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Safety practices of large construction firms.

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Safety Practices of
Large Construction Firms

by

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Abstract

Safety Practices of
Large Construction Firms

by William G. Eich

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This thesis describes a safety study that was conducted on the top 400 (largest in terms of revenue) construction firms of the United States. The objective of this study was to examine construction firm demographics, practices, and various safety policies and determine which variables influence safety performance.

OSHA recordable injuries (those requiring medical treatment) per 200,000 hours of exposure was used as the measure of safety. Results show 26 variables, related to practices and policies, that directly influence the injury rates of large construction companies. Factors that are associated with good safety performance include: establishment of dedicated safety positions, employment substance abuse programs, and safety incentives. All practices found to significantly reduce injury rates are presented. The characteristics and practices found to be typical of large construction firms are also presented.

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Finally, this research would not have been possible without the unselfish and loving support of my spouse Gloria, and the inspirational words of our 18 month old daughter, Selina,..... "Go..Go..Go"!

1. INTRODUCTION

The construction industry continues to be one of the most physically demanding and dangerous industries in the United States. Unlike most occupations, a construction worker is faced with new and different hazards at the onset of each new project and often at the start of each new day. This realization has lead to many efforts in identifying the cause of accidents and their prevention. Safety's omnipresence cannot be taken lightly in the construction industry. Despite a trend that indicates a very gradual improvement in construction safety since 1974 (Hinze 1995) , the National Safety Council (NSC) reported that there were 910 deaths in 1994, a rate of 15 deaths for every 100,000 construction workers. This is nearly four times the national average for all other occupations.

Previous research has covered various aspects of construction safety, but little has been focused on what the industry leaders are doing to curb construction worker injuries. Therefore, it is the purpose of this study is to investigate the current safety practices of large construction firms, analyze them, and determine what makes one company safer than the next.

The law, created by the Occupational Safety and Health Administration (OSHA, 29 CFR 1926), requires employers of construction workers to provide a safe working environment for their employees. Those companies that continue to do the minimum required with respect to safety will probably not survive. Small companies where the owner, superintendent, foreman and lead carpenter are all one in the same person, can likely do fine by following proper safety regulations and maintaining positive job control. Extremely large companies consistently have best safety records, very small firms are less safe, and medium size firms typically have the worst injury rates (BLS 1993, Hinze 1995). When the size of a company is such that thousands of workers are employed and several management layers exist, along with several departments and perhaps regional offices; a firm ordinarily has formalized policies and procedures. A firm's safety department is a subset of this formalized system of operation. Moreover, safety departments for large firms will generally be staffed with

more dedicated safety positions and have access to more resources. A combination of these and many other elements result in more effective safety programs for very large firms. Hence, it follows that small companies with future plans of growth or existing large companies that desire to be successful at preventing injuries must have an aggressive, dynamic and formally structured safety program.

Significant changes have occurred over the past 30 years in the way safety is viewed and how it is approached. The role of management has become increasingly important. Managing a large organization is a complex task. A firm's success is achieved largely though sound decision making. Many management decisions can ultimately impact worker safety. Thus, it is important to include in this study the examination of how the actions (or lack of) and policies of management may influence a firm's safety performance record. Armed with the knowledge resulting from this study, managers and project supervisors should be better prepared to positively influence safety in their organizations.

2. LITERATURE REVIEW

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 the behavioral aspects of construction safety to the elimination of physical hazards. However, very limited research of construction safety 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. A report completed in 1979 by Charles L. Harrison and summarized in a 1981 paper (Hinze and Harrison), involved the surveying of the top (largest in terms of contract value) one-hundred U. S. construction companies. The study established the various features common to typical safety programs for very large construction firms and identified key elements which reduced worker injuries. The Harrison report is significant because it is the only previous study that has investigated the safety programs of large construction firms and, therefore, will be referred to often in this study. One other noteworthy study to mention up front because of its relationship to large construction firms was conducted by Hinze and Raboud (1988). The authors took a slightly different approach by looking specifically at safety practices and experiences on 24 large building construction projects in progress. The projects were located in six major Canadian cities. The Hinze and Raboud study has particular relevance to this study because all the contractors contacted had annual revenues greater than $50 million.

Many research findings on construction safety, including those of the Harrison study, can be viewed from a management perspective. Because management is important, this review will first briefly explore the cause of accidents and management's impact on their occurrence. Next, the importance of worker safety awareness is evident and therefore, will be reviewed. For the purpose of this review, company programs included under the category of safety awareness are: worker orientation, worker recognition and safety training. Then specific company

characteristics that research has shown to affect safety will also be examined. Finally, different elements of corporate policy and their influence on a firm's safety record will be presented. This background provides insight into management and its inter-relationship within an organization, which is fundamental to understanding how a firm can make changes to improve their safety program.

2.1 Accidents and Management's Role

Accidents can be caused by a number of reasons. Distractions from what one is doing may be the primary cause of an accident (Kerr 1957, Hinze 1995). It is easy to comprehend how a worker, distracted from the business at hand, can become the victim of an accident. It is important, however, to realize that distractions can be either mental or physical. Focus on getting the task done expeditiously may be another primary cause for an accident to occur (Hinze 1995). Use of faulty equipment or failure to follow proper procedures may be attributable to an injury. Other, often cited, reasons for the occurrence of an accident are: lack of proper training or supervision, failure to use required protective equipment, improper action by a nearby worker, and lack of awareness of the hazards involved. An underlying cause of every accident may be found by considering management's role. For instance, a worker carrying plywood over uneven ground and wearing tennis shoes severely sprains an ankle. One's first thought might be to blame the individual for not paying attention to where he was walking. However, management having the knowledge that rough terrain is a potential hazard associated with a jobsite, could have eliminated or reduced the hazard in a number of ways. For example, the superintendent could have ensured that even-footed pathways were maintained between material storage areas. Management could also have dictated policy requiring high-top boots to be worn on all construction sites, or better yet, requiring the high-top boots and providing them free to all workers. A related safety study conducted by the Naval Surface Weapons Center (Fine1975), suggests that all accidents can be traced back to management in some fashion. Similar to the links of a chain, a series of events (or links of a chain) must be combined for an accident to occur. Remove one link and the accident is

prevented (Hinze 1995). Management's link to the cause of an accident can be obvious or remote. Another example may help to convey this concept of management being linked to each accident. Consider a worker who was electrocuted while performing interior wiring. Management's part in this example could take many forms. Suppose an investigation revealed the following: (1) the injured party was an apprentice and had never been properly trained for this type of work, (2) the worker had not been indoctrinated in the firm's lockout/tagout procedures, (3) the injury occurred on a Saturday morning and that morning when the worker came to work his foreman smelled alcohol on his breath. The foreman explained his reasons for allowing the person to work regardless, "he is a good worker and friend, besides Joe (the superintendent) often comes to work half sauced", (4) corporate headquarters knew of Joe's drinking problem but "turned a blind eye" to it because he was retiring in a year, and (5) Joe knew they were short on qualified electricians and had requested a week earlier for some additional manpower; his request was denied by the operations manager saying it came straight from the top, "your project is already over budget and you will have to finish with what you already have": So who is responsible in this example. The worker for coming to work intoxicated, the foreman for allowing him to work in his condition or not providing him with proper training and supervision, the superintendent for setting a bad example, the operations manager for not providing the proper resources, the corporate safety director for not covering lockout/tagout procedures during the firm's safety orientation, or top management for placing added budget pressures on the project and not rendering clear guidance that alcohol abuse is not tolerated. Any one of the players could have broken the chain of events leading to this accident and likely prevented it. An additional interesting concept noted in the Navy study was that going beyond simple correction of a potential safety hazard lead to company-wide benefits. By completing the extra steps of investigating and understanding management's involvement in the cause of the hazard or accident, the company was rewarded with improved coordination between departments, increased productivity and the unlikely reoccurrence of similar hazards/accidents.

The involvement of top management has been studied in construction safety. Research has concluded that firms will inevitably be safer places to work given the top executive or owner has a strong concern for safety and communicates this concern to subordinates (Levitt and Samelson 1993). Methods in which top management can express its concern for employee welfare will be seen as a reoccurring theme throughout the remaining areas discussed in this review.

2.2 Safety Awareness, Climate and Culture

The prevailing mindset of employee's feelings about their job can be referred to as the company or work climate. A favorable climate exists when workers generally like coming to work, are happy with their earnings, enjoy working for their boss and with their co-workers and are comfortable with their job security. Having an ideal organizational climate can indirectly result in fewer injuries simply because many potential mental distractions are eliminated. The result of a negative climate on safety is evident in a study conducted on 600 Navy Seabees. Those Seabees found to have low morale (a clear indication of a negative work climate) also had 70% more injuries (Van de Voorde 1991). Similarly, a firm having a favorable safety climate or culture might be one in which workers feel a sense of duty to point out and eliminate hazards, look out for each other, and approach supervisors with innovative and safer procedures to accomplish tasks. Safety "awareness" and "climate" are closely related. An effective awareness program can instill in each employee a serious commitment toward safety. When this is the prevailing condition in an organization, a positive safety climate or "accident-free culture" is said to exist (Hinze 1995, Levitt and Samelson).

The dramatic improvement in safety achieved in less than 2 years for a relatively small ($20 million annual dollar volume) heavy construction firm was the topic of one study. Professor Jim Hinze consulted with this particular firm prior to and throughout its safety culture transformations. The key reason cited for the remarkable turnaround was the president's involvement in changing the entire company's attitude toward safety. This was accomplished through the president's

personal involvement in safety through several actions: appointing himself as chief safety engineer, visiting jobsites more frequently at which safety was the number one issue addressed, continuously emphasizing safety at all supervisory meetings, and personally conducting annual safety sessions (Hinze 1988). The Hinze and Raboud study showed, on large projects, that both top management discussion of safety and holding safety meetings for supervisors positively influenced safety. The two preceding studies demonstrate that the attitudes, behavior and actions of top management and all levels of supervision are key to a proactive stance on safety at the worker level.

There are many methods and practices which a firm and its safety department can employ to enhance awareness. Even observing most OSHA regulations can have an impact on safety awareness. Although many of these rules may not have been written with the intention of promoting awareness, depending on how a company chooses to implement them, they can ultimately lead to a greater safety consciousness. Any regulation that requires precautionary measures can alert an inexperienced worker to potential hazards when the worker makes an effort to comply with the rule. Common examples are: wearing of personal protective gear such as safety goggles and hard-hats (CFR 1926.102 and 1926.100), and placement of barricades and posting of warning signs around open trenches (CFR 1926.651). Other regulations, such as posting of the annual injury log, OSHA No. 200 Form and indoctrinating new workers to job specific hazards (CFR 1926.059) are geared strictly toward promoting better awareness. Certain aspects of communicating and promoting safety awareness have been addressed in past studies and therefore should be briefly reviewed.

Orientation of New Workers

The point when most employees are first introduced to safety is when they are first hired. At this time, safety orientation is normally provided. Research has shown that a high percentage of all construction related accidents occur to workers who have been on the job a short period of time (Levitt and Samelson 1993; Hinze 1990; Van de Voorde 1991) and a formalized safety orientation program is significantly more

effective at preventing injuries than an informal orientation (Hinze and Harrison 1981). A new employee is vulnerable for many reasons. An effective orientation program eases the stress of transitioning to a new job, sets the proper corporate philosophy for safety, and implants in the mind of the worker a lasting memory of the importance of continuous safety vigilance. Formalized orientation assures the training is effective and that every worker is thoroughly indoctrinated (Hinze 1995).

Incentive Programs

Consider the scenario of an average driver. Driving is an inherently dangerous evolution, but the typical driver does not routinely contemplate the risks of driving. Perhaps if the driver had recently witnessed a serious accident or had small children as passengers, the driver might for a certain amount of time be a more cautious driver. Now change the scenario, your car insurance company sets a new policy and notifies you that you are fully covered, yet are required to pay zero premiums until your first accident. Would you be a safer driver? This example illustrates the principle in which an effective safety incentive program might be responsible for fewer injuries. Regarding the example again, you receive a monthly bill from your insurance company, which when opened states in bright print, "You owe nothing! Thanks for being a safe driver". An effective incentive program can be a constant reminder of the importance of safety.

The giving of awards for safe performance to enhance safety awareness was a fairly common practice among large companies in 1979 (Hinze and Harrison). In that study the number of personnel receiving awards broke out into the following percentages: workers 48%, foremen 60%, superintendents 71% and safety personnel 27%. The findings, though not particularly strong, did indicate that incentives may improve safety performances when given to foremen and superintendents. Other studies have also shown controversial results.

Raymond Levitt and Nancy Samelson state that their research has revealed that incentive programs, by themselves, make relatively little difference on whether or not a firm is safe. The main reason given for their ineffectiveness is that "accidents to

individual workers are rare events". Even a relatively unsafe worker is awarded frequently and therefore, the incentive losses its value.

Another possible reason for the inconclusive statistical findings is that the incentive systems used by firms vary extensively. "An incentive is not appropriate unless it (1) reinforces good behavior and (2) alters poor behavior" (Hinze 1995). Thus, one firm's program may be effective while the next is actually counterproductive. A specific drawback that firms electing to use incentives must be wary of, is with awards of particularly high value, as workers may try to hide minor injuries so as to not jeopardize their chances or their supervisor's chances of receiving the award (Hinze 1995; Levitt and Samelson 1993). A recent study generally showed that contractors who have used incentives for a longer period of time had fewer injuries (Piepho 1993). Two plausible reasons may explain this outcome. The first explanation would tend to support incentives as a valuable tool in that, the firms with longer established programs have had a chance to experiment and refine their system to one that works for them. The second explanation of this outcome is that it is simply an indication that these firms have had and maintained safety itself as a top priority for a longer period of time. This assessment would tend to support Levitt's position and nullify the merit of safety incentive programs.

Safety Training

An obvious factor necessary to achieve a high degree of safety awareness is training. One form of training routinely performed throughout the construction industry is referred to as "toolbox meetings". These are brief meetings used to disseminate safety information, review lessons learned from previous incidents and train workers on the various hazards associated with upcoming work (Hinze 1995; Levitt and Samelson 1993). More than 90% of large construction companies hold safety toolbox meetings on a weekly basis (Harrison 1979). Their use was found to have a general positive effect ($p < 0.046$) on reducing injuries. The Harrison study also showed that safety personnel of large firms are well trained and a positive influence on safety was noted when the field safety directors trained their subordinate workers.

Other Aspects of Safety Awareness

Safety dinners have been a common method in the past to promote safety awareness. In the Harrison study, 44% of the responding companies held safety dinners. Of this, in only half of the firms did the president attend the award dinners. This function is an ideal opportunity to review the firm's progress in safety, articulate new goals and recognize individuals and crews that have surpassed established safety goals. If the company president is in attendance and makes award presentations etc., then not only is awareness heightened but a clear message, "safety is of critical importance", is communicated to all employees. On the other hand, if the president does not attend, then message received might be "safety is not important enough that....". The Harrison study did not indicate whether the president's attendance correlated to fewer injuries, therefore it is assumed not to have resulted in any significance.

2.3 Company Demographics

Company Size

In general, as a firm increases in size, unfortunately so does the injury rate. Naturally, as a company grows larger difficulties arise in maintaining effective job control due to the greater number of workers and projects involved. This was examined in a study conducted by Hinze and Maxwell (1987). However, this holds true only to a certain point. The Bureau of Labor Statistics (1993) (Hinze 1995) reported that the frequency of nonfatal injuries steadily decreases as the number of employees per company exceeds the range of 100-150 employees. Thus, very large companies (greater than 500 employees) have even better safety records than companies with less than 20 workers. This phenomenon is consistent with other past studies (Hinze and Harrison, Hinze and Raboud). Isolating and capitalizing on what makes this surprising fact true is a specific goal of this research.

Organizational Structure

An effective company organizational structure establishes clear lines of authority and can lead to improved communication. Therefore, it would be expected that different organizational arrangements could influence the effectiveness of a firm's safety program. Two studies of contractors from the northwest region of the United States firmly concluded that firms with a fewer number of management layers between field workers and the company president had a lower injury rate. Additionally, it was shown that fewer workers per foreman resulted in better safety record (Piepho, Hinze and Maxwell, Reed and Hinze).

In the Harrison study, 86% of the companies responding had full-time safety directors who generally reported to the firm president (13%) or vice-president (45%). The top safety position reporting directly to the highest levels of the corporation sends a clear signal to everyone about the importance of safety and empowers the position with greater authority. Thus, it would be speculated that a firm with such an arrangement would have fewer job related injuries. The results of the Harrison study did convey this trend, with a 10% level of significance or probability that the data received could have evolved purely by chance (probabilities < 5% are considered statistically significant). Another way of saying this is that there is a 90% chance that a relationship exists between the number of injuries and whether or not the safety director reports to top management. Additionally, it was shown that firms which assigned a full-time field safety representative to smaller jobs (300 or less workers) had better safety records than those firms which elected to employ a field safety representative only on relatively larger (greater than 300 workers) projects (Harrison).

2.4 Corporate Policy

Substance Abuse

Many policies established by management are created specifically with the forethought of providing an accident free environment for their workers. A prime

example of this is substance abuse testing. First implemented on a large scale by the military in the late 1970's, acceptance and use by the private sector is not uncommon today. A master's thesis involving 152 large construction contractors in Florida found that about 40% of the firms conducted pre-employment and post accident drug testing (Hill). In the study many reasons were cited by the contractors for having a drug testing program but the top response given was job safety. In 1992, another study conducted by Coble, also in Florida, found the percentage of firms having drug testing was higher than found by the Hill study, at 60%, for larger companies (greater than 100 employees) (Hinze 1995). There has been no notable studies resulting in significant findings that drug and alcohol testing reduces the incident rate in the construction industry. However, the realization that workers under the influence of alcohol or drugs are a danger to themselves as well as their fellow workers is hardly disputable. A survey receiving 227 responses from construction firms in the northwestern region found 70 firms tested their craft workers and 58 firms tested office employees but no significant correlations existed when compared with injury frequencies (Piepho).

How a firm chooses to deal with a drug or alcohol abuser may impact not only the firm's safety position but it could also effect the moral and welfare of employees. It is suggested that those caught, and especially those voluntarily requesting assistance, should be afforded the opportunity to enter a rehabilitation program (Hinze 1986). Some companies which view substance abuse as an illness have set up employee assistance programs (EAP) to aid and counsel the worker through the rehabilitation process. A full EAP will generally only be found in larger firms (Hinze 1995). Little research has been conducted in the area of treatment of substance abusers verses incident rates.

Other Policies

The importance of some policies surrounding the safety positions of a firm are evident in the Harrison study. A firm where the corporate safety director hires the field safety directors is safer (Hinze and Harrison). This hiring arrangement was the case for 72% of the firms responding. Also noted as important in the study was

ensuring field safety representatives train their subordinate workers (level of significance 0.02).

Does the project safety budget come from centrally managed dollars or is it part of the project expenses? A superintendent whom is at ease about requesting additional funds from the home office to cover safety related items, works for a company whose policy creates an opportunity for a safer climate than a superintendent trying the project on budget and wondering if additional personal protective gear should be purchased on the jobsite budget.

Countless management decisions are made daily which unknowingly may affect safety. Research has indicated that contracting for public works projects (mostly competitive bid) can lead to higher injury rates (Reed and Hinze).

A policy which ensures corporate officials make frequent job site visits has been shown to result in fewer injuries (Hinze and Pannullo, Hinze 1976, Harrison). It can be assumed that frequent contact by the home office will ensure field personnel have and the higher level support needed to resolve problems quickly (Hinze 1995). This is another example of how top management can influence worker behavior.

3. RESEARCH METHODOLOGY

The primary purpose of this study was to identify the factors that affect the safety performances of large construction companies. Since the objectives were similar, it affords an excellent opportunity to update and build upon the results obtained by the similar study performed in 1978, by Charles L. Harrison. Recognizing that the larger firms generally set the standard for any industry, this study could confirm if the earlier discoveries found to improve safety are still valid today. In addition, many earlier findings indicated only slightly better safety records were achieved with respect to specific aspects of a firm's safety program. Therefore, expanding the Harrison study might result in more conclusive results, and identify new approaches that will likely propagate the trends of tomorrow.

3.1 Data Collection

Because of the nature of this study, a mailed survey was considered the most appropriate method of data collection. The survey population was determined by selecting the top 400 construction firms listed in the Tenth Edition (1993-1994) of Engineering News Record (ENR). All firms on the list were reported by ENR to have total new contract values (based on 1992 data) in excess of $48 million per year.

Initially, the survey was sent to only 50 of the 400 companies in an endeavor to receive feedback on the clarity and answerability of questions in the questionnaire. Another purpose of the pilot study was to determine if an acceptable response rate could be anticipated. A response rate was anticipated to fluctuate by the time of year in which the surveys were mailed. Therefore, the first 50 surveys were mailed January 30, 1996, well past the holiday season yet before the typical peak months of construction. The response rate data for the trial study three weeks after mailing is shown in Table 1. An acceptable response rate of 29% was obtained. Based on a review of the answers received from these initial responses, the survey questions generally were deemed satisfactory but there were a few exceptions. Modifications to a few questions were made to clarify them or to ensure that more usable answers were received. Answers were also examined for diversification. Since all respondents gave

Table 1
Trial Study Response Data

Number Mailed	Number of Responses Received	Number Returned to Sender (Not Delivered)	Number Responding that Declined to Provide Injury Data
50	14	2	1

the same answer to some questions, these were deleted since they would not provide any useful information.

Once the questionnaire was finalized, the remaining surveys were mailed on February 25, 1996. A total of 141 completed surveys were received. Of the initial 400 firms, addresses for 25 firms were not listed in the ENR publication. Other means were used to find addresses for 11 of the missing 25, leaving a sampling population of 386. Of the 386 surveys mailed out, 16 were returned as undeliverable. New addresses were found for 3 of the 16 surveys which had been "returned to sender" and these were subsequently re-mailed. Thus, 373 (actual population) surveys were delivered and had a chance of being returned completed. The response rate achieved was 38% (141÷373). The final response rate data is shown in Table 2.

Table 2
Total Study Response Data

Number Mailed	Number Returned to Sender	Number Re-mailed	Final Population	Number of Responses
386	16	3	373	141

3.2 Survey Format

Often low response rates to mailed surveys are prohibitive to effective data collection; therefore, the survey was designed to be easily completed. It consisted of 38 questions (some with subparts), a majority of which could be answered by simply checking an appropriate box, 2 questions asked for descriptive responses and the remaining required filling in blanks with mostly numerical data. A copy of the survey, entitled "Safety Survey of Large Construction Firms" can be found in Appendix A. The one page cover letter that accompanied the survey is shown in Appendix B.

Since one objective of this study was to compare the results of this study to the Harrison study, of 17 years ago, many of the Harrison survey questions were repeated. Some of the questions from the Harrison study that are no longer applicable or which resulted in little useful information were excluded. There are four main areas covered by the questions in the survey. The initial part of the survey was designed to establish a firm's corporate safety structure. A second area of the survey dealt with safety awareness and training. Different practices asked about in this section included: new employee orientation, safety dinners, toolbox meetings and supervisory training. Safety incentives and substance abuse testing were two main programs investigated by the third area of questions which centered around corporate policy. The last area requested company statistical information such as: dollar volume, number of employees, number of injury cases, experience modification rating and number of hours worked by field employees. A noteworthy difference between this and the Harrison study is that the past three years of injury frequency data was requested whereas the Harrison study requested data for only a single year. Three years of a firm's injury data can be used to establish individual company trends. Also, more importantly, average injury rates can be established for firms, thereby, reducing the chances of an unusually high or low injury rate for the most recent year which might bias the results. This is perhaps a vital flaw not only in the Harrison study, but in all similar studies mentioned in the literature review. Another significant correlation that can be examined by having three years of data is whether or not safety records have suffered for those companies experiencing a notable amount of growth. This final section of company data provided an alternate means to measure a firm's size and safety performance. It should be noted that an effort was made before mailing the surveys, to insure that each firm could be analyzed by size. This was accomplished by setting five pre-established revenue categories. Based on the revenue data provided in the ENR magazine, each survey was coded so that the size category was known even if the respondent failed to provide revenue information for their firm.

A combination of questions attempted to assess the existing degree of safety culture present in a firm by determining which companies had top managers proactive

in safety and which companies had practices that went beyond traditional expectancies. For example, one question (number 16) asked if safety was mentioned in the firm's mission statement. If a firm answered "yes" to this question they were assumed to be communicating safety as being of equal importance with profit and productivity. This may be a small step toward creating an "accident free" safety culture. Other questions (2, 6E, 6F, 8, 11, 15, 16, 20A, 22, 23, 32, 33, 34A, 35, and 38) were also assumed to be measures of safety culture.

One new area, not addressed in the Harrison study, was substance abuse testing. One type of drug testing might be more effective than another, therefore, the respondents were requested to indicate the type of testing performed, such as pre-employment, random, etc. Other questions asked about substance abuse testing were: what are the consequences of failing a drug test and what is the typical company policy regarding rehabilitation? Identifying trends in the construction industry was the objective in asking the year each firm's testing program was established and the percentage of positive pre-employment test results encountered.

In recent years safety in general has received considerable publicity. Much of the attention has centered on injured parties receiving huge monetary awards through lawsuits. In construction, workers' compensation provides a swift and sure means of recovery for an injured worker and limits an employee's right to sue the employer. However, every construction firm is still faced with potential lawsuits via third party claims, such as a subcontractor worker suing the general contractor. Another method for a worker to circumvent worker compensation rules and possibly recover large monetary damages from an employer is via tort law. These types of claims have proliferated in the construction industry (Sweet 1994). This being the case, question #37 was included in the survey to assess the recent trend large contractors have experienced with respect to the number of litigation cases resulting from safety related incidents.

Since the effectiveness of incentive programs is debatable, several questions explored this area in more depth. The survey attempted to investigate: who received awards, how often awards were given, and the value of awards given to

superintendents (if applicable). Since the size of budget allocated toward a safety incentive program could be an indication of its effectiveness, respondents were asked to report their approximate budget for incentives by one of two means, in percent of field labor cost or in percent of total contract cost. Both measures could result in useful data, making it unnecessary to take into account the relative size of each company. Additionally, respondents were asked to indicate the basis for their firm's award system, such as: are awards based on safe project completion, are awards progressive in nature, and are awards based on achieving a prescribed level of safety. Finally, a subject related to safety incentives, is whether or not a firm tolerates unsafe behavior. The answer to this question was sought by asking the respondents if sanctions (verbal or written) for unsafe behavior were imposed.

As an incentive for the respondents to complete and return the survey, the respondents were requested to indicate if they desired a summary of the findings from this study. The contractors who wanted a copy of the summary report, simply completed the blanks provided for name, job title, company, and mailing address. Companies electing to complete this information were assured that their responses would remain confidential.

3.3 Data Analysis

A statistical program called Statistical Package for the Social Services (SPSS/PC+), was selected to analyze the data. It facilitates extensive flexibility and data manipulation. Two files were created to code the survey information for analysis. They are the "data definition file" and the "data file". The data definition file creates a list of variables, called a "data list", that corresponds to each variable on the survey. The data list also tells which column(s) each variable occupies. Some questions required multiple variables, such as: To whom are safety awards given? Six possible responses were listed on the survey. The respondent was asked to check all that apply. In this example, a separate variable was created for each type of awardee (worker, foremen, superintendent, etc.) in order to preserve the full information from each respondent's answers. Since a variable can only consist of 8 characters, it was

necessary to describe the variables in more detail through the use "variable labels". Also included in the definition file is a means to assign a numerical code to each of the possible answers to all questions. This coding system is called "value labels". A copy of the data definition file, entitled "eich.def", can be found in Appendix C. The second file created contains only numerical data which was entered directly from the surveys or converted to numbers first through the use of value labels. This data file entitled "eich.dat" can be found in Appendix D.

An example of the coding system will help clarify how the numerical data matrix is formed. For a "yes or no" question, value labels were assigned as follows: "1" for a yes response, "2" for a no response, "8" for not applicable, and "9" indicated the question was left blank. In cases where the respondent failed to answer a questionnaire item, a "missing value" must be assigned. The missing value command allows the computer to recognize the data as missing and will not include the value in any computations, such as an average for the variable (Frude 1987).

After establishing the definition file, and reducing the responses of each survey to a numerical matrix, the analysis could begin. Frequencies were first computed for each of the variables. This was used to determine that the data was not normally distributed and to establish that no obvious errors were made in the data entry. Non-parametric testing was chosen to be the appropriate method of analysis. Since both the injury rate and the experience modification rates (EMR) are measures of safety, they were both intended to be used as the dependent variables. In the SPSS program the specific coefficient used was the Kendall's Correlation Coefficient.

Kendall's Correlation test measures the strength of the linear relationship between two variables. The range of the correlation coefficient is restricted to the interval between -1.0 and +1.0. Values approaching +1.0 indicate a strong positive linear relationship, the value -1.0 means a perfect negative linear relationship, and a value of zero would show no relationship between the two variables (Kliemele and Schmidt 1991). Kendall's Correlation test also produces a statistical level of significance (p) associated with each comparison. The level of significance (p) is an inferential statistic which allows one to draw conclusions about whether or not an

association between two variables can simply be attributable to chance (Frude 1987). Thus, the p-value is simply a probability indicating the likelihood the relationship between the variables compared could occur by chance. As the p-value approaches zero, the probability becomes less likely that a particular result would occur randomly when no true relationship existed between the two variables. For example, if the level of significance is 0.1% (0.001), then there is probability of 1 in 1000 that this finding occurred by chance (Piepho 1993). If the variables being compared for this example were injury rates verses whether or not a firm holds safety dinners, then it might be concluded that there is a 99.9% certainty that a firm which holds safety dinners would have a lower injury rate than one that does not. For this study, a level of significance of 5% (0.05) or less was considered statistically significant. In this paper the word "significant" will mean statistically significant. A probability of less than 10% (0.10) is sufficient to conclude that there may be a tendency toward statistical significance between two variables. All significant correlations, as well as those with $p < 0.10$ are disclosed.

The first correlation test computed values for all of the respondents against the 1995 injury rate as the measure of safety. Another test checked each variable verses the 1995 injury rate for only the top 100 largest firms. Restricting the number of firms to only those in the top 25% of the sample population was done in order to make a direct comparison with the Harrison study. The data was also sorted by several variables to test for correlations of particular interest. Some of the other sort variations that were correlated included:

Annual Volume < $100 million
Annual Volume $100 - $250 million
Annual Volume $250 - $500 million
Annual Volume $500 - $1 billion
Annual Volume > $1billion
Only Firms heavily involved in Public Type Work
Only Firms that have a Drug Testing Program

Additionally, all variables for the entire sample were correlated against two other dependent variables: (1) the average injury rate and (2) rate of improvement for past three years of injury rates.

4. RESULTS

4.1 Summary of Company Characteristics and Safety Practices

Company Size Characteristics

There were 141 firms that responded to the survey. Several size characteristics resulted from this study. The first, which is often used to classify the size of any business is revenue. The mean annual revenue was $462 million. Even though the surveys were sent to the 400 largest U. S. construction companies, the relative size of the firms varied significantly. For example, the annual dollar volume of the sample ranged from $20 million to $10 billion. Because of this large variance in company size, five size categories were established to ease in the understanding and analysis of the data. The first category consisted of those firms with an annual dollar volume less than $100,000,000. Thirty-eight of the firms that responded fell into this first category, which had a mean annual revenue of $64 million dollars. The second category consisted of annual dollar volumes from $100,000,000 to $250,000,000, which contained 54 firms. The third category had annual volumes from $250,000,000 to $500,000,000 and was comprised of 22 respondents. The next category contained 13 firms and had annual dollar volumes from $500,00,000 to $1 billion. The fifth and final category contained the 14 largest firms, all having annual volumes greater than $1 billion. The average dollar volume for the fifth category was almost three billion dollars. The sum of the top three size categories (those firms with annual dollar volumes greater than $250 million) equates to 35% (about one-third) of the responding firms. The results of this study for many of the responses are given for the five size categories as well as the totals for the entire sample. This is done simultaneously so that clear distinctions can be made when a variable is influenced by size.

Three other company characteristics reported which are indicative of a firm's size are the number of field workers employed, number of jobs in progress, and number of field worker-hours worked. Over 50% of the firms reported that they had 300 or less field employees. The total average number of field employees was about

1400. The average number of field employees for each of the five size categories were 210, 302, 1137, 2376 and 8977, respectively. Notable about the aforementioned figures, is a large increase in the number of field workers hired by firms with revenues greater than $250 million. It is also important to note that 5% of the firms had fewer than 25 field employees and one firm in the largest size category reported having only 100 field employees. Thus, some firms have a small field employee-to-revenue ratio which would indicate that either a large portion of work is subcontracted or much of the revenue is earned through management services. The typical number of projects in progress ranged from 5 to 700. As would be expected, the average number of projects for each size category increases as revenue increases, with a total sample mean of 59 jobs under construction. The final size variable requested was the number of field worker-hours worked in 1995, 1994 and 1993. An average of 450,000 worker-hours were worked in 1995 by firms in the smallest size category and about 12,350,000 for firms in the largest category. The average worker-hours worked remained relatively constant from 1993 to 1995 for all size categories except for the largest firms (category 5) which showed a thirty percent decrease from 1994 to 1995. A summary of company size characteristics are shown in Table 3.

A company characteristic unrelated to size is the percentage of the firm's revenue generated by private owners verses the various public sectors. Approximately 15% of the responding firms (twenty-two of the 141 respondents did not complete this section of the questionnaire) performed only private projects. Only 3 firms worked strictly for public sector owners. One firm earned as much as 90% of its revenue from federal projects, another had 95% of its revenue funded through state agencies and 5% of the responding firms obtained half of their revenue from the local public sector. A breakdown of the mean percentages of work from the various sectors is as follows: 54% private, 16% local public, 16% state, 12% federal and less than 2% for foreign clients (see Figure 1). Except for the fact that the largest size category derived 14% of its work from foreign sources, the percentages of work for each sector type by size category were roughly equivalent (± 5%) to the sample mean values.

Table 3

Size Characteristics of Large Construction Companies by Dollar Volume

	FIRM REVENUE (in millions of dollars)					
	< 100	**101 - 249**	**250 - 499**	**500 - 999**	**> 1000**	**Total**
No. of respondents	38	54	22	13	14	141
Annual dollar vol (millions)	64	135	315	689	2827	462
No. of field employees	210	302	1137	2376	8977	1408
No. of jobs in progress	25	28	45	98	267	59
Field man-hrs worked 1995	453,319	815,285	3,122,404	4,274,156	12,349,345	2,697,673
Field man-hrs worked 1994	459,462	689,828	2,754,946	4,260,649	17,742,648	3,211,484
Field man-hrs worked 1993	448,530	700,372	2,623,246	3,396,730	17,792,421	3,109,168

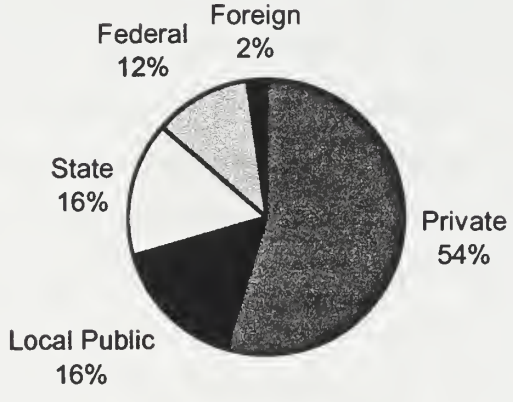

FIGURE 1: Percentage of Revenue Earned from Different Types of Owners

Corporate Safety Structure

One consistent fact found with respect to the corporate safety structure of the responding firms was that most (89%) had a full-time safety director at the corporate level. All firms greater than $500 million had corporate safety directors while about 85% of the firms smaller than $250 million indicated this was the case. A few firms indicated they had a safety consultant on retainer instead of staffing a safety position full-time. The number of full-time field safety representatives varied considerably with size; firms having less than $250 million in revenue averaged less than three while those in the largest size category averaged more than 100. The highest number of full-time field safety employees reported was 386 and 27 firms stated they had none.

The field safety directors reported to the corporate safety director[1] for about 50% of the firms. This variable was influenced by size because it was higher (62%) for firms in the two smallest size categories and only 39% for firms in the two largest firm categories. This somewhat lower percentage might be explained by the fact that the management structure for the largest firms typically included regional offices and therefore, it would be reasonable for field safety representatives to report directly to regional construction managers in such cases. Some firms dictated that field safety representatives report directly to project superintendents (21%) or project managers (8%); while other firms had a dual chain of authority. A dual chain of authority is one where the field directors report to both the project supervisor and the corporate safety director or with a dotted line to the corporate safety director. This dual type of organizational structure for the field safety representatives occurred in 12% of the responding firms. Figure 2 summarizes to whom the field safety directors typically report. Regardless of who the field safety personnel reported to, all had authority to stop the work. The corporate safety director hired field safety directors for 58% of the firms. This percentage was influenced somewhat by size, increasing from 42% for the smallest firms to 79% for the largest firms. The factor listed most often by firms

[1] Note for analysis purposes, if a firm indicated that field safety representatives reported to regional safety directors, these cases were categorized as reporting to the corporate safety director.

when deciding if a full-time field safety representative should be assigned to a job was "project size" (58%)[2]. The next most often stated criteria was "when required by the owner/contract" (46%). Eleven percent of the companies indicated that the only time a full-time field safety director was assigned to a job was when required by the contract. Additional criteria used to decide whether or not to assign a full-time safety director are "project scope and complexity" (30%) and "potential hazard" (20%).

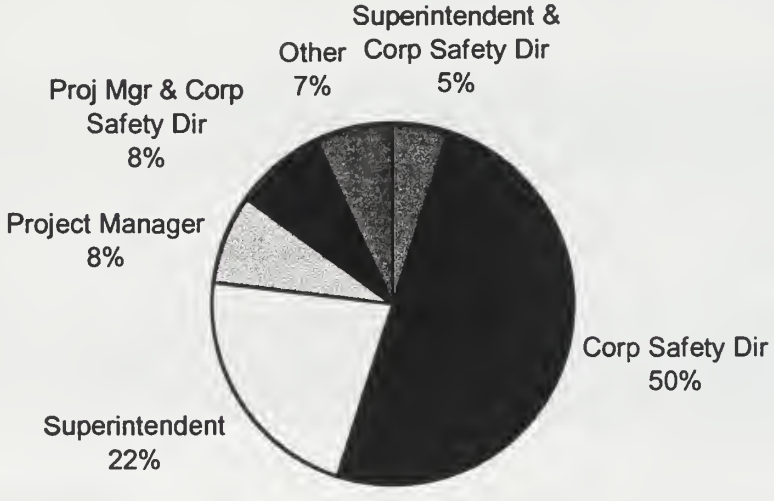

FIGURE 2: To Whom The Field Safety Director Typically Reports

Some firms added an additional layer to their safety structure by staffing a full-time first aid position (nurse, EMT, etc.) on all jobs (about 10%). This practice was rare though, because almost 80% of the firms stated they had no jobs where a full-time first aid person was currently assigned. A breakdown of corporate safety structure characteristics by firm size is shown in Table 4.

[2] Note many firms listed more than one criteria for when to assign a full-time field safety person to a job

Table 4
Corporate Safety Structure Variables
of Large Construction Companies by Dollar Volume

CORP SAFETY ITEM	FIRM REVENUE (in millions of dollars)					TOTAL or
	< 100	101 - 249	250 - 499	500 - 999	> 1000	Total Avg.
Number of respondents	38	54	22	13	14	141
Number of field safety reps	< 3	< 3	11	22	102	15
Firms having safety position at corporate level	32 (84%)	46 (85%)	21 (96%)	13 (100%)	14 (100%)	126 (89%)
Corporate safety director hires field safety reps	16 (42%)	30 (56%)	14 (74%)	9 (69%)	11 (79%)	80 (58%)
Field safety rep reports to corp safety director	16 (62%)	24 (55%)	15 (75%)	5 (47%)	5 (36%)	65 (48%)

Safety Incentives

A majority of the responding companies have formal safety incentive programs (82%). Seventy-six percent of the firms smaller than $250 million use incentives while this percentage is more than 90% for the remaining larger companies. Incentive awards are given more often to superintendents (72%), workers (70%) and foremen (66%) then project mangers (40%) and safety personnel (33%). Firm size does not appear to be a consistent determining factor with respect to the recipients of the awards. However, a general trend indicates that an employee who works for a firm with revenues exceeding $250 million is more likely to receive a safety award. This is especially true for project mangers and safety personnel. A small percentage (9%) of firms indicated safety incentives are given to employees other than those listed above, such as: clerks, various departmental personnel or subcontractors. Six companies stated all employees participate in their awards program. Worker awards are given to individuals with safe records by 21% of the firms while only 15% the firms give each

individual in a crew a safety award only if the entire crew performs safely. More firms (42%) elect to give awards for both safe individual and crew performance. The decision to give awards based on individual or crew performance is not a function of firm size, however, the percentage of firms giving awards for both crew and individual safe performance increases with each larger size category.

The frequency at which awards are given and their relative value may be key factors to an effective incentive program. The two most common (about 20%) frequencies for giving awards to individual workers is either monthly or quarterly. About 15% give individual worker awards annually. Five percent of the firms stated they gave worker awards every week. Approximately five percent reported they gave worker awards for each of the following combination frequencies: monthly and quarterly, monthly and annually, and quarterly and annually. Annually is clearly the prominent period for which superintendent awards are given (49%). Another 15% of superintendent awards are given quarterly, 8% monthly, 8% quarterly and annually, 4% monthly and annually, 2% semi-annually, and 14 % other (such as at project completion). For illustrations of how often workers and superintendents receive awards refer to Figures 3 and 4. The potential amount of the safety bonus that firms are willing to pay superintendents on an annual basis in terms of one month's salary ranged from less than 1% to 1000%. About 35% of the firms allowed a potential superintendent safety bonus of 10% or less of one month's salary while an entire month's salary or more was the potential incentive afforded for superintendents by 22% of the firms[3]. The amount of the bonuses varied randomly when firm size was considered.

The amount of budget allocated for safety awards and incentives was reported by two methods, percent of field labor cost and percent of total contract cost. The first, given in percent of field labor cost[4], had a mean of 2.8%; the second had a mean of 0.80% based on percent of total contract cost[5]. Both budget allocation variables

[3] Note analysis based on 41 responses.
[4] Analysis based on only 30 responses.
[5] Analysis based on only 24 responses.

smallest to largest, the 1995 injury rates were 9.48, 9.09, 4.91, 7.65, and 4.07. From these rates, it can be seen that the number of injuries generally dropped sharply as firms increase in size. The only exception to this was the 7.65 incident rate in the fourth largest size category. A closer examination of the data might suggest that this mean value is a somewhat inflated. Specifically, there were only 13 firms total in this size category of between $500 million and $1 billion; and one of the 13 firms had an incident rate of greater than 19 which was twice as high as the next high rate among the firms.

The lost-time and restricted injury activity rates was also complied. The lost-time injury rate showed very similar trends as the OSHA recordable rates with respect to size category and improvement rate from 1993 to 1995. The restricted activity injury rates were less consistent.

Near misses were also stated as being documented by more 68% of the firms. However, their numbers were not consistently tracked, at least at the home office, by most firms. This was evidenced by the fact that only 48% elected to state how many near misses occurred in 1995. The number of the of near misses reported varied widely from 0 to 1853, with a median value of about 10. Excluding company size, four possible reasons for the occurrence of such a large variation and low median value are: (1) the definition of what constitutes a near miss may vary from firm to firm or even from worker to worker (2) many workers may not bother to stop work and report a close call because no one was actually hurt, (3) many firms do not emphasize the importance of reporting near misses and (4) depending on the safety climate of a firm, a worker might not be inclined to report a near miss out of fear of retribution. The fourth reason would be especially true if the worker felt that his/her unsafe performance contributed to the near miss.

Finally, the mean experience modification rates showed a similar improvement trend as with injury rates, improving or declining by 0.10 from 1993 to 1995. The mean EMR for 1995 was 0.74, ranging from a low of 0.31 to a high of 1.16. Less than 4% of the firms had an 1995 EMR greater than 1.00. The EMR rates tended to

were fairly consistent with the mean values regardless of firm size as can be seen in Part II of Table 5.

Several firms (about 65%) indicated that various elements were key to their safety incentive program. Awards based on safe completion of a project was checked as an integral part of a firm's incentive program for 45% of the firms and 35% used at least in part, incentives of a progressive nature. Twenty percent reported the use of lottery type drawings where only safe crews or individuals are potential winners. An essential incentive program element for about half of the firms is awarding those that achieve preset safety performance criteria such as no lost time injuries for one month or achieving an injury rate below a prescribed level for a specified duration of time. All of the firms in the fifth or largest size category impose sanctions for unsafe behavior while the mean for the entire sample is 74%. A summary of safety incentive program elements is shown in Table 5 (Parts I & II). The separate percentages of firms giving awards to various employees by firm size are included in Table 5.

Substance Abuse Program

A high percentage (89%) of responding firms have a substance abuse testing program. Prior to 1990,this figure would have been much lower because 51% of the firms indicated they established a testing program after 1990. The earliest a firm started drug testing was in 1980, while about 17% implemented their program within the past two years (1994, 1995, or first 2 months of 1996). The data indicates the biggest firms were generally the leaders in testing implementation with an average start year of 1989, with firms in the smallest category commencing a few years later around 1992. All firms with revenues of $500 million or more, have implemented drug testing. Additionally, in all firms of this size, pre-hire drug testing is a part of their program. The most popular types of testing are "pre-employment screening", "post accident" testing, and testing for "reasonable cause"; all of which were performed by about 75% of the respondents. Follow-up (39%) and blanket (11%) testing were the least common forms of testing. The average percent of job applicants who failed drug testing was 5%, with a range of 0 to 30%. One firm stated that their experience was that the number of positive tests for those screened as a condition of employment

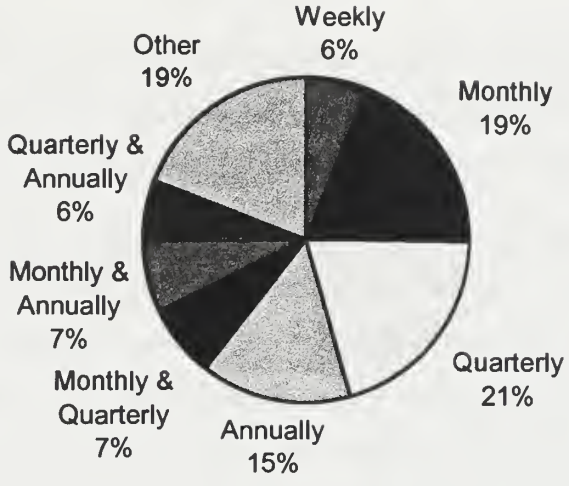

FIGURE 3: How Often Firms Give Safety Awards to Individual Workers?

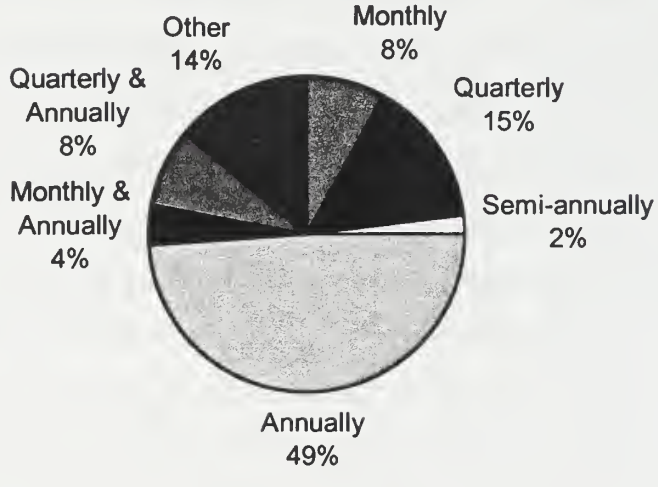

FIGURE 4: How Often Firms Give Safety Awards to Superintendents?

were fairly consistent with the mean values regardless of firm size as can be seen in Part II of Table 5.

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Table 5 (Part I)

Safety Incentive Program Elements by Dollar Volume

INCENTIVE ELEMENTS	FIRM REVENUE (in millions of dollars)					TOTAL AVG
	< 100	101 - 249	250 - 499	500 - 999	> 1000	
Number of respondents	38	54	22	13	14	141
Firms with Incentive Program	29 (76%)	41 (76%)	20 (91%)	12 (92%)	13 (93%)	115 (82%)
Workers given awards	24 (63%)	33 (61%)	17 (81%)	12 (92%)	11 (79%)	97 (70%)
Foremen given awards	24 (63%)	32 (60%)	17 (81%)	11 (85%)	8 (61%)	91 (66%)
Superintendent given awards	27 (71%)	35 (65%)	18 (86%)	11 (85%)	9 (69%)	100 (72%)
Project Manager given awards	9 (24%)	18 (33%)	11 (52%)	9 (69%)	9 (64%)	56 (40%)
Safety Personnel given awards	12 (32%)	9 (17%)	10 (48%)	7 (54%)	8 (62%)	46 (33%)
Worker award to safe individuals	12 (32%)	10 (19%)	3 (15%)	3 (25%)	1 (8%)	29 (21%)
Worker award only to safe crews	4 (11%)	11 (20%)	3 (15%)	1 (8%)	2 (15%)	21 (15%)
Worker award given to both safe individual & crew	9 (24%)	19 (35%)	12 (67%)	8 (62%)	10 (71%)	58 (42%)
Use progressive type incentives	9 (31%)	15 (38%)	12 (60%)	6 (46%)	7 (58%)	49 (35%)
Use lottery type incentives	8 (27%)	9 (23%)	5 (25%)	2 (15%)	4 (31%)	28 (20%)
Incentives awarded at project completion	13 (45%)	21 (51%)	12 (60%)	6 (46%)	10 (77%)	62 (45%)
Award based on achieving min goal	17 (59%)	21 (50%)	11 (55%)	11 (85%)	11 (85%)	71 (51%)
Sanctions imposed for unsafe acts	21 (67%)	32 (74%)	13 (65%)	9 (75%)	13 (100%)	88 (74%)

Table 5 (Part II)
Safety Incentive Program Elements by Dollar Volume

INCENTIVE ELEMENTS	FIRM REVENUE (in millions of dollars)					TOTAL (AVG)
	< 100	101 - 249	250 - 499	500 - 999	> 1000	
Safety bonus for sups (in % of monthly salary)	40%	78%	29%	213%[6]	35%	77%
Budget allocation for awards in % of total contract cost	0.04%	1.02%	0.82%	0.80%	0.85%	0.80%
Budget allocation for awards in % of field labor cost	3.0%	3.0%	3.0%	1.7%	3.0%	2.8%

varied by state, citing as extreme examples Florida and Missouri with 3% and 28%, respectively.

Regarding an employee who fails a drug test, company policies were not consistent. Fifty-one percent stated that termination was the result of a first offense and in 20% of the firms repeat failure caused loss of employment. Suspension was the penalty for first-time drug abusers in 14% of the companies. The number of days of suspension varied from 5 to 180 days, with 30 days occurring in more than half the firms. Many firms recommended treatment but not at company expense (35%), while somewhat fewer firms actually offered to cover the expense of treatment (20%). Only 4% indicated that treatment was not considered part of their substance abuse program. Table 6 summarizes substance abuse program elements for firms of varying sizes.

Safety Training and Awareness

Many of the safety training and awareness practices in question were fairly consistent. Every respondent stated safety personnel were trained in first aid. Also, all

[6] One firm responding had a potential bonus of > 1000%. With the inclusion of this value, the safety bonus is 213% of the monthly salary.

Table 6
Substance Abuse Program Elements by Firm Size

PROGRAM ELEMENTS	FIRM REVENUE (in millions of dollars)					TOTAL (AVG)
	< 100	101 - 249	250 - 499	500 - 999	> 1000	
No. of respondents	38	54	22	13	14	141
Firms with Drug Testing Program	32 (87%)	46 (85%)	19 (86%)	13 (100)	14 (100%)	124 (89%)
Type of testing performed:						
Pre-hire Screening	25 (78%)	40 (85%)	19 (100%)	13 (100%)	14 (100%)	111 (79%)
Random	20 (63%)	31 (66%)	14 (74%)	12 (92%)	12 (86%)	89 (64%)
Reasonable Cause	24 (75%)	40 (85%)	16 (84%)	11 (85%)	13 (93%)	104 (74%)
Post Accident	23 (71%)	38 (81%)	18 (95%)	12 (92%)	14 (100%)	105 (75%)
Blanket	1 (3%)	5 (11%)	5 (26%)	2 (15%)	2 (14%)	15 (11%)
Follow-up	15 (47%)	17 (36%)	10 (53%)	7 (54%)	6 (43%)	55 (39%)
% of job applicants that test positive	5.4%	6.6%	4.0%	4.5%	5.1%	5.5%
Typical year testing implement	1992	1991	1990	1990	1989	1991
Firm's policy when an employee fails a drug test:						
Termination after first failure	8 (27%)	9 (23%)	5 (25%)	8 (62%)	4 (31%)	71 (51%)
Termination after repeat failure	13 (45%)	21 (51%)	12 (60%)	2 (15%)	10 (77%)	28 (20%)
Suspend w/o pay	2 (7%)	10 (21%)	2 (11%)	2 (15%)	3 (21%)	19 (14%)
Treatment offered at firm expense	8 (21%)	9 (17%)	6 (27%)	2 (15%)	3 (21%)	28 (20%)
Treatment recommended-not at firm expense	12 (41%)	13 (28%)	8 (42%)	7 (54%)	8 (57%)	48 (35%)
Treatment not considered	0	4 (9%)	2 (11%)	0	0	6 (4%)

firms held safety training for supervisors at least annually and almost 75% held it as often as quarterly. In addition, toolbox meetings were found to be a standard safety practice for all firms. These meetings were held weekly by 89% of the firms, 7% deviated from the norm by conducting them every day and the remaining few held them less often than weekly. Forty-three percent of the firms reported that they held their toolbox meetings on Mondays and another 43% said their meeting day varied. Other days noted were Tuesdays (3%), Wednesdays (1%), and Fridays (3%). Subcontractors typically attended these toolbox meetings as was indicated by 72% of the firms. The task of presiding over toolbox meetings generally fell on the job supervisor (37%) or the foreman (24%). Only 6% said this task was performed by a safety person, although another 11% indicated that this function was a shared responsibility involving a safety representative. Less than 15% involved workers in conducting toolbox meetings[7]. The remaining firms indicated that the person who ran the meetings varied.

All but two firms stated they had safety orientation training for newly-hired employees. Moreover, 71% said that their orientation training was of a formalized type. A notable disparity was identified when the firm size was considered with respect to formal or informal orientation. Formal orientation was given by more than 90% of the top one-third largest firms (largest 3 categories) but for the smallest two-thirds, this figure dropped to around 60%. New field employees were the focus of every safety orientation program. However, all field employees were the recipients of orientation in 86% of the firms, about half of the firms included new salaried employees, and 7% stated all employees were oriented. In addition, 27% of the firms included new subcontractor employees in safety orientation training.

The use of safety dinners as a means to promote awareness was essentially split, with 44% of the firms stating they held them. Firms larger than $500 million were about 20% more likely to hold safety dinners. Of those firms which held safety

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[7] This figure may be low because the question was multiple choice and the respondents were asked to *check one*. Although the majority of respondents checked more than one block, those that checked only one block may have marked others including that for "assigned worker" if the question had indicated in parenthesis *check all that apply*.

dinners, the company president attended in 89% of the firms and workers attended slightly less often (85%). Another way to communicate safety to employees and their families was by publishing safety information in a company newsletter; this was done at least quarterly by 61% of the firms. Eleven firms cited more innovative means to spread the message of safety to the homes of employees, such as: including literature with employee pay checks, providing CPR/first aid training to family members, and discussing the importance of safety with children at company picnics. In total, 56 firms (42%), stated they communicated safety to employee families (see Table 7).

Corporate Safety Policies and Procedures

Corporate safety policies and procedures can influence how projects are managed. The responses to survey questions that focused on this area are summarized in Table 8. Field supervisors were evaluated on safety by 94% of the firms. Firms consistently stated (93%) that subcontractors were always required, by contract, to comply with any safety regulations they set forth. Another consistent finding was that the country's largest construction firms provide personal protective equipment for their employees, i.e., 97% of the large firms provide safety glasses. However, job supervisors usually had to be concerned about paying for personal protective gear from project funds because only 17% of the firms indicated it was a corporate expense. About 8% said personal protection was included in both project and corporate budgets, possibly meaning that the expense was either shared or that it varied by project. Some of the more aggressive safety practices were not uniformly practiced. For example, only 55% of the firms required that safety glasses be worn at all times while on the job and 49% stated jobs were inspected by someone from the corporate level at least monthly. About 70% stated that an activity hazard analysis study was conducted prior to each major phase of work.

Various questions were asked about policies regarding accidents and project safety reports. Seventy-five percent of the firms said that they investigate every accident, while 17% only investigated accidents if they were serious enough to be

Table 7
Safety Training and Awareness Practices
of Large Construction Firms by Dollar Volume

SAFETY PRACTICE	FIRM REVENUE (in millions of dollars)					TOTAL (AVG)
	< 100	101 - 249	250 - 499	500 - 999	> 1000	
No. of respondents	38	54	22	13	14	141
Who attends safety orientation:						
New field employees	36 (95%)	52 (98%)	22(100%)	13 (100%)	14 (100%)	137 (98%)
All field employees	28 (74%)	50 (94%)	18 (82%)	13 (100%)	12 (86%)	121 (86%)
New Salaried employees	13 (34%)	28 (53%)	11 (50%)	8 (62%)	10 (71%)	70 (50%)
New Sub employees	8 (21%)	13 (25%)	4 (18%)	6 (46%)	7 (50%)	38 (27%)
All employees	0	7 (13%)	0	2 (17%)	1 (8%)	10 (7%)
Firms that give formal safety orientation	23 (61%)	32 (60%)	20 (91%)	12 (92%)	13 (93%)	90 (70%)
Firms that hold safety dinners	13 (34%)	21 (40%)	14 (64%)	6 (46%)	8 (57%)	61 (44%)
President attends safety dinner[8]	11 (92%)	18 (82%)	11 (79%)	6 (100%)	8 (100%)	54 (89%)
Workers attend safety dinner[7]	11 (85%)	18 (82%)	10 (71%)	5 (83%)	8 (100%)	52 (85%)
Safety training/mtgs for supervisors held at least monthly	22 (58%)	16 (30%)	9 (41%)	7 (54%)	9 (69%)	63 (45%)
Toolbox mtgs:						
held daily	3 (8%)	2 (4%)	2 (9%)	2 (15%)	1(7%)	10 (7%)
held Mondays	17 (45%)	20 (37%)	12 (55%)	5 (38%)	9(64%)	63 (45%)
day of wk varies	12 (32%)	30 (56%)	7 (32%)	6 (46%)	4 (29%)	59 (42%)
subs attend	9 (24%)	15 (28%)	5 (23%)	3 (36%)	5 (36%)	37 (27%)

classified as recordable type accidents. For 45% of the firms, both the superintendent and the safety director were responsible for investigating accidents. Summary accident

[8] Percentages indicated are based on the percent of applicable firms which hold safety dinners.

Table 8
Number of Large Construction Companies that Followed Various Safety Policies & Procedures by Dollar Volume

POLICY	NUMBER OF FIRMS Firm Revenue(in millions of dollars)					TOTAL (AVG)
	< 100	101 - 249	250 - 499	500 - 999	> 1000	
No. of respondents	38	54	22	13	14	141
Safety glasses are required to be worn at all times on job	17(45%)	24 (45%)	16 (73%)	8 (62%)	11 (78.6)	76 (55%)
Field Supervisors are evaluated on safety	33 (89%)	48 (94%)	21 (96%)	13 (All)	14 (100%)	129 (94%)
Subs contractually obligated to comply w/ safety	33 (89%)	53 (98%)	20 (91%)	12 (92%)	12 (86%)	130 (93%)
Hazard analysis performed on each major work phase	24 (63%)	30 (57%)	13 (59%)	11 (92%)	12 (86%)	90 (70%)
Corp level person inspects job at least						
Monthly	30 (79%)	48 (89%)	15 (68%)	12 (92%)	7 (49%)	112 (82%)
Quarterly	34 (90%)	54 (All)	19 (86%)	13 (All)	8 (56 %)	128 (94%)
Co. Pres. reviews safety reports	18 (47%)	16 (30%)	10 (46%)	10 (77%)	6 (43%)	60 (43%)
Co. V.P. reviews safety reports	20 (53%)	32 (59%)	15 (68%)	10 (77%)	11 (79%)	88 (62%)
PPE paid from:						
Corporate budget	11 (30%)	9 (17%)	2 (9%)	0	1 (7%)	23 (17%)
Both job & corp	3 (11%)	3 (6%)	2 (9%)	3 (15%)	0	11 (8%)
Summary accident reports provided to all jobs	34 (92%)	41 (77%)	18 (82%)	12 (92%)	14 (100%)	119 (86%)
Type of accident investigated:						
All	24 (63%)	41 (76%)	17 (77%)	9 (69%)	13 (93%)	104 (74%)
Recordable	34 (90%)	49 (91%)	20 (91%)	11 (85%)	14 (100%)	124 (91%)

Table 8 (Part II)
Number of Large Construction Companies that Followed Various Safety Policies & Procedures by Dollar Volume

POLICY	NUMBER OF FIRMS Firm Revenue(in millions of dollars)					TOTAL (AVG)
	< 100	101 - 249	250 - 499	500 - 999	> 1000	
Distributed accident reports to both job & home office	20 (59%)	24 (46%)	15 (72%)	9 (75%)	11 (79%)	75 (56%)
Accident reports are forwarded daily to corporate level	27 (73%)	31 (60%)	20 (91%)	10 (77%)	10 (71%)	98 (71%)
Every job has a first- aid station	8 (44%)	18 (47%)	6 (40%)	2 (40%)	4 (33%)	38 (43%)
No of Litigation cases						
have increased	8 (24%)	16 (36%)	6 (40%)	0	3 (30%)	33 (30%)
have decreased	18 (53%)	18 (40%)	6 (40%)	7 (88%)	4 (40%)	53 (47%)
remained same	4 (12%)	3 (7%)	3 (20%)	1 (7%)	3 (30%)	14 (13%)
none for 10 years	4 (12%)	8 (18%)	0	0	0	12 (11%)
Request a summary	30 (79%)	45 (83%)	20 (91%)	11 (85%)	1 (93%)	119 (85%)

reports were provided to all jobs by 86% of the responding firms and about half of the accident reports were distributed to both job and home office files. About 43% of the company presidents review project safety reports and 62% make it to the level of vice-president. Accident reports are forwarded at least daily to the corporate level by 71% of the firms.

Injury and EMR Data

The EMR and the number of injuries experienced by each firm were reported for three years (1993-1995). Of the 141 respondents, 106 provided injury data and 109 provided hours worked data so that incident rates could be computed. The mean injury rate for 1995 was 7.86 OSHA recordable injuries per 200,000 hours worked. There was a notable annual improvement in the average incident rate of about one injury per 200,000 hours in each of the successive years. The 1994 and 1993 mean incident rates were 8.87 and 9.68 respectively. For the five size categories from

smallest to largest, the 1995 injury rates were 9.48, 9.09, 4.91, 7.65, and 4.07. From these rates, it can be seen that the number of injuries generally dropped sharply as firms increase in size. The only exception to this was the 7.65 incident rate in the fourth largest size category. A closer examination of the data might suggest that this mean value is a somewhat inflated. Specifically, there were only 13 firms total in this size category of between $500 million and $1 billion; and one of the 13 firms had an incident rate of greater than 19 which was twice as high as the next high rate among the firms.

The lost-time and restricted injury activity rates was also complied. The lost-time injury rate showed very similar trends as the OSHA recordable rates with respect to size category and improvement rate from 1993 to 1995. The restricted activity injury rates were less consistent.

Near misses were also stated as being documented by more 68% of the firms. However, their numbers were not consistently tracked, at least at the home office, by most firms. This was evidenced by the fact that only 48% elected to state how many near misses occurred in 1995. The number of the of near misses reported varied widely from 0 to 1853, with a median value of about 10. Excluding company size, four possible reasons for the occurrence of such a large variation and low median value are: (1) the definition of what constitutes a near miss may vary from firm to firm or even from worker to worker (2) many workers may not bother to stop work and report a close call because no one was actually hurt, (3) many firms do not emphasize the importance of reporting near misses and (4) depending on the safety climate of a firm, a worker might not be inclined to report a near miss out of fear of retribution. The fourth reason would be especially true if the worker felt that his/her unsafe performance contributed to the near miss.

Finally, the mean experience modification rates showed a similar improvement trend as with injury rates, improving or declining by 0.10 from 1993 to 1995. The mean EMR for 1995 was 0.74, ranging from a low of 0.31 to a high of 1.16. Less than 4% of the firms had an 1995 EMR greater than 1.00. The EMR rates tended to

improve (decrease) with an increase in firm size. A complete overview of the injury and EMR statistics can be found in Table 9.

Table 9
Incident Rate & EMR Data of Large Construction Companies by Dollar Volume

	FIRM REVENUE (in millions of dollars)					MEAN
	< 100	101 - 249	250 - 499	500 - 999	> 1000	
No. of respondents	38	54	22	13	14	141
1995 Injury Rate	9.48	9.09	4.91	7.65	4.07	7.86
!994 Injury Rate	10.86	10.94	3.71	9.17	3.96	8.87
1993 Injury Rate	11.03	11.92	5.23	9.37	5.27	9.68
Average 3 year injury rate	10.46	10.85	4.62	8.85	4.21	8.89
EMR 1995	0.83	0.73	0.66	0.66	0.73	0.74
EMR 1994	0.89	0.78	0.74	0.71	0.74	0.79
EMR 1993	0.91	0.83	0.79	0.83	0.77	0.84
Average EMR for 3 years	0.88	0.78	0.73	0.73	0.76	0.79
1995 Lost Time Injury Rate	3.05	2.38	1.56	2.16	1.12	2.73
1994 Lost Time Injury Rate	4.67	3.19	1.37	2.76	0.85	3.00
1993 Lost Time Injury Rate	4.65	3.56	2.30	2.58	0.95	3.27
1995 Restricted Injury Rate	1.56	2.01	1.84	2.08	1.16	1.79
1994 Restricted Injury Rate	1.60	2.38	1.82	2.18	1.44	1.96
1993 Restricted Injury Rate	1.37	2.35	2.11	2.03	1.49	1.96
Firms document near misses	17 (46%)	36 (71%)	16 (73%)	10 (83%)	13 (93%)	92 (68%)
Injury rate improvement 1993 to 1995	1.5	2.8	0.3	1.4	2.5	1.9

Note: Injury rate statistics are based on injuries per 200,000 hrs. of worker exposure.

Miscellaneous

Some of the additional subjects addressed in this study revealed some interesting trends about large construction companies. First, the number of litigation cases resulting from a safety or health related incident has decreased for almost half of the firms. For about 30%, the number of litigation cases has increased, 13% say it has remained the same, and 11% have had none for the past 10 years. Trends with respect to litigation cases is illustrated in Figure 5.

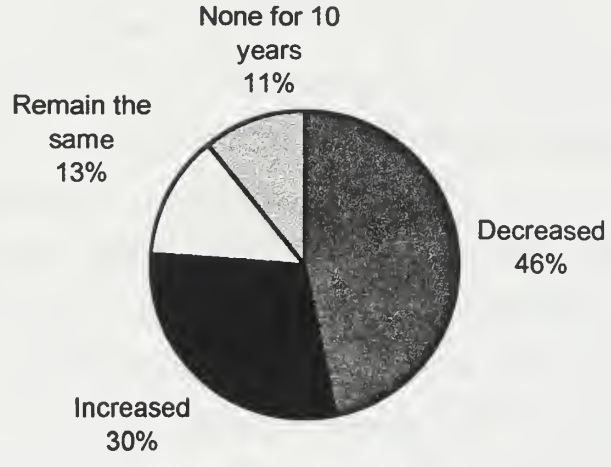

FIGURE 5: Number of Safety Related Litigation Cases Experienced over the past 10 years.

The next topic dealt with support from top management.. When asked to rank from 1 to 10, the level of support safety departments felt they received from top management, 53% indicated a 10. The lowest level of top management support indicated by one firm was 3 and the average rank was 9.33. Finally, a very high number of firms (85%) requested a copy of the summary report from this study. This high percentage of firms requesting feedback, combined with the relatively high response rate for this study, would indicate a high reverence for safety among the safety departments of large firms; and a willingness to share knowledge that can help everyone in the business.

4.2 Significant Findings

Injury Rate vs. All Variables

All variables in the entire sample were correlated against the 1995 injury rate by using Kendall's Correlation Test. In total, 40 independent variables were significantly correlated with the 1995 injury rate. The findings for these variables will be presented in three groups. First, the seven safety measure variables which are closely linked (positively correlated) to the injury rate for 1995 and were expected to show a strong correlation, will be examined briefly. This will be followed by 7 size variables found to be significant. Finally, the significant findings for which a firm has some control will be covered. It is this final area that is perhaps the most meaningful because a firm has a choice whether or not to implement policies, practices or procedures commensurate with these findings.

The seven safety measure variables closely associated with the 1995 injury rate are: injury rate (1994), injury rate (1993), average injury rate (1993-1995), EMR 1995, EMR 1994, EMR 1993, and average EMR (1993-1995). Since the sample consisted of large firms and since large firms usually have well established safety programs, it is assumed that injury rates would not very appreciably from year to year. Hence, it was not surprising to find that the correlations of 1994 and 1993 injury rates, when compared to the injury rate for 1995, both had a level of significance or p-value of less than 0.001. The associated correlation coefficients for the previous two years were also quite high, decreasing slightly from 0.77 for 1994 to 0.70 for 1993. (In this paper the abbreviation "C" will be used to designate the correlation coefficient.) The correlation should obviously be stronger when the three years of injury rates are averaged because the 1995 rate itself makes up one third of the average. The C value for the 1995 injury rate when correlated with the average injury rate was 0.87. This information about consistent injury rates helps to explain why the EMR rates also correlated strongly with them. The equation for calculating a firm's 1995 EMR is partly derived from injury rates for years 1991-1993. Thus, the 1993 injury rate, which strongly correlated with the 1995 injury rate, makes up about 1/3 (of the injury rate portion of the calculation) of the 1995 EMR equation. Therefore, unless the

relationship between a firm and its 1991 and 1992 injury rates vary appreciably from the relationship in 1995, it would be expected that the EMR for 1995 ($p < 0.05$) would have an association with 1995 injury rate. When considering the injury rate with the 1994 EMR and 1993 EMR a correlation significance of $p < 0.009$ and 0.002 were noted, respectively. Table 10 summarizes the above findings.

Table 10
Kendall's Correlation Test for Injury Rate Related Variables
1995 Injury Rate = Dependent Variable

INDEPENDENT VARIABLE	P value	C value	CASES
1. Average injury rate for 3 years	0.001	0.87	106
2. Injury rate in 1994	0.001	0.77	106
3. Injury rate in 1993	0.001	0.70	106
4. Experience Modification Rate (EMR) in 1993	0.002	0.28	97
5. Experience Modification Rate (EMR) in 1994	0.009	0.24	95
6. Average EMR for past 3 years	0.013	0.23	92
7. Experience Modification Rate (EMR) in 1995	0.049	0.17	93

The next group of variables to be examined are those that are ordinarily directly proportional to a company's size. Injury rates were shown to be lower in the larger firms. The variables, along with their associated level of significance when correlated with the 1995 injury rate are: annual dollar volume ($p < 0.012$), number of projects ($p < 0.04$), number of field workers ($p < 0.005$), and number of hours worked in the field for 1995, 1994 and 1993 ($p < 0.003$, 0.003, and 0.005 respectively). Also refer to Table 11. All of these variables had a negative relationship to the 1995 injury rate. That is, injury rate declined as the size parameters increased.

The remaining 26 significant findings, are to some degree, within a firm's control. An additional 9 significant aggregate variables, created by combining some of the original 26 variables, will also be presented.

Table 11
Kendall's Correlation Test for Size Variables
1995 Injury Rate = Dependent Variable

INDEPENDENT VARIABLE	P value	C value	CASES
1. Size of firm w/ revenue divided into 5 groups	0.002	-0.28	106
2. No. of field employee hrs worked in 1995	0.003	-0.27	106
3. No. of field employee hrs worked in 1994	0.003	-0.27	104
4. Average number of field employees	0.005	-0.25	102
5. No. of field employee hrs worked in 1993	0.005	-0.25	104
6. The firm's approx. annual dollar volume	0.012	-0.22	106
7. Average number of projects in progress?	0.040	-0.17	101

The most prominent finding was that firms that had full time safety directors at the corporate level were safer ($p < 0.001$, $C = 0.43$). Another corporate safety structure variable found to be important was the number of full-time field safety representatives employed by a firm. Firms that employed more full-time field safety personnel were safer ($p < 0.035$, $C = 0.18$). Figures 6 and 7 graphically illustrate how these two corporate safety structure variables influence injury rates. In order to facilitate graphical display for some of the results, the data for variables with a large range of responses, such as the number of field safety representatives, were subdivided into a small number of groups. A check to see if this new variable (created by bracketing the original data into 6 groups) had a significant change in the p value, revealed a large increase in strength of the correlation with 1995 injury rate. The new figures found were $p < 0.001$ and $C = -0.42$. This stunning finding lead to further analysis. This strong correlation was initially thought to be primarily due to the fact that the number of field safety employees were directly proportional to the size of the firm (see the data on page 24, Table 4). To verify whether or not this was true, the size influence was discounted by creating three ratios and correlating the ratios with the injury rate for 1995. The ratios created and their respective correlation results were: (1) Number of full-time field safety reps (#FFSR) to the number of projects ($p < 0.006$), (2) #FFSR to firm revenue ($p < 0.005$), and (3) #FFSR to number of field employee hours worked ($p < 0.003$). The fact that the correlations with all three ratios

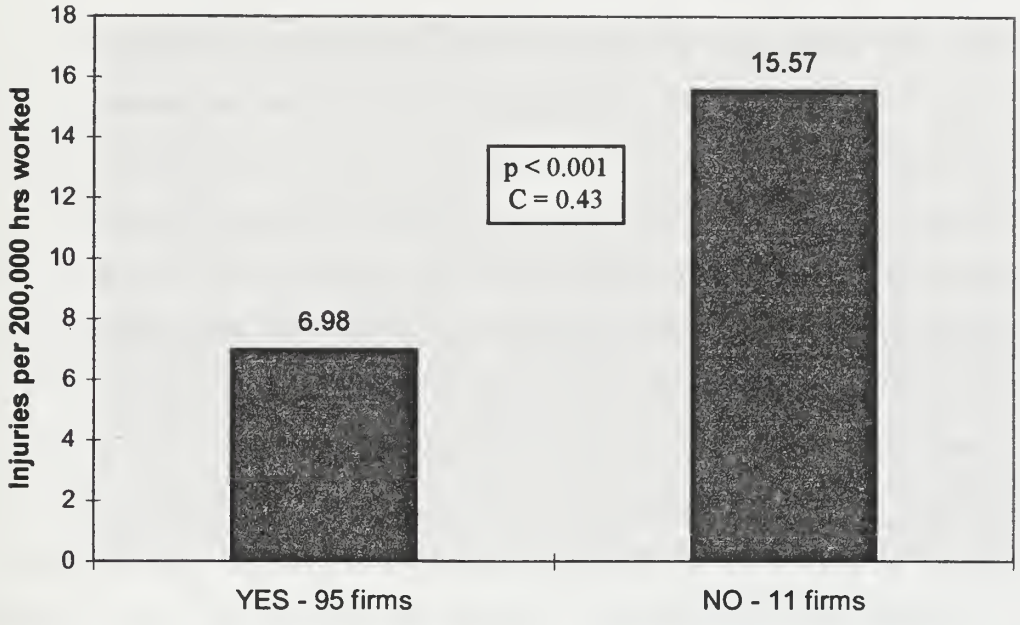

FIGURE 6: Firm has Full-time Safety Director at Corporate Level

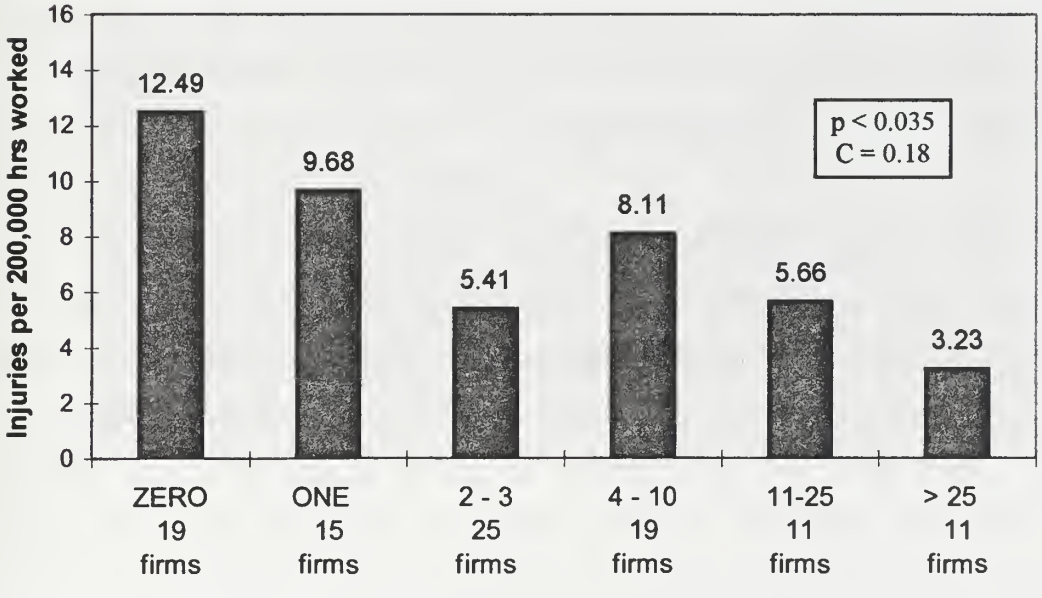

FIGURE 7: Number of Full-time Field Safety Reps Employed

had much stronger levels of significance than the original value of 0.035 gives substantial credence to the fact that employing full-time field safety representatives is a very important factor that reduces injuries. The effect o the number of field hours worked, is illustrated (using the group bracketing technique) in Figure 8. Additionally, a comparison of firms that employed at least one full-time field safety representative with those firms that reported having no full-time field safety employees resulted in injury rates of 6.57 and 12.49 respectively (see Figure 9); and again, a very strong correlation ($p < 0.001$, $C = - 0.39$). A few aspects about the criteria firms used to determine when to assign a FFSR to a job were also found to be significant. First, assigning a FFSR to a job only when requested by the owner/client, or in other words only when contractually obligated, had a detrimental effect on safety ($p < 0.03$) when compared to the group of firms made up of those that had no assignment criteria or listed any criteria other than owner requested. The second significant aspect of assignment criteria for FFSRs is that firms that did not have any specific criteria (by marking "NA") had lower injury rates than those that stated "contract requirement" only; and more injuries than firms that listed some other specific criteria. The ordinal arrangement of these three criteria response groupings had a $p < 0.016$ (see Figure 10). It should be mentioned that one other safety structure variable, firms where the field safety representatives are hired by the corporate safety director, was found to be borderline significant at a p level of 0.059.

The next most notable findings were in the area of substance abuse testing. Three types of drug testing were found to significantly correlated with injury rates: pre-hire drug testing ($p < 0.001$, $C = 0.38$), random drug testing ($p < 0.001$, $C = 0.33$) and reasonable cause testing ($p < 0.012$, $C = 0.22$). One other important fact discovered about drug testing and injury rate related to the year in which firms implemented drug testing. Firms with testing in existence longer had lower injury rates at a p level < 0.003. Refer to Figures 11-14 for graphic illustrations of how these drug testing variables were related to the 1995 injury rates.

Several safety training and awareness practices were noted to influence results. The third most strongly correlated controllable feature found concerned firms that had

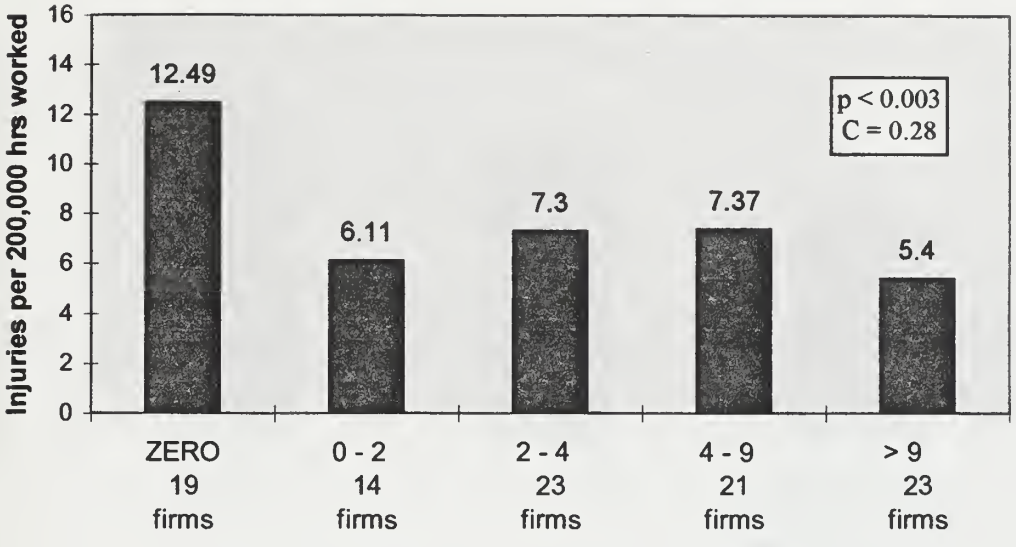

FIGURE 8: Ratio Full-time Field Safety Reps per million Field Hours Worked

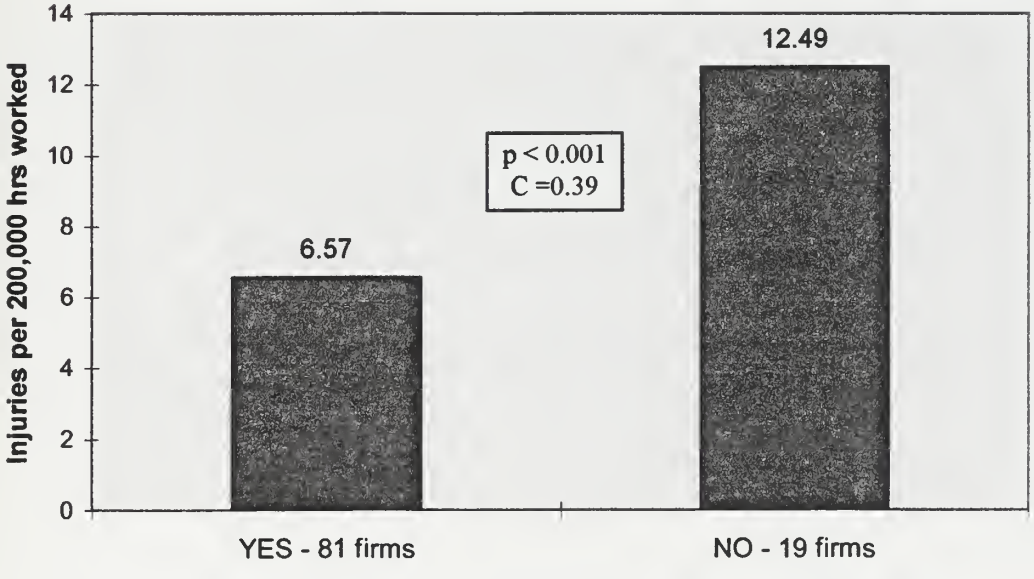

Figure 9: Does Firm Employ Full-time Field Safety Rep?

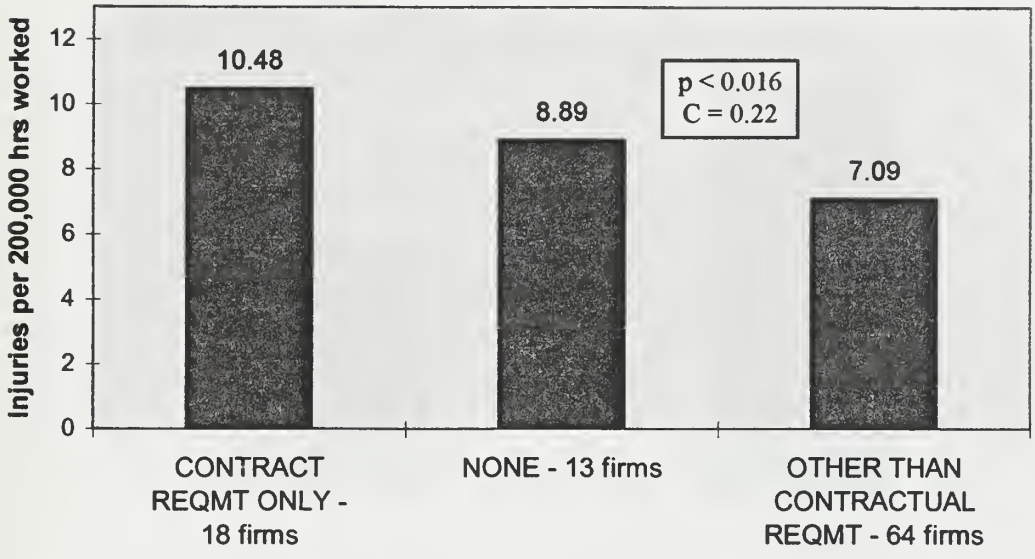

FIGURE 10: What is the Criteria Used to Determine When to Assign a Full-time Field Safety Rep to a Job?

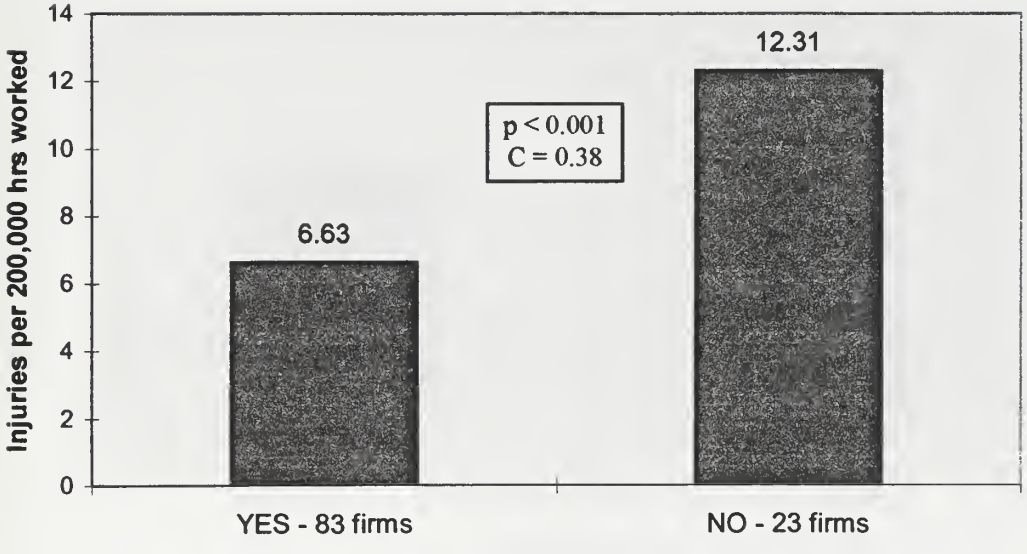

FIGURE 11: Firm Conducts Pre-hire Drug Testing

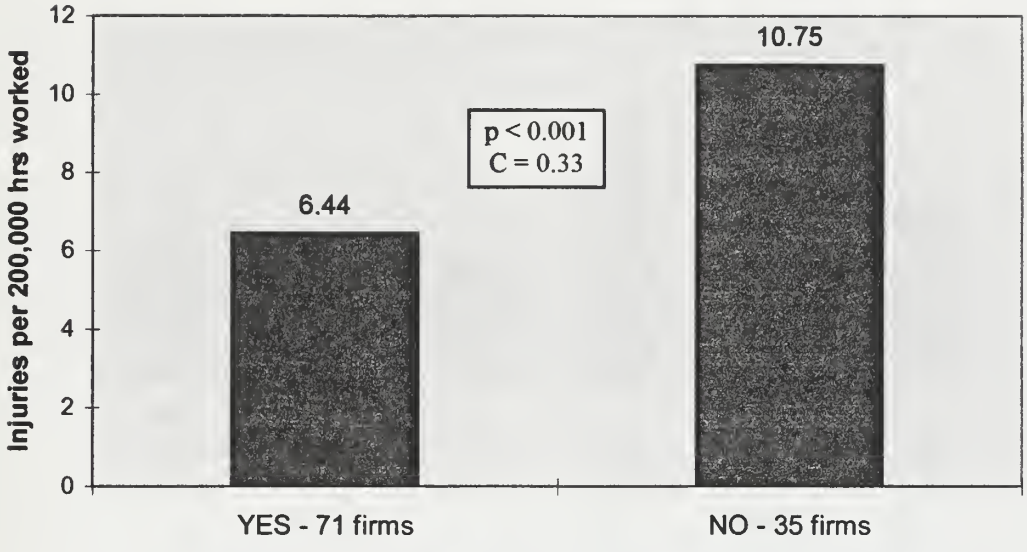

FIGURE 12: Random Drug Testing Conducted

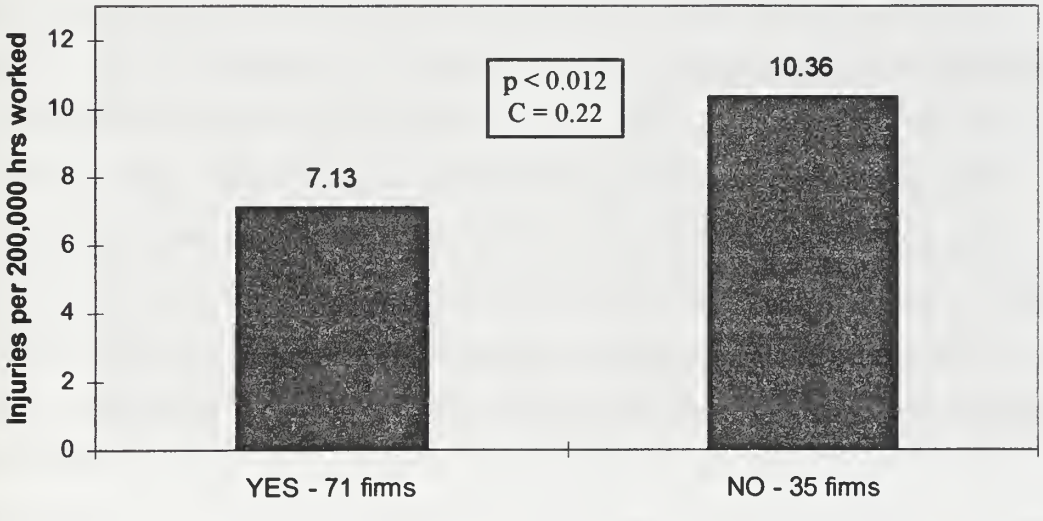

FIGURE 13: Reasonable Cause Drug Testing Conducted

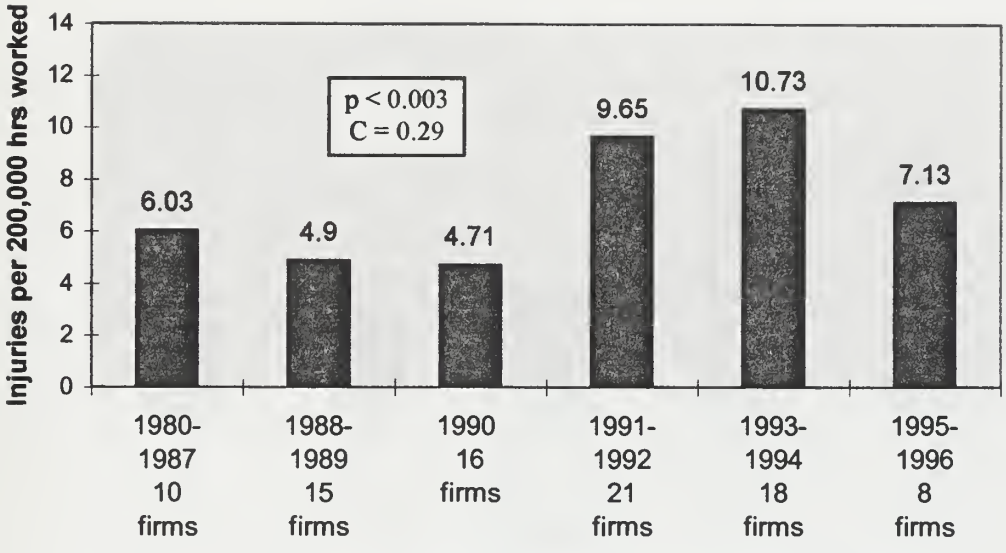

FIGURE 14: Year Drug Testing was Implemented

subcontractors attend their tool box meetings. They had significantly fewer injuries than those that did not or those that let subcontractors hold their own meetings ($p = 0.001$, $C = 0.37$, see Figure 15). Though not statistically significant, it is interesting to note that the injury rates vary depending on which day of the week firms hold their toolbox meetings. Figure 16 shows the incident rates depending on the day of the week in which firms hold their toolbox meetings. Figure 16 also might suggest that the most effective days of the week to hold a weekly toolbox meeting would be either Mondays, Fridays or to vary the day according to the type of work planned for each day of the upcoming week. In addition, it is clear from Figure 16 that the few number of firms which choose to hold toolbox meetings daily had far better injury rates than those following the standard practice of weekly toolbox meetings. This was confirmed to be significant ($p < 0.023$) when the data was divided into two groups: firms that hold toolbox meetings daily and firms that hold them less often (see Figure 17).

Two other areas of training found to be effective practices that improve safety performance are formal safety orientation ($p < 0.002$) and frequent safety training for

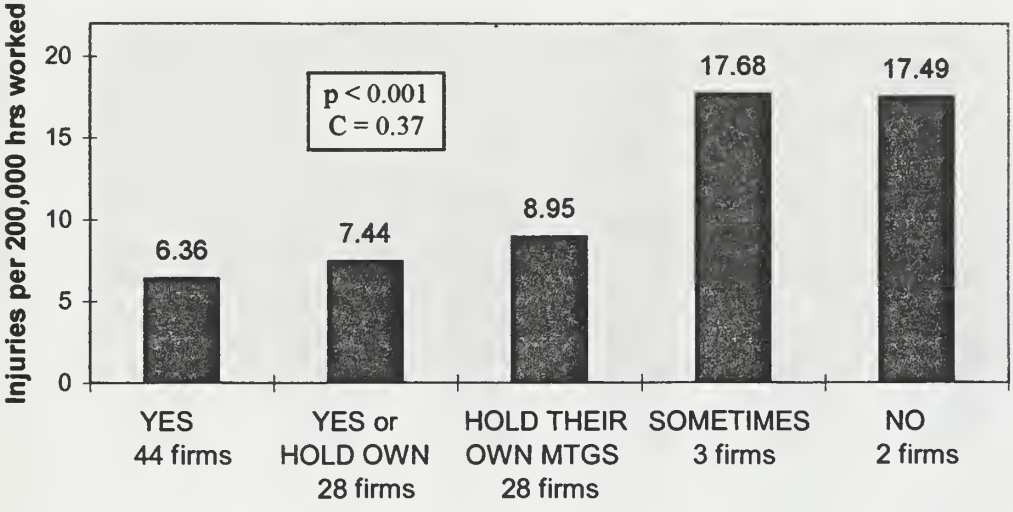

FIGURE 15: Do Subcontractors Attend Toolbox Safety Meetings?

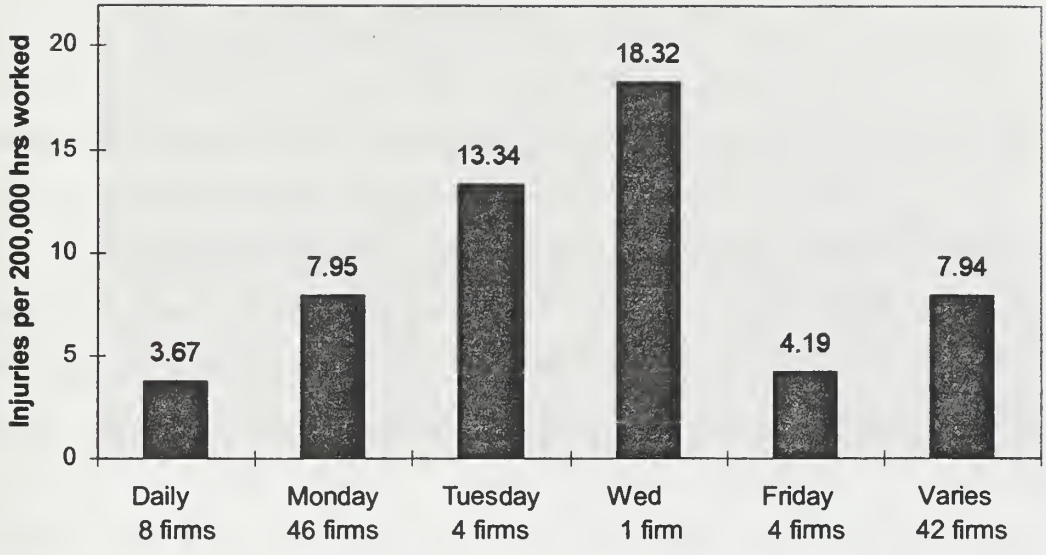

FIGURE 16: When are Toolbox Meetings Held?

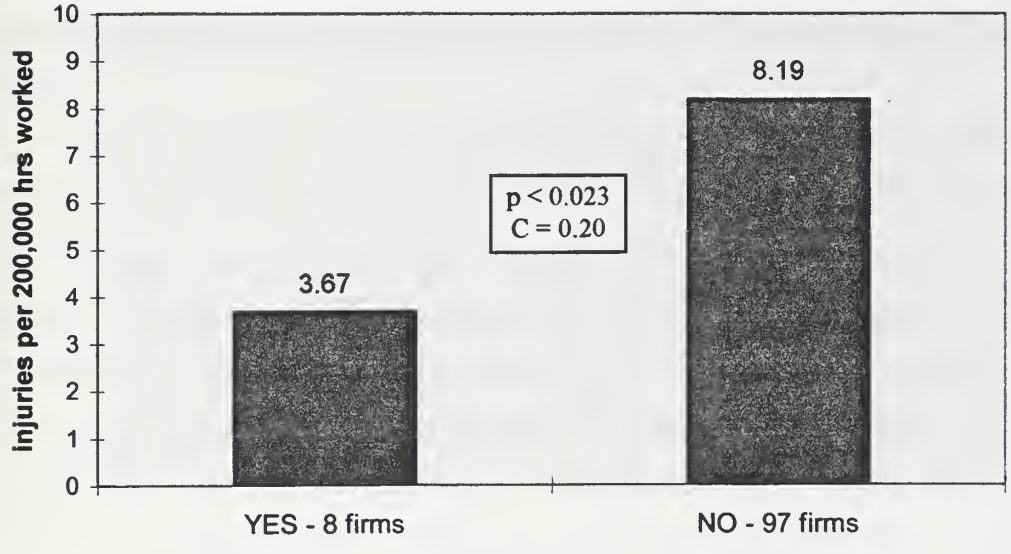

FIGURE 17: Toolbox Meetings are Held Daily?

supervisors ($p < 0.009$). Figures 18 and 19 illustrate the impact of these two training and awareness practices. Figure 19 shows that firms that held weekly (as compared to less frequent) supervisory safety training/meetings had very low injury rates and firms which held "other" than planned periodic safety training for supervisors (such as "sporadic", "at job start", "as needed", "varies") had the highest injury rate. It is also notable that firms that extended their safety orientation to include new subcontractors ($p < 0.063$) and new salaried employees ($p < 0.067$) tended to be safer.

Safety dinners, a method to promote safety awareness, were found to be effective for improving safety performance ($p < 0.007$). The importance of top management's involvement in safety can be seen from the fact that firms where the president attended safety dinners had even better safety records than those that did not ($p < 0.001$). For improved safety, it was also found to be significant for field workers to attend safety dinners ($p < 0.016$). Figures 20, 21 and 22 illustrate how safety dinners are associated with safety performance. Two variables were combined to form one that indicated both workers and presidents attended safety dinners; this combined variable also was associated with safety performance ($p < 0.001$). It should be noted that this is one of a few cases where combining variables improved or at least maintained the same level of significance as obtained with the strongest individual variable.

Another popular means to promote awareness and thereby improve safety has been through the use of incentive programs. Some very interesting aspects about incentive programs were found to be associated with lower injuries. First, it is important to realize that the findings show firms with an incentive program merely exhibited a trend toward a lower injury rate ($p < 0.074$), while specific incentive program elements were found to be more critical. The most significant program element found was that firms that awarded incentives for safe project completion had lower injury rates ($p < 0.001$), see Figure 23. Next, safety awards given to specific personnel were only found to be significant when given to safety personnel ($p < 0.007$) or project managers ($p < 0.053$). The level of significance found for safety personnel receiving awards may be inflated somewhat because this variable correlated strongly

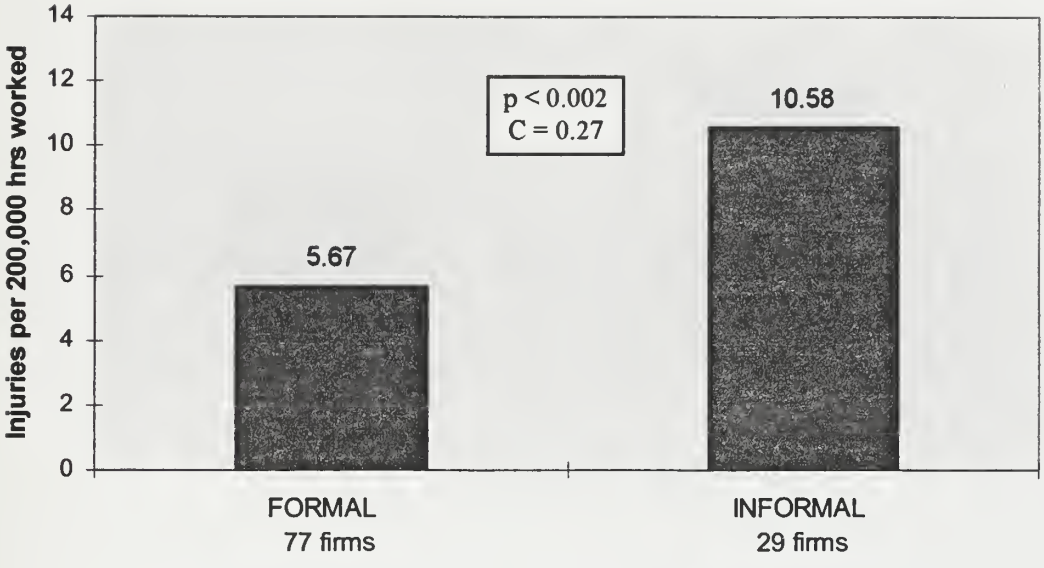

FIGURE 18: What Type of Safety Orientation is Given?

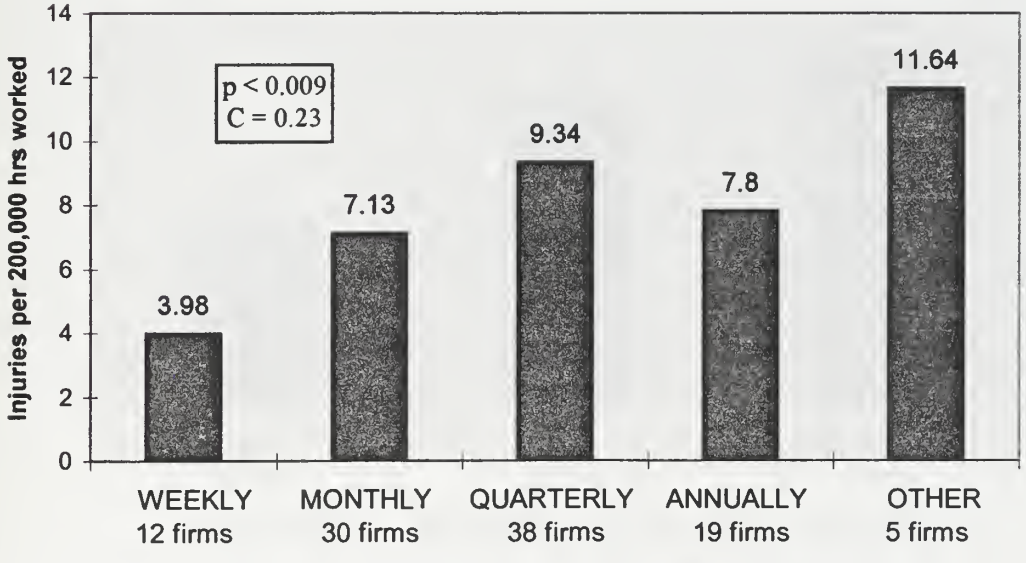

FIGURE 19: How Often Are Safety Meetings/Training Held for Supervisors?

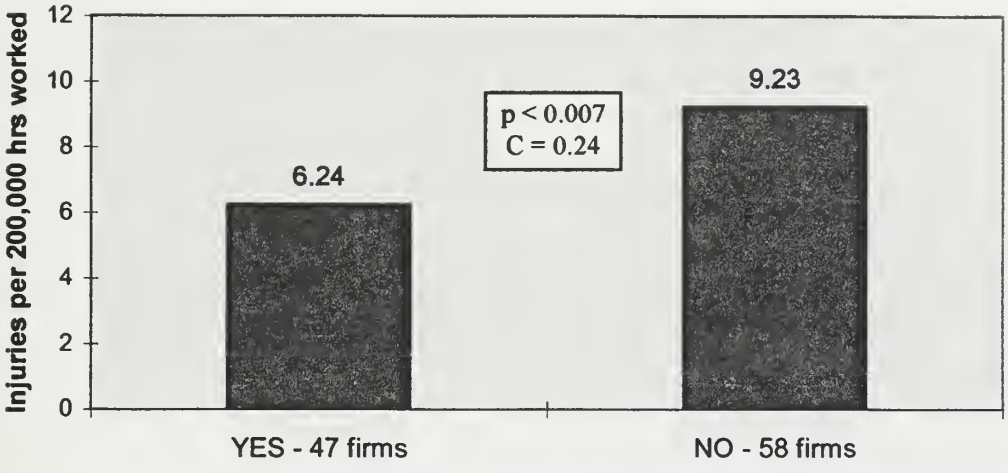

FIGURE 20: Firm Holds Safety Dinners

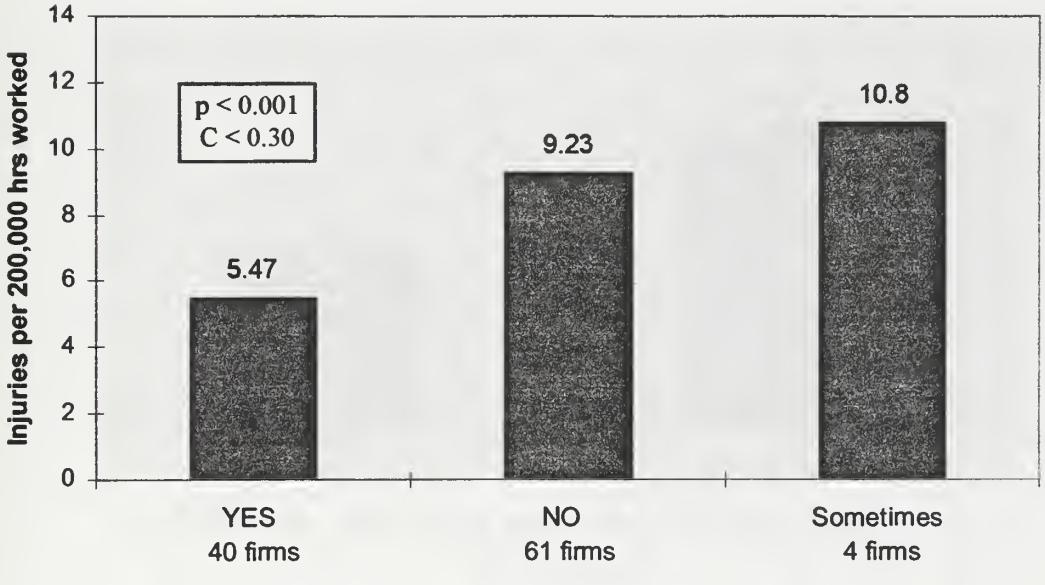

FIGURE 21: President Attends Safety Dinners

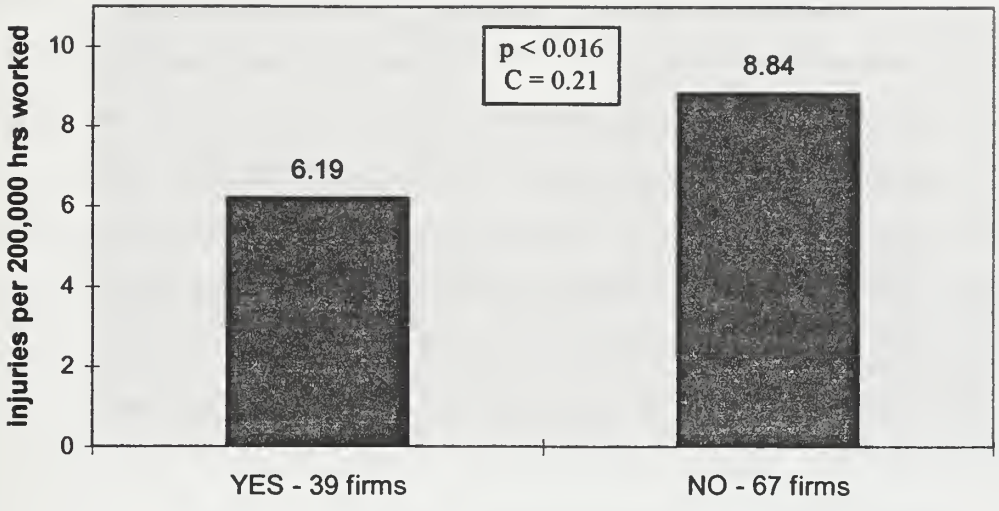

FIGURE 22: Field Workers Attend Safety Dinners

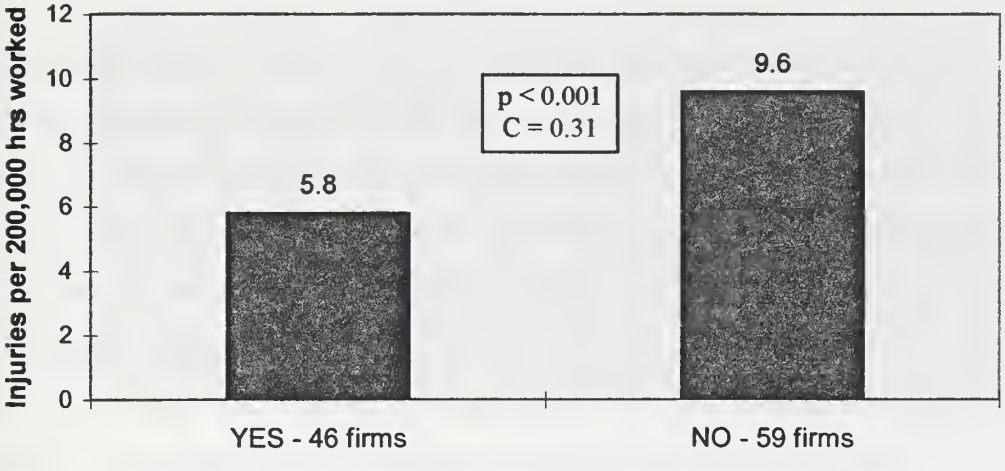

FIGURE 23: Incentives are Given for Safe Completion of Projects

with firms that have field safety representatives ($p < 0.001$, $C = 0.31$). Contrary to popular practices and some expert strategy recommendations regarding incentives, providing awards for field supervisors such as foremen and superintendents was not shown to produce better safety records. The safety performance difference between firms that do and do not provide awards for safety personnel and project managers are shown in Figures 24 and 25, respectively. Another significant aspect related to providing awards to employees was that awarding workers on the basis of safe crew performance was better than awarding on an individual basis only ($p < 0.011$), see Figure 26. The average injury rate for firms that award workers based solely on an individual's safe performance was 10.22 injuries per 200,000 hours worked. By comparison, this figure is actually worse than the injury rate of 9.66 found for the 20 firms that had no incentive program. It should be noted that there was a high correlation between firms that gave crew-based awards and those that gave awards for safe project completion ($p < 0.001$, $C = 0.43$). This result is understandable since it takes teamwork on everyone's part to achieve an overall safe project.

Another intriguing aspect about incentives that may be inferred from the results of this study, is that offering incentives of greater value or allocating more money to incentive programs, makes very little difference toward influencing safety. This inference is based on the fact that responses to questions about the amount firms allocate toward potential superintendent safety bonuses and safety incentive programs as a whole, did not positively or negatively influence safety. Bare in mind that there is no statistical evidence to support this notion and that the responses to these questions were somewhat limited. The final-incentive related finding was that it is appropriate for safety to impose sanctions for unsafe behavior ($p < 0.009$), see Figure 27.

The remaining 5 significant factors found to improve safety mostly center on corporate policy decision making. The requirement to wear safety glasses on the jobsite at all times distinctly improved safety for the workers in the field ($p < 0.001$). Slightly more than half the firms had this policy regarding safety glasses which resulted in a combined injury rate that was 22% below the average for the entire sample (see Figure 28). Firms that investigated more accidents, even less serious ones, were also

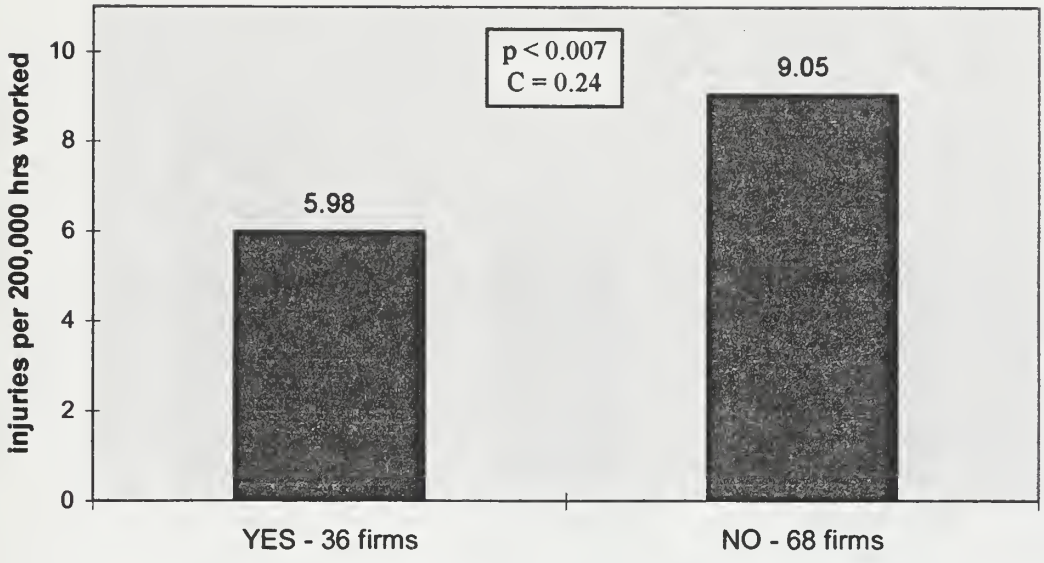

FIGURE 24: Safety Personnel Given Awards

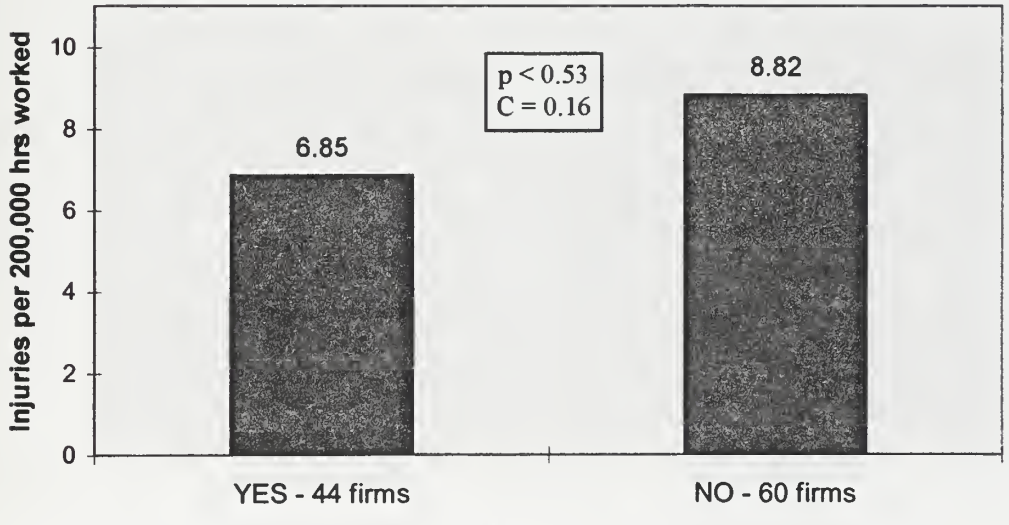

FIGURE 25: Project Manager Given Safety Awards

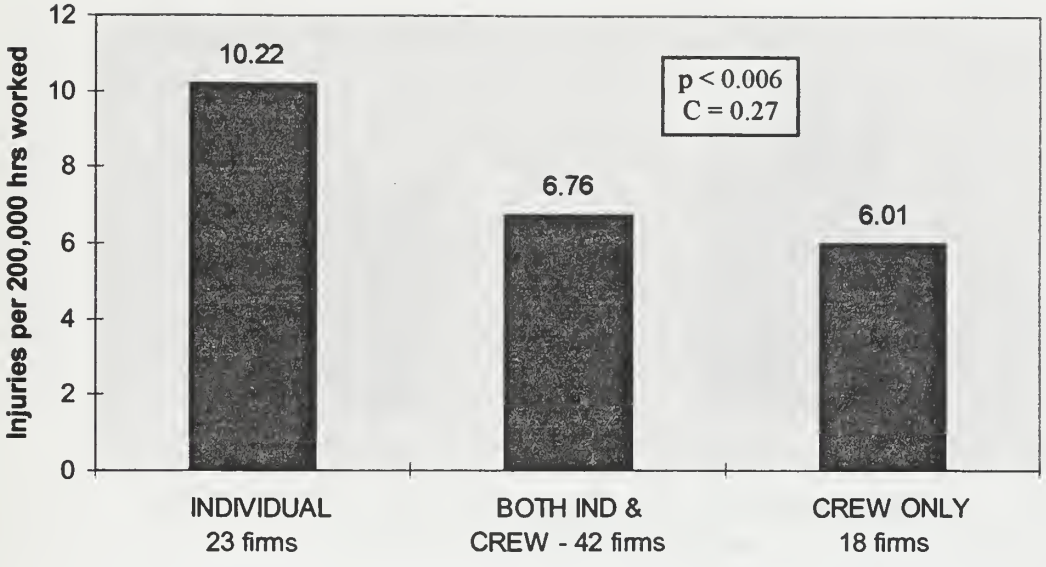

FIGURE 26: Basis for Awarding Incentives to Workers

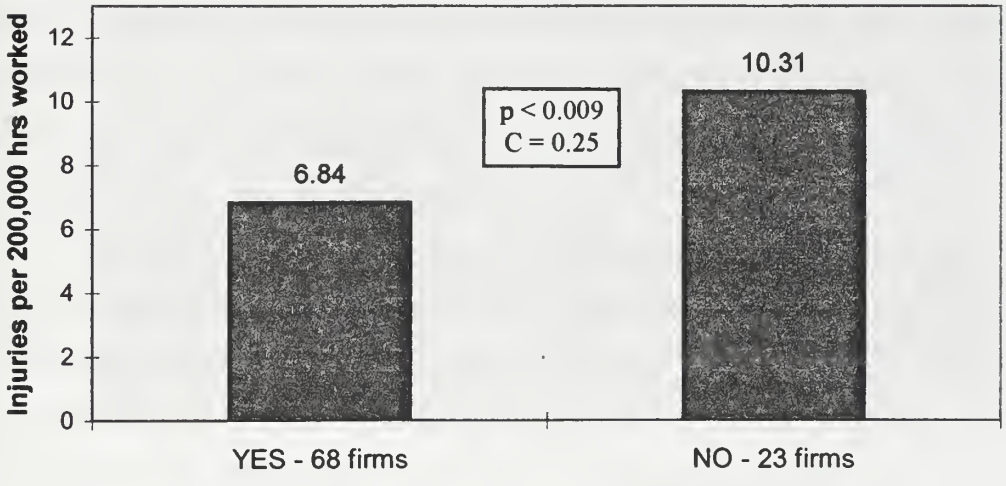

FIGURE 27: Sanctions are Imposed for Unsafe Behavior

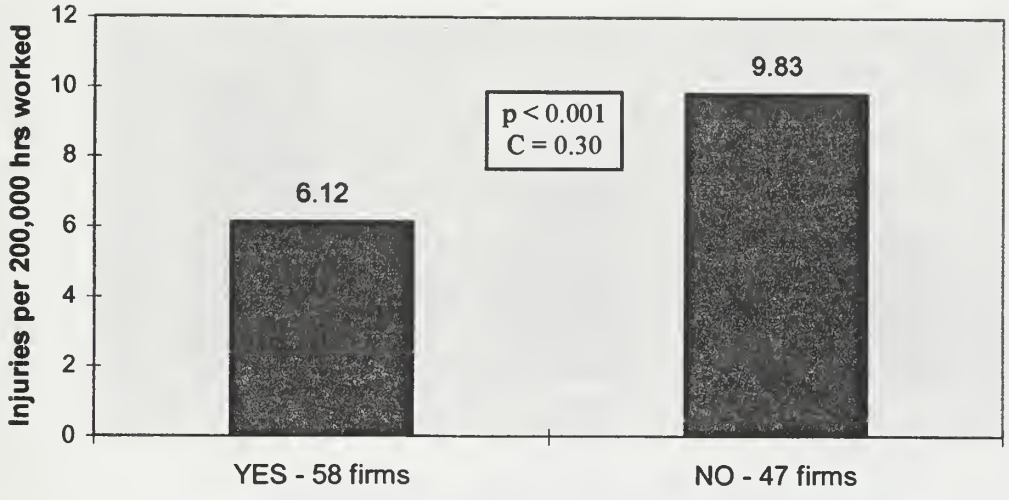

FIGURE 28: Safety Glasses are Required to be Worn on the Jobsite at All Times

safer ($p < 0.001$). A policy of this nature, such as requiring the investigation of all accidents would be expected to result in fewer injuries because such firm's are expected to have an aggressive safety program. It is important however, to comprehend that the real benefit here stems not from the policy itself but how well the lessons learned from the accident investigations are used to prevent future injuries. Moreover, the investigation of a minor accident could avert the circumstances leading to more serious injuries. Figure 29 shows the injury rates associated with the investigation of different types of accidents.

Three other variables, that corporate policy controls, were found to have a strong correlations with the 1995 injury rate. First, as the percentage of firm's work with local public clients increased, so did the firm's injury rate ($p < 0.028$). This adverse outcome (see Figure 30) is typically associated with contracting for competitively bid public projects. Secondly, percentage of revenue from foreign owners had a negative correlation of $p < 0.031$, indicating that firms with higher percentages of foreign revenue had better safety records. One might initially expect that doing work overseas would be riskier on all counts including safety, but this result suggests another view might be considered. Perhaps, a firm has all programs

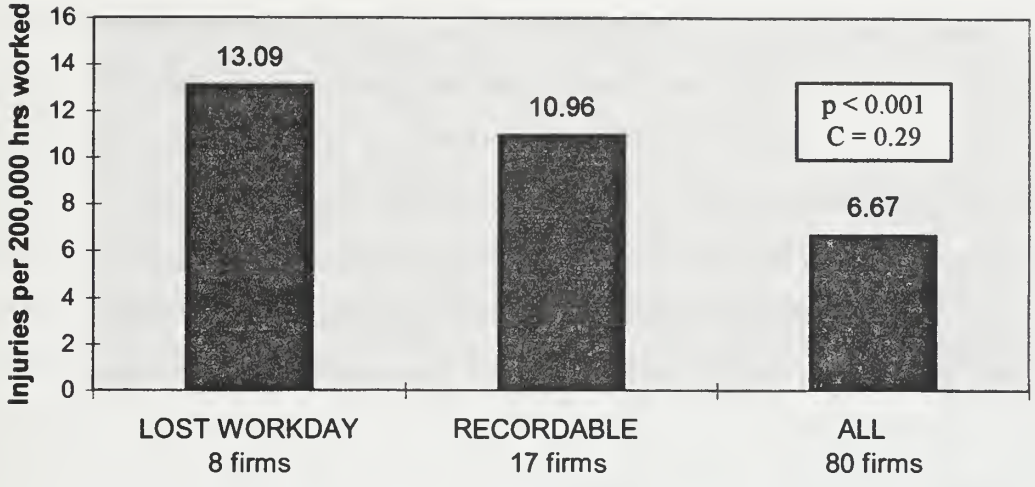

FIGURE 29: Which Type of Accidents are Investigated?

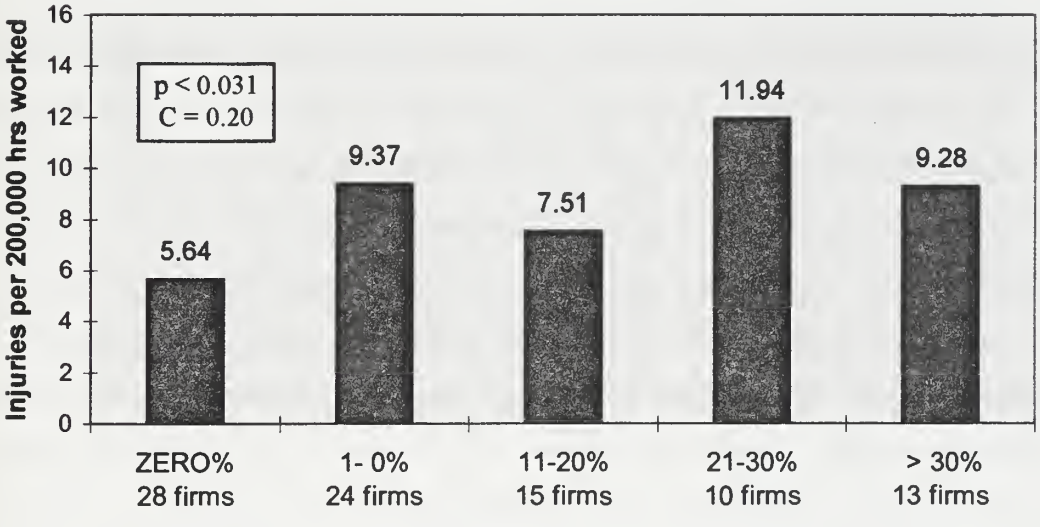

FIGURE 30: Pecentage of Revenue from Local public Owners

(including safety) well structured and functioning effectively before venturing overseas. Figure 31 helps illustrate the few number of firms accomplishing foreign construction and how that fact is associated with safety. Finally, the third variable, signified that it was better to have personal protective equipment expenses paid from a jobsite budget instead of from a centrally managed budget from the corporate office ($p < 0.033$). It was expected that such an arrangement would have an adverse effect on safety since the project supervisor would have the added economic burden of personal protection while still staying within budget for the project. Perhaps, for large companies, getting funding approval from headquarters is a hindrance and a jobsite safety budget is more convenient than dealing with some other level of management for the procurement of safety items. The actual results indicate that the 9 firms that responded by marking both jobsite and corporation had the lowest injury rates, see Figure 32. A summary of all the significant controllable variables are listed in Table 12 by descending strength of significance. Table 13 is a repetition of Table 12 except the statistical values have been deleted so that the specific practices and procedures that make a firm safer could be clearly summarized.

In two situations, variables were combined to produce a more significant correlation than each variable on its own merit. Both situations involved who in the home office reviewed the safety reports from the projects. In the first situation, no relationship was found when the president reviewed safety reports and only a trend existed ($p < 0.067$) when the vice president did so. However, when both reviewed the reports, the p level was reduced to 0.053. The second aggregate variable that resulted in a stronger positive influence on safety involved firms that had more home office managers review project safety reports. This variable (called "REV" in the definition file found in Appendix C) was created by combining the following multiple levels of review: president ($p < 0.14$), vice president ($p < 0.67$), safety department ($p < 0.20$), operations manager ($p < 0.10$), various department heads ($p < 0.31$), and other ($p < 0.47$). Each of these review levels was assigned a value of +1 and added together for each firm to create the variable "REV" that had a possible value of zero to six. The

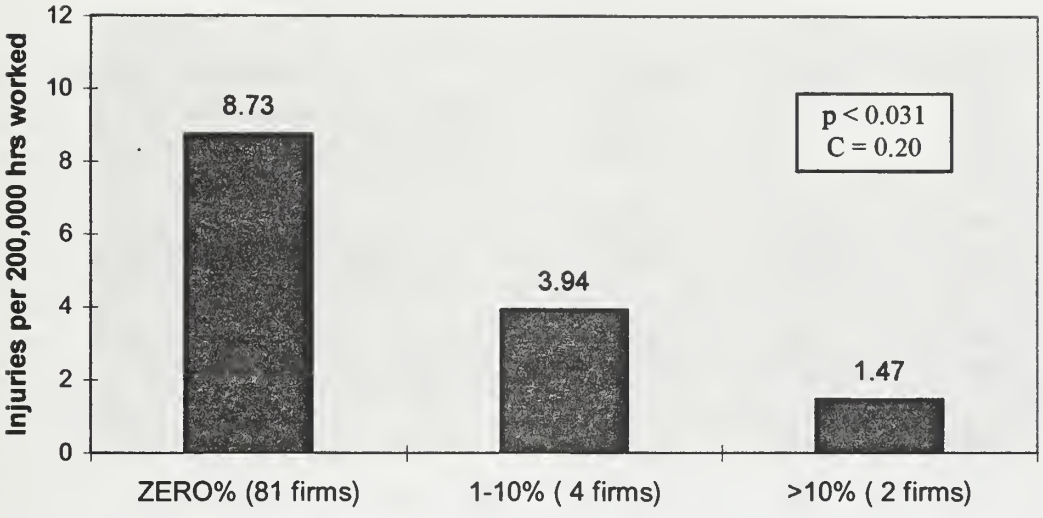

FIGURE 31: Percentage of Firm's Revenue from Foreign Source

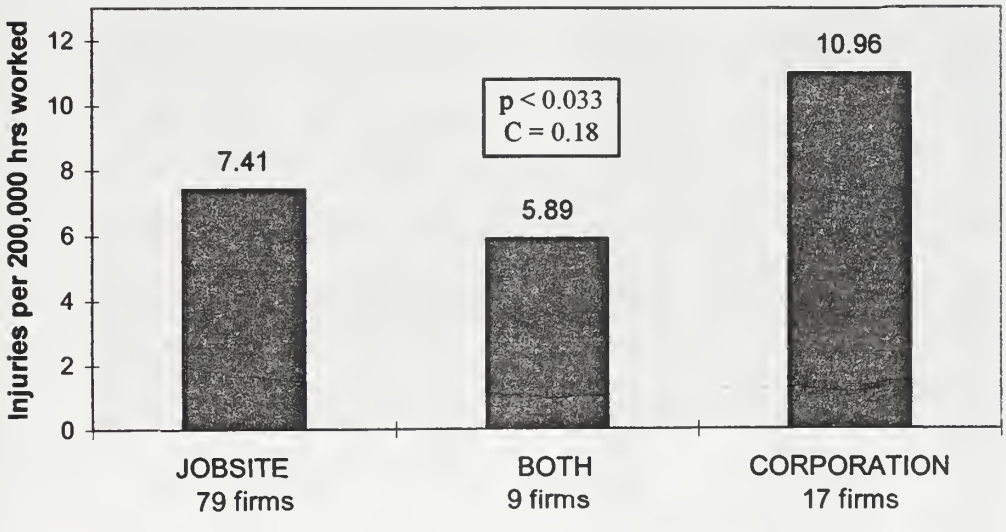

FIGURE 32: How is Personal Protection Funded?

Table 12

Kendall's Correlation Test for Variables within a Firm's Control
1995 Injury Rate = Dependent Variable

INDEPENDENT VARIABLE	P value	C value	CASES
1. Firm has a full-time corp safety director	0.001	0.43	106
2. Firm employs at least 1 full-time field safety representative	0.001	0.39	100
3. Pre-hire drug testing conducted	0.001	0.38	106
4. Do subcontractors attend safety meetings	0.001	0.37	106
5. Random drug testing conducted	0.001	0.33	106
6. Incentives are awarded for safe project completion	0.001	0.31	106
7. President attend safety dinners	0.001	0.30	105
8. Are safety glasses req'd to be worn at all times on job?	0.001	0.30	105
9. Which types of accidents are investigated?	0.001	0.29	106
10. Formal safety orientation given	0.002	0.27	106
11. When was drug testing implemented in your firm?	0.003	0.29	88
12. Ratio of # of full-time field safety reps to field hours worked	0.003	0.28	100
13. Awards to workers are crew based	0.006	0.27	102
14. Company holds safety dinners	0.007	0.24	105
15. Safety awards given to safety personnel	0.007	0.24	104
16. Sanctions are imposed for unsafe behavior	0.009	0.25	91
17. Safety meetings/training held more often for supervisors	0.009	0.23	106
18. Reasonable cause drug testing conducted	0.012	0.22	106
19. Criteria for assigning full-time field safety rep to a job	0.016	0.22	95
20. Field workers attend safety dinners	0.016	0.21	106
21. Toolbox safety meetings are held daily	0.023	0.20	105
22. % revenue fm Local Public sector	0.028	0.20	90
23. % of foreign revenue	0.031	0.20	90
24. How is personnel protection paid for?	0.033	0.18	105
25. Number of full-time field safety reps	0.035	0.18	100
26. Safety awards are given to project mgr	0.053	0.16	104

Table 13
A Large Construction Firm is Clearly Safer When the Firm:

1. Employs a full-time safety director at the corporate level.
2. Employs at least 1 full-time field safety representative.
3. Has a substance abuse program that:
    - includes pre-hire drug testing.
    - includes random drug testing.
    - was implemented earlier.
    - includes testing for reasonable cause.
4. Has subcontractors attend safety toolbox meetings.
5. Has an incentive program that includes:
    - awarding incentives for safe completion of a project.
    - awarding incentives to workers only if the entire crew performs safely.
    - awarding safety personnel.
    - awarding project managers.
6. Holds safety dinners where the president attends.
7. Requires safety glasses to be worn at all times on job.
8. Investigates all types of accidents.
9. Conducts formal safety orientation.
10. Has a higher ratio of number of full-time field safety reps when compared to number of field hours worked, number of projects or revenue.
11. Holds safety dinners
12. Imposes sanctions for unsafe behavior.
13. Holds safety meetings/training more often for supervisors
14. Has an established criteria for assigning a full-time field safety representative to a job other than only when required by the owner/contract
15. Holds safety dinners where field workers attend.
16. Hold toolbox safety meetings daily.
17. Does no or less local public sector work.
18. Does a higher percentage of foreign work.
19. Funds personnel protection from the jobsite.
20. Employs a greater number of full-time field safety representatives.

correlation of "REV" resulted in a p value of 0.04, meaning more reviewers is better for safety.

Similarly, a few other aggregate variables were created. Under the assumption that a incentive program that offered more variety was better, one combination summed the different key elements of a firm's safety incentive program (see question 7 on the survey in Appendix A). The level of significance for this aggregate variable, which included imposing sanctions as a one possible element, was 0.002 with C = 0.35. When the same aggregate variable for multiple incentive program elements was correlated, excluding sanctions, it also resulted in a p level of 0.002, but with a lower C of 0.28. Another combination of variables which emphasized positive top management practices produced a $p < 0.017$ and $C = 0.21$, by combining the following: president attends safety dinners plus frequent job inspections from corporate level plus both president and vice president review safety reports. In addition, several other combinations were tried with a goal of defining a group of variables that would describe those firms with the strongest safety cultures. The best combination resulted in $p < 0.001$ and $C = 0.37$, which included the following variables: multiple incentive program elements, sanctions, safety glasses worn at all times, both president and workers attend safety dinners, and multiple levels review safety reports.

Several other variables had a level of significance between 0.05 and 0.10, when correlated with the 1995 injury rate as a dependent variable. These, as well as all significant individual and combination variables are listed in Table 14.

Regression Analysis

Regression analysis was performed on several of the variables having the strongest correlations with injury frequency. The objective was to define a model equation that would predict injury rates in large construction firms. The stepwise regression was used to accomplish this analysis by establishing the best fit equation for predicting the dependent variable (injury rate) by placing into the equation the most influential independent variables, one variable or "step" at a time. The R-squared value, given by the program, is a measure of model effectiveness. An $R^2 = 1$, means

Table 14 (Part I of III)
Kendall's Correlation Test for Entire Sample
1995 Injury Rate = Dependent Variable

INDEPENDENT VARIABLE	P value	C value	CASES
1. Average injury rate for 3 years	0.001	-0.87	106
2. Injury rate in 1994	0.001	-0.77	106
3. Injury rate in 1993	0.001	-0.70	106
4. Firm has a full-time corp safety director	0.001	0.43	106
5. Firm employs at least 1 full-time field safety representative	0.001	0.39	100
6. Pre-hire drug testing conducted	0.001	0.38	106
7. Subcontractors attend safety meetings	0.001	0.37	106
8. Aggregate safety culture variable[9]	0.001	0.37	98
9. Random drug testing conducted	0.001	0.33	106
10. Incentives are awarded for safe project completion	0.001	0.31	106
11. President attend safety dinners	0.001	0.30	105
12. Are safety glasses req'd to be worn at all times on job?	0.001	0.30	105
13. Both president & workers attend safety dinners	0.001	0.30	101
14. Which types of accidents are investigated?	0.001	0.29	106
15. Several elements marked (incl sanctions) as key to a firm's incentive program[10]	0.002	0.35	67
16. Size of firm w/ revenue divided into 5 groups	0.002	-0.28	106
17. Firm's incentive program consist of multiple elements (except sanctions)[11]	0.002	0.28	104
18. Experience Modification Rate (EMR) in 1993	0.002	0.28	97
19. Formal safety orientation given	0.002	0.27	106
20. When was drug testing implemented in your firm?	0.003	0.29	88
21. Ratio of # of full-time field safety reps to field hours worked	0.003	-0.28	100
22. Number of field employee hours in 1995	0.003	-0.27	106

[9] Aggregate Culture (CULTURE0) = Multiple home office positions review safety reports (REV) + Firm's incentive program based on multiple elements (ELEMENTS) + Both workers & president attend safety dinners (BOTHWP) + Safety glasses worn at all times (GLASWORN). Note actual variable name used in definition file is shown in ( ).

[10] Aggregate incentive variable (ALLKEYS) = (ELEMENTS) + (SANCTIONS)

[11] Aggregate inventive var (ELEMENTS) = Progressive type awards (PROGRESS) + Lottery type awards (LOTTERY) + Safe project completion awards (COMPPROJ) + Awards based on min. injury rates (ACHLEVEL) + Other award program elements (KEYOTHER)

Table 14 (Part II of III)

INDEPENDENT VARIABLE	P value	C value	CASES
23. Number of field employee hours in 1994	0.003	-0.27	104
24. Number of field employee hours in 1993	0.005	-0.25	104
25. What is average number of field employees?	0.005	-0.25	102
26. Awards to workers are crew based	0.006	0.27	102
27. Company holds safety dinners	0.007	0.24	105
28. Safety awards given to safety personnel	0.007	0.24	104
29. Sanctions are imposed for unsafe behavior	0.009	0.25	91
30. Experience Modification Rate (EMR) in 1994	0.009	0.24	95
31. Supervisors hold safety meetings/training more often	0.009	0.23	106
32. For reasonable cause drug testing conducted	0.012	0.22	106
33. The firm's approx. annual volume in millions	0.012	0.22	106
34. Average EMR for past 3 years	0.013	0.23	92
35. Criteria for assigning full-time field safety rep to a job	0.016	0.22	95
36. Field workers attend safety dinners	0.016	0.21	106
37. Award program consist of elements & position types[12]	0.017	0.21	103
38. Aggregate top management support variable[13]	0.017	0.21	98
39. Toolbox safety meetings are held daily	0.023	0.20	105
40. % of firm's revenue fm Local Public sector	0.028	0.20	90
41. % of firm's revenue from Non US sector?	0.031	-0.20	90
42. How is personnel protection paid for?	0.033	0.18	105
43. Number of full-time field safety reps	0.035	-0.18	100
44. Multiple staff levels & departments review safety reports from projects	0.040	0.17	106
45. Average number of projects in progress?	0.04	-0.17	101
46. Experience Modification Rate (EMR) in 1995	0.049	0.17	93

[12] Aggregate incentive var. (PROGRAM) = (ELEMENTS) + Multiple positions receive awards (MANY)

[13] (TOPMGMT) = Presidents attend dinners (DIN1) + Frequent corporate level job inspections (INSP) + pres & vp review project safety reports (PRESVP)

Table 14 (Part III of III)

INDEPENDENT VARIABLE	P value	C value	CASES
47. Both President & VP review safety reports from projects.	0.053	0.16	106
48. Safety awards are given to project mgr	0.053	0.16	104
49. What is min size job that has a first aid station?	0.056	0.19	106
50. Firm's safety incentive program has other key element	0.059	0.15	106
51. Corp safety director hire field safety reps	0.059	0.15	104
52. Policy-suspend after first failure of a drug test	0.063	0.15	105
53. All new salaried employees receive safety orientation	0.065	0.15	106
54. All new sub contractor employees receive safety orientation	0.065	0.15	106
55. Vice-president reviews project safety reports	0.067	0.15	106
56. Firm has safety incentive program	.074	0.14	106
57. Firm has substance abuse testing program	0.077	0.14	106
58. Post accident drug testing conducted	0.079	0.14	106
59. No. of jobs have full-time first aid pers	0.080	0.16	81
60. Safety incentive program is lottery type	0.08	0.14	105
61. Awards given to many positions & levels	0.08	0.14	104
62. Treatment recommended, but not at company expense	0.082	0.14	105
63. Field safety personnel trained in first aid	0.086	0.13	106
64. Percentage of jobs have full-time first aid personnel	0.090	0.15	77
65. Field supervisors are evaluated on safety performance	0.090	0.13	106
66. Treatment offered at co. expense	0.09	0.13	105
67. How many near misses were documented in 1995?	0.096	-0.17	58
68. Treatment offered at co. expense, employee terminated if they refuse treatment	0.096	0.12	105
69. Firms reporting > 45 near misses in 1995	0.098	0.17	58
70. Follow-up drug testing conducted	0.098	0.13	106
71. Operations Mgr reviews project safety reports	0.10	0.13	106
72. How are investigation reports distributed?	0.108	0.12	100

the variables in the equation exactly predict the dependent variable. In this analysis, the dependent variable is the 1995 injury rate. First, the resulting R-squared values for each independent variable in the equation by itself are shown in Table 15. Each variable name is also defined in Table 15 and can be referred to whenever a variable name (designated by all CAPITAL LETTERS) is encountered in this portion of the text.

Various combinations of the variables listed in Table 15 were analyzed. The highest R-squared value achieved was 0.48. An $R^2 = 0.48$ is relatively high considering the multitude of factors which effect construction safety and the variability found to exist within the various size categories of the sample. Listed in Table 16 is the combination of variables found to derive an $R^2 = 0.48$. Even though the variables FULLTIME ,NOREPS and YEARTEST were not actually a part of the final equation, as part of the possible combination they were necessary to achieve an $R^2 = 0.48$. Other regression models were found to achieve an R^2 value of similar magnitude (see Table 17).

The regression analysis thus far was purposely restricted to variables within a firm's control because the entire premise for conducting this study was to identify practices that can help construction firms improve safety performance. However, looking at it from a third party perspective, predicting a firms future safety performance could be very useful for owners concerned about safety and insurance companies. The single best variable to predict the 1995 injury rate is to use the 1994 injury rate (which has an R^2 value of 0.60 by itself). Using the "Step" program function, the best model found for a combination of variables including the 1994 and 1993 injury rates obtained an R^2 value of 0.75, see Table 18.

Table 15
Regression R-squared Values
1995 Injury Rate = Dependent Variable

INDEPENDENT VARIABLE	R^{2*}	P value	C value
1. FULLTIME-full-time corp. safety dir.	0.18	0.001	0.43
2. NOREPS-at least 1 full-time field safety rep employed	0.15	0.001	0.39
3. PRESCREN-Pre-hire drug testing	0.15	0.001	0.38
4. SUBMTGS-Subs attend safety mtgs	0.13	0.001	0.37
5. RANDOM-Random drug testing	0.11	0.001	0.33
6. COMPPROJ-Incentives are awarded for safe project completion	0.10	0.001	0.31
7. RATHRS-Ratio of Full-time Field Safety Reps to Field Hours Worked	0.10	0.001	0.28
8. PRESATTD-Pres attends safety dinners	0.09	0.001	0.30
9. GLASWORN-Safety glasses required to be worn at all times on job	0.09	0.001	0.30
10. TYPINVES-Type accident investigated	0.08	0.001	0.29
11. YEARTEST-Year drug testing started	0.08	0.003	0.29
12. TYPORIEN-Formal safety orientation	0.07	0.002	0.25
13. SAFPERS-Awards given to safety pers	0.06	0.007	0.24
14. SANCTION-Sanctions are imposed	0.05	0.009	0.25

Table 16: "Stepped" Regression Equation Using Only Controllable Variables

VARIABLE	"STEPPED" R^2
1. PRESCREN	0.24
2. GLASWORN	0.40
3. SANCTIONS	0.44
4. PRESATTD	0.48
5. NOREPS	-
6. YEARTEST	-

Table 17: "Stepped" Regression Equation Using Only Controllable Variables

VARIABLE	"STEPPED" R^2
1. FULLTIME	0.19
2. PRESCREN	0.28
3. GLASWORN	0.39
4. SANCTIONS	0.43
5. PRESATTD	0.47
6. YEARTEST	-

* R^2 values computed for the independent variable as the only variable in the regression equation used to explain the dependent variable.

Table 18: "Stepped" Regression Equation (Including 1994 Injury Rate)

VARIABLE	"STEPPED" R^2
1. RATE94	0.60
2. FULLTIME	0.71
3. RANDOM	0.74
4. GLASWORN	0.75

1995 Injury Rate vs. All Variables by Firm Size

It was believed that specific variables might have a more profound effect when restricting the firms by size. Therefore, the firms were isolated into the five pre-established size categories and Kendall's Correlation test was performed against all variables for each category. The findings are summarized in Table 19. Table 19 also shows the analysis result for the entire sample so that a comparison can be readily made. Table 19 indicates a significant correlation level with two asterisks, "**"; and tendency toward significance with one asterisk, "*". In addition, a plus sign, "+", allows the reader to quickly find relationships which were stronger than those found using the entire sample and "x" indicates opposite outcomes to that expected. Some of these more significant relationships are discussed in the following paragraphs. For ease of explanation the size groupings will be referred to as 1, 2, 3, 4, and 5. Note that most of the analysis for groups 4 and 5 was based on 10 to12 cases.

Significant findings found on Part I of Table 19 are reviewed first. Having a full-time safety director at the corporate level was significant for the two smallest size categories but not for the larger firms. The larger firms were noted to almost always have such a position staffed. Groups 1, 2 and 3 also had better safety records when the field safety representative reported to the corporate safety director. Those firms in Group 3 which indicated having a criteria for assigning a field safety director to a job, were safer. Having an incentive program was more important for the smaller firms than for the entire sample. Firms in Group 4 which gave awards to the foreman, had a very strong relationship to better injury rates ($p < 0.005$, $C = 0.77$). Group 4 also shared a marked improvement over that of the entire sample for awards given to safe

Table 19 (Part I of V)
Level of Significance Results for all Variables (by Total Sample & Restricting Variables to Size Categories 1-5) when Correlated with 1995 Injury Rate as Dependent Variable

INDEPENDENT VARIABLE	All	By Revenue (5 = largest firms)				
		1	2	3	4	5
Does firm have full-time corp safety director?	.000	**	**			
To whom corp safety director reports?				+*		
Number of full-time field safety reps?	.035	**				
Does corp safety director hire field safety reps	.059	*				
To whom field safety director reports		+**	X*			+**
Criteria used to assign field rep to job				+**		
Do field rep have authority to stop work						
Does firm have safety incentive program?	.074	+**	*			
Safety awards are given to workers						
Safety awards are given to foreman					+**	
Safety awards are given to superintendents						
Safety awards are given to safety personnel	.007		*		+**	
Safety awards are given to project manager	.053		*		+**	
Safety awards are given to others			+**			
Awards given to individuals of safe crews	.011				+**	
How often is individual worker award given?						
Frequency of award to worker is a combination (i.e. monthly & annually)[14]				*		
How often is superintendent award given?						
Sups safety bonus potential of mo salary				+**		+*
Sup bonus bracketed				+**		
% of field labor cost budgeted for safety awards"						
% of contract cost budgeted for safety awards"						
Safety incentive program is progressive type						
Safety incentive program is lottery type	.08					
Are sanctions imposed for unsafe behavior	.009	*	*			
Incentives are awarded for safe proj completion	.001		**			

"*" - indicates tendency toward significant
"**" - indicates significance
"+" - indicates improvement over entire sample
"X" - indicates outcome opposite to expected

[14] An aggregate variable.

Table 19 (Part II)

INDEPENDENT VARIABLE	All	By Revenue (5 = largest firms)				
		1	2	3	4	5
Award is based on achieving min injury freq levels"						
Other key to firm's safety incentive program	.059					
Firm's incentive program consist of Multiple element[1]	.002		**			
Field supervisors evaluated on safety performance?"	.09	+*				
Are field safety personnel trained in first aid?	.086					
How many jobs have full-time first aid pers(in %)?"	.09		*			+*
How many jobs have full-time first aid personnel?	.08					
Does firm communicate safety to employee families?						
Describe how communicate safety to families		+*				
What is min size job that has a first aid station?	.056			+**		
How often are accident reports fwd to corp level?		x*		x**		+**
Are toolbox meetings held on the jobsite?						
How often are toolbox meetings held?		+**				
When are toolbox meetings held?						
Safety person involved in toolbox meetings			x**			+**
Do subcontractors attend safety meetings?	.001	*	**			*
Are safety meetings-training held for supervisors?						
How often are supervisors meetings(training) held?	.009				+**	**
Is safety reflected in firm's mission statement?						
Is hazard analysis study done prior to each major phase of work?						
Type of safety orientation new hires receive?	.005		*		+**	
All field employees receive safety orientation						
All new salaried employees rcv safety orientation	.065		*			
All new field employees receive safety orientation						
All new sub employees receive safety orientation	.065		+**			+**

Table 19 (Part III)

INDEPENDENT VARIABLE	All	By Revenue (5 = largest firms)				
		1	2	3	4	5
All employees are given safety orientation						
Others that are given safety orientation						
Does the company have safety dinners?	.007		**			*
Does president attend safety dinner?	.001	*	**	*		
Do field workers attend safety dinners?	.016					
Both workers & pres. attend safety dinners[1]	.001					*
Does firm have a substance abuse testing program?	.077	+**				
Pre-employment Screening drug testing conducted	.000	+**				
Random drug testing conducted	.000	**			+**	
For reasonable cause drug testing conducted	.012	**		*		
Post accident drug testing conducted	.079					
Blanket drug testing conducted						
Follow-up drug testing conducted	.098	+*				x*
What % test positive on pre-employment screening?				+**		+**
Policy-terminate for first failure of a drug test						
Policy-terminate for repeat failure of drug test		+**				
Policy-suspend after first failure of a drug test	.063		*			
No. of days suspended for failure of a drug test						+**
Other policy for failure of a drug test						
Treatment offered at co. expense, employee terminated for repeat drug test failure						
Treatment offered at co. expense, employee terminated if they refuse treatment	.096					
Treatment recommended, but not at company expense	.082					
Treatment offered at co. expense (either of the 2 previous variables answered "yes")[1]	.09					
Treatment not considered, drug abusers are terminated						
Other treatment policy for failure of a drug test						
Year drug testing implemented by firm	.003		**			
How often does corporate office inspect the jobsite?				+**		

[1]An aggregate variable.

Table 19 (Part IV)

INDEPENDENT VARIABLE	All	By Revenue (5 = largest firms)				
		1	2	3	4	5
President reviews project safety reports					x**	x**
Safety dept reviews project safety reports						
Vice-president reviews project safety reports	.067					
Operations Mgr reviews project safety reports	.10					
Various Dept Heads review project safety reports						
Others reviews project safety reports		x**				
Both pres. & VP review proj. safety reports[1]	.053				*	
Summary corp accident report provided to all jobs?						
Which types of accidents are investigated?	.001		**	**		
Safety pers is responsible for investigating accidents?				+**		
Multiple personnel investigate accidents[1]						
How are investigation reports distributed?	.108					+*
The firm's annual volume in millions?	.012					
Average number of projects in progress?	.04	*				
% of firm's revenue from Private sector?						
% of firm's revenue fm Local Public sector?	.028					
%of firm's revenue from State sector?				+**		
% of firm's revenue from Federal sector?						+*
% of firm's revenue from all public type proj				+**		
% of firm's revenue from Non US sector?	.031					x*
Sub's contractually obligated to comply safety requirements?						
What is average number of field employees?	.005		*			
Does your company provide safety glasses?						
Are safety glasses req'd to be worn at all times on job?	.001	*				
How is personnel protection paid for?			x**			+**
Are near misses documented?				+**	+**	
How many near misses were documented in 1995?	.10 X	x**				
Number of near misses > 45 for 1995	.098					

[1]An aggregate variable.

Table 19 (Part V)

INDEPENDENT VARIABLE	All	By Revenue (5 = largest firms)				
		1	2	3	4	5
Does your company publish a newsletter?						
How often is newsletter published?						
How often is safety a topic in newsletter?						
Firm's trend with accident litigation cases.			X*	+**		
Rate support safety dept receives from top mgnt?						
Number of lost workday cases in 1995		+*		+**		
Number of lost workday cases in 1994	*					
Number of lost workday cases in 1993	*					
Number of restricted workday cases in 1995	*					
Number of restricted workday cases in 1994	*	*		*		
Number of restricted workday cases in 1993	*			*		
Number of OSHA recordable cases in 1995		**				
Number of OSHA recordable cases in 1994	*		*			
Number of OSHA recordable cases in 1993	*	*				
Number of field employee hours in 1995	.003	**	**			
Number of field employee hours in 1994	.003	**	*		*	
Number of field employee hours in 1993	.005	**	*		*	
Experience Modification Rate (EMR) in 1995	.049					
Experience Modification Rate (EMR) in 1994	.009		*	**		*
Experience Modification Rate (EMR) in 1993	.002		**	**	*	*
Average EMR for past 3 years			*	**		
Firm requested Summary Report						
Size of firm w/ revenue divided into 5 groups	.002					
Injury rate in 1994	.000	**	**	**		
Injury rate in 1993	.000	**	**	**		
Average injury rate for 3 years	.000	**	**	**		
All incentive program elements w/ sanctions[1]	.002				**	
Multiple positions receive awards[1]	.080					
Incentive program = multiple elements + multiple awardees[1]	.017				**	
Multiple levels review project safety reports[1]	.040				*	
Aggregate of top mgnt support for safety[1]	.017				**	*
Aggregate safety culture[1]	.000				*	*

[1] An aggregate variable.

crews ($p < 0.004$, $C = -0.47$). An almost perfect linear relationship existed for firms in the third group with respect to potential safety bonuses received by superintendents ($p < 0.008$, $C = -0.94$)[15] and safety bonuses when bracketed in ranges improved the relationship to $p < .005$ and $C = -0.96$.

On Part II of Table 19, the percentage of jobs having a full-time first aid person assigned had a strong relationship with injury rate for group 5 ($p < 0.062$, $C = -0.70$)[16]. The frequency for which accident reports are forwarded to the corporate level showed conflicting results. For both groups 1 and 3, it was negatively correlated (opposite of expected) while for group 5 it was strongly positive ($p < 0.003$, $C = 0.73$). When a safety person was involved in running the toolbox meetings, the relationship again correlated positively for group 5 and negatively for group 2 (not expected). Frequent safety training for supervisors was notable in group 4 ($p < 0.004$, $C = 0.78$). Group 4 also had a very strong link to fewer injuries when formalized orientation training was given ($p < 0.001$, -0.89). Including subcontractors in safety orientation benefited groups 2 ($p < 0.009$, $C = 0.38$) and 3 ($p < 0.036$, $C = 0.54$).

Continuing on Part III of Table 19, pre-hire drug testing had a stronger correlation with injury rate for group 2 than for the entire sample ($p < 0.001$, $C = 0.60$) and random testing was stronger for group 4 ($p < 0.001$, $C = 0.89$). The breakdown of the injury rate for group 4 random testing results is revealing: 9 firms conducted random testing with a mean injury rate of 6.48 and the 1 firm that did not had a rate of 18.20. Firms with higher percentages of job applicants testing positive correlated positively to higher injury rates for two groups (Group 3: $p < 0.019$, $C = 0.60$; Group 5: $p < 0.034$, $C = 0.60$). Group 5 was strong with respect to number of days suspended for a drug test failure ($p < 0.49$, $C = -0.99$)[17]. How frequently someone from the corporate office inspects the jobsite was significant for only Group 3 ($p < .012$, $C = 0.70$). Injury rates dropped for firms in which the president reviewed project safety reports in the two largest groups (Group 4: $p < 0.012$, $C = -0.70$; Group 5: $p < 0.048$, $C = -0.50$). This may be an indication that presidents of even

[15] Analysis based on a sample of size 5.
[16] Analysis based on a sample of size 6.
[17] Analysis based on a samples of size 3.

very large firms should take the time to review safety reports from their projects regardless of their expansiveness. The same was true for Group 1 when others (such as division managers, regional health and safety managers, corporate safety councils/committees, and all other jobs) reviewed project safety reports ($p < 0.001$, $C = -0.55$). In Group 3, it was found to be important for safety personnel to at least assist in investigating accidents ($p < 0.022$, $C = 0.51$). The injury rate increased for Group 3 in firms that did a higher percentage of public work ($p < 0.033$, $C = 0.50$); an expected consequence of competitively bid projects. It was significant for personal protection to be paid for by the jobsite for Group 2 ($p < 0.016$, $C = -0.56$) and contrarily, centrally funded from the corporation for Group 5 ($p < 0.015$, $C = 0.62$).

The effort of documenting near misses was significantly correlated with injury rate for Group 3 ($p < 0.03$, $C = 0.48$), and even more so for Group 4 ($p < 0.005$, $C = 0.77$). For Group 1, the number of near misses documented had an opposite than expected effect similar to that previously seen for the entire sample. These unexpected results may suggest that the small firms (Group 1) do not use near misses as a "warning signal" and learn from them; instead more near misses are simply an indication that more actual injuries are also occurring. The firms of Groups 3 and 4 probably have a more proactive position on investigating the cause of near misses and using this information to become safer. Reviewing the four reasons given on page 36 for the inconsistency among firms with respect to reporting and documenting near misses stated, may lend additional insight on this matter.

Finally, on Table 19 (Part V), the idea that a firm with an increasing number of safety related litigation cases, would have an problem with safety is supported by the results for Group 3 ($p < 0.01$, $C = -0.66$).

Comparison with the Harrison Study

A direct comparison with the Harrison study was performed by restricting the analysis of firms to only those in the top 25%. This percentage equated to only firms with an annual dollar volume greater than $300 million. Thirty-six respondents fit this limited size category. First, the difference of mean injury rates for the two studies indicates that the construction industry has made steady progress toward fewer

injuries. The past rate of 7.3 was reduced by 26% over 18 years to a level of 5.37. Note that the comparable 1994 and 1993 injury rates were 5.64 and 6.36 respectively. Secondly, it an be seen from Table 20 that virtually all the variable frequencies have increased over the past practices. In addition, Table 21 lists the distinguishable findings from the Harrison study along with the comparable p-values for the present study. It shows only minor similarities between the past and present.

One variable that did not influence safety in the past but was found to be statistically significant in this study was safety dinners ($p < 0.017$). Other factors found to be significantly linked to safety in this study that were not considered in the past are: (1) more frequent safety meetings/training for supervisors ($p < 0.001$), random drug testing ($p < 0.023$), dismissing employees after first failure of a drug test ($p < 0.048$), wearing safety glasses at all times on the jobsite ($p < 0.001$), documenting near misses ($p < 0.005$), when both the president and vice-president review project safety reports ($p < 0.032$), and workers attending safety dinners ($p < 0.047$).

Improving Injury Rate vs. All Other Variables

The fact that there was a noticeable improvement trend in the injury rates from 1993 to 1995 lead to the decision to correlate a firm's rate of improvement with all other variables to see if certain variables might be responsible for the improvement. Eighteen variables were significantly correlated to improving injury rates (dependent variable). These variables are listed in Table 22. Very strong positive correlations were found for the injury rates of previous years: 1993 Injury Rate ($p < 0.001$, $C = 0.75$), Average Three Year Injury Rate ($p < 0.001$, $C = 051$), and 1994 Injury Rate ($p < 0.001$, $C = 0.49$); clearly showing that the most of the firm's with highest injury rates in the past few years are also the firms that have improved the most. Perhaps the most important revelation this correlation test shows is in the area of drug testing. Several substance abuse testing variables were significantly correlated with the highest rates of improvement in safety performance. Firms having testing programs had a p level of 0.003 and $C = 0.27$. Since over half of the firms implemented their programs

Table 20
Comparison of the Percentage of Firms Conforming to Each Practice

VARIABLE		HARRISON	CURRENT
Percentage of Firms that:		1978	1996
Have a Full-time Safety Director		86%	97%
Full-time Safety Director Reports to:	President	13%	56%
	Vice-president	45%	16%
	Lower Mgmt	42%	28%
Holds Safety Dinners		44%	54%
President Attends Safety Dinners[18]		58%	97%
Corporate Safety Director Hires Field Safety Reps		72%	72%
Field Safety Reps Report to Corporate Safety Dir		68%	80%[19]
All jobs Have a First Aid Station		44%	30%
Give Formal safety Orientation		56%	92%
Give Safety Awards to:	Workers	48%	91%
	Foremen	60%	80%
	Superintendents	71%	83%
	Safety Personnel	27%	60%
Forward Accident Reports to Home Office Daily		76%	81%
The President or Vice-pres Reviews Safety Reports		53%	79%
Pay for Personnel Protection from Jobsite		94%	89%
Have Corporate Level Jobsite Inspections:	Monthly	39%	74%
	Quarterly	25%	9%

[18] Applies where firms hold safety dinners.
[19] 23% of this figure represents firms where the field safety rep. reports to both the corporate safety director and either the superintendent or the project manager in a dual chain of authority.

Table 21
Comparison of Correlation Test P-value Results for Each Practice
Dependent Variable = Injury Rate

VARIABLE	HARRISON 1978	CURRENT 1996
Minimum Size Job w/ Full-time Safety Director	0.02	na
Does Corporate Safety Dir Hire Field Safety Reps?	0.01	0.21
Do Field Safety Dir Train Their Subordinate Workers	0.02	na
Safety Director Reports to President or Vice-pres.	0.10	0.09
Firm Hold Formal Safety Orientation	0.04	0.10
Safety Awards are Given to Workers	0.09	0.38
Safety Awards are Given to Foremen	0.10	0.27
Are Toolbox Safety Meetings Conducted?	0.046	All Do
Firm's Annual Dollar Volume	0.006	0.16

in the past five years, indicates that drug testing has an impact on safety for several years once initiated by a company. Other significant drug testing variables had the following correlation results: Number of days worker is suspended for a drug test failure ($p < 0.001$, $C = 0.89$)[20], post accident testing ($p < 0.03$, $C = 0.19$), and reasonable cause testing ($p < 0.042$, 0.17). The combination of all these outcomes plus the fact that most of these drug testing practices were probably implemented in the past few years is strong evidence that drug testing improves safety performance.

Other variables that had a strong correlation with injury rate improvement are: better safety communication to employee families ($p < 0.32$), accident reports forwarded more often to corporate level ($p < 0.035$), and holding safety training more often for supervisors ($p < 0.036$). As was stated earlier, firms with the highest (worst) rates have also shown the most improvement. This being the case, one can speculate the reason these variables have recently improved safety is that the firms have

[20] Based on a sample size of 9.

Table 22
Correlation Test for Entire Sample
Improving Injury Rate = Dependent Variable

INDEPENDENT VARIABLE	P value	C value	CASES
1. Injury Rate 1993	0.001	0.75	103
2. Average injury rate for 3 years	0.001	0.51	103
3. Injury Rate 1994	0.001	0.49	103
4. EMR 1993	0.001	0.38	96
5. No. of days suspended for failure of drug test	0.001	0.89	9
6. Average EMR for past 3 years	0.001	0.34	91
7. Summary corporate accident report forwarded to all jobs	0.001	0.30	103
8. Firm has a substance abuse testing program	0.003	0.27	103
9. EMR 1994	0.014	0.23	94
10. Both president and VP review project safety reports	0.017	0.21	98
11. Vice-president reviews project safety reports	0.021	-0.20	103
12. Firm conducts post accident testing	0.030	0.19	103
13. Describe how communicate safety to families	0.032	0.28	43
14. How often are accident reports forwarded to corporate level?	0.035	0.18	10
15. How often are safety meetings/training held for supervisors	0.036	0.18	101
16. Test for reasonable cause	0.042	0.17	103
17. EMR 1995	0.044	0.18	91
18. Safety awards given to others	0.051	-0.15	101
19. Safety person involved in running toolbox meetings	0.071	0.14	103
20. Multiple levels review project accident	0.076	-0.14	103
21. Aggregate top mgnt support for safety	0.079	-0.15	95
22. President reviews project safety reports	0.080	-0.14	103
23. Percent of field labor cost budgeted for safety	0.092	0.32	19
24. Superintendent potential safety bonus	0.099	0.23	32
25. Both pres. & VP review project safety reports	0.10	0.13	106
26. How are investigation reports distributed?	0.108	0.12	100

instituted the following corrective measures in the past few years to counteract the fact that they have poor safety records: corporate level reviews accident reports more often and supervisors are trained and discuss safety at meetings more often. Another way to view these findings is that these administrative actions are essential practices that lead to continuous improvement in a firm's safety performance. This concept appears to be more valid for the practice of holding frequent safety meetings/training for supervisors because this variable also had a strong correlation to the 1995 injury rate; meaning that these firms have good (low) injury rates and still show strong signs of making them even better (high rate of improvement).

Other Correlations

Other types of correlations were performed of which some will be mentioned briefly. All variables were checked against the 1995 lost-time injury rate and the 1995 restricted injury rate. For many variables, similar relationships to that of the 1995 recordable to were found (but to a lesser degree of significance) when lost-time injury rate was the dependent variable. Restricted injury rate as the dependent variable had very little in common with recordable rate findings. This outcome is understandable because the correlation results between the recordable rate and the lost-time rate was $p < 0.001$, $C = 0.57$; and between the recordable rate and the restricted rate was $p < 0.013$, $C = .24$.

It was also intended to run correlations using EMR as the dependent variable. However, it was later decided that the injury rate was the most accurate measure of safety and ,therefore, only the different types of injury rates were compared separately to all another variables by computing a correlation coefficient.

5. CONCLUSIONS

This study has shown many practices of large construction firms that directly influence safety performance. The findings are conclusive in several areas where only inconsistent research findings previously existed. In addition, some findings confirm that practices previously found to improve safety for the construction industry as a whole, also hold true for large firms. Finally, this research effort provides a comprehensive insight into what a typical safety program consists of for large construction firms.

Three broad reoccurring themes associated with improving safety performance are prevalent in large construction firms. They are: commitment from the top, communicating the importance of safety, and continuous coordination and improvement.

Indications of positive top management support and strong safety philosophies were present in large construction firms surveyed. First, all but 3 firms had safety as part of their company mission statement. Other signs of top down involvement in safety were: frequent jobsite inspections by corporate level personnel, review of project safety reports by the company vice-president, daily forwarding of accident reports to the corporate level, and presidents attending safety dinners for most of the firms which held them. Finally, most safety departments felt they received outstanding support from top management.

When safety program elements were compared to company injury rates, numerous factors clearly contributed to better safety performances. A definite asset to large construction firms is a professionally trained safety organization. One party, namely the corporate safety director, whose sole purpose is to focus on only company safety programs is vital to a large organization's success. There were 15 respondents that did not have a full-time corporate level safety director. Only 4 (2 of which had a part-time corporate safety director and another had a safety consultant on retainage) of these 15 firms had a mean injury rate below the average for the entire sample . The safety director spearheads many of the practices that amplify a firm's safety awareness

and culture. In addition, the authority vested in the position, along with experience and knowledge, enables the corporate safety director to guide and champion upper management which can foster top-down commitment.

Next, is the field safety director, who clearly makes a difference through proper coordination at the project level. This is accomplished by: conducting routine inspections, ensuring toolbox meetings are effective, conducting jobsite training, and assisting the superintendent and project manager to integrate safety into the daily planning and routine of all workers. At the project level, company-wide policies that require (1) subcontractors to attend safety toolbox meetings, (2) safety glasses to be worn at all times on the job, and (3) investigation of all accidents regardless of the seriousness; were all found to be essential practices which reduced injury rates. Subcontractors are undoubtedly present at all important construction planning meetings and the same should hold true for toolbox meetings. Subcontractors that are not kept abreast of upcoming project events/changes and their associated potential hazards, are not only at risk themselves but also place all other workers in danger including those employed by the general contractor. The requirement to wear safety glasses at all times is an example of a relatively simple practice that can pay big returns for jobsite safety. It should be obvious that more than just eye injuries are being prevented by this policy. So what exactly is happening here to cause such a significant reduction in the injury rate. It could be theorized that enforcing a rule of this sort strengthens a firms safety culture. Perhaps a worker is reminded of safety and realizes safety is important at this company every time a pair of glasses are donned. This rule may also be indicative of numerous other practices and policies that such firms enforce that impact safety. Regardless, its effect is clearly far-reaching. It is not known from this study, whether or not the practice of always wearing safety goggles is a relatively recent practice implemented by most firms or if the impact of this policy will have lasting effects.

Two program areas were explored in detail by this study: (1) incentives and (2) substance abuse. No previous studies in these areas have conclusively linked the practices to fewer injury frequencies. What this study did that most others failed to do

was look at specific aspects of each of the programs in order to determine what constitutes an effective program.

Firms that have substance abuse programs in general were only found to have a tendency toward safer performance. However, certain aspects such as pre-hire and random testing were found to be a must for a substance abuse program to be effective. In addition, it can be concluded from this study that reasonable cause testing is also an effective component of the testing program. An explanation for this may be that current workers are not subject to pre-hire testing and some abusers may be willing to gamble against the odds that their name will not come up for random testing. However, with reasonable cause testing a worker could be singled out at anytime and thus can be an effect deterrent. The final convincing finding about substance abuse programs was that firms with more established substance abuse programs were clearly safer. The combination of these findings in the area of substance abuse suggest persuasive evidence that not only is drug testing effective but that the effects of commencing such a program takes a few years to weed out the "bad apples" or drug abusers. This process of elimination can occur through employee dismissals or perhaps the conversion of abusers to non-abusers. Short term improvement may be contingent on what happens in the first year after implementation. For instance, if during the first year no current employees test positive (by chance or because the firm is already quasi drug free) and only a few new applicants test positive, then it is likely that little noticeable improvement in safety will result. However, if a number of current employees or someone well known and respected (such as a general foreman) losses their job as a result of a positive drug test, then testing implementation is more likely to change the behavior of a higher percentage of workers. This behavior change would likely be reflected in an immediate improvement in a firm's injury rate. In summary, substance abuse is a problem in construction, it can be successfully combated through an affective substance abuse program, and drug testing has a positive impact on safety for several years once initiated.

The use of incentive programs can be effective to communicate the importance of safety to the workforce. Firms that used incentives again tended to be safer.

However, a few specific aspects of incentives were found to be significant. The program element most conclusively linked to good safety performance was awarding incentives for safe project completion as opposed to awarding incentives only at preset reoccurring intervals (such as monthly, quarterly, annually). Two possible explanations are offered for this result: (1) safety is a team effort and unless the overall project safety record is satisfactory it is likely that no one will receive awards, and (2) perhaps project completion is a more tangible and meaningful milestone for workers to associate safety with than say receiving an award every month, quarter or year. It is at project completion when workers see the fruits of their labor. Accompanied with this event typically would be an overwhelming sense of accomplishment and pride. Couple this with the gratitude and recognition for doing it safely, awards at project completion perhaps have a more influential and longer lasting effect on workers. The giving of awards to workers for safe performance on a crew basis instead of an individual basis, was another critical aspect of an effective incentive program. Moreover, it can be concluded from this study that individual-based awards, by themselves, have a negative impact on safety because the injury rates associated with-crew based awards were significantly. Also, the injury rates for firms having no incentive program were 6% less. Lastly, giving awards to safety personnel and project managers were found to be important.

Communicating the importance of safety to all employees is paramount in a construction firm. The use of sanctions communicates a clear message that unsafe behavior will not be tolerated. Other means of communication is through effective training and awareness practices. Safety dinners, formalized orientation for newly-hired workers, and more frequent safety meetings/training for supervisors are all effective safety program elements. This study also shows the importance of the company president attending safety dinners. Workers by themselves attending safety dinners are also very important, but did not have quite as high of a level of significance as when only the president or when both the president and the workers attended. Many large firms may have difficulty in managing to hold safety dinners due to the widespread dispersion of projects, as evidenced by the fact that less than half of the

firms used them. Some firms indicated that they held dinners at the project level and at the corporate level. Something similar to this arrangement is managed by the very largest firms studied because all 6 firms in this size category that held dinners stated both the workers and the president were in attendance.

Finally, using the Harrison study as a benchmark, it can be concluded that 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. Top management involvement in safety matters has increased tremendously. The notable improvement in safety performance can be attributed to these changes, as well as the introduction of drug testing programs.

More recently, firms with the worst safety records are the firms that have improved the most in the past three years; establishing a promising trend for the near future. Furthermore, large firms with good safety records in the recent past are very likely to carry that trend forward into the near future. This consistency in performance is one of the many rewarding benefits of having formalized safety programs and procedures. Practices found by this study to positively influence safety in large construction firms may improve safety performance in smaller companies.

6. RECOMMENDATIONS

The recommendations covered in this section are oriented to construction contractors, interested third parties of construction firms, and further research. Some third party examples: prospective clients, employees and investors; as well as insurance and bonding agencies. For a reliable prediction of a firm's short term future outlook on safety of a firm, it is recommended that the following prioritized items be checked:

1. The firm has a good safety record for the past few years and shows no signs of a negative trend.
2. Professional safety staffing consist of a safety director at the corporate level and one or more field safety representatives.
3. A substance abuse program is well established and consists of pre-hire, random and reasonable cause testing.

From a construction firm's point of view, this study has identified numerous factors which improve safety performance. The first two recommendations follow items 2 and 3 above. One way to be committed to safety is to endorse a structured safety organization by employing a team of safety professionals. It is an absolute must that firms that do greater than $40 million in annual revenue staff a full-time safety director position at the corporate level. Second, it is highly recommended that all firms of this size hire at least one full-time field safety director. If a firm already employs a full-time corporate safety director and yet the safety record is not acceptable with little signs of improvement (a good relative assessment starting point might be to consider that the mean OSHA recordable 1995 injury rate for this study was 7.86 and the mean rate for firms with full-time safety directors was 6.98), then a hard look should be taken and a minimum of two possible questions answered: (1) Is the current safety director qualified, capable and performing? (2) Is the necessary support, commitment, and proper direction coming from the top?

For firms that have jobs more geographically dispersed, it is recommended that additional field safety representatives be employed to cover geographical regions that are limited based on number of jobs, job complexity, and distances between jobs.

Specific criteria should be created for determining when to assign a full-time safety director to one job or at least each job should be reviewed independently to determine if such a position is warranted. Finally, the corporate safety director should be involved in hiring the field safety employees.

For large construction firms that do not currently have a substance abuse program, it is highly recommended that a program be initiated as soon as practical. A start-up program or an existing program that is to be effective at reducing injuries should include at least pre-hire, random and reasonable cause testing.

Incentive programs can improve safety performance. The following practices are recommended to ensure a higher rate of success is achieved through use of incentives: (1) recognize safe performance at the completion of all projects that have been executed safely, (2) avoid awarding individuals unless they are part of an entire crew that has performed safely, (3) in addition to the field workers, award field safety personnel and project managers for their efforts in a successful project, and (4) listen to employees, if something about the awards program is affecting worker morale or is in of change. In addition, negative reinforcement for unsafe behavior can be constructive. Therefore, it is recommended that sanctions be used consistently and fairly, especially when the unsafe act is a deliberate violation of established safety procedures.

A periodic social gathering such as a safety dinner, to formally recognize the company's successes in safety, is also highly recommended. Both the firm president as well as the workers should attend in order to optimize the effectiveness of this event.

Two improvements on the standard safety toolbox meeting are strongly recommended. First, ensure that any subcontractors with ongoing work are always participants; and second, consider holding toolbox meetings as often as daily rather than weekly especially during periods of high activity. Two other recommendations that involve training are for firms to conduct: (1) formalized safety orientation for new employees and (2) more frequent safety training/meetings for supervisors. The thorough and consistent coverage of all aspects of safety can be achieved with a formalized orientation process. A large construction firm that holds supervisory safety

training annually or quarterly will likely achieve substantial benefits from supplementing this with monthly or weekly safety meetings for supervisor. These meetings can be relatively brief because of their being held more often. One recommendation might be to tack this safety meeting onto the front-end or the tail-end of an existing monthly or weekly operations planning meeting. A number of things could be accomplished at these meetings, such as: sharing of relevant safety information from other projects, conducting refresher training in specific areas, disseminating lessons learned from accident investigations, and it is an ideal opportunity for top management to keep safety at the forefront of the minds of supervisors. Include at the supervisory safety meetings a discussion of the implementation of policy changes. Two such policy changes (if not current practices already) that are highly recommended are that all accidents be investigated and that safety glasses be worn by everyone (including visitors) at all times while on the jobsite.

Firm's should adopt a philosophy of "If you can't operate a construction firm safely than you shouldn't be in the construction business".

The final recommendations are suggestions for research in construction safety. This study was very successful in identifying numerous factors which impact the safety performance of large firms. Therefore, it is recommended a similar study on a larger scale be conducted on construction firms of all sizes. Specific recommendations/questions to be included in a future study of this nature are:

- What practices make for an effective orientation program?
- Does a high level official make an appearance at the safety orientation training session?
- How often are safety incentive programs reviewed for changes and when was the last time a change was actually made?
- What types of awards are given at project completion?
- Are spot awards given to all employees for innovative ideas that result in a safer work environment and what is the nature of the spot awards (cash, personal recognition)?
- Is a cost accounting system used to track the true cost of worker injuries?

- Does project profit correlate with injury rates.
- Does the company retain a safety consultant or make use of outside safety professionals?
- Is it the company's policy to hire only subcontractors with a drug testing program?
- What is the effect of unions and union training programs on construction safety.

It was noted that there were a few firms that seem to defy the odds by not conforming to some any of the significant safety practices identified in this study yet still manage to achieve injury rates much lower than the mean. Follow-up research on these special cases to determine what is uniquely effective in their organization may be warranted. The research may require one on one interviews with employees of these firms and/or specific jobsite visits. Additionally, it might prove interesting to interview firms that have implemented policies such as wearing safety glasses at all times and compare the results between firms with a low injury rate to firms with a high injury rate.

The final area of further research involves drug testing. The notion that drug testing has a delayed effect on improving construction safety hints at an explanation of why previous studies were unable to conclusively find that implementation of drug testing significantly reduced worker injuries. For example, the study performed in 1992 by Saleh Altayeb only looked at the year before and the year after testing implementation. For this reason it is recommended that future research in this area be conducted for a longer time duration, including at least 5 years after testing implementation.

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APPENDIX A
A SAFETY SURVEY OF LARGE CONSTRUCTION FIRMS

1. Does your company have a full-time safety director at the corporate level? ☐ Yes ☐ No

2. To whom does the safety director report? (Position)_____

3. How many full-time field safety representatives does the company employ? _____

   A. Does the corporate safety director hire field safety representatives? ☐ Yes ☐ No

   B. To whom does the field safety director report? ☐ Corp Safety Director
   ☐ Superintendent ☐ Project Manager ☐ Other_____

4. What is the criteria used to determine when a full-time field safety director is assigned to a job?_____

5. Do the field safety personnel have the authority to stop work? ☐ Yes ☐ No

6. Does your company have a formal safety incentive program? ☐ Yes ☐ No

   A. If yes, to whom are awards given for good safety performance?

   ☐ Worker ☐ Superintendent ☐ Project Manager
   ☐ Foreman ☐ Safety Personnel ☐ Other_____

   B. Are worker safety awards given for individual safe performance or only if the crew performs safely? (Check one.) ☐ Individual ☐ Crew ☐ Both ☐ NA

   C. How often are individual worker safety awards given? ☐ Weekly ☐ Biweekly
   ☐ Monthly ☐ Quarterly ☐ Annually ☐ Other_____ ☐ NA

   D. How often are superintendent awards given? ☐ Weekly ☐ Biweekly
   ☐ Monthly ☐ Quarterly ☐ Annually ☐ Other_____ ☐ NA

   E. If a safety bonus is given to superintendents, what is the potential equivalent amount?
   _____% of one month's salary

   F. What is the approximate budget allocation for safety awards and incentives?
   _____% of field labor costs or _____% of total contract cost.

   Which of the following are key elements to your company's safety incentive program? (Check all that apply.)

   ☐ Incentive is progressive in nature (i.e. points, coupons, trading stamps etc. are earned which can be cashed in at any time for an appropriate award).
   ☐ Lottery type drawing where only safe crews/individuals are potential winners.
   ☐ Sanctions are imposed for unsafe behavior. ☐ Verbal ☐ Written ☐ Both
   ☐ Other_____
   ☐ Incentives awarded for safe completion of a project.
   ☐ Award is based on achieving performance below a prescribed injury frequency level.
   ☐ Other_____

7. Are field supervisors evaluated on safety performance? ☐ Yes ☐ No

8. Are field safety personnel trained in first aid? ☐ Yes ☐ No

9. How many jobs have full-time first aid medical personnel (i.e. Nurse, EMT, etc.)? (Approx.)_____

10. Does the company communicate safety to employee families? ☐ Yes ☐ No

    If yes, describe briefly:_____

    _____

11. What is the minimum size job that has a first aid station? (Approximate)_____

12. How often are accident reports forwarded from the job site to the corporation level?
    ☐ Daily ☐ Weekly ☐ Monthly ☐ Quarterly ☐ Yearly

13. Are toolbox (safety) meetings held on the jobsite? ☐ Yes ☐ No

    If yes, how often are they held? ☐ Weekly ☐ Biweekly ☐ Other_____

    A. When are they held? (Check one.)
    ☐ Monday ☐ Tuesday ☐ Wednesday ☐ Thursday ☐ Friday ☐ Varies

    B. Who presides at these meetings? (Check one.)
    ☐ Assigned worker ☐ Foreman ☐ Safety man ☐ Job Supervisor ☐ Other

    C. Do subcontractor workers attend safety meetings? ☐ Yes ☐ Hold their own ☐ No
    ☐ Other_____

14. Are safety meetings/training sessions held for supervisors? ☐ Yes ☐ No

    If yes, how often are they held? ☐ Weekly ☐ Monthly ☐ Quarterly
    ☐ Annually ☐ Other_____

15. Is safety reflected in your company's general policy or mission statement? ☐ Yes ☐ No

16. Is an activity hazard analysis study conducted prior to each major phase of work?
    ☐ Yes ☐ No ☐ Unknown

17. What type of safety orientation do the new hires receive? (Check one.)
    ☐ No safety orientation ☐ Informal orientation ☐ Formal orientation

18. Who is oriented? (Check all that apply.)
    ☐ All Company Field Employees ☐ New Company Field Employees
    ☐ New Salaried Employees ☐ New Subcontractor Employees
    ☐ Other_____

19. Does the company have safety dinners? ☐ Yes ☐ No

    A. If yes, does the president attend? ☐ Yes ☐ No

    B. If yes, do field workers attend? ☐ Yes ☐ No

20. Does your company have a substance abuse testing program? ☐ Yes ☐ No

A. If yes, what types of testing are conducted? (Mark all that apply.)

☐ Pre-employment Screening ☐ Random ☐ Reasonable Cause
☐ Post Accident ☐ Blanket Testing ☐ Follow-up Testing

B. If you conduct pre-employment screening, what percent test positive? _____%

C. If yes, what is the policy when an employee fails a drug test? (Check all that apply.)

☐ Termination after first failure ☐ Suspension for _____days
☐ Termination after repeat failure ☐ Other_____

☐ Treatment offered at company expense followed by termination for second offense
☐ Treatment offered at company expense, refusing treatment results in termination
☐ Treatment recommended, but not at company expense
☐ Treatment not considered, drug abusers are terminated
☐ Other_____

D. If yes, when was drug testing implemented in your firm? (year) 19___

21. How often does someone from the home(corporate) office make safety inspections on the jobs?

☐ Weekly ☐ Monthly ☐ Quarterly ☐ Every 6 months ☐ Other_____

22. Who in the home office reviews safety reports from the company projects? (Check all that apply.)

☐ President ☐ Safety Department ☐ Vice-President ☐ Others_____

23. Is there a summary or corporate accident report provided to all the jobs? ☐ Yes ☐ No

24. Which types of accidents are investigated? ☐ All ☐ Recordable ☐ Lost workday
☐ Other _____

A. Who is responsible for investigating? ☐ Superintendent ☐ Safety Dir ☐ Other____

B. How are investigation reports distributed? ☐ Job File ☐ Home Office ☐ Other____

25. What is the approximate annual dollar volume of the company? _____

26. What is the average number of projects in progress? _____

27. What is the approximate percentage breakdown of your firm's revenue for the sectors listed below?

___% Private ___% Local Public ___% State ___% Federal ___% Non US

28. How often are subcontractor's <u>contractually</u> obligated to comply with your firms safety requirements?
☐ Always ☐ Never ☐ Most of the time ☐ Occasionally

29. What is your firm's average number of field employees (exclude superintendents & above)? ____

30. Does the company provide safety glasses? ☐ Yes ☐ No

31. Are safety glasses required to be worn on the jobsite at all times? ☐ Yes ☐ No

32. How is personnel protection paid for? ☐ Jobsite ☐ Corporation

33. Are near misses documented? ☐ Yes ☐ No

    A. How many near misses were documented in 1995?_____

34. Does your company publish a newsletter? ☐ Yes ☐ No

    A. If yes, how often? ☐ Monthly ☐ Quarterly ☐ Annually ☐ Other_____

    B. If yes, how often is safety a topic in your newsletter?
    ☐ More than once per newsletter
    ☐ At least once per newsletter
    ☐ More than 50% of the newsletters
    ☐ About 1 in 4 newsletters
    ☐ Almost never

37. What has been your firm's experience with litigation cases (settled in or out of court) arising from
accidents or job-related illnesses between 1990 - 1995 when compared with 1985 - 1990?
☐ it has increased ☐ it has decreased ☐ it is the same ☐ we have had none

38. How would you rate the level of support the safety department receives from top management?

    Poor 1 2 3 4 5 6 7 8 9 10 Outstanding Support (Circle one)

39. Please complete the following table for information regarding the past 3 years:

	1995	1994	1993
Number of Lost Workday Injury Cases			
Number of Restricted Workday Injury Cases			
Number of OSHA Recordable Cases			
Employee Hours Worked (field employees only)			
Experience Modification Rate (EMR)			

REQUEST FOR SUMMARY REPORT

If you would like a copy of the summary report, please provide the following information:
(ALL YOUR RESPONSES WILL REMAIN CONFIDENTIAL)

Name_____Title_____

Company_____

Street_____

City_____State_____Zip_____

APPENDIX B
Cover Letter

UNIVERSITY OF WASHINGTON
SEATTLE, WASHINGTON 98195

artment of Civil Engineering

Dr. Jim Hinze
121 More, FX-10
Seattle, WA 98195
Phone (206) 543-7612
Fax (206) 543-1543

Wednesday, August 7, 1996

«Firm Name»
«SAFETY DIR»
«Street Address»
«Address»

Dear Manager of Safety:

We at the University of Washington (Graduate Program of Construction Engineering and Management) are conducting a nationwide survey that is focused on construction safety as practiced by large construction firms. The objective is to establish the current status of construction safety practices. It is anticipated that the safety practices of large firms will influence the entire construction industry in the future.

To have a successful study, your participation is needed in the completion of the enclosed survey. Please feel free to answer only those questions for which answers can be readily obtained. The survey is designed to be completed in a few minutes. Your responses will be kept confidential.

As an expression of our gratitude for your participation in this study, we will provide you with the summary findings of this research. This report, to be completed later this spring, will contain important information on the various safety practices identified in this study. Thank you for your consideration.

Yours truly,

Jim Hinze
Professor

William Eich
Graduate Student

Encl. (1): Questionnaire

APPENDIX C
SPCC/PC+
Definition File

```
data list file = "eich.dat"
/CASE    1-3
/FULLTIME 1  DIREPORT 3 NUMSREPS 5-7 DIRHIRE 9 FIELDRPT 11
 CRITERI1 13-14 CRITERI2 16-17 CRITERI3 19-20 STOPWORK 22 INCENTIV 24
 WORKER 26 FOREMAN 28 SUPERINT 30 SAFEPERS 32 PROJMGR 34
 AWRDOTH1 36 AWRDOTH2 38 INDCREW 40 OFTENWKR 42 OFTENSUP 44
 BONUSPCT 46-48 BUDGETPL 50-53 BUDGETPC 55-58 PROGRESS 60
 LOTTERY 62 SANCTION 64 COMPPROJ 66 ACHLEVEL 68 KEYOTHER 70
 SUPEVAL 72 TRAINED 74 PJOBSEMT 76-77 NJOBSEMT 79-80
/FAMILIES 1 DESCRFAM 3 FIRSTAID 5-6 REPORTS 8 TOOLBOX 10
 OFTENMTG 12 WHENMTGS 14 PRESIDES 16 SUBMTGS 18 TRAINSUP 20
 WHENTRSP 22 MISSION 24 HAZSTUDY 26 TYPORIEN 28 ALLFIELD 30
 NEWSALRY 32 NEWFIELD 34 NEWSUB 36 ALLEMPLY 38 ORIOTHER 40
 DINNERS 42 PRESATTD 44 WKRSATTD 46
/TESTPROG 1 PRESCREN 3 RANDOM 5 FORCAUSE 7 POSTACCD 9
 BLANKET 11 FOLLOWUP 13 PTESTPOS 15-16 TERMFRST 18 TMREPEAT 20
 SUSPEND 22 SUSPDAYS 24-25 FAILOHTR 27 TREATTER 29 TREATOFF 31
 TREATREC 33 TREATNOT 35 TREATOTH 37 YEARTEST 39-40
/INSPECT 1 REVWPRES 3 REVWSDPT 5 REVWVP 7 REVWOPSM 9
 REVWVDHS 11 REVWOTHR 13 REPORTJB 15 TYPINVES 17 WHOINVES 19
 RPTDISTR 21 REVENUE 23-27 PROJNUM 29-31 PPRIVATE 33-34
 PLOCALPB 36-37 PSTATE 39-40 PFEDERAL 42-43 PCTNONUS 45-46
 SUBCOMPL 48 NFLDWKRS 50-54 SGLASSES 56 GLASWORN 58 PPEPAID 60
 NEARMISS 62 NNEARMIS 64-66 NEWSLTR 68 OFTENLTR 70 SAFELTR 72
 LITCASES 74 SUPPORT 76-77
/LOSTWD95 1-3 LOSTWD94 5-7 LOSTWD93 9-11
 RESTWD95 13-15 RESTWD94 17-19 RESTWD93 21-23
 OSHARD95 25-27 OSHARD94 29-31 OSHARD93 33-35
 HRSWRK95 37-44 HRSWRK94 46-53 HRSWRK93 55-62
 EMR95 64-67 EMR94 69-72 EMR93 74- 77
 REQUESTR 79
/DUMMY 1.

variable labels
/CASE    "Case Number"
/FULLTIME "Does firm have fulltime corp safety dir?"
/DIREPORT "To whom corp safety director reports?"
/NUMSREPS "Number of fulltime field safety reps?"
/DIRHIRE  "Does corp safety dir hire fld safety rep"
/FIELDRPT "To whom field safety director reports"
/CRITERI1 "Criteria used to assign field rep to job"
/CRITERI2 "Criteria used to assign field rep to job"
/CRITERI3 "Criteria used to assign field rep to job"
/STOPWORK "Do field rep have authority to stop work"
/INCENTIV "Does firm have safety incentive program?"
/WORKER   "Safety awards are given to workers"
/FOREMAN  "Safety awards are given to foreman"
/SUPERINT "Safety awards are given to superintendents"
/SAFEPERS "Safety awards are given to safety personnel"
/PROJMGR  "Safety awards are given to project manager"
/AWRDOTH1 "Safety awards are given to other1(    )"
/AWRDOTH2 "Safety awards are given to other2(    )"
/INDCREW  "Are awards given individuals or crews?"
/OFTENWKR "How often is individual awards given?"
/OFTENSUP "How often is superintendent award given?"
/BONUSPCT "Sups safety bonus potential of mo salary"
/BUDGETPL "% of field labor cost budgeted for safety awards"
/BUDGETPC "% of contract cost budgeted for safety awards"
/PROGRESS "Safety incentive program is progressive type"
/LOTTERY  "Safety incentive program is lottery type"
/SANCTION "Are sanctions imposed for unsafe behavior"
/COMPPROJ "Incentives are awarded for safe proj completion"
/ACHLEVEL "Award is based on achieving min injury freq levels"
/KEYOTHER "Other key to firm's safety incentive program"
/SUPEVAL  "Field supervisors evaluated on safety performance?"
/TRAINED  "Are field safety personnel trained in first aid?"
/PJOBSEMT "How many jobs have full-time first aid pers(in %)?"
/NJOBSEMT "How many jobs have full-time first aid personnel?"
/FAMILIES "Does firm communicate safety to employee families?"
```

/DESCRFAM "Describe how communicate safety to families"
/FIRSTAID "What is min size job that has a first aid station?"
/REPORTS "How often are accident reports fwd to corp level?"
/TOOLBOX "Are toolbox meetings held on the jobsite?"
/OFTENMTG "How often are toolbox meetings held?"
/WHENMTGS "When are toolbox meetings held?"
/PRESIDES "Who presides at toolbox meetings?"
/SUBMTGS "Do subcontractors attend safety meetings?"
/TRAINSUP "Are safety meetings-training held for supervisors?"
/WHENTRSP "How often are supervisors meetings(training) held?"
/MISSION "Is safety reflected in firm's mission statement?"
/HAZSTUDY "Is haz study done prior to each major phase of wk?"
/TYPORIEN "Type of safety orientation new hires receive?"
/ALLFIELD "All field employees receive safety orientation"
/NEWSALRY "All new salaried employees rcv safety orientation"
/NEWFIELD "All new field employees receive safety orientation"
/NEWSUB "All new sub employees receive safety orientation"
/ALLEMPLY "All employees are given safety orientation"
/ORIOTHER "Others that are given safety orientation"
/DINNERS "Does the company have safety dinners?"
/PRESATTD "Does president attend safety dinner?"
/WKRSATTD "Do field workers attend safety dinners?"
/TESTPROG "Does firm have a substance abuse testing program?"
/PRESCREN "Pre-employment Screening drug testing conducted"
/RANDOM "Random drug testing conducted"
/FORCAUSE "For reasonable cause drug testing conducted"
/POSTACCD "Post accident drug testing conducted"
/BLANKET "Blanket drug testing conducted"
/FOLLOWUP "Follow-up drug testing conducted"
/PTESTPOS "What % test positive on pre-employment screening? "
/TERMFRST "Policy-terminate for first failure of a drug test"
/TMREPEAT "Policy-terminate for repeat failure of drug test"
/SUSPEND "Policy-suspend after first failure of a drug test"
/SUSPDAYS "No. of days suspended for failure of a drug test"
/FAILOHTR "Other policy for failure of a drug test"
/TREATTER "Treatment offered at co. expense, term for repeat"
/TREATOFF "Treatment offered at co. expense, term if refuse"
/TREATREC "Treatment recommended, but not at company expense"
/TREATNOT "Treatment not considered, drug abusers are terminated"
/TREATOTH "Other treatment policy for failure of a drug test"
/YEARTEST "When was drug testing implemented in your firm?"
/INSPECT "How often does corporate office inspect the jobsite?"
/REVWPRES "President reviews project safety reports"
/REVWSDPT "Safety dept reviews project safety reports"
/REVWVP "Vice-president reviews project safety reports"
/REVWOPSM "Operations Mgr reviews project safety reports"
/REVWVDHS "Various Dept Heads review project safety reports"
/REVWOTHR "Others reviews project safety reports"
/REPORTJB "Summary corp accident report provided to all jobs?"
/TYPINVES "Which types of accidents are investigated?"
/WHOINVES "Who is responsible for investigating accidents?"
/RPTDISTR "How are investigation reports distributed?"
/REVENUE "The firm's approx annual volume in millions?"
/PROJNUM "What is the avg number of projects in progress?"
/PPRIVATE "Percent of firm's revenue from Private sector?"
/PLOCALPB "Percent of firm's revenue fm Local Public sector?"
/PSTATE "Percent of firm's revenue from State sector?"
/PFEDERAL "Percent of firm's revenue from Federal sector?"
/PCTNONUS "Percent of firm's revenue from Non US sector?"
/SUBCOMPL "Sub's contract obligated to comply saf reqmnts? "
/NFLDWKRS "What is average number of field employees?"
/SGLASSES "Does your company provide safety glasses?"
/GLASWORN "Are safety glasses req'd to be worn at all times on job?"
/PPEPAID "How is personnel protection paid for?"
/NEARMISS "Are near misses documented?"
/NNEARMIS "How many near misses were documented in 1995?"
/NEWSLTR "Does your company publish a newsletter?"
/OFTENLTR "How often is newsletter published?"
/SAFELTR "How often is safety a topic in newsletter?"

```
/LITCASES "Firm's trend with accident litigation cases."
/SUPPORT  "Rate support safety dept receives from top mgnt?"
/LOSTWD95 "Number of lost workday cases in 1995"
/LOSTWD94 "Number of lost workday cases in 1994"
/LOSTWD93 "Number of lost workday cases in 1993"
/RESTWD95 "Number of restricted workday cases in 1995"
/RESTWD94 "Number of restricted workday cases in 1994"
/RESTWD93 "Number of restricted workday cases in 1994"
/OSHARD95 "Number of OSHA recordable cases in 1995"
/OSHARD94 "Number of OSHA recordable cases in 1994"
/OSHARD93 "Number of OSHA recordable cases in 1993"
/HRSWRK95 "Number of field employee hours in 1995"
/HRSWRK94 "Number of field employee hours in 1994"
/HRSWRK93 "Number of field employee hours in 1993"
/EMR95    "Experience Modification Rate (EMR) in 1995"
/EMR94    "Experience Modification Rate (EMR) in 1994"
/EMR93    "Experience Modification Rate (EMR) in 1993"
/REQUESTR "Firm requested Summary Report".

missing values
/FULLTIME TO LITCASES (9) SUPPORT (11) LOSTWD95 TO REQUESTR (9).

value labels
/FULLTIME 1 "Yes" 2 "No" 9 "No Response"
/DIREPORT 1 "CEO" 2 "President" 3 "Vice-President" 4 "V.P. Operations"
      5 "V.P. Admin" 6 "V.P. of Corp Services/Human Resources"
      7 "Asst Managing  Partner" 8 "NA" 9 "No Response"
/DIRHIRE  1 "Yes" 2 "No" 8 "NA" 9 "No Response"
/FIELDRPT 1 "Corp Safety Director" 2 "Superintendent" 3 "Project Manager"
      4 "Superintendent with a dotted line to Corporate" 5 "Other"
      6 "Prog Mgr with dotted line to Corporate" 7 "District Mgr"
      8 "NA" 9 "No Response" 0 "Not to Corp Safety Director"
/CRITERI1 CRITERI2 CRITERI3 1 "Size" 2 "> 50" 3 "> 100" 4 ">200"
      5 "Potential Hazard" 6 "Project Scope & Complexity" 7 "Location"
      8 "Contract-Owner Requirement" 9 "No Response" 10 "Dollar Amount"
      11 "Misc Other" 12 "NA"
/STOPWORK 1 "Yes" 2 "No" 8 "NA" 9 "No Response"
/INCENTIV 1 "Yes" 2 "No" 9 "No Response"
/WORKER   1 "Yes" 2 "No" 8 "NA"
/FOREMAN  1 "Yes" 2 "No" 8 "NA"
/SUPERINT 1 "Yes" 2 "No" 8 "NA"
/SAFEPERS 1 "Yes" 2 "No" 8 "NA"
/PROJMGR  1 "Yes" 2 "No" 8 "NA"
/AWRDOTH1 1 "Yes" 2 "No" 8 "NA"
/AWRDOTH2 1 "Yes" 2 "No" 8 "NA"
/INDCREW  1 "Individual" 2 "Crew" 3 "Both" 0 "NA" 9 "No Response"
/OFTENWKR 1 "Weekly" 2 "Quarterly & Annually" 3 "Monthly" 4 "Quarterly"
      5 "Annually" 6 "Monthly & Quarterly" 7 "Monthly & Annually" 8 "NA"
      0 "Other"
/OFTENSUP 1 "Semi-annually" 2 "Quarterly & Annually" 3" Monthly" 4 "Quarterly"
      5 "Annually" 6 "Monthly & Quarterly" 7 "Monthly & Annually"
      8 "NA" 9 "No Response" 0 "Other"
/PROGRESS 1 "Yes" 2 "No" 8 "NA" 9 "No Response"
/LOTTERY  1 "Yes" 2 "No" 8 "NA" 9 "No Response"
/SANCTION 1 "Verbal" 2 "Written" 3 "Both" 4 "Both & Stop Incentive"
      5 "Both & Suspend without pay" 6 "Both & Terminate" 7 "No" 8 "NA"
      0 "Yes but no sanction type indicate"
/COMPPROJ 1 "Yes" 2 "No" 8 "NA" 9 "No Response"
/ACHLEVEL 1 "Yes" 2 "No" 8 "NA" 9 "No Response"
/KEYOTHER 1 "Yes" 2 "No" 8 "NA" 9 "No Response"
/SUPEVAL  1 "Yes" 2 "No" 9 "No Response"
/TRAINED  1 "Yes" 2 "No" 8 "NA" 9 "No Response"
/PJOBSEMT 44 "All-a first 50 survey" 99 "All"
/FAMILIES 1 "Yes" 2 "No" 9 "No Response"
/DESCRFAM  1 "Corporate Publication" 2 "Safety Newsletter"
      3 " Corp & Safety Newsletter" 4 "Corp & Safety Newsletter plus other"
      5 "Other" 6 "Literature w paycheck" 8 "NA" 9 "No Response"
/FIRSTAID 01 "Every job" 02 "No jobs" 03 "All First Aid Kit"  08 "NA"
      09 "No Response"
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/REPORTS  1 "Daily" 2 "Weekly" 3 "Monthly" 4 "Quarterly" 5 "Yearly"
      6 "As they occur" 9 "No Response"
/TOOLBOX  1 "Yes" 2 "No" 9 "No Response"
/OFTENMTG 1 "Weekly" 2 "Biweekly" 0 "Daily" 4 "Other" 5 "Monthly"  8 "NA"
/WHENMTGS 1 "Monday" 2 "Tuesday" 3 "Wednesday" 4 "Thursday" 5 "Friday"
      6 "Varies" 7 "Monday or Tuesday" 8 "NA" 9 "No Response" 0 "Daily"
/PRESIDES 1 "Assigned worker" 2 "Foreman" 3 "Safety man" 4 "Job Supervisor"
      5 "Safety man & Job Sup" 6 "Varies" 7 "Other" 8 "Foreman & Safety man"
      9 "No response" 0 "Assigned worker & Foreman"
/SUBMTGS  1 "Yes" 2 "Hold their own" 3 "Yes & Hold their own" 4 "Other"
      5 "No" 8 "NA" 9 "No Response"
/TRAINSUP 1 "Yes" 2 "No" 9 "No Response"
/WHENTRSP 1 "Weekly" 2 "Monthly" 3 "Quarterly" 4 "Annually" 5 "Other"
      6 "Biweekly" 7 "Semi-annually" 8 "NA" 9 "No Response"
/MISSION  1 "Yes" 2 "No" 9 "No Response"
/HAZSTUDY 1 "Yes" 2 "No" 3 "Unknown" 9 "No Response"
/TYPORIEN 1 "No safety orientation " 2 "Informal orientation"
      3 "Formal orientation" 9 "No Response"
/ALLFIELD 1 "Yes" 2 "No" 8 "NA" 9 "No Response"
/NEWSALRY 1 "Yes" 2 "No" 8 "NA" 9 "No Response"
/NEWFIELD 1 "Yes" 2 "No" 8 "NA" 9 "No Response"
/NEWSUB   1 "Yes" 2 "No" 8 "NA" 9 "No Response"
/ALLEMPLY 1 "Yes" 2 "No" 8 "NA" 9 "No Response"
/ORIOTHER 1 "Yes" 2 "No" 8 "NA" 9 "No Response"
/DINNERS  1 "Yes" 2 "No" 3 "Breakfast" 4 "Lunch" 8 "NA" 9 "No Response"
/PRESATTD 1 "Yes" 2 "No" 3 "Sometimes" 8 "NA" 9 "No Response"
/WKRSATTD 1 "Yes" 2 "No" 8 "NA" 9 "No Response"
/TESTPROG 1 "Yes" 2 "No" 3 "Yes for DOT Drivers" 8 "NA" 9 "No Response"
/PRESCREN 1 "Yes" 2 "No" 8 "NA" 9 "No Response"
/RANDOM   1 "Yes" 2 "No" 8 "NA" 9 "No Response"
/FORCAUSE 1 "Yes" 2 "No" 8 "NA" 9 "No Response"
/POSTACCD 1 "Yes" 2 "No" 8 "NA" 9 "No Response"
/BLANKET  1 "Yes" 2 "No" 8 "NA" 9 "No Response"
/FOLLOWUP 1 "Yes" 2 "No" 8 "NA" 9 "No Response"
/TERMFRST 1 "Yes" 2 "No" 8 "NA" 9 "No Response"
/TMREPEAT 1 "Yes" 2 "No" 8 "NA" 9 "No Response"
/SUSPEND  1 "Yes" 2 "No" 8 "NA" 9 "No Response"
/SUSPDAYS 1 "Yes" 2 "No" 8 "NA" 9 "No Response"
/FAILOHTR 1 "Yes" 2 "No" 8 "NA" 9 "No Response"
/TREATTER 1 "Yes" 2 "No" 8 "NA" 9 "No Response"
/TREATOFF 1 "Yes" 2 "No" 8 "NA" 9 "No Response"
/TREATREC 1 "Yes" 2 "No" 8 "NA" 9 "No Response"
/TREATNOT 1 "Yes" 2 "No" 8 "NA" 9 "No Response"
/TREATOTH 1 "Yes" 2 "No" 8 "NA" 9 "No Response"
/INSPECT  1 "Weekly" 2 "Monthly" 3 "Quarterly" 4 "Every 6 months"
      5 "Other" 6 "Biweekly" 7 "Bimonthly" 8 "Annually" 9 "No Response"
      0 "Annually"
/REVWPRES 1 "Yes" 2 "No" 9 "No Response"
/REVWSDPT 1 "Yes" 2 "No" 9 "No Response"
/REVWVP   1 "Yes" 2 "No" 9 "No Response"
/REVWOPSM 1 "Yes" 2 "No" 9 "No Response"
/REVWVDHS 1 "Yes" 2 "No" 9 "No Response"
/REVWOTHR 1 "Yes" 2 "No" 9 "No Response"
/REPORTJB 1 "Yes" 2 "No" 9 "No Response"
/TYPINVES 1 "All" 2 "Recordable" 3 "Lost workday"
      4 "All including first aid & near misses"
      5 "All requiring medical attention" 6 "Only Serious"  9 "No Response"
/WHOINVES 1 "Superintendent" 2 "Safety Dir" 3 "Both Sup & Safety Dir"
      4 "Sup, Safety & Other" 5 "Sup & PM" 6 "Sup & Foreman" 7 "Foreman"
      8 "Varied by seriousness of accident" 9 "No Response"
      0 "Supervisor or Other"
/RPTDISTR 1 "Job File" 2 "Home Office" 3 "Both" 4 "Other" 5 "Both & Other"
      9 "No Response"
/SUBCOMPL 1 "Always" 2 "Never" 3 "Most of the time" 4 "Occasionally"
      9 "No Response"
/SGLASSES 1 "Yes" 2 "No" 9 "No Response"
/GLASWORN 1 "Yes" 2 "No" 9 "No Response"
/PPEPAID  1 "Jobsite" 2 "Corporation" 3 "Both" 9 "No Response"
/NEARMISS 1 "Yes" 2 "No" 9 "No Response"
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/NEWSLTR  1 "Yes" 2 "No" 9 "No Response"
/OFTENLTR 0 "Weekly" 1 "Monthly" 2 "Quarterly" 3 "Annually" 5 "Other" 8 "NA"
      9 "No Response"
/SAFELTR  1 "More than once per newsletter" 2 "At least once per newsletter"
      3 "More than 50% of the newsletters" 4 "About 1 in 4 newsletters"
      5 "Almost never" 8 "NA" 9 "No Response"
/LITCASES 1 "it has increased" 2 "it has decreased" 3 "it is the same"
      4 "we have none" 9 "No Response"
/SUPPORT  1 "Poor support from top management" 10 "Outstanding support"
      11 "No Response"
/REQUESTR 1 "Yes" 2 "No".

COMPUTE EMR1993 = EMR93*100.
COMPUTE EMR1994 = EMR94*100.
COMPUTE EMR1995 = EMR95*100.
COMPUTE LABORPCT = BUDGETPL*100.
COMPUTE CONTRACT = BUDGETPC*100.
RECODE SUPPORT (91=9).
RECODE WORKER TO AWRDOTH2 (8=2).
IF (ALLFIELD EQ 1) NEWFIELD = 1.
COMPUTE AVGEMR = (EMR1993 + EMR1994 + EMR1995)/3.
COMPUTE RATE95 = OSHARD95*200000/HRSWRK95.
COMPUTE RATE94 = OSHARD94*200000/HRSWRK94.
COMPUTE RATE93 = OSHARD93*200000/HRSWRK93.
COMPUTE AVGRATE = (RATE95 + RATE94 +RATE93)/3.
COMPUTE LOST95 = LOSTWD95*200000/HRSWRK95.
COMPUTE LOST94 = LOSTWD94*200000/HRSWRK94.
COMPUTE LOST93 = LOSTWD93*200000/HRSWRK93.
COMPUTE AVGLOST = (LOST95 + LOST94 + LOST93)/3.
COMPUTE REST95 = RESTWD95*200000/HRSWRK95.
COMPUTE REST94 = RESTWD94*200000/HRSWRK94.
COMPUTE REST93 = RESTWD93*200000/HRSWRK93.
COMPUTE AVGREST = (REST95 + REST94 + REST93)/3.
COMPUTE SIZE = REVENUE.
IF (REVENUE LT 100) SIZE =1.
IF (REVENUE GT 99 AND REVENUE LT 250) SIZE = 2.
IF (REVENUE GT 249 AND REVENUE LT 500) SIZE = 3.
IF (REVENUE GT 499 AND REVENUE LT 1000) SIZE = 4.
IF (REVENUE GT 999) SIZE = 5.
COMPUTE RATIOJOB = NUMSREPS/PROJNUM.
COMPUTE RATIOREV = NUMSREPS/REVENUE.
COMPUTE RATIOHRS = NUMSREPS/HRSWRK95.
COMPUTE RATIOHRS = RATIOHRS*1000000.
IF (RATIOHRS EQ 0) RATHRS = 1.
IF (RATIOHRS GT 0 AND RATIOHRS LT 2) RATHRS = 2.
IF (RATIOHRS GT 2 AND RATIOHRS LT 4) RATHRS = 3.
IF (RATIOHRS GT 4 AND RATIOHRS LT 8) RATHRS = 4.
IF (RATIOHRS GT 8) RATHRS = 5.
IF (NUMSREPS EQ 0) REPS = 1.
IF (NUMSREPS EQ 1) REPS = 2.
IF (NUMSREPS EQ 2 OR NUMSREPS EQ 3) REPS = 3.
IF (NUMSREPS GT 3 AND NUMSREPS LT 11) REPS = 4.
IF (NUMSREPS GT 10 AND NUMSREPS LT 26) REPS = 5.
IF (NUMSREPS GT 25) REPS = 6.
IF (NUMSREPS EQ 0) NOREPS = 1.
IF (NUMSREPS GT 0) NOREPS = 2.
IF (YEARTEST LT 88) YEAR = 1.
IF (YEARTEST EQ 88 OR YEARTEST EQ 89) YEAR = 2.
IF (YEARTEST EQ 90) YEAR = 3.
IF (YEARTEST EQ 91 OR YEARTEST EQ 92) YEAR = 4.
IF (YEARTEST EQ 93 OR YEARTEST EQ 94) YEAR = 5.
IF (YEARTEST GT 94) YEAR = 6.
COMPUTE A = PCTNONUS.
IF (A EQ 0) NONUS = 1.
IF (A GT 0 AND A LT 10) NONUS = 2.
IF (A GT 10) NONUS = 3.
COMPUTE L = PLOCALPB.
IF (L EQ 0) LOCAL = 1.
IF (L GT 0 AND L LT 11) LOCAL = 2.
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IF (L GT 10 AND L LT 21) LOCAL = 3.
IF (L GT 20 AND L LT 31) LOCAL = 4.
IF (L GT 30) LOCAL = 5.
RECODE DIRHIRE TO FIELDRPT (8=2).
RECODE PROGRESS TO LOTTERY (8=2).
RECODE SANCTION (8=9).
RECODE COMPPROJ TO KEYOTHER (8=2).
RECODE PRESATTD TO TREATOTH (8=2).
RECODE INDCREW (8=0).
RECODE OFTENWKR TO OFTENSUP (8=9).
RECODE DESCRFAM TO FIRSTAID (8=9).
RECODE DIREPORT (7=1).
RECODE REPORTS (6=1).
RECODE OFTENMTG (3=0).
RECODE WHENTRSP (6=1).
RECODE WHENTRSP (7=3).
RECODE HAZSTUDY (3=9).
RECODE ALLFIELD TO ORIOTHER (8=2).
RECODE DINNERS (3=1).
RECODE DINNERS (4=1).
RECODE SUBCOMPL (2=5).
RECODE INSPECT (6=2).
RECODE INSPECT (7=3).
RECODE INSPECT (0=8).
RECODE INSPECT (5=9).
RECODE TYPINVES (4=1).
RECODE TYPINVES (5=2).
RECODE OFTENLTR (6=0).
IF (OFTENLTR EQ 0 AND SAFELTR LE 2) LETTER = 1.
IF (OFTENLTR EQ 1 AND SAFELTR LE 2) LETTER = 2.
IF (OFTENLTR EQ 2 AND SAFELTR LE 2) LETTER = 3.
IF (OFTENLTR EQ 3 AND SAFELTR LE 2) LETTER = 4.
IF (OFTENLTR EQ 0 AND SAFELTR EQ 3) LETTER = 2.
IF (OFTENLTR EQ 0 AND SAFELTR EQ 4) LETTER = 2.
IF (OFTENLTR EQ 1 AND SAFELTR EQ 3) LETTER = 3.
IF (OFTENLTR EQ 1 AND SAFELTR EQ 4) LETTER = 3.
IF (OFTENLTR EQ 2 AND SAFELTR EQ 3) LETTER = 4.
IF (OFTENLTR EQ 2 AND SAFELTR EQ 4) LETTER = 4.
IF (SAFELTR EQ 5) LETTER = 6.
IF (NEWSLTR EQ 2) LETTER = 6.
IF (OFTENSUP EQ 3) BONUS = 12*BONUSPCT.
IF (OFTENSUP EQ 4) BONUS = 4*BONUSPCT.
IF (OFTENSUP EQ 5) BONUS = BONUSPCT.
IF (BONUS LE 5) BONUSRG = 1.
IF (BONUS GT 5 AND BONUS LE 10) BONUSRG = 2.
IF (BONUS GT 10 AND BONUS LE 25) BONUSRG = 3.
IF (BONUS GT 25 AND BONUS LE 50) BONUSRG = 4.
IF (BONUS GT 50 AND BONUS LT 100) BONUSRG = 5.
IF (BONUS GE 100) BONUSRG = 6.
COMPUTE PUBLIC = PLOCALPB + PSTATE + PFEDERAL.
IF (CRITERI1 EQ 8 AND CRITERI2 EQ 9 AND CRITERI3 EQ 9) CRITERIA = 0.
IF (AWRDOTH1 EQ 1 OR AWRDOTH2 EQ 1) AWRDOTH = 1.
IF (AWRDOTH1 EQ 2 AND AWRDOTH2 EQ 2) AWRDOTH = 2.
IF (PROGRESS EQ 1) KEY1 = 1.
IF (PROGRESS EQ 2) KEY1 = 0.
IF (LOTTERY EQ 1) KEY2 = 1.
IF (LOTTERY EQ 2) KEY2 = 0.
IF (COMPPROJ EQ 1) KEY3 = 1.
IF (COMPPROJ EQ 2) KEY3 = 0.
IF (ACHLEVEL EQ 1) KEY4 = 1.
IF (ACHLEVEL EQ 2) KEY4 = 0.
IF (KEYOTHER EQ 1) KEY5 = 1.
IF (KEYOTHER EQ 2) KEY5 = 0.
COMPUTE ELEMENT = KEY1 + KEY2 + KEY3 + KEY4 + KEY5.
IF (SANCTION EQ 1) KEY6 = 1.
IF (SANCTION EQ 2) KEY6 = 1.
COMPUTE ALLKEYS = ELEMENT + KEY6.
IF (WORKER EQ 1) AWRD1 = 1.
IF (WORKER EQ 2) AWRD1 = 0.
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IF (FOREMAN EQ 1) AWRD2 = 1.
IF (FOREMAN EQ 2) AWRD2 = 0.
IF (SUPERINT EQ 1) AWRD3 = 1.
IF (SUPERINT EQ 2) AWRD3 = 0.
IF (SAFEPERS EQ 1) AWRD4 = 1.
IF (SAFEPERS EQ 2) AWRD4 = 0.
IF (PROJMGR EQ 1) AWRD5 = 1.
IF (PROJMGR EQ 2) AWRD5 = 0.
IF (AWRDOTH1 EQ 1) AWRD6 = 1.
IF (AWRDOTH1 EQ 2) AWRD6 = 0.
IF (AWRDOTH2 EQ 1) AWRD7 = 1.
IF (AWRDOTH2 EQ 2) AWRD7 = 0.
IF (GLASWORN EQ 1) GLASS = 1.
IF (GLASWORN EQ 2) GLASS = 0.
COMPUTE MANY = AWRD1 + AWRD2 + AWRD3 + AWRD4 + AWRD5 + AWRD6 + AWRD7.
COMPUTE PROGRAM = ELEMENT + MANY.
IF (INSPECT LT 2) INSP = 2.
IF (INSPECT EQ 2) INSP = 1.
IF (INSPECT GT 2) INSP = 0.
IF (PRESATTD EQ 1) DIN1 = 1.
IF (PRESATTD EQ 2) DIN1 = 0.
IF (WKRSATTD EQ 1) DIN2 = 1.
IF (WKRSATTD EQ 2) DIN2 = 0.
COMPUTE BOTHWP = DIN1 + DIN2.
RECODE REVWPRES TO REVWOTHR (2=0).
COMPUTE REV = REVWPRES + REVWVP + REVWSDPT + REVWOPSM + REVWVDHS + REVWOTHR.
COMPUTE PRESVP = REVWPRES + REVWVP.
IF (FAMILIES EQ 1) FAM = 1.
IF (FAMILIES EQ 2) FAM = 0.
RECODE FULLTIME (0=2).
COMPUTE FIELDYES = FIELDRPT.
RECODE FIELDYES (0, 3, 5 = 2) (4, 6, 7 = 1).
COMPUTE WKR = OFTENWKR.
RECODE WKR (2=4) (0=9) (6, 7 =3).
COMPUTE TWICE = OFTENWKR.
RECODE TWICE (0=9) (6, 7 = 2) (1, 4, 5 = 3).
COMPUTE SUPAWARD = OFTENSUP.
RECODE SUPAWARD (7=3) (2=4) (1=5) (0=9).
RECODE TRAINED (8=9).
COMPUTE FIRSTALL = FIRSTAID.
RECODE FIRSTALL (2=99) (3=9).
RECODE WHENMTGS (7=1).
COMPUTE RUNSTOOL = PRESIDES.
RECODE RUNSTOOL (5, 6, 8 =3) (0, 1, 2, 7 = 4).
RECODE TESTPROG (3=1).
COMPUTE SAFINVES = WHOINVES.
RECODE SAFINVES (0, 1, 6, 7 = 5).
RECODE RPTDISTR (4=1).
RECODE PPEPAID (1=4).
RECODE LITCASES (2=5) (3=6) (1=7).
IF (NNEARMIS GE 45) NEAR = 1.
IF (NNEARMIS LT 45) NEAR = 2.
IF (TREATTER EQ 1 OR TREATOFF EQ 1) EXPENSE = 1.
IF (TREATTER NE 1 AND TREATOFF NE 1) EXPENSE = 2.
COMPUTE TOPMGNT1 = DIN1 + INSP + PRESVP.
COMPUTE TOPMGNT2 = TOPMGNT1 + SUPPORT.
COMPUTE CULTURE1 = PROGRAM + INSP.
COMPUTE CULTURE2 = CULTURE1 + GLASS.
COMPUTE CULTURE3 = CULTURE2 + BOTHWP.
COMPUTE CULTURE4 = CULTURE3 + REV.
COMPUTE CULTURE5 = CULTURE4 + FAM.
COMPUTE CULTURE7 = CULTURE4 - INSP.
COMPUTE CULTURE8 = ELEMENT + GLASS.
COMPUTE CULTURE9 = CULTURE8 + BOTHWP.
COMPUTE CULTURE0 = CULTURE9 + REV.
COMPUTE IMPROVE = (RATE93 - RATE94) + (RATE94 - RATE95).
RECODE SUBMTGS (1=0) (3=1).
RECODE TYPORIEN (1=2).
IF (CRITERI1 EQ 8) CRITERIA = 1.
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IF (CRITERI1 EQ 12) CRITERIA = 2.
IF (CRITERI1 NE 8 AND CRITERI1 NE 12) CRITERIA = 3.
IF (OFTENMTG EQ 0) DAILY = 1.
IF (OFTENMTG NE 0) DAILY = 2.
```

APPENDIX D
SPCC/PC+
Data File

001
1 1 036 1 4 01 05 08 1 1 1 1 1 1 1 1 2 2 3 7 5 010 3.75 0009 1 1 6 1 1 9 1 1 75 09
1 4 01 1 0 0 0 2 1 1 1 1 1 3 1 2 2 2 2 2 1 1 1
1 1 1 1 1 1 1 07 2 1 2 09 2 2 2 2 2 2 91
2 1 1 1 2 1 1 2 1 1 2 00500 150 75 10 05 05 05 1 05000 1 1 1 1 101 1 2 1 2 10
009 021 005 020 018 005 108 158 048 04156416 05413636 03023467 0.71 0.72 0.80 1

002
1 3 003 1 4 06 10 11 1 1 1 1 2 2 2 2 2 3 1 5 009 0009 0009 1 2 3 1 2 2 9 1 09 00
2 8 08 1 1 1 7 6 1 1 3 1 1 2 1 2 2 2 2 2 2 8 8
1 2 1 1 1 1 1 09 2 1 1 05 2 2 2 1 2 2 89
1 2 1 2 2 2 2 1 1 2 2 00120 015 80 05 05 00 00 1 00175 1 1 1 9 009 1 2 3 1 10
003 008 001 006 008 002 008 016 003 00416696 00281199 00327473 0.57 0.62 0.69 2

003
1 4 001 2 3 01 09 09 1 2 8 8 8 8 8 8 8 8 8 8 009 0009 0009 8 8 8 8 8 8 1 1 00 00
2 8 01 1 1 1 6 4 1 1 2 1 1 3 1 2 2 2 2 2 2 8 8
1 2 2 1 2 2 2 09 2 1 2 09 2 2 2 1 2 2 90
1 2 2 1 2 2 2 1 1 2 2 00100 010 09 09 09 09 09 1 00005 1 2 1 9 009 1 2 2 2 08
009 009 009 009 009 009 009 009 009 00000009 00000009 00000009 0009 0009 0009 2

004
1 1 9.1 1 1 01 08 09 1 1 1 2 1 2 2 2 2 3 0 1 005 0005 0009 2 2 3 1 2 2 1 1 09 06
2 8 05 1 1 1 1 3 2 1 3 1 1 3 1 1 1 1 1 2 2 8 8
1 1 2 1 1 2 2 09 1 2 2 09 2 2 2 2 2 2 09
2 2 1 1 2 2 2 1 1 3 3 00101 050 99 09 09 09 09 1 00750 1 1 3 2 008 1 3 1 2 08
013 011 013 051 025 024 055 068 041 01357000 01024000 00861000 0.64 0.75 0.80 1

005
1 1 9.1 1 1 65 08 09 1 1 1 1 1 1 1 2 2 3 6 5 010 0009 0009 2 1 3 1 1 2 1 1 09 01
2 8 99 1 1 1 6 0 2 1 3 1 1 3 1 1 1 1 9 9 1 1 1
1 1 1 1 2 2 1 04 1 2 2 09 2 2 2 1 2 2 89
1 1 1 1 2 2 2 1 1 3 3 00600 045 09 09 09 09 09 1 00425 1 1 3 1 008 1 1 1 2 10
010 013 008 020 008 005 030 022 013 00941114 00816707 00922462 0.70 0.47 0.85 1

006
1 6 041 2 1 11 09 09 1 1 1 1 1 1 1 2 2 2 3 4 4 010 0009 0009 1 2 3 1 1 2 1 1 09 10
2 8 50 1 1 1 1 6 1 1 1 1 1 3 1 1 2 2 2 2 1 1 2
1 1 1 1 1 2 1 03 1 2 2 09 2 2 2 1 2 2 88
1 2 1 1 2 2 2 1 1 3 3 00420 151 99 09 09 09 09 1 08000 1 1 1 1 400 1 2 2 3 91
028 042 061 096 094 098 241 240 280 18457614 14200614 13038515 0.53 0.79 0.79 1

007
1 2 009 9 2 01 06 09 1 1 1 1 1 1 1 1 2 2 1 2 0 009 0009 0001 1 2 6 1 1 2 1 1 09 01
2 8 09 3 1 1 1 6 9 1 9 1 1 2 1 1 2 2 2 2 2 2 2
1 1 2 1 1 2 1 03 2 1 2 09 2 1 2 2 2 2 88
2 2 1 1 1 2 1 2 1 3 3 00150 020 09 09 09 09 09 1 00150 1 1 1 1 011 1 1 2 2 10
002 002 001 002 002 009 013 019 020 00396464 00346092 00334526 0.55 0.62 0.62 1

008
2 4 000 8 2 08 09 09 1 1 1 1 1 2 2 2 2 1 4 8 009 0009 .010 2 2 7 2 1 2 2 1 09 00
1 5 09 1 1 1 1 2 5 1 3 1 1 3 1 2 2 2 2 2 2 8 8
1 2 2 1 1 2 2 09 1 2 2 09 2 2 2 2 2 2 93
1 2 2 1 2 2 2 1 3 3 3 00070 012 99 00 00 00 00 1 00300 1 2 1 1 002 1 2 2 3 10
004 001 001 007 001 004 040 017 021 00283567 00222034 00152067 .516 .630 .785 1

009
1 1 001 2 1 12 12 12 1 1 1 2 1 2 2 2 2 1 3 3 009 0009 0009 2 2 1 2 1 1 1 1 75 09
1 5 03 4 1 1 1 5 1 1 2 1 1 2 1 2 2 2 2 2 2 8 8
1 2 2 2 1 2 1 09 9 9 9 09 9 9 9 9 9 9 09
1 1 2 1 2 2 2 1 1 2 3 00065 020 30 60 05 05 00 1 00130 1 2 1 1 002 2 8 8 4 08
012 010 008 003 002 000 019 017 012 00348384 00253970 00249279 .585 .326 .309 1

010
1 4 015 1 6 08 13 09 1 1 1 1 1 1 1 2 2 3 6 3 009 0.05 0009 2 1 2 1 1 1 1 1 99 09
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000 000 001 001 000 004 012 002 014 01480223 00459738 00364538 0.80 0.80 0.80 1

011
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1 1 1 1 1 1 1 05 2 2 2 09 2 2 2 1 2 2 89
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012
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3 1 1 2 2 2 2 1 1 3 2 00200 047 91 05 02 02 00 1 00900 1 2 1 2 009 1 2 2 2 10
027 021 021 018 018 018 055 038 034 01752546 01928170 01398187 0.65 0.68 0.74 1

013
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014
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1 1 1 2 2 2 2 15 1 2 2 09 2 2 2 2 2 2 92
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015
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016
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017
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018
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019
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020
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021
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022
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023
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1 2 1 1 2 2 2 1 1 4 5 00110 020 99 00 00 00 00 1 00500 1 1 1 1 009 1 2 2 1 08
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025
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026
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027
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028
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029
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030
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031
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032
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034
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035
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036
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1 2 1 2 2 2 2 1 2 3 2 00051 030 60 10 20 10 00 1 00420 1 1 2 1 008 1 2 1 1 10
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037
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1 1 1 1 1 2 1 09 1 2 2 09 1 1 1 2 2 2 90
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038
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2 2 2 1 2 2 2 2 2 2 3 3 00020 020 30 50 20 00 00 1 00040 1 2 2 2 009 2 8 8 2 10
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039
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040
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041
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1 2 1 2 2 2 2 2 1 3 3 00065 012 90 05 03 02 00 3 00175 1 2 2 2 009 2 8 8 2 08
009 009 009 009 009 009 009 009 009 00000009 00000009 00000009 0.73 0.74 0.73 2

042
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1 1 2 2 2 2 2 03 1 2 2 09 2 2 2 2 2 2 90
1 2 1 2 2 2 2 1 1 3 3 00250 040 50 00 25 25 00 1 00050 1 2 1 1 010 2 8 8 1 07
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043
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009 009 009 009 009 009 009 057 015 00000009 00000009 00000009 0.70 0.76 0.73 1

044
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045
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024 008 005 014 012 016 050 013 035 01185000 00762000 00597000 0.64 0.72 0.86 1

046
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1 2 1 1 2 2 1 2 2 4 2 00101 025 09 09 09 09 09 1 00150 1 1 1 1 009 1 3 2 2 10
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047
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2 2 1 1 2 2 2 1 1 3 3 00100 010 99 00 00 00 00 1 00009 9 9 9 9 009 9 9 9 9 11
009 009 009 009 009 009 009 009 009 00000009 00000009 00000009 0009 0009 0009 9

048
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049
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050
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051
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052
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055
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2 2 1 2 2 2 2 2 2 2 2 2 00050 008 70 10 10 10 00 1 00100 1 1 2 1 004 2 8 8 2 10
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057
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2 8 8 8 8 8 8 09 8 8 8 09 8 8 8 8 8 8 09
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058
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059
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2 1 1 1 2 2 2 2 3 2 2 00100 015 40 30 30 00 00 1 00025 1 2 2 2 009 1 2 4 1 07
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060

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061
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1 1 1 2 1 2 2 00 2 1 2 09 2 2 2 2 2 2 94
2 2 1 2 2 2 2 1 3 1 3 00125 025 40 25 15 10 00 1 00090 1 2 2 1 002 1 2 2 3 10
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062
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2 8 09 2 1 1 1 2 1 1 3 1 1 3 1 1 2 2 2 2 1 1 1
1 1 1 2 1 2 2 01 2 2 1 91 2 2 2 1 2 2 88
1 1 1 1 2 2 2 1 1 1 3 00500 090 70 10 20 00 00 1 05000 1 1 1 9 009 1 1 2 2 10
020 013 041 009 009 009 009 009 009 00000009 00000009 00000009 0.38 0.56 0.61 1

063
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064
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065
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3 1 1 1 1 2 1 00 2 2 2 09 2 2 2 2 2 1 96
6 2 1 2 2 2 1 1 1 1 3 00100 012 00 25 75 00 00 1 00200 1 2 1 1 008 2 8 8 9 10
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066
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067
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1 2 1 1 1 2 2 09 1 2 2 09 2 2 2 1 2 2 91
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068
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3 2 1 2 2 2 2 1 2 1 2 00180 050 60 10 10 20 00 1 00250 1 2 1 1 005 2 8 8 1 91
024 024 047 014 014 016 070 092 085 00634485 00540945 00579638 0.86 0.91 0.97 2

069
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1 6 08 1 1 1 1 0 1 1 1 1 1 2 1 1 2 2 2 2 1 1 1
1 1 1 1 1 2 2 02 1 2 2 09 1 2 2 1 2 2 93
3 1 1 1 2 2 2 1 1 1 2 00100 200 05 10 05 80 00 1 00625 1 1 2 2 009 1 1 2 1 08
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070
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1 1 1 1 1 2 2 08 2 2 2 09 2 2 1 2 2 2 90
3 2 1 2 2 2 2 1 3 3 9 00320 025 09 09 09 09 09 1 00200 1 1 1 2 009 1 1 5 9 91
009 009 009 009 009 009 009 009 009 00000009 00000009 00000009 0009 0009 0009 1

071
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1 1 2 1 1 2 1 02 1 2 2 09 2 2 2 1 2 2 91
3 2 1 1 2 2 2 1 2 1 3 00650 100 61 34 05 00 00 1 00410 1 2 1 2 009 1 1 3 2 91
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072
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1 2 2 1 1 2 2 09 2 2 2 09 2 2 2 2 2 2 91
2 2 1 1 2 2 1 2 2 0 4 00100 045 09 09 09 09 1 00250 1 2 2 2 009 1 1 2 1 10
020 016 014 009 009 009 052 046 043 00523671 00497100 00431250 0.75 0.83 0.87 1

073
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074
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3 1 1 1 1 2 2 1 1 4 5 00300 045 00 00 00 00 00 1 01800 1 1 1 1 048 9 9 9 2 07
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075
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076
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2 2 1 2 2 2 2 1 2 4 3 00300 075 40 10 40 10 00 3 00500 1 1 3 1 003 1 1 2 2 08
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077
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1 2 1 2 2 2 2 1 1 3 9 00080 010 10 90 00 00 00 1 00150 1 2 1 2 008 1 1 4 9 07
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078
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079
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2 1 1 1 2 2 2 1 1 2 1 00300 010 00 00 10 90 00 1 00100 1 2 1 2 009 2 8 8 9 08
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080
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1 1 1 1 1 1 1 04 1 2 2 09 2 2 2 1 2 2 90
2 1 1 1 2 2 2 1 1 1 2 00250 075 80 15 02 02 01 1 01000 1 2 1 1 009 2 8 8 9 10
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081
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082
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2 8 8 8 8 8 8 09 8 8 8 09 8 8 8 8 8 8 09
1 1 2 2 2 2 2 1 2 3 9 00075 009 10 05080 10 00 4 00250 1 1 2 2 009 2 8 8 1 91
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083
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1 1 1 1 1 2 1 04 2 1 1 30 2 1 1 2 2 2 90
1 2 1 1 2 2 2 1 1 1 2 00400 045 10 00 30 60 00 1 01250 1 1 1 1 018 1 2 1 1 10
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084
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1 1 2 1 1 2 2 05 1 2 2 09 2 2 2 2 2 2 93
2 2 1 2 2 2 2 1 2 5 2 00100 030 50 25 25 00 00 1 00075 1 2 2 1 000 1 3 5 1 10
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085
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1 1 1 1 1 2 2 09 1 2 2 09 2 2 2 2 1 2 90
2 1 1 1 2 2 1 1 1 1 2 00350 040 00 00 00 00 00 1 01600 1 1 1 1 009 1 1 2 1 91
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086
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2 1 1 1 1 2 2 1 1 4 3 04000 600 00 00 00 00 00 4 14000 1 1 1 1 009 1 2 2 3 10
058 077 089 333 532 529 682 987 999 28000000 30000000 33000000 0009 0.54 0.69 1

087
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2 8 09 6 1 1 6 3 3 1 3 1 2 3 1 1 1 2 2 2 2 8 8
1 1 1 1 1 1 1 10 1 2 2 09 2 2 2 1 2 2 90
2 2 1 2 2 2 2 1 1 3 3 00550 100 00 00 00 00 00 1 00500 1 1 1 1 009 1 2 2 2 10
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088
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2 8 09 1 1 1 6 4 1 1 3 1 2 2 2 2 1 2 2 2 2 8 8
1 1 1 1 1 2 2 09 1 1 1 09 2 2 2 1 2 2 94
1 2 1 2 2 2 2 1 2 1 9 00060 008 00 00 00 00 00 1 00070 1 2 1 2 009 2 8 8 2 91
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089
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1 1 1 1 1 2 2 06 1 2 2 09 2 2 2 1 2 1 88
4 1 1 1 2 2 1 1 1 6 3 05000 070 80 05 00 05 10 3 07500 1 1 2 1 049 1 1 3 2 91

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090
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1 1 1 1 2 2 1 03 2 2 2 09 2 2 1 2 2 2 93
0 2 1 1 1 2 2 1 1 3 2 00070 015 80 00 05 15 00 1 00450 1 2 3 1 010 1 1 2 2 07
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091
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1 1 1 1 1 2 2 04 1 2 2 09 2 2 2 1 2 2 89
2 2 1 1 2 2 2 1 1 1 3 00101 005 99 00 00 00 00 1 00750 1 1 1 1 025 1 2 4 4 07
001 003 003 019 019 031 020 022 034 00929292 00754146 01646508 0.80 0.80 0.80 1

092
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1 6 99 1 1 1 6 3 1 1 4 1 1 3 1 1 1 1 2 1 1 1 1
1 1 1 1 2 2 1 04 2 2 2 09 2 2 1 2 2 2 87
1 1 1 1 2 2 1 1 1 8 3 00160 025 60 00 10 30 00 1 01100 1 1 1 1 050 1 2 1 2 10
004 004 008 010 004 005 110 089 132 02377212 02207233 02866099 0.61 0.62 0.69 1

093
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1 1 1 1 1 2 1 10 1 2 2 09 2 2 2 1 2 2 87
2 1 1 2 2 2 2 1 1 3 1 01400 110 40 10 10 40 00 1 01000 1 2 1 1 045 1 1 2 1 10
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094
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5 2 1 1 2 2 2 1 1 2 3 00050 005 99 00 00 00 00 1 00300 1 1 1 2 009 2 8 8 2 08
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095
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096
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097
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1 1 1 1 1 2 1 04 1 2 2 09 2 2 2 2 2 2 88
2 1 1 1 2 2 2 1 1 1 3 00800 050 40 25 25 10 00 1 01200 1 1 1 1 029 1 2 2 2 91
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098
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1 1 1 1 1 2 2 01 1 2 2 09 2 2 2 2 2 2 94
1 2 1 1 2 2 2 1 1 3 2 00100 020 89 10 00 01 00 1 00130 1 1 1 1 025 1 1 2 2 06
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1 1 1 1 1 1 1 06 2 1 1 30 2 2 2 1 2 2 89

4 2 1 1 2 2 2 1 1 1 3 04500 600 50 05 05 30 10 1 18000 1 1 1 1 999 1 2 2 1 08
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100
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101
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1 1 1 1 1 1 2 02 2 2 1 09 2 2 2 1 2 2 89
1 2 1 1 2 2 2 1 1 3 3 00100 010 70 10 05 05 00 1 00050 1 2 1 1 010 1 2 3 1 10
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102
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3 1 1 1 2 2 2 1 2 2 3 00098 010 05 95 00 00 00 1 00500 1 9 1 2 009 1 2 2 1 10
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103
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1 1 1 1 1 2 1 05 1 2 2 09 2 2 2 1 2 2 91
6 1 1 1 2 2 2 1 1 3 3 00065 026 80 20 00 00 00 1 00090 1 2 1 2 009 1 1 2 1 08
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104
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1 1 1 1 1 2 2 05 1 2 2 09 2 2 2 2 2 2 93
1 2 1 1 2 2 2 1 1 3 2 00080 025 99 00 00 00 00 1 00500 1 1 1 1 015 1 2 1 2 07
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105
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2 2 2 1 2 2 2 2 1 1 3 3 00180 025 80 00 00 00 20 1 00050 1 2 2 1 006 1 1 3 2 91
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106
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107
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1 2 1 1 1 2 1 09 1 2 2 09 2 2 2 1 2 2 94
1 2 2 1 2 2 2 1 2 2 1 00100 025 75 15 05 05 00 1 00100 1 2 2 1 002 1 2 2 2 10
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108
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1 2 1 1 1 2 2 09 2 2 2 09 2 2 2 2 2 2 93
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109
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001 002 002 001 001 000 003 003 004 00120000 00110000 00100000 0.76 0.73 0.70 1

110
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1 2 1 1 1 2 2 01 2 2 1 30 1 2 2 1 2 2 92
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111
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1 1 1 1 1 2 1 03 1 2 2 09 2 2 1 2 2 2 91
1 1 1 2 2 2 2 1 1 1 2 00060 010 50 00 20 30 00 1 00300 1 1 2 1 006 1 2 2 1 10
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112
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1 1 1 1 1 2 1 07 2 1 1 30 2 2 1 2 2 2 91
1 1 1 1 2 2 2 1 1 1 3 00200 040 10 00 70 20 00 3 00700 1 2 1 2 009 1 1 2 9 10
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113
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1 2 1 1 2 2 2 1 1 3 3 00100 015 95 02 00 03 00 1 00150 1 2 1 1 003 1 1 2 1 91
009 009 009 009 009 009 009 009 009 00000009 00000009 00000009 0009 0009 0009 2

114
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1 1 1 1 1 2 2 00 2 1 2 09 2 2 2 2 2 2 96
1 2 1 1 2 2 2 1 1 3 3 00100 015 65 15 10 10 00 1 00075 1 1 2 1 002 1 1 2 2 10
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115
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1 1 1 1 1 2 1 09 2 1 2 09 2 2 1 2 2 2 96
2 1 1 2 2 2 2 1 1 1 3 00040 008 99 00 00 00 00 2 00035 1 1 1 1 003 1 2 2 2 91
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116
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2 1 1 2 2 2 2 1 1 1 3 00100 020 05 10 45 40 00 1 00600 1 1 1 1 037 1 2 2 1 10
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117
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2 2 1 2 2 2 2 1 1 1 3 00101 020 09 09 09 09 09 1 00400 1 2 1 2 009 2 8 8 2 04
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118
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1 1 1 1 1 2 2 05 1 2 2 09 2 2 2 1 2 2 92
1 1 1 1 2 2 2 1 1 1 3 00050 006 99 00 00 00 00 1 00170 1 1 1 1 006 2 8 8 2 10
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119
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1 1 1 1 1 2 2 00 2 2 2 09 2 1 2 2 2 2 95
3 2 1 2 2 2 2 1 3 1 2 00100 010 10 70 20 00 00 1 00010 1 2 1 2 009 2 8 8 4 03
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120
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121
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1 1 2 1 2 2 2 04 2 1 2 09 2 1 1 2 2 2 91
2 2 1 2 2 2 2 1 1 2 1 00050 020 40 00 00 60 00 1 00200 2 1 1 1 020 3 8 8 2 06
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122
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123
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2 2 1 1 2 1 2 1 1 3 2 00130 020 30 15 57 03 00 1 00500 1 2 1 1 010 1 3 2 1 91
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124
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4 2 1 1 2 2 2 1 1 3 3 10000 400 09 09 09 09 09 1 30000 1 1 1 1 009 1 1 2 9 11
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125
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2 1 1 1 2 2 2 1 1 3 3 01001 050 09 09 09 09 09 1 15000 1 1 1 1 010 1 1 2 9 11
035 064 068 009 009 009 240 268 352 34949082 35256976 39243574 0.71 0.75 0.75 1

126
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1 1 2 1 1 2 1 05 2 1 2 09 2 1 2 2 2 2 89
5 2 1 1 2 2 2 1 3 3 2 00251 050 30 30 30 10 00 1 00200 1 1 2 1 020 1 2 3 9 11
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127
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1 1 2 1 1 2 2 09 1 2 2 09 1 2 2 1 2 1 95
3 1 1 2 2 2 2 1 2 1 3 00251 009 09 09 09 09 09 1 00600 1 1 2 1 009 1 2 2 9 11
011 012 008 037 033 038 048 045 046 02225000 03132000 01771000 0009 0009 0.75 1

128
1 1 100 2 6 85 01 05 1 1 1 1 1 2 2 2 2 3 1 5 100 0001 0009 1 2 0 1 1 2 1 1 09 01
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2 1 1 1 2 2 2 1 3 3 3 00700 009 25 20 20 45 00 1 01000 1 2 3 1 009 1 2 4 9 11
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129

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130
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2 8 09 3 1 1 6 4 2 1 7 1 1 3 2 1 1 2 2 2 2 8 8
1 1 2 1 1 2 2 09 2 2 2 09 2 1 1 2 2 2 90
1 2 1 2 1 2 2 1 1 8 3 02600 009 85 05 05 05 00 1 01000 2 2 1 2 009 1 2 4 9 11
008 007 007 009 009 009 027 024 051 01000000 01000000 01000000 0.87 1.00 1.15 1

131
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1 1 1 1 2 2 2 1 1 3 3 00350 030 20 20 20 40 00 1 00300 1 2 1 1 010 1 2 2 2 11
024 008 008 009 009 009 072 022 018 01387993 01506137 01304455 0.67 1.00 1.09 1

132
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1 1 2 2 2 2 2 09 2 2 2 09 2 2 2 2 2 2 09
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002 001 000 001 000 000 005 001 000 00000009 00000009 00000009 0009 0009 0009 1

133
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2 8 55 1 1 1 6 2 1 1 2 1 2 3 1 1 2 1 2 1 2 8 8
1 1 1 1 1 2 2 07 2 1 2 09 2 2 1 2 2 2 90
4 2 1 1 2 2 2 1 2 1 3 01380 125 30 25 25 20 00 1 00600 1 1 1 1 009 1 1 2 2 11
000 003 001 000 004 004 003 014 011 01500000 01600000 01500000 0.35 0.41 0.46 1

134
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1 2 1 1 2 2 2 1 1 7 3 00090 010 30 20 20 30 00 1 00200 1 2 1 1 003 1 2 3 9 11
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135
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136
1 1 250 1 0 02 09 09 1 1 1 2 2 2 2 2 2 2 3 0 8 009 0009 0009 2 2 0 1 1 2 1 1 44 09
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137
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1 1 1 1 1 2 2 05 2 2 2 09 1 1 1 2 2 2 90
1 1 1 1 2 2 2 1 3 1 3 00800 100 20 15 15 50 00 1 05000 1 2 1 1 010 1 1 2 9 11
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138
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2 8 8 8 8 8 8 09 8 8 8 09 8 8 8 8 8 8 09
2 1 1 1 2 2 2 1 1 3 3 00200 014 09 09 09 00 09 1 00009 1 2 1 1 009 1 2 2 9 11
000 000 002 000 000 002 000 001 004 00256000 00219000 00227000 0.70 0.87 0.87 1

139
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5 2 1 2 2 2 1 1 1 3 3 00400 009 10 10 10 70 00 1 01800 1 1 3 1 069 1 2 2 9 11
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140
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2 1 1 1 1 1 2 1 6 5 9 00045 022 40 60 00 00 00 9 00300 1 1 1 2 009 1 2 2 9 10
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141
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2 1 1 1 2 2 2 1 1 0 9 00800 275 09 09 09 09 09 4 00009 1 2 1 2 009 1 2 3 9 11
107 081 119 076 041 024 378 248 259 08160574 06264660 05789141 0.60 0.68 0.88 1