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MAKING ZERO ACCIDENTS  
A REALITY:  
FOCUS ON SHUTDOWNS,  
TURNAROUNDS, AND OUTAGES

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**Making Zero Accidents A Reality:  
Focus on Shutdowns, Turnarounds, and Outages**

Prepared by  
The Construction Industry Institute  
Making Zero Accidents A Reality Research Team

Research Summary 160A-1  
July 2002

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## Executive Summary

This research study extended prior CII studies that focused on effective safety practices on large construction projects. This effort focused on short duration projects that are commonly referred to as shutdowns, turnarounds, or outages. While different sectors of the construction industry use these terms interchangeably, the term shutdown is most common and will be used here.

This research was conducted by interviewing contractor personnel on 44 different shutdown projects. The shutdown projects included in this research had impressive safety performance records. The median injury rate for these projects was less than 0.7 OSHA recordable injuries per 200,000 worker hours of exposure. In addition, 50 percent of the projects reported having achieved zero OSHA recordable injuries. While these projects all had safety performance records well below the national average for the construction industry, differences between the safety performances of these shutdown projects were found to be associated with the differences in their work practices.

The study found that there are indeed unique aspects of shutdown projects that warrant particular concern. For example, shutdown projects with better safety records were those that were successful in transferring workers from other projects to perform the work. Better safety performances were also noted on projects that began hiring workers a few weeks before the shutdown. Safer performances resulted when shorter work weeks were worked and when shutdown durations were shorter in length, especially less than two weeks. Research also found that projects have better safety performance records when crews were smaller and when projects were completed under incentivized contracts.

The findings of the study on shutdowns are consistent with the findings of prior CII research on zero accidents. There is no simple or singular solution to achieving zero injuries. There also is no

single practice that makes a tremendous difference in safety performance in the absence of the other safety practices. Excellent safety performance is achieved through applying those practices that have shown to be effective, whether on large projects or on shutdown projects. This publication will be an aid to those who want to achieve safety excellence during shutdowns.

## Introduction

The terms shutdowns, turnarounds, and outages are used interchangeably in some settings. For other personnel, these may have different and distinct meanings. For example, for power plants the term is generally "outage" but in the petrochemical arena the terms "shutdown" and "turnaround" are used with essentially the same meaning. For this study, there seemed little value in trying to define these terms. After several discussions with industry personnel, it became apparent that there simply is no consistent definition of these terms in the industry. Regardless, general terminology will suffice for this study. The term "shutdown" is used in this report, but the terms turnaround or outage could have been used as well.

In general, a shutdown occurs when an operating facility (process plant, power plant, paper mill, and so on) must stop operations while a modification or major repair is made to some facility component. To the owner of the facility, this cessation of operations generally stops the revenue stream. Thus, there is a great deal of interest in getting the facility operational as soon as possible. This means that the shutdown will be handled differently than are most typical construction projects.

The first major difference in shutdowns when compared to conventional construction projects is that work is often performed around the clock. The construction workers may work three consecutive seven 12-hour work weeks. Even the shift work makes shutdown work different from most conventional construction projects. In addition, to satisfy the short project duration schedule, the buildup of the work force is fast. This places a heavy burden on the construction firm to properly educate and train the new hires. All of these factors could compromise the safety performance of a contractor performing shutdown work if appropriate measures are

not taken. The goal of this study was to identify those practices that were associated with the better safety performances realized on shutdown projects.

## Purpose and Methodology

This study was undertaken to identify current effective safety practices in that segment of the construction industry involving shutdowns. While it is recognized that some aspects of shutdowns are unique, the basic findings are expected to apply to other types of construction projects. Regardless of the type of project, the goal continues to be zero accidents.

Information was obtained through personal interviews that were conducted on 44 projects in various locations throughout the United States, with the largest number of projects being located along the Gulf Coast. Contacts were made with various contractors involved in industrial construction, the sector that is commonly most active in shutdown work. These shutdown projects were being performed by a few different construction firms, and it was apparent that shutdown work tends to be specialized with a small number of firms doing most of this work.

In conducting this study, contacts were made with personnel affiliated with shutdown projects. Participation in the study was completely voluntary and involved a commitment of about two hours to respond to an extensive interview questionnaire. The only firms that were not direct participants in the research were those reporting no shutdown projects being undertaken at the time.

When shutdown projects were identified for the researchers, onsite safety personnel were generally contacted directly to arrange an interview. During the telephone conversation, the purpose of the study was discussed along with a brief history of CII.

## Findings

The typical shutdown project included in this study had an OSHA recordable injury rate that was less than 0.7 injuries per 200,000 hours of worker exposure. Twenty-two projects reported the achievement of zero OSHA recordable injuries. Thirty-eight projects reported zero lost time injuries. In general the projects in the study had good safety performance. All had OSHA recordable injury rates well below the national average for the construction industry. Even with the strong safety performances being reported by these projects, however, the results showed that some practices are more effective than others in achieving stellar safety performances.

The study disclosed that virtually all projects enjoyed a demonstrated management commitment and that safety staffing was sufficient to properly support project safety efforts. This research effort identified additional key topic areas that contribute to improved safety performance. Thus, the findings of this research are consistent with the nine effective safety approaches identified in the previous CII study. The effective approaches to achieve world-class safety performance on shutdown projects include:

1. Demonstrated management commitment
2. Safety staffing
3. Planning: pre-project and pre-task
4. Safety education: orientation and specialized training
5. Worker involvement
6. Evaluation and recognition/reward
7. Subcontract management

8. Accident/incident investigations
9. Drug and alcohol testing

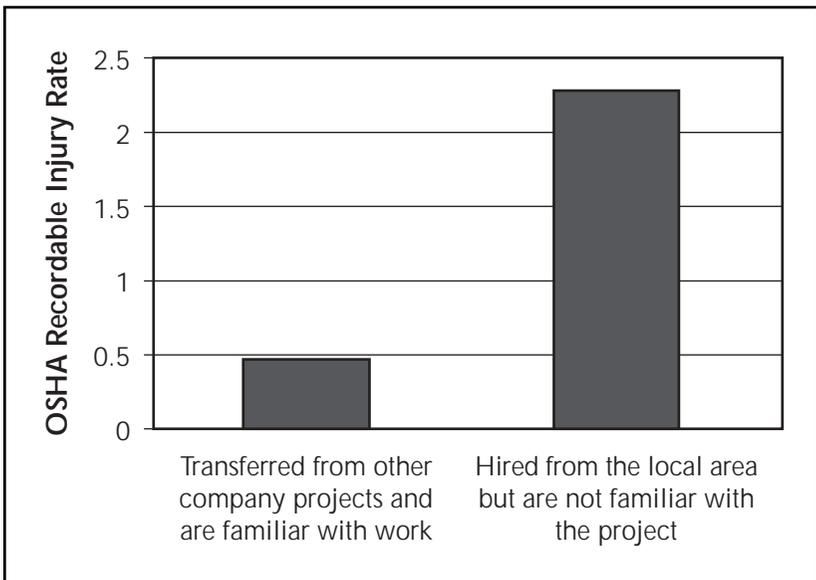
### **Unique Aspects of Shutdown Projects**

The first findings that are presented are those that appear to be unique to shutdown projects. After that, the topics are presented in order of how the development of a safety initiative might take place. There is no attempt to prioritize these practices, as none can be totally effective in the absence of all of the others.

Since shutdowns are characterized by a rapid buildup of the work force, a readily available source of locating workers is an ongoing challenge. Most shutdowns occur on projects where the contractor has a maintenance contract, necessitating a steady employment of workers. This onsite work force may number from as few as 20 to over 100 workers. This will depend largely on the size of the project. When a small shutdown occurs, it may be possible to complete the shutdown within a period of one or two days with a work force of only a dozen workers. When this occurs, it is common for maintenance employees to be assigned to the shutdown work. This assures that the workers are familiar with the work and the need for orientation and training of the workers is diminished.

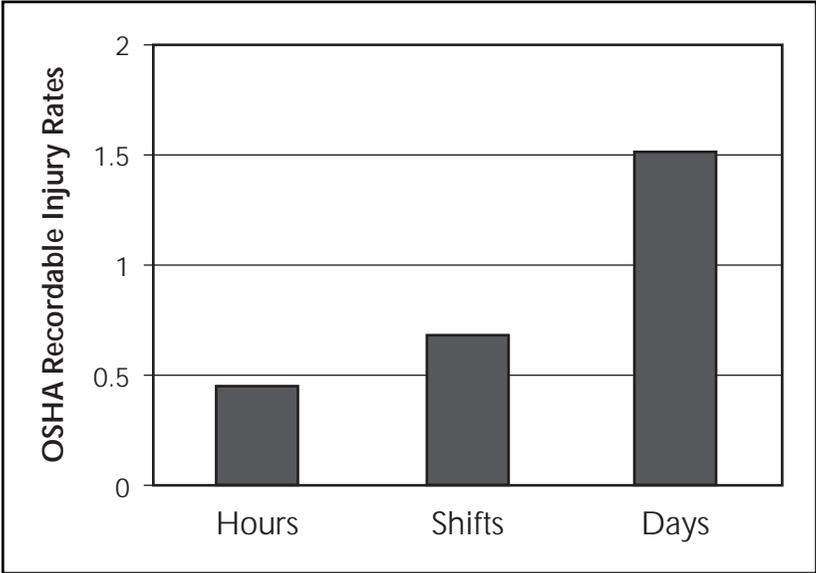
Some shutdowns entail extensive work and require a large number of workers. Even with the additional hiring of workers, it is common for the contractor to assign a considerable proportion of the onsite maintenance employees to the shutdown work. This is done to ensure that some key personnel are familiar with the project. Other workers must be hired, which presents a major challenge to the contractor. The research found basically two means of finding workers to complete the hiring for large shutdowns. One method is to hire local residents (farmers were mentioned by several contractors as shutdowns are scheduled at times when farmers are

not particularly busy). Another method used by some firms was to hire workers from other similar projects or to transfer their own employees from other projects in the area. Since this is a fairly common procedure, it is possible to hire additional workers who have already been on the project site. As shown in Figure 1, worker familiarity with the project and the type of work performed during shutdowns was found to be particularly important for project safety.



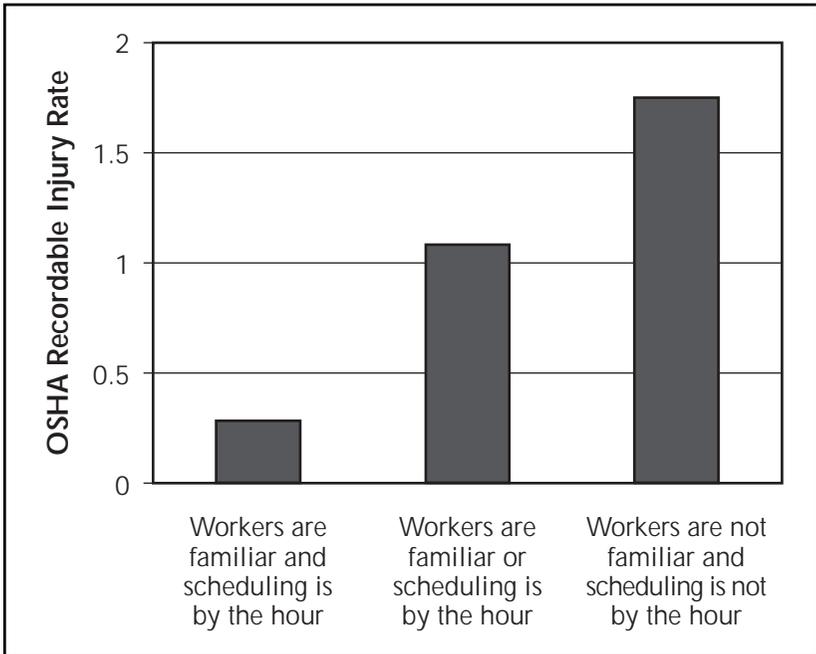
**Figure 1.** Method Used to Build Up the Work Force

One characteristic of shutdowns is that they must be performed efficiently and within tight time constraints. Most projects utilize scheduling software programs to organize and plan their work activities. Scheduling efficiency is difficult to measure in an objective manner. However, it is possible to get an assessment of the degree of detail that is used to schedule shutdown work. For example, it was found that projects were scheduled by using time units of hours, shifts, or days. It was further determined that projects that used smaller scheduling units (especially hours) had better safety records (see Figure 2). Smaller units of time require more detailed planning, which enhances safety performance.



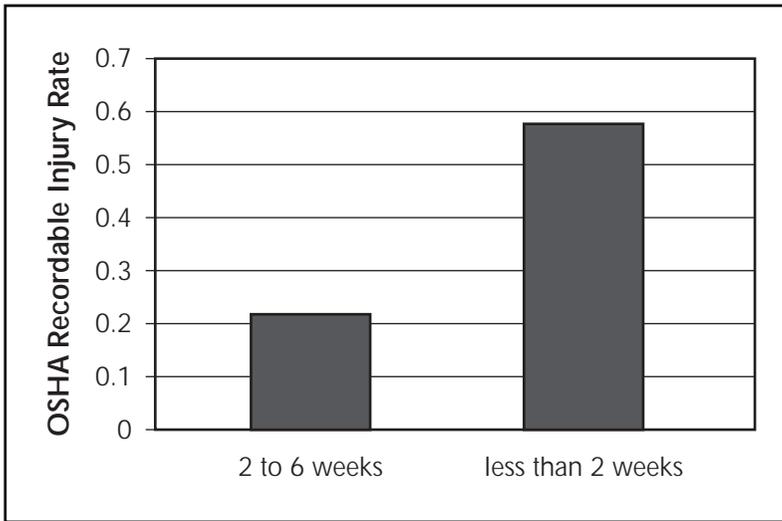
**Figure 2.** Units of Time Used in Scheduling Shutdowns

The familiarity of the work force with both shutdown work and units of measure in scheduling was an important factor influencing safety performance. These variables were combined and found to have a significant impact on safety performance (see Figure 3).



**Figure 3.** Worker Familiarity and Scheduling by the Hour

Building up the work force is an important aspect of shutdowns. Workers must not only be hired, but trained for the work as well. In order for this training to be effective, it is generally necessary to begin hiring before the shutdown actually begins. If workers are hired in advance, they can be trained and can become acclimated to the worksite. The research shows that safety performance was better on those projects where hiring of workers began considerably before the shutdown work was to begin (see Figure 4).

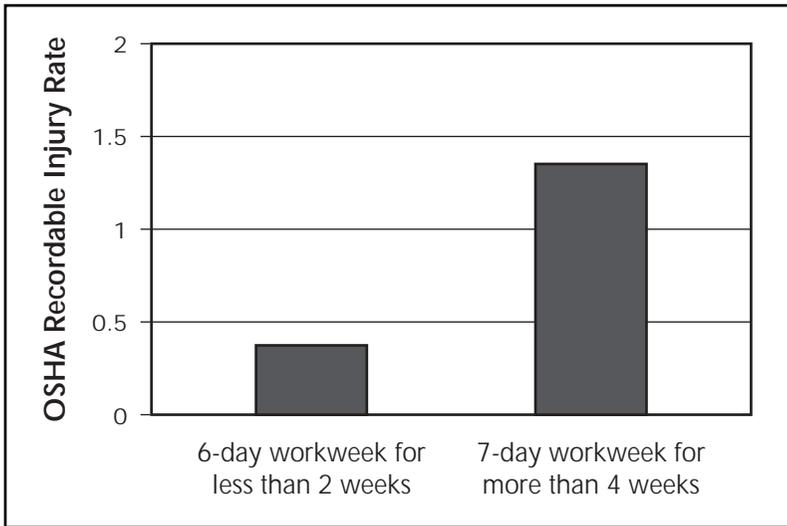


**Figure 4.** Time Prior to the Shutdown that Hiring of Extra Workers Begins

Various scheduling aspects, other than the scheduling units, must be considered when shutdowns are being planned. Since projects that are shut down will directly impact the revenue stream of the facility, it is important to have the facility operational as soon as possible. This is why the number of workers is bolstered to the number required to deliver the completed facility as soon as possible.

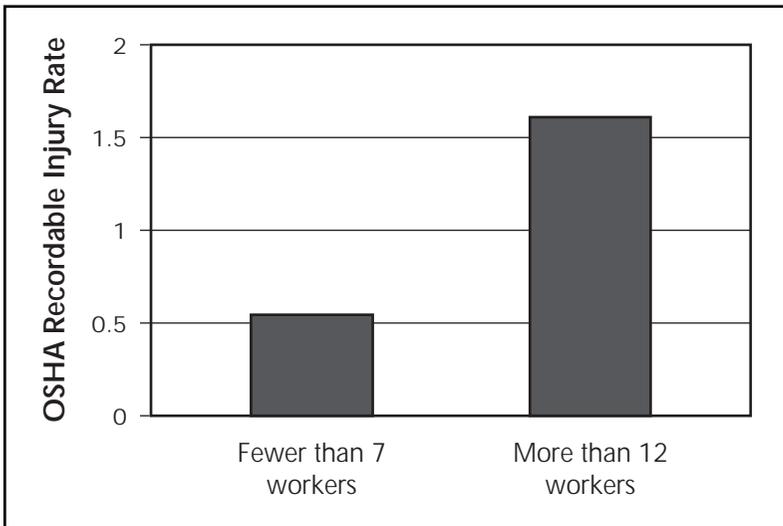
In order to optimize the delivery of the project to operational status, it is common for shutdowns to be constructed in shifts with the shutdown workers remaining fully employed with extensive overtime until the work is completed. For example, some projects will organize shutdown work to be performed by workers being scheduled for six twelve-hour days or even seven twelve-hour days each week. The research indicates that projects tended to have better safety records when six twelve-hour days were worked each

work week instead of seven twelve-hour days. It was also discovered that safety performances were better when shutdown periods were shorter in duration. Further analysis revealed that these two findings were related. It was found that better safety performances were realized when six twelve-hour workdays were scheduled on shutdowns that were of shorter duration (see Figure 5). The fatigue impact of the twelve-hour workday schedule over an extended period has a negative impact on safety performance.



**Figure 5.** Workweek Schedule and the Shutdown Duration

Building up the work force raises concerns about productivity. Productivity is compromised by long work hours and when the work force is larger than would be considered ideal under normal circumstances. The impact on safety performance is also evident when workers are inadequately supervised. While findings did not disclose any impact on safety performance when the work force was large or small, the findings did show a relationship between the level of supervision offered and safety performance. It was found that safety performance was better for the smaller work crews or when the ratio of workers to supervisors was smaller (see Figure 6).



**Figure 6.** Size of the Crew

## Incentivized Contracts

The owner's commitment to safety is addressed in many ways. The owner begins to demonstrate a posture toward safety in the contract itself. One way that this is dramatically shown is to reward safe work performance through an "incentivized" contract (one in which the contractor receives a financial reward or monetary benefit for performing work safely). The definition of safe work is generally stated in terms of a stipulated OSHA recordable injury rate. Failure to deliver the project at the stated injury rate means a loss of financial reward or a reduction in the amount. Safety performance that is not within the stated range parameters generally will mean a loss of any financial payment for safe performance. Such contracts were shown to be associated with better safety performances (see Figure 7).

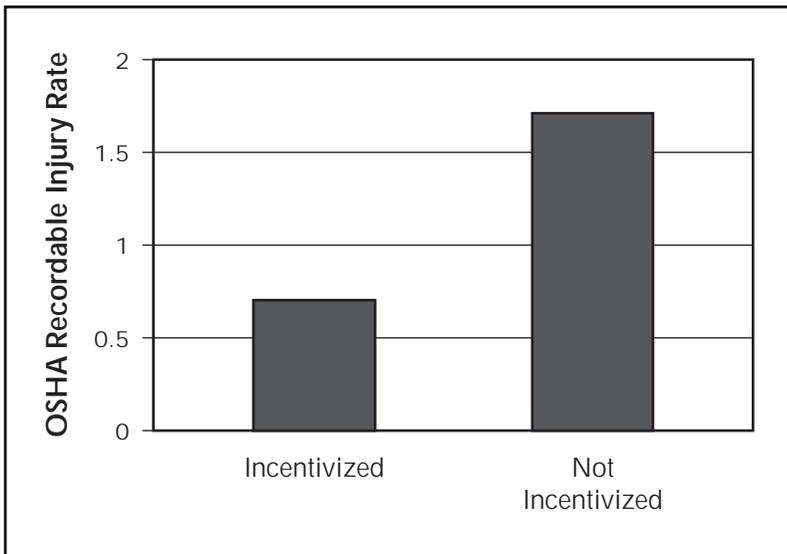
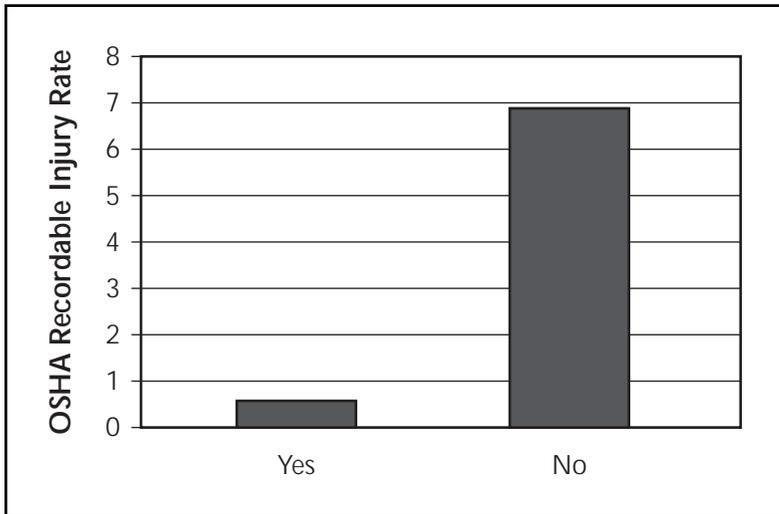


Figure 7. Type of Contract

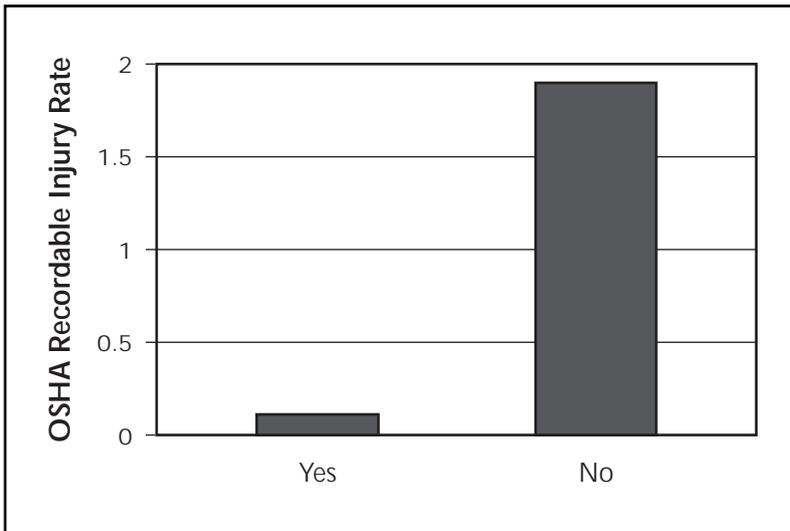
In addition to the previously-noted findings that were unique to shutdown projects, the results of this study showed support for seven of the nine categories noted in the findings of the research on Making Zero Accidents A Reality. A single finding from each of these categories follows to indicate the nature of these findings.

1. **Pre-project and pre-task planning** plays a vital role in jobsite safety on shutdown projects. The pre-task safety plans ensure that the daily tasks are performed with safety integrated into the daily work routine. Most shutdown projects were noted to implement a well-established pre-task planning program. Pre-task safety plans are developed with every changing task, often resulting in several such plans being developed by a single crew in a typical workday. These plans are also documented and monitored by other personnel on site. Pre-task safety plans were employed on those projects with better safety performances (see Figure 8).



**Figure 8.** Is Pre-Task Planning a Regular Part of Project Planning?

2. **Safety education and training** is a major component of jobsite safety. Worker training begins with an orientation session that workers receive when they arrive at the project site. Every worker should receive orientation training. The safety performances of projects that provided orientation training to all workers were significantly better than those without this practice (see Figure 9). Additional training should be provided as the need arises with changes in jobsite conditions and work activities. Examples of this type of training include the dissemination of information on confined spaces, lockout/tagout procedures, hot work, fire watch, and emergency procedures. It is essential that the appropriate level of training be offered to all jobsite personnel, including training provided for supervisory and managerial personnel.



**Figure 9.** Do all new field employees receive orientation training?

3. **Worker involvement** in the construction process and in ensuring the safety of the jobsite is important to jobsite safety. If workers are involved in the process, they are more inclined to feel that they are a part of it. Morale will generally improve when workers are allowed and encouraged to be active participants in shaping their environment. Means of encouraging worker involvement and participation include observations of worker behavior and input through worker safety perception surveys and through service on safety committees. Worker involvement in the safety program was found to be associated with those projects with better safety performances (see Figure 10).

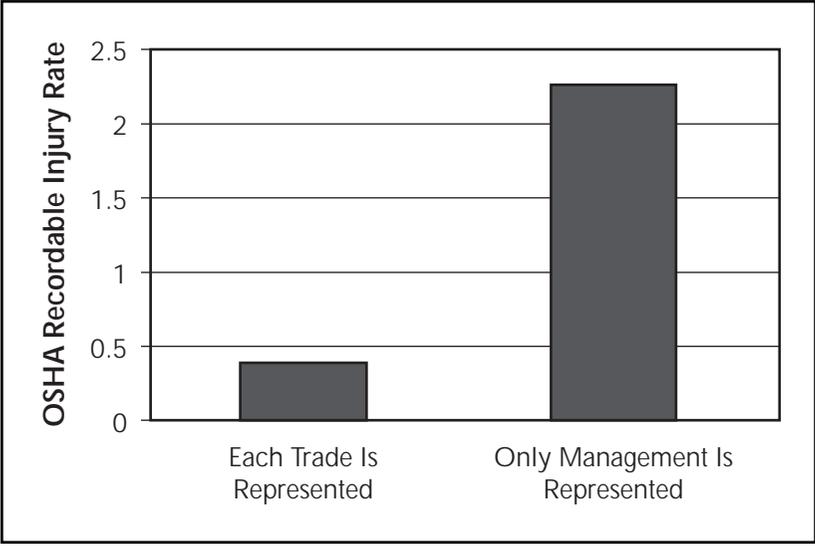
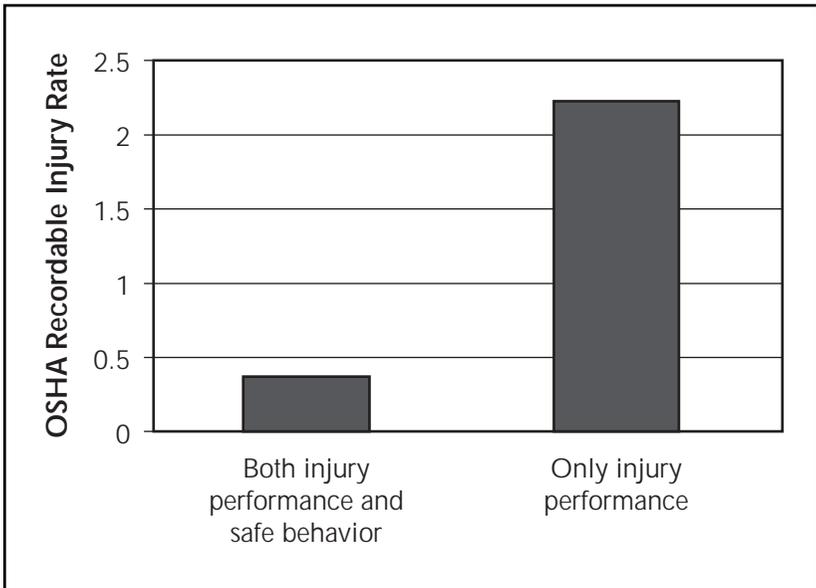


Figure 10. What is the makeup of the project safety committee?

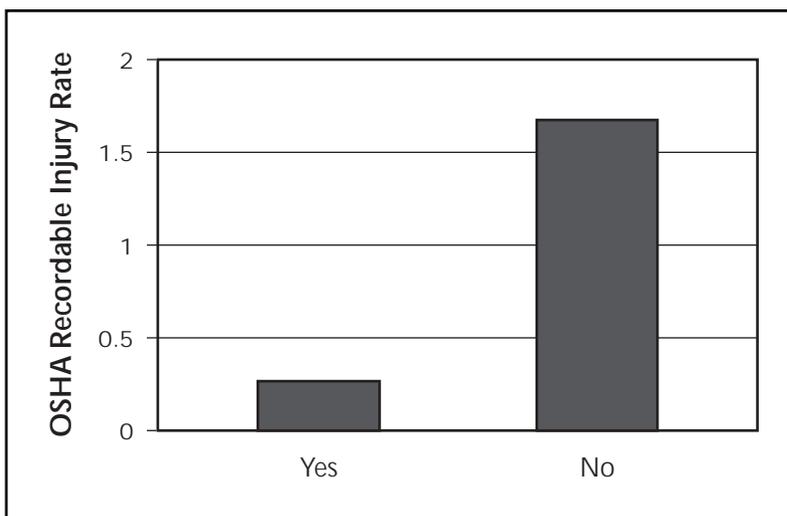
4. **Worker evaluations and recognition/reward programs** have shown some success in improving safety performances. The shortcomings of traditional incentive programs were noted in the earlier study on Making Zero Accidents A Reality. Particularly effective safety incentive programs focus on addressing injury occurrences (negative results) and safe worker behavior (positive results) and not solely on the occurrence of injuries (see Figure 11).



**Figure 11.** Basis for Providing Safety Incentives

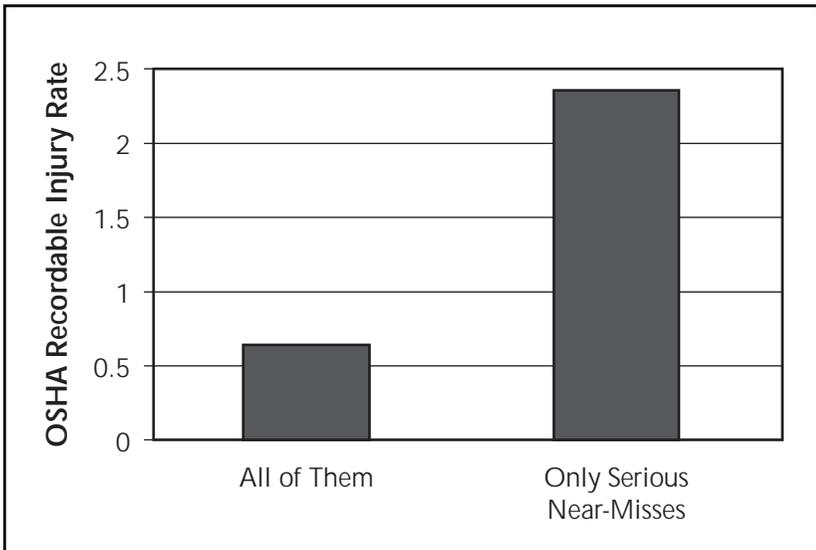
5. **Subcontract management** must address the issue of subcontractor safety. Consistency is important when implementing safety programs on a jobsite. All parties must comply with the same safety guidelines. In fact, the employees of the subcontractors should not be viewed differently from the employees of the general contractor. For example, every employee of every subcontractor should go

through the same orientation training session as the employees of the general contractor. Just as worker involvement in construction safety was found to be conducive to better safety performance, so too with the direct involvement of subcontractors in the safety process. For example, better safety performances were noted when subcontractors were required to attend regular project safety meetings. The safety agenda of the project must make no distinction between the general contractor and the subcontractors. If the safety program is to be effective, it must involve the subcontractors whereby they are included in the orientation training, the drug testing, the safety planning, and so on (see Figure 12). By not making a distinction between the general contractor and the subcontractors or their employees, the safety mission can have a clear and singular focus. The primary issue should not be one of indemnification or shifting liability, but rather in assuring every employee with a safe and healthy place in which to work.



**Figure 12.** Do Regular Project Safety Meetings Include Subcontractor Participation?

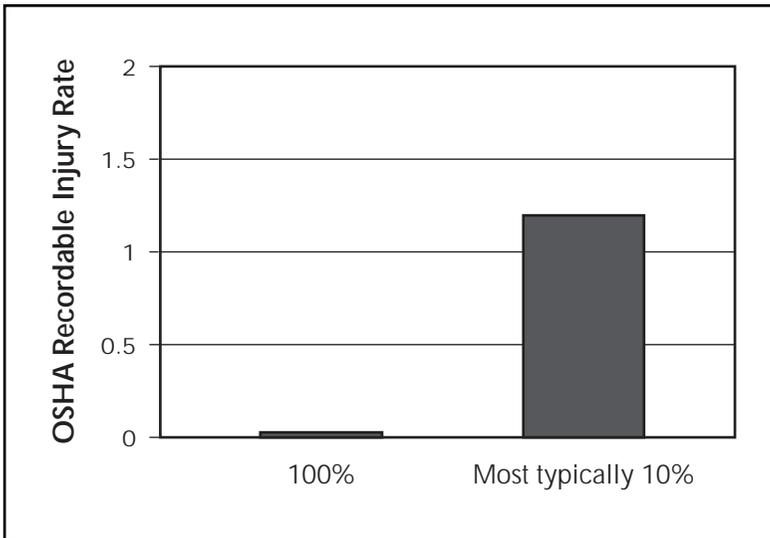
6. **Accident/incident investigations** are important for identifying the root causes of injuries in order to devise effective preventative measures. While such investigations are standard in the construction industry, proactive firms include near misses in these investigations. The firms with particularly good safety records were those that investigated every near miss and that made no distinction on the basis of severity (see Figure 13).



**Figure 13.** Which Near-Miss Accidents Are Investigated?

7. **Drug and alcohol testing** has become a standard practice on many construction sites. Maintaining a drug-free work force is one means of helping to ensure a safe work environment. This research showed the safety benefits realized through drug testing. The types of drug testing include pre-employment, random, post-accident, for cause, and follow-up testing. One finding of interest in this study relates to random testing. Normally, random testing is conducted on a

monthly basis with perhaps 10 percent of the work force being tested. On some projects, the tests were conducted randomly, but with 100 percent of the work force being tested. These firms were noted as having particularly strong safety performance records (see Figure 14). Similarly, better safety performances were noted with firms that did follow-up drug testing.



**Figure 14.** What Percent of the Work Force Is Tested in Random Drug Tests?

The results have shown that safety performances on shutdown projects are impacted by various project practices. Many were also found to be similar to those of the earlier zero accidents study. In addition, several findings were unique to the work encountered with shutdowns. Thus, the nature of shutdown work presents unique challenges to the project managers and safety personnel.

## Conclusions

Perhaps the most notable conclusion that can be drawn from this study is that the achievement of zero injuries on shutdown projects is a goal that is achievable. Half of the participating shutdown projects reported zero OSHA recordable injuries.

Part of the success of achieving zero injuries or stellar safety performance is founded in specifically addressing the unique aspects of shutdown projects. For exemplary safety performance, workers for the shutdown should be familiar with the shutdown work. This can best be accomplished by first transferring onsite maintenance workers to the shutdown operations, and second, by transferring such workers from other similar projects in the area. The scheduling of the shutdown work is also a key issue for conducting safe shutdown operations. For best safety results, scheduling must be done in greater detail, in terms of hours as opposed to shifts or days. Better safety performances are also achieved when shutdowns are for shorter durations and when the work weeks are not as long. Thorough planning and pre-shutdown preparations can assist considerably in reducing the actual shutdown period. Even when the shutdown situation is such that the duration cannot be kept to a short period of time or when excess overtime cannot be avoided, steps can still be taken to maintain the safety performance of the project.

The results show that while the unique aspects of shutdowns must be addressed, the basics of achieving safety in any setting cannot be ignored. The following is a summary of the significant findings of this study:

- Safer projects scheduled operations by the hour.
- Safer projects employed workers who were familiar with shutdown work.

- Safer projects had smaller work crews.
- Safer projects implemented pre-task planning on all operations.
- Safer projects were those who provided orientation training for every worker on the project (including subcontractor workers).
- Safer projects included workers in project safety committees.
- Safer projects included their subcontractors in regular safety planning meetings.
- Safer projects were those that had their worker incentives based on injury performance and safe work behavior, not exclusively on injury performance.
- Safer projects were those with well-established drug testing programs.
- Safer projects conducted thorough near miss investigations with involvement of various personnel.
- Safer projects had incentivized contracts.

This study showed that good safety performance is regularly achieved on shutdown work. In addition, the research provided insights as to how such safety performance can be achieved. This is accomplished by implementing various practices as there is no single practice that will make all the difference in safety performance. The safety agenda must be broad-based, encompassing various practices that address the differing needs of the project.

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## Notes

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