THESIS

EVALUATION OF A SAFETY PROGRAM FOR THE RESIDENTIAL CONSTRUCTION INDUSTRY

Submitted by

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Signature page

ABSTRACT OF THESIS

EVALUATION OF A SAFETY PROGRAM FOR THE RESIDENTIAL CONSTRUCTION INDUSTRY

This study describes the development, implementation, and evaluation of a safety program designed for the residential construction industry. This safety program, called the HomeSafe Program, was developed as a result of cooperative efforts between the Home Builders Association of Metropolitan Denver and the Occupational Safety and Health Administration, Region VIII. All companies involved with residential construction that work in the Denver six-county area are invited to participate in the program. The purpose of HomeSafe is to reduce the incidence of injuries and fatalities on residential construction sites through the use of engineering, administrative, and behavioral interventions. The heart of the HomeSafe Program consists of ten sections that encompass the most common and serious safety hazards encountered on residential construction sites. Implementation of the program began in January 1997 and it is scheduled to run through the year 2000.

The purpose of this study was to determine if companies that participated in the HomeSafe Program exhibited a higher degree of safety performance than

companies that did not participate in the program. A safety audit was developed to measure company safety performance. A total of 17 items were included on the audit. Most pertained to employee behaviors and work site characteristics that were encouraged in the program. Most items on the audit were scored all-or-none. A high score was related to high safety compliance.

Study subjects were separated into three test groups which included: 1) pretest, 2) posttest, and 3) control. The pretest group consisted of companies that had signed up for participation in the program, but had not yet attended the HomeSafe training/orientation session. The posttest group consisted of companies that had been HomeSafe participants for approximately four months. The control group consisted of randomly selected companies that were not HomeSafe participants. A total of 374 audits were completed, which consisted of 98 pretests, 94 posttests, and 182 controls. Only companies with employees that worked on construction sites were administered the audit. Fifteen trades were identified among all the audits.

Analysis was conducted using companies that had both a pretest and a posttest completed. The interaction between mean total scores, test groups, and the 15 trades was non-significant ($p>0.05$). Analysis of several variables, such as amount of safety training and electrical cord condition, indicated that subjects in the posttest group scored slightly higher than pretest subjects, but the results were non-significant ($\chi^2=0.682$ and 0.307, respectively). The difference in mean total scores between the three test groups was statistically significantly ($p=0.036$). The significance was due to the difference in mean scores between the posttest and control groups (p=0.022). The difference in mean scores between the pretest and posttest groups was not significant (p=0.715).

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Introduction

The construction industry is the sixth largest employer nationwide accounting for 5% of America's labor force with over 7 million workers (Kisner and Fosbroke, 1994; Robinson et al., 1995). Data from the Bureau of Labor Statistics (1997a) indicate that in 1995, the construction industry was second only to manufacturing in the incidence of nonfatal occupational injuries and illnesses (10.6 and 11.6 per 100 full-time workers, respectively). According to Georgine et al. (1997), the construction industry has the third highest fatality rate in the nation (14.7 per 100,000 workers), behind mining (25 per 100,000) and agriculture (22.6 per 100,000). Nationally, this industry accounts for more than 50% of all work related fall fatalities and 17% of all fatal work related injuries (Bureau of Labor Statistics, 1997b). Between 1980 and 1989, 226 fatalities occurred in the Colorado construction industry, the second highest number of workplace fatalities among all industries in the state (NIOSH, 1997). In 1991, workers in the Colorado residential construction industry experienced seven fatalities (Division of Workers' Compensation, 1995; Baltz, 1997).

Construction workers experience a high rate of injuries and fatalities mostly due to their work environment. Work is often performed from roof tops, on scaffolds, and in excavations, while being exposed to constant fluctuations in weather and temperature. Safety and health regulations for the general construction industry are outlined in the Code of Federal Regulations (CFR), part 1926 (Office of the Federal Register, 1997). Safe work practices for residential construction are also addressed in the CFR; however, these regulations have not met the expectations of safety professionals and workers in this industry (Office of the Federal Register, 1997; Fowler, 1997). The largest complaints were that the OSHA regulations were too complex and geared mostly for commercial construction (Baltz, 1997). In an attempt to simplify the CFR for the residential construction industry, OSHA published a booklet that summarized health and safety standards specifically for the home building industry (OSHA, 1997c). This booklet, however, contained the same complex regulations that were the focus of the industry's complaints.

A new safety program was developed and implemented to address the immediate need for reducing residential construction related injuries and fatalities, and to provide simple, relevant safety regulations for this industry. This program, called the HomeSafe Program, is intended to reduce injury incidence and severity, and particularly fatality rates in residential construction through the application of safety regulations specific to this industry.

This thesis describes the development and use of a safety audit designed to measure on-site safety performance among residential construction companies that did and did not participate in the HomeSafe Program. The purpose is to determine if participation in HomeSafe increases worker safety performance. Determining the real success of the HomeSafe Program is dependent on the ability of the program to reduce compensable work related injury incidence, severity, and fatality rates and related workers' compensation costs.

Literature Review

History of the HomeSafe Program

HomeSafe is an acronym for the Home Builders and OSHA Mutually Ensuring Safe Accident-Free Employment. Development of the HomeSafe Program began in 1991, following the seven deaths in the residential construction industry in Colorado. In 1992, The Occupational Safety and Health Administration-Region VIII (OSHA) began to focus enforcement activities in the residential construction industry. The home building community was initially in opposition to OSHA's enforcement actions. However, members of the Home Builders Association of Metropolitan Denver (HBA) decided to enlist the help of OSHA to increase safety, rather than continuing an adversarial relationship by fighting the administration every time an inspection was conducted.

Communication and negotiation between the HBA and OSHA began in 1992 and continued through 1996. During this time, the HBA and OSHA researched the available data and identified the significant risk factors associated with the incidence of construction safety violations, work-related injuries and illness, and fatalities in the construction industry. The administrator of OSHA Region VIII maintains that the HomeSafe Program was developed in response to the residential construction industry's complaints that current construction standards didn't apply to the unique work of home building, and the standards were too complicated, outdated, non-specific, and difficult to understand

(Chadwick, 1995). HomeSafe is designed to address the most important safety needs of the residential construction industry in a simple, straightforward manner, and is intended to reduce injury incidence and severity, and particularly fatality rates in this industry.

From the inception of the program, OSHA maintained that HomeSafe would not be considered a success unless it was associated with a measurable decrease in injury and fatality rates. Both OSHA and the HBA realized that scientific evaluation was necessary to determine if an association existed. In 1996, OSHA and the HBA invited researchers in the Department of Environmental Health at Colorado State University to take the leading role in the program evaluation. Currently, there are four Masters degree candidates, one Doctoral candidate, a Professor of Industrial Hygiene, a Professor of Statistics, and a Professor of Ergonomics working on the HomeSafe Program evaluation project. Funding for the evaluation is provided by a grant issued by the National Institute for Occupational Safety and Health.

The HomeSafe Program represents a unique partnership between the Denver home building industry and OSHA. Never before have these two entities worked together as they have during the development of the program. Should HomeSafe prove to be a success, it would represent a 'win-win' situation for OSHA and the home building industry. OSHA would succeed in reducing injuries and fatalities and the residential construction industry would have a safety program that was industry specific. Currently, HomeSafe is a pilot program. Implementation of the HomeSafe Program began January 1, 1997. The program was officially recognized by the Assistant Secretary of Labor on April 24, 1998 and it is scheduled to run for three years from this date. The program time may be expanded if shown efficacious.

Components of the HomeSafe Program

The heart of the HomeSafe Program consists of ten sections that encompass the most common and serious safety hazards encountered on residential construction sites. Serious hazards are those that are likely to result in injuries or fatalities, such as a lack of fall protection or a missing saw blade guard. These sections are contained in a booklet distributed to all participating companies called the "Guide to Safe Work Practices for Home Builders: HomeSafe - 10 Point List" (HBA, 1996). See Appendix A for an example of pages taken from the HomeSafe booklet. The focus of the ten sections is supported by both professional experience and conclusions of research investigations. In fact, nearly all items in the 10 point list are also represented in OSHA's list of the 100 most frequently cited construction standards (OSHA, 1993). Design of the booklet was driven by the intent that workers would carry it with them while on the job site to use as a safety reference (Safe Guard, 1998). Consequently, the booklet measures 3.5 by 7 inches, small enough to carry in a shirt pocket or inside the webbing of a hardhat. The booklet uses a simple, straightforward approach to encourage proper safety characteristics and behaviors with respect to each of the sections. Safety issues presented in the booklet are exemplified by a number of simple, yet humorous illustrations. Listed below are the ten safety sections with examples of their associated hazards commonly observed on residential construction sites.

1. **Company Safety Policy**

It is well known that unsafe work practices are a precursor to the occurrence of accidents (Bird and Germain, 1996). A well-established safety policy and written program provides employees with a resource that provides guidelines on how to perform work in a safe manner. OSHA considers the existence of a written safety program to be very important. This is reflected by the fact that failure to have such a program was the 11th most frequently cited construction standard (OSHA, 1993).

2. **Personal Protective Equipment**

Exposures to falling objects, flying wood particles, and protruding nails are very common hazards on residential construction sites and are among the top causes of injuries (Hunting, et al., 1994; Waller et al., 1989). OSHA places great emphasis on employee training about personal protective equipment, its use, maintenance, and limitations (OSHA, 1995).

3. **Scaffolding**

Several different types of scaffolds are used on residential construction sites including pump jack, tubular welded, and job built. Improperly constructed or supported scaffolds or scaffolds constructed of faulty components can collapse causing serious injury or death. Falls from scaffolds are a leading cause of injuries due to falls on construction sites (Cattledge et al, 1996). More importantly, the majority of fatalities due to falls on construction sites are the result of falls from scaffolds (Sorock et al., 1993). Approximately 15% of the 100 most frequently cited construction standards were related to scaffolding issues (OSHA, 1993).

4. **Ladders**

Ladders are used extensively on construction sites to provide a means of access to elevated surfaces. Hazards associated with ladder use include defective rails and rungs, and improper usage, such as using the top step of a step ladder as a work platform. Falls from ladders are a major cause of injuries on construction sites, accounting for as much as 33% of all fall injuries (Cattledge et al., 1996). Injuries and fatalities due to falls from ladders are of particular concern to OSHA, which has published a document that specifically addresses guidelines for safe ladder use (OSHA, 1997b).

5. **Construction Electrical and Power Cords**

Workers who use power tools are potentially exposed to hazards associated with electricity. Most electrical hazards arise when workers use defective equipment or do not use ground fault protection (Ore and Casini, 1996). Additionally, much of the home building process is conducted while workers, their tools, and cords are exposed to the outdoor elements. Wet conditions can pose significant hazards when electricity is used. Electrocution is the second leading cause of fatalities on construction sites and construction workers account for the largest number of electrical deaths in the U.S. (Ore and Casini, 1996). Approximately 20% of the 100 most cited construction standards were associated with electrical issues (OSHA, 1993).

6. **Access and Housekeeping**

Many different materials are used in the home building process, such as wood, drywall, insulation, concrete, and brick. Workers are exposed to significant slip, trip, and fall hazards when these materials are not organized or properly disposed. Failure to provide general housekeeping was the 18^{th} most frequently cited construction standard (OSHA, 1993).

7. **Open Holes and Unprotected Sides and Edges**

During much of the construction process, workers are exposed to falls through holes, such as stair holes, and from elevated surfaces, such as open-sided floors and window openings. Many window openings expose workers to falls greater than 25 feet, which can cause significant injury or death. Failure to guard open-sided floors was the second most frequently cited construction standard (OSHA, 1993).

8. **Fall Protection**

Workers that engage in roof construction, installation, and tiling are at particular risk to injury and death due to falls from roofs (Kisner and Fosbroke, 1994). Falls are the primary cause of fatalities on construction sites (Kisner and Fosbroke, 1994; Swanson, 1996). Even among workers that use fall protection, defective or improperly used equipment is a major cause of injuries (Cattledge et al. 1996).

9. **Excavation and Trenching**

Construction of most new homes in Colorado begins with an excavation to pour the concrete foundation and a trench to install the plumbing system. Potential collapse of the dirt walls in excavations and trenches poses a significant hazard to concrete workers and pipelayers, particularly when the walls have been improperly guarded and depths exceed five feet (Stanevich and Middleton, 1988; Suruda et al., 1988). Trench cave-in is one of the leading causes of fatalities on construction sites (Sorock et al., 1993).

10. **Power Tools and Motorized Equipment**

Nearly all construction trades use power tools. Many of these tools are dangerous, such as circular saws and air-powered nail guns, and can cause serious injury if used improperly or if the appropriate protective equipment is not worn during use (OSHA, 1996). Lacerations are the most common injuries in the construction industry, and are most often caused by cutting or piercing objects, such as power tools (Hunting et al., 1994; Kisner and Fosbroke, 1994; Waller et al., 1989)

All companies involved with the residential construction industry in the metropolitan Denver area, which includes Adams, Arapahoe, Boulder, Denver, Douglas, and Jefferson counties, are welcome to participate in the HomeSafe Program. Participation in the HomeSafe Program requires that each company attend one three- hour group orientation and training session. These sessions are generally offered once per month and are presented at the HBA home office in central Denver. One-time membership fees to participate are currently $50 for HBA members and $85 for non-members. The membership fee allows for two representatives from each company to attend the sessions. HomeSafe booklets and other materials pertinent to the program are distributed to the participants at the orientation/training sessions. The other materials that are distributed include blank OSHA 200 injury report logs, workers' compensation claim report sheets, and HomeSafe presentation evaluation forms. Data taken from these data sources are necessary to evaluate the effectiveness of the HomeSafe Program. Conditions for participating in the HomeSafe Program require that companies complete and submit these documents to researchers at Colorado State University (CSU) for analysis. Confidentiality is greatly stressed by the HBA and CSU concerning data handling. In addition to the paperwork requirements, HomeSafe participants must agree to allow authorized individuals to conduct safety audits on their work sites for purposes of program evaluation. These individuals include HomeSafe Safety Committee members and the study investigator. The roles of these individuals in program evaluation will be discussed later.

The format of the orientation/training session includes an introduction and description of the HomeSafe Program. Motivational speeches are presented from prominent construction safety professionals in the early stages of the session. Following the presentations is a description of the program evaluation procedures and instructions on how to complete and submit the required documentation (i.e. OSHA 200 logs, workers' compensation data, etc.). At this time, the participants are educated about the purpose of the evaluation and the necessity of on-site visits to collect safety and health related data. Next, a page-by-page slide presentation of the HomeSafe booklet is conducted that includes discussion about safe and at-risk behaviors and an explanation of the requirements set forth by the HomeSafe Program. Finally, a question and answer session is held to ensure that all the participants understood the materials that were presented to them.

The HomeSafe Program was designed to be self-regulated by the HomeSafe Safety Committee, which is represented by a number of safety professionals, managers, and labor representatives that work in metropolitan Denver and have extensive experience in the home building industry. All members of the safety committee volunteer their time to assist in the implementation of the program. The committee is central to the implementation of the program. Major issues related to the HomeSafe Program are decided upon by the committee. This includes the coordination of evaluation efforts and communication between the HBA, CSU, OSHA, and the home building industry.

Another major role of the committee is to conduct work site visits of companies that are participating in HomeSafe. Approximately twice per month, representatives from OSHA and the HomeSafe Safety Committee randomly select participating companies to be evaluated. Both OSHA and the committee expect employees of participating companies, at minimum, to be following the guidelines set forth in the HomeSafe booklet. The safety committee evaluates each job site visited by use of a standardized checklist (Appendix B) to determine the companies' level of compliance with the program. Companies unsatisfactorily implementing the HomeSafe Program may be expelled from the program, however, the checklist is mainly used as a feedback mechanism to help companies improve their safety performance. During the visits, employers and employees have an opportunity to interact with members of the committee to discuss specific problems they may have in the implementation of the HomeSafe Program. Feedback from the companies is important so that adjustments to the HomeSafe Program implementation and booklet can be made to ensure that the target audience (residential construction companies) is being sufficiently served.

The HomeSafe Program is not meant to replace or downgrade safety and health programs that may already exist among the participating companies. Rather, the program is intended to enhance, or supplement these preexisting programs. The HomeSafe Program may be used as a 'starter' safety and health program if no other programs exist. However, companies in this situation are expected to use the program as a basis for developing a more comprehensive safety and health plan (Chadwick, 1995).

Participation and implementation of the HomeSafe Program is encouraged by the use of several incentives. The most powerful is a special partnership between the program participants and OSHA. This relationship provides unique benefits not realized by non-participating companies, but only if the participants fulfill their obligations to the program and sincerely attempt to implement HomeSafe in their companies. The OSHA 'carrot' includes the following benefits: 1) no programmed inspections, 2) limited scope complaint inspections, 3) use of phone and fax procedures to expedite the handling of complaints, whenever appropriate, 4) focused inspections based on the HomeSafe 10-point list rather than the full OSHA construction safety standard, 5) appropriate penalty reductions for serious hazards, 6) no citations or penalties for other than serious hazards corrected in the compliance officer's presence, and 7) priority technical assistance (Safe Guard, 1997). For employers unwilling to embrace the HomeSafe Program, traditional enforcement will be offered that does not include the advantages listed above. Traditional enforcement includes holding companies accountable to the CFR 1926 construction standards, rather than the HomeSafe 10-point list.

Another incentive offered to companies is the possibility of workers' compensation premium discounts. Not all HomeSafe participants are required to pay workers' compensation; many are self-employed with no other employees.

However, for those companies that do have more than one employee, this discount can significantly effect the 'bottom line'. The Colorado Workers' Compensation Premium Cost Containment Board provides a 5% premium discount to employers who qualify for certification by submitting a quality safety program with proof of implementation that is supported by favorable loss history experience (Gilkey et al., 1998).

Site visits by the HomeSafe Safety Committee are also an incentive of the program. The safety committee educates employers and employees about hazardous site characteristics and employee behaviors that were not recognized as potential causes of accidents. This function of the committee provides positive reinforcement of safety work practices. Additionally, companies view the committee feedback as 'freebie' OSHA inspections; they are given the opportunity to correct the hazards, particularly those that are serious, that OSHA may have otherwise cited.

The HBA has developed its own list of HomeSafe incentives that is used to encourage participation in the program. This list has been published in several newsletters and magazines and consists of the following points (Burris, 1997):

1. The program reduces the OSHA rules to a simple 10-point safety program that everyone can understand;
2. Reduces the risk of possible fines if you have an OSHA inspection;
3. Creates or supplements your company safety program;
4. Reduces accident and lost time and workers' comp rates;

5. You can choose your OSHA - abide by the 1000 page CFR 1926 or follow the simple HomeSafe 10 point Program;
6. Specialized HomeSafe training for partners of the program;
7. A safety program designed specifically for the home building industry; and,
8. Recognition by OSHA as being a HomeSafe Partner.

HomeSafe Theory

Built into the HomeSafe Program are three major theoretical constructs designed to increase the chances of successful implementation. These three constructs include the use of incentives, self-regulation, and multiple intervention design. Each of these constructs is described below.

Use of incentives.

Bird and Germain (1996) describe the principle of "positive, immediate, and certain" consequences as a result of engaging in particular behaviors. Using an example of people who drive at excessive speeds, although they risk causing an accident or receiving a ticket, these events are "negative, future, and uncertain". Conversely, causes for speeding such as the desire to do other activities other than driving or to get somewhere on time are positive, immediate, and certain. Construction workers are in a very similar situation. The consequences of unsafe behavior, such as accidents or fatalities, are negative, future, and uncertain. However, workers may feel that cutting corners on safety precautions allows them to finish tasks in less time. To them, this consequence is positive, immediate, and certain.

The HomeSafe Program attempts to associate safe work practices with positive, immediate, and certain consequences through the use of various incentive mechanisms. The workers' compensation premium discount (for companies that qualify for certification) and the OSHA 'carrot' are both positive and certain consequences of participation in HomeSafe. Closely related to the 5% workers' compensation premium savings are two case studies; one conducted on a framing contractor, the other on a roofing contractor (Gilkey et al., in press-b; Safe Guard, 1997). Both of these companies have been active members of the HomeSafe Program since its inception. Additionally, both companies have realized significant savings in workers' compensation premium costs because their strong safety and health programs have greatly reduced the incidence of work related injuries. These case studies are presented at each orientation/training session and serve to exemplify the financial benefits of safety and health in residential construction.

Feedback provided by the HomeSafe Safety Committee during site visits is a positive and immediate consequence that is intended to increase workers' awareness of safety hazards. This is a proven mechanism for modifying risk perception, which can ultimately lead to improvements in safety performance (Howarth, 1987; McAfee and Winn, 1989; Geller et al., 1990). Several safety experts agree that the use of incentives and feedback are established methods to improve and reinforce safe behaviors (Bird and Schlesinger, 1970; Bird and

Germain, 1996; Geller, 1994; McAfee and Winn, 1989). In an extensive literature review conducted by McAfee and Winn (1989), the authors found that all interventions which used incentives and feedback were successful, to varying degrees, in reducing the occurrence of accidents and/or improving safety performance

<u>Self-regulation.</u>

Compared to safety and health programs solely promulgated by OSHA, the self-regulation feature of the HomeSafe Program is a distinctive advantage for several reasons. First, much the enforcement of safety regulations is shifted from external to internal sources (Hofmann et al., 1995). OSHA is still the main enforcer of safety regulations, but the HomeSafe Safety Committee also plays a major role in ensuring that participants are following the program regulations. HomeSafe participants may be more accepting of safety regulations that are endorsed by safety representatives that work in the construction industry rather than OSHA alone.

Second, management and employees are encouraged to work as a team to solve safety problems (Hofmann et al., 1995). As stated earlier, the HomeSafe Safety Committee membership consists of volunteers ranging from owners, top management, labor representatives, and laborers. A cooperative effort in designing, implementing, and enforcing the HomeSafe Program is more beneficial than employees simply serving as recipients of the safety rules. The

HomeSafe Safety Committee encourages feedback about the program from employees in the residential construction industry.

Third, research has shown that industries that had input into their health and safety programs were more likely to follow the regulations set forth in the programs (French and Bell, 1984). This aspect is important for workers to 'buy' into the program. During the development of the HomeSafe Program, construction workers served as valuable resources for information about safety hazards related to their trades (Baltz, 1997). The HomeSafe Program represents a merging of OSHA's knowledge and the industry's experience to create a safety program designed specifically for the residential construction industry.

Multiple intervention design.

The presently accepted theories for implementing safety interventions include engineering, administrative, and behavior modification approaches (Goldenhar and Schulte, 1994, National Safety Council, 1992). These methods represent forms of primary interventions. They focus on the prevention of accidents, injuries, and illnesses, and not on the control of morbidity progression or its final impact (Rhomberg et al., 1995).

Engineering interventions are designed to remove occupational hazards using various controls that manipulate the work environment (Goldenhar and Schulte, 1994; Howarth, 1987). Once in place and properly functioning, engineering controls do not require employee intervention to ensure worker safety. Examples of engineering interventions include substitution of hazardous tools with safer ones and the use of guardrails.

Administrative interventions consist of management-implemented controls designed to reduce employee exposures to work-related hazards. Examples of administrative controls include company policies, work procedures, work schedules, and enforcement of safety and health rules and work practices (Dedobbleer and Beland, 1991; Goldenhar and Schulte, 1994). These types of controls require some employee participation to ensure their effectiveness.

Behavioral interventions require direct employee involvement to be effective. These interventions attempt to modify workers' behaviors and risk perception to reduce occupational exposures to hazards (Howarth, 1987). This is generally accomplished through employee training and education programs (Chhokar and Wallin, 1984; Goldenhar and Schulte, 1994; Komaki, 1978). Examples of behavioral interventions include instruction on safe behaviors that should be practiced on construction sites regarding the use of ladders, housekeeping, tools, and personal protective equipment (Chhokar and Wallin, 1984; Goldenhar and Schulte, 1994).

The preferred hierarchy to protect employees from occupational hazards is the implementation of engineering followed by administrative and behavioral interventions (National Institute for Occupational Safety and Health, 1988; Office of Technology Assessment, 1985). Reasons why engineering and administrative interventions are preferred to behavioral include: 1) individual behavior is not assumed to be the cause of accidents, 2) individual workers are held responsible for controlling hazards, and 3) the employer and workplace remain solely responsible for employee safety and health. However, several experts say that implementing only one of the intervention methods is a less effective strategy than using a combination of the three (Cohen, 1987; Sloan, 1987; Vojtecky, 1988). Vojtecky (1988) recommends that behavioral in combination with existing engineering methods be used to improve worker protection because engineering interventions alone cannot address all the factors responsible for worker health and safety. For example, the use of personal protective equipment (PPE) is characterized as both engineering and behavioral in nature (Goldenhar and Schulte, 1994). PPE in itself is an engineering intervention, but the behavioral component associated with workers properly using the appropriate equipment precedes the benefits realized from PPE use (Gilkey et al.,1998).

The HomeSafe Program utilizes a combination of all three intervention methods to improve worker safety performance on residential construction sites. However, the HomeSafe Program is primarily a behavioral intervention with some crossover into engineering and administrative methods (Geller, 1996). The reason for this classification is that the HomeSafe Program focuses on the principle that increasing safe behaviors or decreasing unsafe behaviors will reduce the risk of accidents. Safe behavior is a manner of behaving or acting to prevent harm, injury, danger, or risk to oneself or others (Hoyos and Ruppert, 1995). Human actions are the cause of most injuries and are the result of either people committing "unsafe acts" or creating "unsafe conditions" (NSC, 1992). Maintaining safety on work sites requires that workers engage in certain behaviors including perceiving hazards, assessing physical dimensions, decision-making, and acting in accordance with norms and standards (Hoyos and Ruppert, 1995). HomeSafe addresses all of these safe behavior requirements.

The behavioral focus of HomeSafe Program is driven by the dynamic nature of the residential construction industry. There are several unique characteristics of this industry that justify the program's focus on changing worker behaviors. First, to contrast with industrial work settings where tasks are often repetitive and controlled by the location of machinery, workers in the construction industry are extremely mobile and usually work simultaneously with and/or around workers of other trades on the same site (Ringen and Stafford, 1996). Second, as work proceeds, the characteristics of the work site rapidly change, which results in the need for workers to be constantly aware of potential hazards (Center to Protect Workers' Rights, 1997). Third, again contrasting the industrial setting where employees may work years for one employer, most construction projects are short-lived (Advancing the Agenda for Safety and Health, 1995). Workers are most often hired from project to project; many trades work only briefly on a site. Roofers and masonry/stucco companies, for example, may have only a few days employment on a new building. Therefore, construction workers are continuously working themselves out of their jobs and may work for five or more employers in a year (Advancing the Agenda for Safety and Health, 1995; Ringen and Stafford, 1996). These industry-wide characteristics make it difficult to develop and maintain effective employee safety programs, particularly at the project level. In essence, construction workers are required to be much more responsible for their own safety compared to workers in more stable industries (Ringen and Seegal, 1995). HomeSafe attempts to train and educate construction workers so that they can not only be more responsible for their own safety and health, but also the safety and health of others that work beside them.

Each of the ten safety sections in the HomeSafe Program represent at least one of the three methods of intervention. Examples of how the ten safety sections apply to each type of intervention are described below.

***Administrative Interventions*:**

An administrative control mandated in the first section of the HomeSafe Program is the requirement for companies to develop a written safety program with the following conditions: (a) the program must include a policy statement from the employer clearly stating that safe and healthful working conditions are required for everyone working on the job site; (b) the safety program should be simple, easy to understand, and easily implemented; (c) the program should be explained by management to all employees; and (d) the program should be available to all employees and subcontractors. The HomeSafe Program also encourages the use of a safety policy statement that should be included at the beginning of the safety program. This statement is to ensure each company's commitment to safe work practices and the safety and health of all employees and subcontractors. Examples of how companies should write this statement are provided in the HomeSafe booklet.

***Engineering Interventions*:**

Many sections in the HomeSafe booklet address engineering controls. Examples are discussed below:

Section 3 - Scaffolding:

Recommendations are made for constructing and accessing several types of scaffolds including job-built wood, tubular welded, pump-jack, and ladder-jack. Diagrams are provided which show the proper way to construct these types of scaffolds. Special attention is given to access, planking, and footing for pump-jack scaffolds. Due to the various types of scaffolds commonly encountered on residential construction sites, the scaffolding section is one of the largest in the HomeSafe booklet.

Section 4 - Ladders

Both step and extension ladders are addressed. Engineering requirements dictate specific type, load capacity, design, and materials specifications. In comparison to the OSHA construction standard, the HomeSafe Program does not permit the use of job-built ladders. The reason for this was that OSHA and the HomeSafe Safety Committee believed that improper construction of these types of ladders was a major cause of accidents on residential construction sites.

Section 5 - Electrical Power and Power Cords

All cords must be construction-grade and be free of any defects, such as cuts in the insulation or missing ground plugs. Additional engineering controls require the use of ground fault circuit interrupters (GFCI) on all 110-volt temporary power suppliers. Use of GFCIs are also required for all systems that split a 220-volt power supply into 110-volt. Failure to provide ground fault protection was the third most cited construction standard related to physical hazards (OSHA, 1993). Use of GFCI is so important that OSHA has published a document specific to its use (OSHA, 1992).

Section 6 - Access and Housekeeping

Ramps or stairs must be used when areas of access to structures are greater than 19 inches from the lower level. Illustrations show proper construction and placement of access ramps.

Section 7 - Open Holes and Unprotected Sides and Edges

Engineering controls in this section require that open-sided floors and holes that expose employees to fall distances greater than six feet be protected by the use of guardrails or covers. Specifications require type and design of guardrails as well as materials and placement of guardrails. Particular attention is given to providing guardrails around windows and doors that are not used for access. Failure to provide guarding around open sided floors and platforms was the number one most frequently cited construction standard related to physical hazards (OSHA, 1993).

Section 8 - Fall Protection

Different types of fall arrest systems are discussed, including personal fall arrest systems and roof slide guards, and diagrams are presented to illustrate proper usage. Several different configurations of personal fall arrest systems are available. Therefore, companies using fall protection are recommended to contact the manufacturer for specifications regarding proper installation and usage.

Section 9 - Excavations and Trenching

This section presents specifications for safe excavation design. Illustrations and tables are presented which provide requirements regarding soil classification, sloping, benching, and excavation depth. Examples of safe excavation designs are offered for each of the soil types. Failure to provide adequate protective systems for trenches and excavations was the fifth most cited construction standard related to physical hazards (OSHA, 1993).

Section 10 - Power Tools and Motorized Equipment

Engineering controls in this section require that tools be free of defects and have properly functioning safety devices.

***Behavioral Interventions*:**

Throughout the booklet, a great amount of emphasis is placed on how employees should behave to reduce occupational hazards. Examples of behavioral controls specified in the HomeSafe booklet are discussed below:

Section 2 - Personal Protective Equipment

In this section, employees are encouraged in the proper use of personal protective equipment when hazards exist. Different types of equipment are discussed including head, foot, and eye protection. Emphasis is placed on the adverse effects of not using the equipment properly. Safe use of saws and air-powered tools is stressed since these are very common and dangerous tools used in the residential construction industry.

Section 4 - Ladders

This section details proper and safe use, climbing methods, work position, placement, storage, securing practices, limitations, and various types of other potential hazards associated with ladders. Examples of improper use are illustrated. Failure to extend the rails of an extension ladder three feet above the landing surface was the 21^{st} most frequently cited construction standard related to physical hazards (OSHA, 1993).

Section 5 - Electrical Power and Power Cords

Behavioral controls in this section require employees to inspect electrical equipment for defects and repair or replace items if defects are found. Illustrations of electrical equipment that should not be used are also presented.

Section 6 - Access and Housekeeping

Employees are encouraged to keep the work site free of unnecessary debris. Illustrations in this section associate cleanliness with a safe work environment.

Section 7 - Open Holes and Unprotected Sides and Edges

In this section employees are educated on how and where to properly construct guardrail systems. Examples of properly built guardrail systems are illustrated.

Section 8 - Fall Protection

This section of the booklet identifies potential fall environments familiar to residential construction. The application, need, and use of fall arrest systems are briefly explained, diagramed, and advised. Needs assessment, selection, training, and employee responsibility are emphasized.

Section 10 - Power Tools and Motorized Equipment

A considerable amount of this section is devoted to safe work practices and maintenance of various power tools including hand saws, table saws, nail guns, jack hammers, and compressors. Recommended safe work practices include tool and equipment inspections, use of tool guarding, appropriate selection and use of personal protective equipment, safe materials handling, and safe tool handling. Illustrations are used to show sources of potential hazards and examples of proper and improper behaviors.

To summarize, the HomeSafe Program is a unique safety and health intervention that is based on complex, but sound principles. The design of the HomeSafe Program is similar to most accident prevention programs that were reviewed by Barnett and Brickman (1986). The authors found that most programs consist of a five-point hierarchy. These five priorities are 1) eliminate the hazard and/or risk, such as substituting hazardous tools with those that are safer or conducting work processes in a manner that eliminates risk of injury, 2) apply safeguarding technology, which includes the use of barriers and safety devices, 3) use warning signs, placards, 4) train and instruct workers by verbal and written communication, and 5) prescribe personal protection such as hard hats and eye protection.

Except for the use of warning signs or placards, the HomeSafe Program has this hierarchy incorporated into its design. As mentioned before, the HomeSafe Program is primarily a behavioral intervention. Therefore, the first priority of the HomeSafe Program is the encouragement and reinforcement of safe work practices to eliminate the risk of accidents. Second, engineering controls are required as methods to separate the hazards from the workers. Guardrails, GFCI, saw blade guards, and excavation safeguarding technology are only a few examples of the many required engineering controls. Third, participating companies are required to develop written safety programs and use the HomeSafe booklets as employee safety training guides. The written safety program informs the employee about the requirements of the company safety program and assures the employee that his/her safety is important to management. Finally, the use of personal protective equipment (PPE) is only recommended when no other methods are available to control hazards. Due to the constantly changing environment of construction sites, use of the most basic types of PPE such as hardhats, safety glasses, and safety shoes, are almost always necessary to protect workers.

Evaluation Theory

Goldenhar and Schulte (1994) point out that inferences about the effects of new interventions are best supported by theoretically based research methods. Linked to the success of this HomeSafe evaluation study is the theory of causality. The theory of causality in intervention research is rooted in the establishment that a program has more of an effect on a target population than would have occurred without the intervention, or due to the effect of other circumstances (Rossi et al., 1979). If the effects of other circumstances cannot be ruled out, or the test group changes regardless of the intervention, the effect of the intervention cannot be established (Lipsey, 1996). Statements about causality are best described as probabilities. Hence, as Rossi et al. (1979) note, causality is best described with a statistical statement using the phrase "'is more likely to occur'". For example, the statement 'participation in the HomeSafe Program increases worker safety performance' means that if workers participate in the program, they are more likely to work safer than if they did not participate. This statement does not imply that worker safety performance will always improve if workers participate in the HomeSafe Program.

To establish causality between an intervention and its effects, an appropriate evaluation model must be utilized. Vojtecky and Berkanovic (1985) identify three major evaluation models, each measuring different processes associated with the implementation of intervention programs. The first model is process evaluation. This type of evaluation assesses the operations and procedures of program implementation, as well as determining the portion of the target population that was reached (NCIPC, 1989; Vojtecky and Berkanovic, 1985). The second model is outcome evaluation. Outcome evaluation measures the end-effects of an intervention, such as the impact on injury and fatality rates (Vojtecky and Berkanovic, 1985). Both of these models are being utilized in other studies that are evaluating the effects of the HomeSafe Program. The overall success of the HomeSafe Program is going to be based on the results of the outcome assessment, but interpretation of the results is dependent on the outcome of the third evaluation method. The third model, which is being utilized in this study, is impact evaluation. The impact model is essential to establish causality (Rossi et all, 1979; Vojtecky and Berkanovic, 1985). Supposing that injury and fatality rates were shown to decrease based on the results of the outcome evaluation, the impact evaluation is necessary to establish that the decrease was “caused” by the HomeSafe Program.

Rossi et al. (1979) describe two prerequisites that should be satisfied before an impact evaluation can be conducted: 1) the intervention to be evaluated should have sufficiently articulated goals, and 2) the intervention should be satisfactorily implemented so that the critical elements of the intervention reach the appropriate subjects. Both of these criteria have been satisfied. First, the HomeSafe Program has a number of clearly expressed goals, ranging from the program goal of reducing injury and fatality rates, to having all HomeSafe Participants implement the rules in the 10-point list. Second, HomeSafe is designed specifically for the workers performing tasks directly associated with residential construction. Participants of the orientation/training sessions are safety representatives, managers, supervisors, foremen, and laborers that are often responsible for maintaining their company’s safety program. Each of these participants is given materials to take back to their individual companies and share with other coworkers that were unable to attend. All participants are encouraged to incorporate the HomeSafe Program as an integral part of their safety meetings.

Although the HomeSafe Program has a built-in evaluation component that is performed by the HomeSafe Safety Committee, the function of the evaluation is to monitor the implementation of the program, not to measure the effect of the program in the target population. Regardless, the committee is not in a position to conduct program evaluation since the members are biased towards its success. Garrett et al. (1988) recommend evaluation conducted by an unbiased outside source to determine the effect of an intervention program.

Evaluating Safety Performance

Implementation of an impact assessment to measure the effect of an intervention can be accomplished through the measurement of changes in the target group's knowledge, attitudes, behaviors, and physical environments (Geller, 1994; Geller, 1995; Geller, 1996; Vojtecky and Berkanovic, 1985). Program evaluation procedures should be directed towards measuring characteristics of an intervention that directly relate to the outcome intended to be controlled (Jacobs, 1970; Lipsey, 1996; NCIPC, 1989). Accident records have been traditionally used to evaluate the effectiveness of safety program implementation (Grimaldi, 1970). One major disadvantage with this method of evaluation is that lost-time accidents are statistically rare events (Jacobs, 1970). Lesser injuries, which do not qualify as disabling but require medical treatment are subject to underreporting and recording inaccuracies (Tarrants, 1970). Measures based on these endpoints are after-the-fact and record only the consequences of a particular problem. These measurements do not record the events that lead to the consequences (Cooper et al., 1993).

Instead of using accident records, certain behavior characteristics have been identified as proxy measures for changes in the incidence of injuries and fatalities (NCIPC, 1989). Proxy measures are substitute outcomes that have been shown, through either research or general acceptance, to be associated with specific outcomes. One example proxy behavioral measure is the proper use of personal protective equipment. Proper use of this equipment has been shown by both research and general acceptance to be associated with decreased injury and fatality rates (NCIPC, 1989). Several studies stress the value of direct observation of employee behaviors to determine intervention success and establish proxy measures for injury and fatality incidence (Chhokar and Wallin, 1984; Cooper et al., 1993; Fitch et al., 1976; Geller, 1994, 1995; Goldenhar and Schulte, 1994; Hinze and Figone, 1988b; Hoyos and Ruppert, 1995; Komaki et al., 1978; Tarrants, 1970; and Vojtecky and Schmitz, 1986). These proxy measures include housekeeping issues, equipment usage (i.e. tools, ladders, and scaffolds), erection of rails/guards, and the use of various types of personal protective equipment.

To scientifically measure the effect of an intervention program on the target population, measurable changes in performance criteria must be recorded in a format that can be mathematically analyzed. For example, hardhat use is an observable behavior that can be translated into a dichotomous variable such as yes/no, or 1/2 (1 meaning employee is wearing a hardhat). In the safety and health industry, the most common tools used to record and translate safety performance information are data collection instruments such as questionnaires, checklists, and audits. The use of these instruments is well established, as demonstrated by studies published by Goldenhar and Schulte (1994), Chhokar and Wallin (1984), Cooper et al. (1993), and Dedobbeleer and German (1987). See the review of case studies in this section for further discussion of these studies. Many of the performance criteria applied in these studies were based on the proxy measures discussed above. In all cases, safety performance was determined by mathematical analysis of the observations that were recorded on the data collection instruments.

Similar to other intervention studies, evaluation of the HomeSafe Program required some method of quantifying changes in worker safety performance as a function of participatory status in the program. To accomplish this, an auditing tool was developed to record and translate observable performance criteria into analyzable data. Most of the criteria were based on the proxy measures discussed above. The development of this instrument and the protocol for its use are detailed in the methods section.

Experimental Design

A true experimental study design that incorporates randomized assignment to exposure groups is ideal in program evaluation (Goldenhar and Schulte, 1994). This study design is the only way to rule out confounding factors associated with subject selection. However, many papers have been written that state the difficulties in implementing this design for evaluating safety and health interventions and instead recommend a quasi-experimental study design as a valid option (Goldenhar and Schulte, 1994; Hennessy, 1995; Lipsey, 1996; NCIPC, 1989; Rossi et al., 1979; Vojtecky and Berkanovic, 1985). The HomeSafe evaluation design, which used an untreated control group with pretest and posttest design, is the most frequently utilized design in social science (Cook and Campbell, 1979).

There are two major issues associated with this study design that may make interpretation of the HomeSafe evaluation difficult. One is the possibility of self-selection bias (Cook and Campbell, 1979; Rossi et al., 1979). Problems associated with this type of bias are due to the possibility that the self-selected participant group is inherently different from the control group as demonstrated by the desire to voluntarily participate in the HomeSafe Program. In other words, companies that select themselves to participate in the HomeSafe Program may be inherently more safety conscious than those companies that choose not to participate.

The other issue is the possibility of bias due to the 'Hawthorne effect' (Goldenhar and Schulte, 1994; Kroemer, et al., 1994); Rossi et al., 1979). The Hawthorne effect was described in a study performed on women working on a small electronics assembly line. The purpose of the study was to measure productivity as a result of varying light intensity in the work area. As a result, the investigators found that any change in the light intensity, whether it was turned up or down, created an increase in productivity. The increase in productivity was attributed to the employees feeling important due to the attention that was given to them during the evaluation, and not to the changes in light intensity. Similarly, it is possible that HomeSafe participants may feel more important if they are selected to participate in the study, and therefore may perform safer when they are being evaluated regardless of how well they implemented the HomeSafe Program.

Construction Injuries and Fatalities

Many studies have been published that document and describe the occurrence of injuries and fatalities among workers in the construction industry. It should be noted, however, that no studies were found that presented data specifically for the residential construction industry. Historically, safety-related studies have been performed only on large commercial projects (Hinze and Talley, 1988a). The lack of accident data for the residential construction industry may be because work on residential construction sites is much less regimented and regulated than on commercial construction sites (Bigelow et al., in press). According to Georgine et al., (1997) nearly 83% of all construction companies consist of only one to nine employees. OSHA does not require companies with less than ten employees to complete OSHA 200 logs, which are a major source of information for construction accident studies. The majority of the studies discussed below present data that summarize the incidence of injuries and fatalities in the commercial and residential construction industries combined. Furthermore, several of these studies discuss fatality rates due to vehicular accidents. Unfortunately, the HomeSafe Program does not address this aspect of work on residential construction sites. The reason is that OSHA does not have standards that address vehicle usage (Chadwick, 1997).

Non-fatal construction injuries.

Hunting et al. (1994) conducted a study that evaluated the types and occurrence of illnesses and injuries among 592 construction workers treated in an urban emergency department. Data for work-related illnesses and injuries were collected from the medical records of all patients treated at the George Washington University Emergency Department between November 1, 1990 and October 31, 1992. Carpenters represented 24% of the sample, followed by construction laborers (17%), and “construction workers” not otherwise specified (11%). Lacerations were the most common injury observed, accounting for 38% of the cases. Following were strains and sprains (17.9%), contusions (15.7%), and eye injuries (12.3%). The authors found that the leading cause of construction injuries were cutting or piercing from objects (26%), falls (18%), being struck by falling objects (12%), and foreign objects entering the eyes (9.8%). Falls from ladders and scaffolds were the predominate causes of fall injuries. Among the twenty-eight injuries severe enough to require hospitalization, 18 (64%) were caused by falls.

A study conducted by Kisner and Fosbroke (1994) identified injury hazards in the construction industry using the Bureau of Labor Statistics' Supplementary Data System, which contained information for over 700,000 injury reports from 15 states between the years of 1981 and 1986. The nature of injuries most frequently observed was sprains and strains (34.3%). Cuts, lacerations and punctures (16.8%), and fractures (10.8%) followed this. The leading types of injuries were found to be overexertion (24%), struck by an object (22%), falls from elevations (13%), and struck against an object (9%). The four leading sources of injuries were metal items (18%), the working surface (16%), non-powered handtools (7%), and wood items (6%). The authors noted that their calculated total injury rate for construction workers of 2.5 times the occupational injury rate for all industries combined in the fifteen states was similar to data published in the Bureau of Labor Statistics Annual Survey, which was based on national data.

Cattledge et al. (1996) conducted analysis of nonfatal occupational fall injuries from elevated surfaces in the West Virginia construction industry. Data for the study was obtained from the West Virginia Workers' Compensation Fund and included cases when construction workers experienced a nonfatal occupational fall between July 1, 1990 and June 30, 1991. Construction laborers, not otherwise classified, represented 29.1% of the injury cases, followed by carpenters (14.8%) and electricians (7.1%). Falls from ladders accounted for 33.5% of the injury cases, followed by scaffolds (21.4%), and roof trusses, walls, beams, or other building structures (13.7%). Workers reported that the leading causes of falls from ladders were a slippery substance on the surface, unstable footing, or a loss of balance. The leading causes of falls from scaffolds were reported to be due to a slippery substance on the surface, unsafe equipment, or equipment failure. Thirty-nine percent of reported falls occurred from elevated work surfaces less than six feet in height. Overall, 58% of all falls occurred at a height of 10 feet or less. The authors indicated that use of personal protective equipment (PPE) was infrequent among the accident cases. Reasons given by the injured workers for not using PPE included 1) difficult to use, 2) not required, 3) unable to determine which type to use, 4) did not have, and 5) unable to use on job site. Interestingly, 63% of the injured workers had received training or education in fall protection.

Zwerling et al. (1996) analyzed injuries among construction workers in rural Iowa using emergency department surveillance. Data was collected by means of a specially developed software program that was used to record emergency department visits at all hospitals in the test area. The authors identified 189 construction workers with injuries out of 1843 injury visits of all employed patients with known occupations. Approximately half of the injuries to the construction workers were work-related. The work-related injury rate for construction workers of 35.1 injuries per 100 workers per year was 4.6 times that of all other employed people. Among the construction workers, 61% of work-related injuries were open wounds, sprains and strains, and fractures and dislocations. The authors also noted that construction workers had a high proportion of work-related falls from ladders and scaffolds.

Waller et al. (1989) studied the incidence of injuries among carpenters in northwestern Vermont. A total of 208 injuries to carpenters were treated during the study period. The injury rate was calculated to be 13.3 to 17.2 per 100 workers. Results of the study indicated that 1/3 of injuries were caused by nails, splinters, or sawdust, 1/4 injuries were due to falls from elevations, over 1/5 involved the use of lumber or other construction materials, and 1/5 of injuries were associated with the use of power tools. Interestingly, the study noted that although most injuries associated with power tool use resulted in trauma due to direct contact, the majority of injuries from the use of circular saws were eye injuries due to flying sawdust particles.

Fatal construction injuries.

In an official communication issued by the OSHA Directorate of Construction, falls from finished roofs (n=12) were the primary cause of fatalities among workers on residential construction sites between January 1 and December 31, 1995 (Swanson, 1996). Although not explicitly stated, the numbers of fatalities were assumed to be nationwide. Nine fatalities were the result of trench cave-ins and 15 were the results of falls from ladders. Appendix C presents the fatality data as published in the letter.

Sorock et al. (1993) investigated fatal occupational injuries in the New Jersey construction industry for the years 1983 through 1989. Four sources of information were used to compile data, which included death certificates, medical examiner reports, OSHA fatality reports, and worker's compensation reports. Two hundred fatalities were identified during the study period. The authors determined a fatality rate of 4.6 deaths per 100,000 person-years in the construction industry, which was 3.2 times higher than the death rate among all industries combined in New Jersey. Ironworkers and roofers had the highest fatality rates of 109/100,000 and 56.2/100,000, respectively. Falls (47%) were the leading causes of death. Roofers, painters, ironworkers, and carpenters were most likely to be involved in fatal falls. Most fatal falls were the result of falls from scaffolds (22%), roofs (19%), and through roof openings (13%). Motor vehicle-related accidents were the second leading causes of death (15%), followed by electrocutions (14%), and trench cave-ins (7%). Most electrical fatalities resulted from direct contact with an energy source. Only limited information was available on the trench cave-in fatalities. Information available on 7 of the 14 fatalities indicated that shoring was either nonexistent or improperly used.

Kisner and Fosbroke (1994) obtained data from the National Institute for Occupational Safety and Health (NIOSH) National Traumatic Occupational Fatalities (NTOF) surveillance system which consists of death certificate data for 52 U.S. vital statistics reporting units. Data was collected for construction work-related fatalities that occurred between the years 1980 and 1989. The number of construction fatalities ranked second to mining. The construction fatality rate was calculated at 25.6 per 100,000 full-time workers, compared to 7.0 per 100,000 full-time workers for all industries combined. Leading causes of death among construction workers were falls (25%), electrocutions (15%), and motor vehicle-related incidents (14%). Construction laborers had the highest fatality rate in the industry, 39.5 per 100,000 full-time workers.

Pollack et al. (1996) analyzed the incidence of fatalities in the U.S. construction industry for the years 1992 and 1993. Fatality data was collected from the Census of Fatal Occupational Injuries (CFOI) of the Bureau of Labor Statistics. The CFOI consists of many data sources to identify work-related fatalities including death certificates, state workers' compensation reports, medical examiner reports, OSHA reports, news media, and other reports. Confirmation from at least two sources was required to classify a fatality as work-related. The construction population was divided into two groups, 1) 'construction occupations', which included production, construction, operation, maintenance, and material handling, and 2) 'other construction occupations', which included clerical workers, secretaries, and accountants. Among the two groups, a total of 1931 work-related construction fatalities were identified for the two-year period. As expected, the fatality rate among construction occupations was much greater than the other occupations. Structural metal workers had the highest fatality rate, although construction laborers suffered the greatest number of fatalities. This was due to a larger number of workers that were construction laborers. Falls accounted for 30% of total fatalities among the construction occupations, over 70% fatalities among roofers, and almost 70% among structural metal workers. Transportation accidents were reported as the second leading cause of fatalities among the construction occupations (26%).

Suruda (1992) investigated work-related deaths among painters in the construction industry. Fatality data for the years 1982 through 1986 were obtained from the OSHA Integrated Management Information Systems (IMIS) database. Data in IMIS does not include fatalities due to motor vehicle accidents or homicide. A total of 129 fatalities were identified. Fifty percent of fatalities

(65) were due to falls from elevations. Particularly, 52% of the fall fatalities involved scaffolds and 13% involved falls from ladders. Although 40 (31%) of the fatalities were due to electrocution, information for only 28 was available. Fifty percent of these cases were the result of contact between a metal ladder and a power line.

A study conducted by Ore and Casini (1996) identified electrocutions as the second leading cause of fatalities on construction sites in the U.S. between the years 1980 and 1991. Electrocution fatality data was collected from the NIOSH NTOF surveillance system. A total of 2015 occupational electrocution fatalities were identified, which accounted for 15% of all fatalities in the construction industry. Construction workers accounted for the largest number of electrical deaths in the U.S. Electricians were identified as having the highest crude fatality rate (6.0 per 100,00), followed by structural metal workers (5.2 per 100,000), and construction laborers (4.8 per 100,000). The authors suggest that use of ground-fault circuit interrupters may reduce the occurrence of electrocution fatalities related to the use of power tools. Similar to the Kisner and Fosbroke (1994) study, the study conducted by Ore and Casini was limited by problems associated with use of death certificates to identify fatality cases (see discussion above).

Fatalities caused by trench cave-ins in the construction industry were investigated by Suruda et al. (1988). The authors investigated 306 fatality cases that occurred between 1974 and 1986. Data was collected from the OSHA Management Information Systems database and newspaper clippings.

Newspaper reports were used to identify cases that were not reported to OSHA; 20 such cases were identified. Information on the trench depth was available for 265 of the cases. The mean trench depth at which fatalities occurred was 11.4 feet. Less than 2% of fatalities occurred in trenches less than 5 feet in depth. In almost all cases, inadequate shoring or sloping was evident.

Stanevich and Middleton (1988) also investigated excavation cave-in fatalities that occurred between 1974 and 1981. The authors used OSHA investigative reports, which were believed to provide an underestimate of the amount of fatalities that were due to cave-ins. A total of 85 cave-ins were investigated which resulted in 92 fatalities. Fifty-two percent of fatalities were construction laborers, followed by pipelayers (18%), and supervisors (14%). Sixty-four cave-ins and 70 fatalities occurred in excavations with vertical walls and depths greater than 5 feet.

Case Studies of the Effectiveness of Safety Interventions

Goldenhar and Schulte (1994) provide an overview of occupational health and safety intervention studies published between 1988 and 1993. Studies were separated into three categories of intervention types: engineering, behavioral, and administrative. Thirty-seven studies were evaluated on research criteria including the theoretical basis, the duration, frequency and intensity of the intervention, study design, subject selection, instrument reliability and validity, and statistical analysis techniques. Established "adequate" criteria for intervention duration, frequency, and intensity were not found in any of the studies evaluated. Instead, the authors evaluated duration, frequency, and intensity based on whether 1) the intervention appeared to last long enough to effect the sample and enough time passed between pretest and posttest measurements, 2) the subjects had a reasonable amount of exposure to the intervention, 3) the intervention was sufficient to elicit a behavior change. In summary, the authors found that many studies used insufficient sample size, lacked a theoretical basis, lacked the intensity, duration, and frequency necessary to cause change, used experimental or quasi-experimental designs, and had uncontrolled sources of bias.

Chhokar and Wallin (1984) used an applied behavior analysis approach in an attempt to improve safety in a metal fabrication plant. The intervention design incorporated several methods including training, goal setting, and feedback. Training consisted of showing workers slides of safe and unsafe behaviors and briefly explaining the safe/unsafe component of each slide. Goal setting consisted of setting a difficult but attainable goal of achieving a certain percentage of safe behaviors exhibited in the plant. The 'goal' sign was displayed during the training session and placed in a prominent location following the session. Feedback consisted of posting signs around the plant that displayed current safety performance compared to the goal level. Changes in safety performance were determined by observing and recording specifically identified behaviors exhibited by the plant employees. These behaviors were determined by analyzing past accident reports for behaviors that either caused or contributed to accidents in the plant. A final list of "35 key behaviors for observation" was developed based on several sources including the plant's accident reports, input from plant supervisors and employees, literature from the National Safety Council and the American National Standards Institute, and personal observations. Observed behaviors included the use of appropriate personal protective equipment, installation of protective systems (i.e. railings, guards), wearing of appropriate clothing and shoes, tool usage, material handling, housekeeping, and equipment usage (i.e. ladders, scaffolds). The occurrence of safe and unsafe behaviors was observed for individual employees in the plant. Observations were conducted on different days of the week, took approximately 20-30 minutes to complete, and were conducted in full view of the employees. A total of 323 observations were conducted over 42 weeks. Measurement of individual employee safety performance was determined by use of an all-or-none (AON) scale. Thus, employees were only considered to be working safely when all safe behaviors were observed. The safety performance for the entire plant was determined by dividing the total number of employees by the total number working safely and multiplying this fraction by 100. The authors argue that this measurement method has a positive connotation since it focuses on desired safety performance. Results of the study indicated that employee safety performance was significantly increased from baseline levels after training and goal-setting were administered, however the desired levels of safety performance were not achieved until after employees were given feedback about their performance.

Cooper et al. (1993) developed and tested a safety audit checklist to measure safe behaviors on construction sites. The number of construction sites audited was not specified. Initially, items included on the audit were selected based on a review of health and safety literature, science journals, and accident records. All items were represented among all phases of construction. The final audit consisted of the top 24 items from the initial list that nearly 200 construction personnel considered most significant based on three criteria: 1) the frequency of occurrence within the last five years, 2) the likelihood of an accident occurring because of the event, and 3) the likely severity of injury if an accident occurred. The audit items were separated into five categories: 1) personal protective equipment, 2) housekeeping, 3) access to heights, 4) scaffolding, and 5) plant. An 11-point rating scale was used to for each item on the audit, which included a "not seen" category. The purpose of the rating scale was to measure the proportion of unsafe situations and behaviors. This method of measurement was termed the "Proportional Rating Scale" (PRS). As an example given by the authors, the PRS would measure the proportion of unsecured ladders on a work site by counting the number of ladders improperly secured and calculating this as a percentage of the number of ladders in position and available for use. The authors argue that use of the PRS is superior to the traditional all-or-none (AON) scoring system since the PRS has a lower overall variance, the measure avoids possible floor and ceiling effects seen with the use of AON, and the PRS is more likely to detect any improvements in safety performance.

Dedobbeleer and German (1987) studied workers' safety practices in relation to individual and situational factors. The study was conducted on nine non-residential construction sites with construction stages ranging from frame to finishing. A total of 384 workers, 88 foremen, and 9 superintendents were administered a survey designed to collect data on demographic and occupational characteristics such as training, knowledge, safety practices, beliefs, and perceptions. Additionally, observations of safety practices were conducted on non-participants of the study. Selected safety practices were taken from the Occupational Safety and Health Administration safety standards and included hard hat use, use of heavy working shoes, eye protection, ladders, and scaffold installation. Behaviors were observed only once at each site and behaviors not related to the selected practices were ignored. Several different measures were collected during the study which included the following: 1) worker safety performance index, 2) workers' knowledge of safety practices, 3) workers' attitude toward safety performance, 4) foremen's safety performance, knowledge, and attitude toward safety performance, 5) control over one's own safety on the job, 6) risk-taking as part of the job, 7) top management, union, and spouse and/or family attitudes toward safety practices, 8) availability of appropriate equipment, 9) availability of safety equipment, 10) work pace, 11) foremen's safety enforcement, 12) co-workers' attitudes toward safety practices, and 13) site safety climate. Observations of safety performance revealed that 65% of employees were wearing hard hats at the time of observation. Most workers displayed a high degree of safety compliance with the other safety practices that were observed. One of the most powerful predictors of safety performance was attitude towards safety. No relationship was found between workers' attitude and exposure to safety training or safety meetings. In addition, no relationship was found between workers' knowledge of safety performance and safety interventions. The authors recommend mandatory safety training for all new employees and implementing more effective safety interventions that develop workers' safety practices and foremen's safety training abilities as well as reinforce safety practices and safety conditions on the work site.

Jaselskis et al. (1996) explored possibilities to improve safety performance on construction sites. A questionnaire was developed and distributed to 450 construction companies of various trades and sizes. The questionnaire requested information pertaining to the individual respondent and respective company and project safety programs. In total, 48 company safety programs and 69 individual project safety programs were included in the analysis. Safety performance measures included OSHA incidence rates (i.e. OSHA 200 logs), experience modification rating (determined by the number of workers' compensation claims), and various subjective measures. Highlights of the analysis included an association between improved safety performance on construction projects and 1) improved attitude of management towards safety, 2) an increase in the number of safety meetings with supervisors, 3) an increase in the number of safety meetings with specialty contractors, and 4) an increase in the number of informal site inspections.

Hofmann et al. (1995) explore some of the root causes of unsafe behaviors. The authors cite a study that evaluated the safety performance of coal mine workers and found that taking extraordinary safety precautions was seen as a sign of weakness. Four contributing factors of unsafe behaviors are identified: 1) a desire to 'be a man' by not being overly safe, 2) misunderstandings and misinformation, 3) a reliance on personal experience rather than safety regulations, and 4) a desire to finish the job easier and faster. No doubt the construction industry, much like the mining industry which is male-dominated and labor intensive, shares these factors.

Methods

Scope

OSHA has specific interests in the outcome measurements of the HomeSafe evaluation project that are restricted to overall injury and fatality rates. These rates will not be calculated until the end of the pilot test stage and after all data has been collected. The purpose of this study is to evaluate changes in worker safety performance associated with participation in the HomeSafe Program. Data collected from this study has multiple purposes, each essential to the overall evaluation process. First, the information produced from this study can be used to pinpoint deficiencies and fine-tune the program so that the chances of success are increased. Second, data can provide information that will aid in the understanding of what components of the program are effective and why they are, or are not effective in changing worker safety performance. Finally, data can be used to determine to what extent worker safety performance affects changes in injury and fatality rates.

Study Design and Hypothesis

A quasi-experimental study design was used to evaluate the effectiveness of the HomeSafe Program. The design incorporated three comparison groups: 1) pretest; 2) posttest; and 3) control. The hypothesis of this study is that there is a difference between the safety performance of companies audited before participating in the HomeSafe Program and the safety performance of companies audited after joining the program. In other words, the desired effect of the program is that HomeSafe participants will experience a measurable improvement in safety performance compared to their performance levels before participating in the program.

Audit Development

A major component of this study was the development of a safety audit designed to collect health and safety related data on residential construction sites. The purpose of the audit was to collect data that could be used to establish a causal link between participation in the HomeSafe Program and increased safety performance. The safety audit was developed and administered by the study investigator. Assistance in designing the audit came from members of the Home Builders Association of Metropolitan Denver, safety specialists in OSHA Region VIII, and consultants of the OSHA 7(c)1 Consultation Program.

The audit consisted of 117 items that were divided into ten sections based on the format of the HomeSafe booklet. Most of the items on the audit pertained to employee behaviors and work site characteristics that were encouraged in the booklet. For example, use of hardhats, fall protection, excavation sloping, housekeeping, and guardrails around open stairwells were all noted. Additional items taken from the OSHA construction standards were added to the audit to assess conditions and behaviors that were more detailed than covered in the

HomeSafe Program. These additional items provided a wider range of scores for companies whose safety and health behaviors and conditions exceeded what was suggested in the HomeSafe Program. The format of the audit was similar to the OSHA construction standard. In several sections, rather than one item on the audit summarizing the existence of a hazard (i.e. improper scaffold erection), several items focused on very specific characteristics related to the hazard. For example, items in the scaffolding section addressed characteristics associated with four different types of scaffolds, including footing, plank construction, bracing, and physical dimensions. A copy of the audit is shown in Appendix D.

Similar to the study conducted by Chhokar and Wallin (1984), the method of scoring the audit was all-or-none (AON). Each scored item on the audit form pertained to a behavior or characteristic that was scored either 'yes' or 'no'. Thus, if three ladders were being used by a company and only one of them had a defect, the question pertaining to the structural soundness of the ladders was marked 'no'. In some instances, behaviors and work site conditions that were included on the audit form were not seen on-site because they were specific to certain stages of construction or work tasks; in those cases a code indicating that the item was not applicable was recorded and was not included in the score. Some questions in the Company Safety Policy section of the program were not answered due to language barriers between the company employees and the auditor. Regardless, questions in this section were not included in the determination of the total scores because they were not answered using a dichotomous scale. Instead, these and other items on the audit form were used as independent variables in data analysis (i.e. degree of safety training).

Validity and reliability are two issues that must be addressed concerning the accuracy of the audit (Lipsey, 1996; Rossi et al., 1979). Establishing validity meant ensuring that the audit was actually measuring what it was intended to measure (Rossi et al., 1979). Sulzer-Azaroff and Fellner (1984) recommend selecting evaluation criteria that are related to actual causes of accidents to increase validity. In response, proxy measures that are associated with the incidence of injuries and fatalities were incorporated into the HomeSafe audit. For example, the use of eye protection while workers use circular saws (and related tools) was one evaluation criteria used on the audit form. Circular saw use is associated with the incidence of eye injuries (Waller et al., 1989). Eye protection is widely accepted as a form of personal protective equipment that reduces the risk of eye injuries, and is therefore a proxy measure for the incidence of eye injuries.

Addressing reliability meant assuring that the results of the audit were consistently repeated when the situation being measured did not change between measurements (Rossi et al., 1979). Suggestions for reducing measurement unreliability include standardizing the intervention implementation and measurement procedures (Rossi et al., 1979). In response to the first suggestion, procedures related to the implementation of the HomeSafe Program were well standardized. All participating companies attended the three hour orientation/training session. The format of the sessions was the same each time the class was offered. Additionally, all companies received the same program materials (i.e. booklets), and all companies were required to complete the questionnaires, OSHA 200 logs, and related materials handed out at the sessions. Likewise, procedures related to the evaluation of the program were well standardized. All study subjects were administered the same audit using the same administration protocol. Additionally, the audit was administered only by the study investigator. This eliminated variability in scores due to individual differences (i.e. preferences, knowledge, and biases) among multiple auditors.

Testing of the audit form was conducted using similar methods described in a study conducted by Hinze and Talley (1988a). Ten residential construction sites were selected for test administrations of the audit. After analyzing the preliminary results, the audit was modified by rewriting items that were inconsistent with the scope of the evaluation or frequently misunderstood. Additionally, modification of the audit eliminated all or part of those items that were extraneous to the information being gathered. Items on the audit were also recoded to permit easier analysis. The resulting audit form was used for all data collection conducted during the study.

Subject Selection

Because companies are responsible for the health and safety of their employees at construction work sites, the units of analysis for this study were the companies. Any company performing work in the residential construction industry in the six county Denver metropolitan area was eligible for inclusion in this study. Three major categories of companies were identified in the residential construction industry: 1) general contractors, 2) mid-contractors, and 3) individual companies. General contractors are upper management in the industry, responsible for coordinating the activities of other companies hired to perform construction. Several companies, particularly among the frame and exterior trim trades, serve almost as an equivalent to temporary employment agencies. These contractors, called mid-contractors for purposes of this study, provide general contractors with individual companies to perform construction activities. In these situations, the individual companies are contracted by the mid-contractors, which are contracted by the general contractors. General contractors and mid-contractors usually do not have employees that perform labor on-site. Both types of contractors participated in HomeSafe as representatives for their subcontracted companies with the intent of passing the program along to them. Therefore, the safety performance of these contractors was measured based on the performance of their individually subcontracted companies.

Audited companies were categorized into three groups according to participation in the HomeSafe Program: 1) program participants that had not yet received HomeSafe training; audits conducted on these companies were called pretests; 2) program participants that had received training; audits conducted on these companies were called posttests; and 3) non-participants; audits conducted on these companies were called controls. Pretest and posttest subjects were selected from the roster of HomeSafe orientation/training sessions that were conducted monthly from January 1997 through March 1998. Control subjects were randomly selected. The protocol for subject selection is discussed below.

Subject Selection Protocol

Although many companies representing a variety of trades participate in the HomeSafe Program, not all were selected for participation is this study. Trades that were generally accepted as not having significant hazard exposures were not audited. Examples of these trades included waterproofing services, landscaping, carpet laying, fireplace installation, tile setting, and window cleaning. Although some aspects of the HomeSafe Program were applicable to employees in these trades, time restrictions required that the auditing selection focus on trades with significant hazard exposures that were addressed by the program. Additionally, many of the trades mentioned above were not adequately represented among the program participants to conduct any meaningful analysis. For example, only one fireplace installation company currently participates in HomeSafe. Some of the trades that were targeted as having significant hazard exposures include frame carpentry, exterior trim carpentry, foundation form setting, and drywall installation. See Table 3 for a complete list of the trades that were audited.

Selection of pretest subjects was usually made one to two weeks prior to each orientation/training session. All pretests were conducted before the companies attended the orientation/training sessions. Pretest subjects were notified by phone that their participation in the program required them to allow the study investigator to conduct a safety audit at one of their work sites. The location of a work crew was specified by the company representative. The company representative was asked to not notify the work crew that the program auditor would be arriving on the site.

Posttest subjects were contacted approximately four months after the company had attended the HomeSafe training session. Again, the location of a work crew was specified by the company representative who was asked to not notify the work crew that the program auditor would be arriving on the site. The posttest audit was not always conducted on the same employees or at the same work site that the pretest audit was conducted.

Occasionally, coordination of auditing times and company work schedules was not possible. Additionally, difficulties associated with telephone communication resulted in the inability of the study investigator to contact participating companies. For these reasons, not all companies that were administered a pretest were administered a posttest. Likewise, not all companies that were administered a posttest were administered a pretest. Because it was unknown whether the missing pretests and posttests would affect the study results, separate analyses was conducted using only companies that had pretests and posttests (see Results section).

In many instances, control subjects were sought at the same housing project at which a participant was audited. Since these companies were not members of the HomeSafe program, permission was obtained from the employees on the site to conduct the safety audit. Before the audit was conducted, a representative of the company was required to sign a consent form. Only one audit per control company was performed.

The study protocol and consent form were approved by the Colorado State University Human Subjects Committee. All subjects were assured confidentiality with respect to the information collected on the audit forms. All information regarding the study subjects was maintained by the study investigator.

Audit Administration Protocol

Generally, only one company was administered an audit at any given site. Only a few instances occurred when two audits were performed at the same site. In these cases, the companies were performing totally different duties and were working on separate parts of the construction project. A site was defined as a single, free-standing unit, such as a house or a track of condominiums. Upon entering a work site, the audit administrator announced to the company that a HomeSafe audit was going to be performed. One company employee was identified to answer a few structured questions that were on the audit form. These included questions about the employee's knowledge of the HomeSafe Program and the occurrence of company safety meetings, if any. To avoid confusion with the company management, the study investigator attempted to identify the company owner, a supervisor, or a foreman to answer the questions.

Following the completion of the questions, site characteristics were noted and individual employees were observed to assess whether they were behaving safely or unsafely for all of the items on the audit applicable to their activity at the time of observation. General contractors and mid-contractors that were HomeSafe participants may have had multiple subcontractors working at a single project consisting of several sites. In these cases, a maximum of three subcontractors were audited per general or mid-contractor. Since these contractors often participated in HomeSafe as representatives for their subcontracted companies, the purpose of the multiple testing was to determine if the subcontracted companies in these situations experienced a change in safety performance.

Depending on the size of the site, the number of employees at the time of the audit, and the amount of equipment used by the employees, one audit session lasted approximately 15 to 30 minutes. Observations were made in full view of the employees; however, the audit was completed as unobtrusively as possible. The audits were conducted at different times of the day during the normal five-day workweek.

Score Determination and Data Analysis

Data from the audit forms were entered into a computer database and analyzed using the Statistical Package for the Social Sciences (SPSS Inc., 1988; SPSS Inc., 1997). The score for each audit was determined by dividing the total number of "yes" responses by the total number of questions that were applicable;

this ratio was then multiplied by 100. A high score was related to a high level of compliance with the program. Employee safety performance based on several select variables was evaluated using chi-square tests for association. Differences in mean scores between the three test groups were statistically evaluated using independent samples t-test and one-way analysis of variance (ANOVA); the least-significant-difference (LSD) method was used to further elucidate the differences in scores among these groups. Additionally, two-way ANOVA was used to investigate the interaction of certain variables with respect to the audit scores.

Results

Descriptive Statistics

Table 1 shows the distribution of audit collection among eight counties in Northern Colorado. Companies working in Larimer and Weld counties were not eligible for participation in the HomeSafe Program. However, several companies in these counties were audited for use as control subjects. The largest number of audits were performed in Boulder (n=108) and Douglas (n=108) counties.

Table 1
Frequency Distribution and Percent of Audit Collection in Colorado Counties

County	Frequency	Percent
Adams	69	18.4
Arapahoe	21	5.6
Boulder	108	28.9
Denver	9	2.4
Douglas	108	28.9
Jefferson	36	9.6
Weld	19	5.1
Larimer	4	1.1
Total	374	100

Table 2 shows the distribution of the types of residential structures companies were building during observation. The largest percentage of structures observed were single family homes (n=340).

Table 2
Frequency Distribution and Percent of Audits Among Various Types of Residential Structures

Structure	Frequency	Percent
Single family	340	90.9
Apartment	16	4.3
Condominium	9	2.4
Townhouse	9	2.4
Total	374	100

Audits were administered between the months of January 1997 and March 1998. A total of 374 audits were administered during this time period, representing 15 construction trades (Table 3). The largest number of audits were conducted on frame construction companies (n=116), followed by exterior trim installation companies (n=47). The least amount of audits were conducted on roof gutter installation companies (n=4). Sewer/water pipe installation companies had the highest mean audit score (79.3%). Masonry/stucco companies had the lowest mean audit score (58.3%). Both frame and exterior trim carpentry companies had the most items applicable on the audit (29.1 and 33.8, respectively). Concrete flatwork companies had the fewest items applicable (6.00).

Table 3
Distribution of Audits and Mean Total Items Applicable Among All Trades

Trade	# Audits	% of total sample	Total Items Applicable Mean
Frame	116	31	29.1
Roof	31	8.3	23.4
Drywall	21	5.6	21.5
Plumbing	14	3.7	18.9
Exterior Trim	47	12.6	33.8
Insulation	10	2.7	14.3
Concrete Foundation	22	5.9	16.4
Masonry/Stucco	30	8	21.7
Roof Gutter	4	1.1	27.3
HVAC	10	2.7	19.8
Electric	15	4	21.3
Concrete Flatwork	7	1.9	6
Interior Trim	12	3.2	15.1
Paint	21	5.6	16
Sewer/Water Pipe	14	3.7	12.9
Total	374	100	23.9

Among all the employees observed during the data collection process, only two women were seen performing labor on residential construction sites. One woman was a plumber; the other was an exterior trimmer. Both of these women were working for companies that were audited.

One employee of each company audited was asked questions related to job title, the number of company employees, knowledge of the name 'HomeSafe', and the amount of safety training the employee had received. Occasionally, no employees in a particular company were able to speak and understand English well enough to answer these questions. Table 4 shows the number of audits that were performed on companies that did not have an employee on-site that could fully communicate with the study investigator (n=28).

Table 4

Frequency of English-speaking Companies Among All Trades

	Speaks English					
Trade	Yes	%	No	%	Total	%
Frame	112	29.9	4	1.1	116	31
Roof	26	7	5	1.3	31	8.3
Drywall	18	4.8	3	0.8	21	5.6
Plumbing	14	3.7			14	3.7
Exterior Trim	46	12.3	1	0.3	47	12.6
Insulation	8	2.1	2	0.5	10	2.7
Concrete Foundation	17	4.5	5	1.3	22	5.9
Masonry/Stucco	26	7	4	1.1	30	8
Roof Gutter	4	1.1			4	1.1
HVAC	10	2.7			10	2.7
Electric	15	4			15	4
Concrete Flatwork	6	1.6	1	0.3	7	1.9
Interior Trim	12	3.2			12	3.2
Paint	19	5.1	2	0.5	21	5.6
Sewer/Water Pipe	13	3.5	1	0.3	14	3.7
Total	346	92.5	28	7.5	374	100

Among the employees that could speak English, a question was asked regarding job title (Table 5). Job titles were divided into three categories: 1) company owners, 2) foreman or supervisors, and 3) laborers (general employees). Both frame and exterior trim carpentry companies had the largest number of owners that were approached during auditing (70.2% and 63.8%, respectively).

Table 5

Frequency of Worker Job Title Among All Trades

	Job Title						
Trade	Owner	%	Foreman/ Supervisor	%	Laborer	%	Total
Frame	80	70.2	10	8.8	24	21.1	114
Roof	4	12.9	3	9.7	24	77.4	31
Drywall	2	9.5	7	33.3	12	57.1	21
Plumbing	1	7.1	5	35.7	8	57.1	14
Exterior Trim	30	63.8	4	8.5	13	27.7	47
Insulation			2	20.0	8	80.0	10
Concrete Foundation			13	59.1	9	40.9	22
Masonry/Stucco	3	10.3	15	51.7	11	37.9	29
Roof Gutter					4	100.0	4
HVAC	2	20.0	3	30.0	5	50.0	10
Electric			5	33.3	10	66.7	15
Concrete Flatwork	1	14.3	4	57.1	2	28.6	7
Interior Trim	4	33.3	1	8.3	7	58.3	12
Paint	5	26.3	8	42.1	6	31.6	19
Sewer/Water Pipe	1	7.1	8	57.1	5	35.7	14
Total	133	36.0	88	23.8	148	40.1	369

The number of employees working on-site for each audited company was noted; employees of other companies that may have been working on the same site were not included in the count. In many cases among the frame construction and exterior trim companies, tasks were completed by cooperation between a number of one-person companies. Workers in these situations worked together as single functioning units, but were officially separate companies. For auditing and analysis purposes, workers in these situations were considered as one company. Table 6 details the mean number of company employees observed working in each trade. Concrete foundation, drywall, and masonry/stucco companies had the largest average number of employees working per site (4.9, 4,6, and 4.5, respectively). At one site, 19 workers were observed installing drywall. Interior trim and electric companies had the least average number of workers per site (1.5 and 1.7, respectively).

Table 6

Mean, Minimum, and Maximum Number of Employees Observed in Each Company During Auditing Among All Trades

Trade	N	Mean # Employees	Minimum	Maximum
Frame	116	3	1	12
Roof	31	2.3	1	7
Drywall	21	4.6	1	19
Plumbing	14	2.1	1	6
Exterior Trim	47	2.8	1	8
Insulation	10	2.6	1	7
Concrete Foundation	22	4.9	1	10
Masonry/Stucco	30	4.5	2	16
Roof Gutter	4	2.8	2	4
HVAC	10	2	1	3
Electric	15	1.7	1	3
Concrete Flatwork	7	3.7	2	5
Interior Trim	12	1.5	1	3
Paint	21	2.8	1	6
Sewer/Water Pipe	14	3.9	2	8
Total	374	3.1	1	19

A structured question on the audit form that was asked of one employee at each site was related to the number of employees that worked for the company. Table 7 shows the mean number of employees per trade based on the average number of employees working for the individual companies that were audited. Concrete foundation companies had the largest mean number of employees (n=43.5). Exterior trim carpentry companies and frame carpentry companies had the fewest mean number of employees (4.5 and 4.6, respectively).

Table 7

Mean, Minimum, and Maximum Number of Employees Working in Each Company Among All Trades

Trade	N	Mean	Minimum	Maximum
Frame	100	4.6	1	34
Roof	15	23.7	1	90
Drywall	5	18.2	5	40
Plumbing	11	23.7	1	60
Exterior Trim	40	4.5	1	30
Insulation	2	17.5	8	27
Concrete Foundation	11	43.5	5	200
Masonry/Stucco	24	18.1	2	65
Roof Gutter	3	10.7	3	23
HVAC	7	12.3	1	25
Electric	8	27.9	13	80
Concrete Flatwork	4	14.3	3	19
Interior Trim	9	5.2	1	15
Paint	15	23.2	2	99
Sewer/Water Pipe	6	25.3	2	99
Total	260	12.5	1	200

Table 8 shows the number of sections in the HomeSafe Program that were applicable to each of the 15 trades. All companies within each trade were assumed to perform basically the same tasks and therefore have the same exposures to hazards. Accordingly, observation of only one company exposed to a particular hazard addressed in HomeSafe Program was sufficient to classify the hazard as a trade-wide characteristic. The Safety Program section was not included in this table since this section consisted only of structured items and not items based on exposure status. The least number of sections in the program were applicable to concrete flatwork companies (n=3). All sections were applicable to the frame and exterior trim carpentry companies.

Table 8
Number of HomeSafe Sections Applicable to All Trades

Trade	PPE	Scaffolds	Ladders	Electric Power and Cords	Access/ Housekeeping	Open Holes, Sides, & Floors	Falls	Excavations	Power Tools
Frame	X	X	X	X	X	X	X	X	X
Roof	X		X	X	X	X	X	X	X
Drywall	X	X	X	X	X	X	X		X
Plumbing	X		X	X	X	X	X	X	X
Exterior Trim	X	X	X	X	X	X	X	X	X
Insulation	X	X	X	X	X	X			X
Concrete Foundation	X		X	X	X		X	X	X
Masonry/Stucco	X	X	X	X	X	X	X		X
Roof Gutter	X		X	X	X		X		X
HVAC	X		X	X	X	X			X
Electric	X		X	X	X	X			X
Concrete Flatwork	X				X		X		
Interior Trim	X		X	X	X	X			X
Paint	X		X	X	X	X	X		X
Sewer/Water Pipe	X		X	X	X		X	X	X

The Kolmogorov-Smirnov Test for Normality (K-S) was used to determine if the audit scores were normally distributed among the pretest, posttest, and control groups. The results of the K-S tests are presented in Figures 1, 2, and 3 (pretest, posttest, control groups, respectfully). Scores in all three test groups were normally distributed.

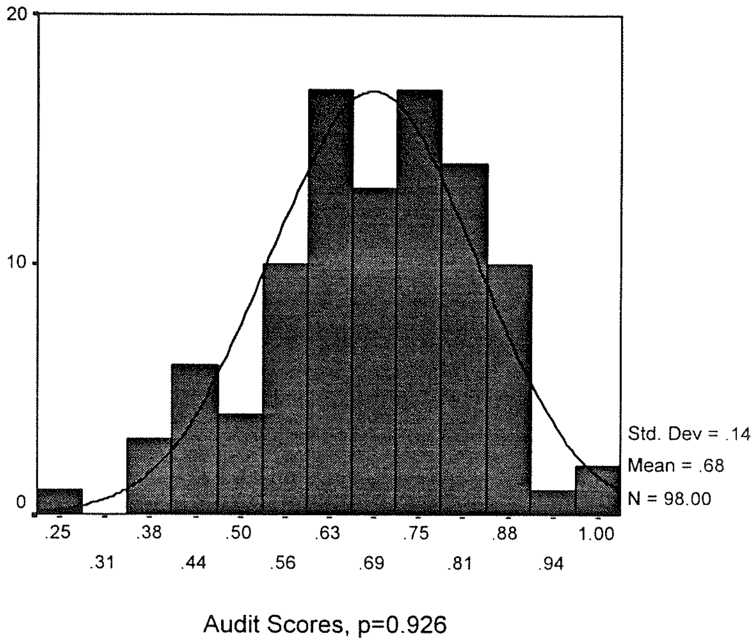

Figure 1
Results of Kolmogorov-Smirnov Test for Normality for the Pretest Group

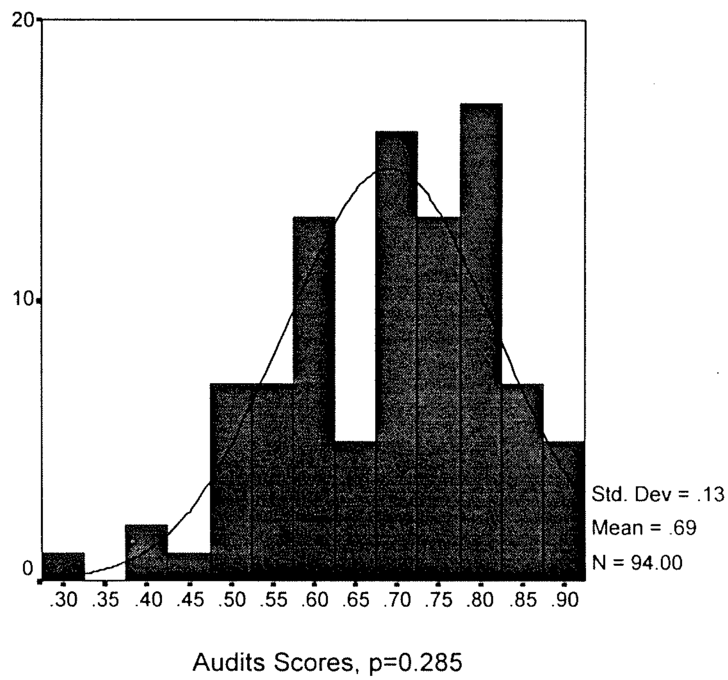

Figure 2
Results of Kolmogorov-Smirnov Test for Normality for the Posttest Group

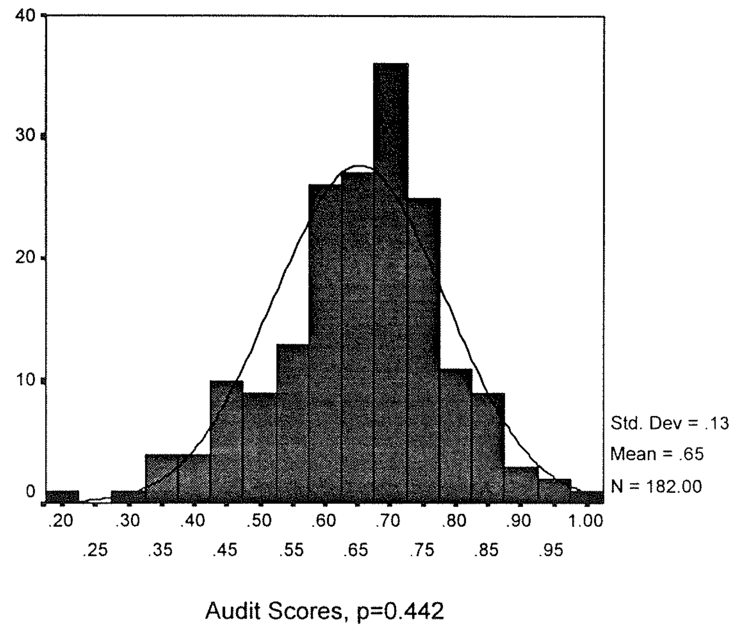

Figure 3
Results of Kolmogorov-Smirnov Test for Normality for the Control Group

Table 9 shows the number of audits and mean scores within each trade that were performed on all companies in the pretest, posttest, and control groups. Among the 374 completed audits, 98 were pretests, 94 were posttests, and 182 were control audits.

Table 9

Number of Audits and Mean Audit Scores Among All Trades in the Pretest, Posttest, and Control Groups

	Test Group							
	Pretest		Posttest		Control		Total	
Trade	N	Mean Score	N	Mean Score	N	Mean Score	N	Mean Score
Frame	27	65.0	28	67.5	61	67.7	116	67.0
Roof	8	70.2	8	79.5	15	66.7	31	70.9
Drywall	7	59.5	7	60.5	7	55.0	21	58.3
Plumbing	4	77.7	3	76.4	7	67.9	14	72.5
Exterior Trim	6	66.0	12	69.6	29	65.1	47	66.3
Insulation	4	77.4	5	63.9	1	57.1	10	68.6
Concrete Foundation	7	59.1	4	66.2	11	62.8	22	62.2
Masonry/Stucco	8	64.0	5	62.0	17	48.4	30	54.8
Roof Gutter	3	73.2	1	78.6			4	74.5
HVAC	4	74.6	2	78.6	4	72.7	10	74.6
Electric	3	77.1	4	76.3	8	74.9	15	75.7
Concrete Flatwork	2	77.9	2	50.0	3	70.0	7	66.5
Interior Trim	4	69.3	3	62.6	5	71.8	12	68.7
Paint	4	73.6	5	71.4	12	69.6	21	70.8
Sewer/Water Pipe	7	80.1	5	82.1	2	69.0	14	79.3
Total	98	68.5	94	69.2	182	65.3	374	67.1

Companies that had both a pretest and posttest performed were considered matched. However, the matching was not one-to-one since some companies, such as general contractors and mid-contractors, had multiple subcontractors working at the same project. In these cases, more than one pretest or posttest may have been performed, depending on the number of subcontractors on-site. Additionally, posttests conducted on the general contractors and mid-contractors were not always performed on the same subcontractors that were used for pretests. Table 10 shows the number of audits within each trade that were performed among companies that had both a pretest and posttest completed. A total of 138 audits were performed among the matched companies, representing 64 pretest companies and 74 posttest companies. The trade with the largest number of matched audits performed was frame construction (16 pretest, 25 posttest). The trades with the least number of matched audits performed were interior trim companies and roof gutter installation companies, each having only 1 pretest and 1 posttest.

Table 10
Frequency of Matched Audits and Mean Scores Per Test Group Among All Trades

	Test Group					
	Pretest		Posttest		Total	
Trade	N	Mean	N	Mean	N	Mean
Frame	16	63.8	25	66.9	41	65.7
Roof	6	71.3	7	79.3	13	75.6
Drywall	6	59.7	7	60.5	13	60.1
Plumbing	4	77.7	3	76.4	7	77.1
Exterior Trim	2	54.8	5	67.8	7	64.1
Insulation	4	77.4	4	62.6	8	70
Concrete Foundation	4	61	3	68.5	7	64.3
Masonry/Stucco	6	65.3	4	62.2	10	64.1
Roof Gutter	1	71	1	78.6	2	74.8
HVAC	2	81.5	2	78.6	4	80
Electric	3	77.1	3	76.3	6	76.7
Concrete Flatwork	2	77.9	2	50	4	63.9
Interior Trim	1	86.7	1	71.4	2	79
Paint	3	75.9	3	62.8	6	69.4
Sewer/Water Pipe	4	77.9	4	87.9	8	82.9
Total	64	69.1	74	68.9	138	69

Data Analysis

Chi-square analysis of matched data.

Employees of the audited companies were asked if they had ever heard of the name 'HomeSafe'. The number of companies among the matched audits that either had or had not heard the name is detailed in Table 11. Analysis using the chi-square test indicated a significant association between knowledge of the program name and the posttest group ($p<0.05$).

Table 11
Chi-square Analysis of Test Group and Knowledge of the Name 'HomeSafe' Among the Matched Audits*

	Heard of HomeSafe		
	Yes	No	Total
Pretest	14	49	63
	22.2%	77.8%	100%
Posttest	39	25	64
	60.9%	39.1%	100%
Total	53	74	127
	41.7%	58.3%	100%

*$p<0.05$

Workers exposed to head hazards were observed for use of hard hats. If an exposure existed, all employees of the audited company must have been properly wearing a hard hat to obtain a 'yes' response for the corresponding item on the audit. Proper use of a hard hat was defined as brim forward-facing and no defects or modifications to the hat. Table 12 details the occurrence of matched audits with all employees properly wearing hard hats if they were exposed to head hazards at the time of observation. The chi-square test indicated that there was no association between test groups and wearing hard hats ($p>0.05$). Note that a higher percentage of companies in the posttest group were observed not wearing a hardhat (66.7%).

Table 12

Chi-square Analysis of Test Group and Hardhat Use Among the Matched Audits*

	Wearing Hardhat		
	Yes	No	Total
Pretest	19	29	48
	39.6%	60.4%	100%
Posttest	20	40	60
	33.3%	66.7%	100%
Total	39	69	108

*p=0.502

One employee of each company audited was asked about the occurrence of safety training/meetings that were received while working with the current company. Table 13 details the number of companies among the matched test groups that had some type of safety training/meetings. Results of the chi-square test indicated that there was no association between the test groups and the occurrence of safety training/meetings ($p>0.05$).

Table 13

Chi-square Analysis of Test Group and Occurrence of Safety Training/Meetings Among the Matched Audits*

	Safety Training/Meetings		
	Yes	No	Total
Pretest	46	17	63
	73.0%	27.0%	100%
Posttest	48	15	63
	76.2%	23.8%	100%
Total	94	32	126

*p=0.682

Companies that used electrical power cords to operate tools and other machinery were evaluated on the condition of the cords. Specifically, cords were checked for presence of ground plugs, current continuity, and condition of the insulation. Similar to the hard hat item, all cords used by a company must have been free of any defects to obtain a 'yes' response for the corresponding item on the audit. Table 14 shows the number of companies among the matched groups that had either 'acceptable' or 'damaged' cords. No association was found between test groups and cord condition ($p>0.05$). The observation of acceptable cords was 10% greater among the posttest companies (41.8%).

Table 14
Chi-square Analysis of Test Group and Cord Condition Among the Matched Audits*

	Cord Condition		
	Acceptable	Damaged	Total
Pretest	14	30	44
	31.8%	68.2%	100%
Posttest	23	32	55
	41.8%	58.2%	100%
Total	37	62	99

*p=0.307

Work site characteristics that were noted during each audit included worker exposures to open holes and unprotected sides and edges that were not used for access. The exposure was noted only when the fall distance was six feet or greater. Companies must have covered all holes and properly guarded the open sides and edges to obtain a 'yes' for the corresponding item on the audit form. Table 15 shows the frequency of matched companies that protected the exposures. Results of the chi-square test indicated no association between test groups and protection from exposures to open-sided floors and holes ($p>0.05$).

Table 15

Chi-square Analysis of Test Group and Exposure to Open Holes, Sides, and Edges Among the Matched Audits*

	Open Holes, Sides, and Edges Protected		
	Yes	No	Total
Pretest	10	14	24
	41.7%	58.3%	100%
Posttest	17	19	36
	47.20%	52.80%	100%
	27	33	60

*p=0.672

Analysis of audit scores using matched data.

Among the matched pretest and posttest groups, two-way ANOVA was conducted to investigate the potential inter-relationship between audit scores, test group, and trade (Table16). The result of the test indicated that there was no interaction among these variables (p=0.440), however, mean scores between trades did significantly differ when averaged over the test groups (p=0.005). Additionally, mean scores between the pretest and posttest groups did not significantly differ when the scores among all trades were averaged (p=0.513).

Table 16

Two-way ANOVA Between Audit Scores, Test Group, and Trade Among Matched Audits

	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	0.833[a]	29	0.029	1.649	0.034
Intercept	39.965	1	39.965	2295.1	0.000
Trade Group	0.598	14	0.043	2.455	0.005
Test Group	0.008	1	0.008	0.431	0.513
Trade Group * Test Group	0.248	14	0.018	1.019	0.440
Error	1.881	108	0.017		
Total	68.375	138			
Corrected Total	2.713	137			

[a] R Squared = .307 (Adjusted R Squared = .121)

<u>Analysis of audit scores using unmatched data.</u>

Not all pretest audits were matched with posttests, and vice versa. 34 unmatched pretests and 20 unmatched posttests were not included in the two-way ANOVA procedure described above. Independent samples t-test was used to determine significant differences between the mean scores of the matched pretest audits and the unmatched pretest audits. Additionally, the test was used to determine significant differences between the mean scores of matched posttest audits and the unmatched posttest audits. Results of the t-tests indicated that the mean scores between the two pretest groups (p=0.589, Table 17) and the mean scores between the two posttest groups were not significantly different (p=0.681, Table 18).

Table 17

Comparison Between Mean Scores of Matched and Unmatched Pretest Audits

Test Group	Number of Audits	Mean Audit Scores (%)	p-value
Matched Pretests	64	69.1	0.589
Unmatched Pretests	34	63.6	

Table 18

Comparison Between Mean Scores of Matched and Unmatched Posttest Audits

Test Group	Number of Audits	Mean Audit Scores (%)	p-value
Matched Posttests	74	68.9	0.681
Unmatched Posttests	20	70.2	

Because no significant difference was found between the mean scores of the matched and unmatched groups, two-way ANOVA was conducted using all pretests and posttests to investigate the potential inter-relationship between audit scores, test group, and trade type. Similar to the results stated above, no significant interaction between the variables was found (p=0.640, Table 19). Mean scores between trades were significantly different when averaged over the test groups (p=0.001), however, the mean scores between the pretest and posttest groups did not significantly differ when the scores among all trades were averaged (p=0.585).

Table 19

Two-way ANOVA Between Audit Scores, Test Group, and Trade Among Unmatched Audits

	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	0.834[a]	29	0.029	1.728	0.018
Intercept	58.161	1	58.161	3494.6	0.000
Trade Group	0.629	14	0.045	2.701	0.001
Test Group	0.005	1	0.005	0.299	0.585
Trade Group * Test Group	0.193	14	0.014	0.826	0.640
Error	2.696	162	0.017		
Total	94.490	192			
Corrected Total	3.530	191			

[a] R Squared = .236 (Adjusted R Squared = .099)

One-way ANOVA was used to determine significance in mean total scores among all audits in pretest, posttest, and control groups. The test indicated that all three test groups differed significantly in mean total scores (p=0.036, Table 20). Based on the results of the LSD method, the posttest group was found to have a significantly higher mean score than the control group (p=0.022). The LSD analysis also indicated that the mean scores between the pretest and control groups was nearly significant (p=0.057, Table 21). Confirming the results of the two-way ANOVA described above, no significant difference was detected between the mean scores of the pretest and posttest groups (p=0.715).

Table 20

Comparison of Mean Pretest, Posttest, and Control Group Scores Among All Audits

Test Group	Mean %	Std. Dev.	95% C.I.	p-value
Pretest	68.5	0.144	65.6, 71.4	
Posttest	69.5	0.127	66.6, 71.8	0.036
Control	65.3	0.131	63.4, 67.2	

Table 21

Results of LSD Analysis in Comparison of Mean Pretest, Posttest, and Control Group Scores Among All Audits

		Mean Difference (I-J)	Std. Error	95% Confidence Interval		p-value
(I) Test Group	(J) Test Group			Lower Bound	Upper Bound	
Pretest	Posttest	-7.06E-03	0.019	-4.50E-02	3.09E-02	0.715
	Control	3.21E-02	0.017	-8.94E-04	6.50E-02	0.057
Posttest	Pretest	7.06E-03	0.019	-3.09E-02	4.50E-02	0.715
	Control	3.91E-02	0.017	5.71E-03	7.26E-02	0.022

Analysis of differences between the pretest and posttest groups among the individual trades was conducted to measure changes in individual trade performance. Statistical differences between mean pretest and posttest scores among the individual trades was determined using independent samples t-tests. As shown in Table 22, no significant difference was observed among any of the trades.

Table 22
Differences in Mean Audit Scores Between Pretest and Posttest Groups Among All Trades

	Pretest		Posttest			
Trade	% Score Mean	# of Companies	% Mean Score	# of Companies	% Difference	p-value
Frame	65	27	67.5	28	2.5	0.411
Roof	70.2	8	79.5	8	9.3	0.083
Drywall	59.5	7	60.5	7	1	0.905
Plumbing	77.7	4	76.4	3	-1.2	0.882
Exterior trim	66	6	69.6	12	3.6	0.505
Insulation	77.4	4	63.9	5	-13.5	0.333
Foundation	59.1	7	66.2	4	7	0.461
Mortar	64	8	62	5	-2	0.843
Gutter	73.2	3	78.6	1	5.4	0.7
HVAC	74.6	4	78.6	2	4	0.746
Electric	77.1	3	76.3	4	-0.8	0.911
Flatwork	77.9	2	50	2	-27.9	0.071
Interior trim	69.3	4	62.6	3	-6.8	0.616
Paint	73.6	4	71.4	5	-2.2	0.834
Sewer/Water Pipe	80.1	7	82.1	5	2	0.792
Total	68.5	98	69.2	94	0.7	0.72

Discussion

This study described the development, implementation, and evaluation of the HomeSafe Program. This safety program, developed specifically for the residential construction industry, represents a unique relationship between government and industry. Many safety experts in both arenas have spent several years working on the program. These people are dedicated to ensuring the success of HomeSafe and truly believe that this program will reduce injuries and fatalities on construction sites.

Three major theoretical applications are incorporated into the HomeSafe Program. The first theory, as described by Bird and Germain (1996), is that behaviors that produced positive, immediate, and certain consequences tend to be repeated. This theory is incorporated into HomeSafe through the use of incentives, such as the OSHA 'carrot' and the workers' compensation premium reduction, which are used to provide construction workers with positive, immediate, and certain consequences as a result of working safely. The second theory is the use of feedback. As reported by Howard (1987), McAfee and Winn (1989), and Geller et al. (1990), the use of feedback results in an improvement in worker safety performance. Feedback is provided to the HomeSafe participants during the HomeSafe Safety Committee site visits. The third theoretical application in HomeSafe is the use of self-regulation. Hoffman et al. (1995), French and Bell (1994), and Baltz (1997) all reported positive benefits associated with self-regulation. The HomeSafe Program is designed to be self-regulated by the HomeSafe Safety Committee, which consists of safety representatives from all levels of management in the residential construction industry.

The design of the HomeSafe Program incorporates three methods of intervention: 1 administrative; 2) engineering; and 3) behavioral. The characteristics of each intervention were discussed by Goldenhar and Schulte (1994). Use of a combination of these interventions to increase worker protection was recommended by (Vojtecky, 1988). Although all three methods are used, the behavior aspect is the major focus in HomeSafe because one of the primary goals of the program is to reduce the risk of accidents by increasing the occurrence of safe behaviors. The unique work conditions associated with the residential construction industry require that workers engage in safe behaviors to protect themselves and others on the work site.

Determining the effect of the program was dependent on establishing causality between the HomeSafe Program and changes in worker safety performance. Causality in this study was established by use of the impact model, which was discussed by Rossi et al. (1979) and Vojtecky and Berkanovic (1985). Two prerequisites to performing an impact assessment, as reported by Rossi et al. (1979), included ensuring the intervention had sufficiently articulated goals and ensuring the intervention was sufficiently implemented. Both of these requirements were met in this study.

All participating companies were expected to begin implementing the HomeSafe Program immediately following participation in the orientation/training sessions. A period of four months was selected as the time between pre and post testing. No studies were found that described an evaluation procedure similar to this study, therefore, there was no reference for time allotted between initial training and testing. However, discussions with members of the HomeSafe Safety Committee and the CSU research team supported the four-month span between audits.

A quasi-experimental study design was used in this study because the subjects could not be randomly assigned to exposure groups. Use of this study design to evaluate safety and health intervention programs has been well established in the literature and is recommended when a true experimental design is not possible (Goldenhar and Schulte, 1994; Hennessy, 1995; Lipsey, 1996; NCIPC, 1989; Rossi et al., 1979; Vojtecky and Berkanovic, 1985). Three comparison groups were incorporated into the quasi-experimental design, 1) pretest, 2) posttest, and 3) control. A total of 374 audits were collected and analyzed for this study. The pretest group consisted of 98 audits, the posttest had 94, and the control group included 182 audits.

The greatest percentage of audits was performed on carpentry companies. Of the 374 audits performed, 116 (31.0%) were conducted on frame construction companies and 47 (12.6%) were conducted on exterior wood trim installation companies. The larger sample size of these companies compared to all other trades was in agreement with a previously published study in which carpentry made up 21% of all construction companies, the largest of all the construction trades represented (Georgine et al., 1997). Additionally, there are two main reasons why carpentry companies were the focus of a large percentage of the audits. First, frame and exterior trim companies had the most items on the audit applicable (29.1 and 33.8, respectively). Second, employees of these companies had exposures to all of the sections in the HomeSafe Program. Therefore, it was felt that improvements in safety performance would most likely be observed among these companies.

Control group participation was very successful with only 4 of the 182 companies refusing to participate. Two of the companies who refused were exterior trimmers and two were framers. Only the framing companies offered explanations why they chose not to participate. Both were because they feared that OSHA would use the data to cite and fine them. The non-participating exterior trim companies refused to answer any questions. Participation among the pretest and posttest groups was 100%.

Information collected on the audit included items such as the company name, name of the general contractor and/or mid-contractor, number of employees in the company, knowledge of the 'HomeSafe' name, and amount of safety training the employees had received. These questions required that one employee of each audited company be able to speak and understand enough English to communicate with the study investigator. Among the 374 audits collected, 28 (7.5%) did not include the information described above due to language barriers. All other data on these audits were able to be collected.

All employees approached to answer questions on the audit were asked to specify their job title. In situations where the company owner or a supervisor was not available for questioning, another employee was chosen. In most cases, employees who could not speak English fluently were still able to designate their job titles. A total of 369 audits were collected with job title information. Both frame construction companies and exterior trim companies had the highest percentage of owners that were approached. This was due to the high number of one-person companies that were predominant in these trades. Most of these one-person companies worked together on the same site with other one-person companies. These companies usually worked for the same mid-contractor.

The average number of employees observed working at each site was 3.08, but this number was heavily weighted by the large sample of frame construction companies. Regardless, the average number of company employees observed was no greater than five for any of the trades. The actual number of employees observed varied widely. Several trades, such as framing, drywall, concrete foundation, and masonry/stucco, ranged from a minimum of one to two employees to greater than 10 employees at one site.

The average number of employees that worked for each company was 12.45. Again, this was heavily weighted by the large sample of frame construction companies, which had the smallest mean number of employees among all the trades (4.58). Concrete foundation companies had the highest mean number of company employees (43.45); one of these companies employed as many as 200 workers. The roofing, painting, and sewer/water pipe trades each had at least one company that employed nearly 100 workers. The interior rim trade had the fewest maximum number of company employees of all the trades (n=15).

Although samples were collected in all six counties of the metropolitan Denver area, the majority were performed in Douglas and Boulder counties (28.9% each). Both of these counties were experiencing a large growth in residential construction and many companies performed work in these areas. Selection of the county in which each audit was performed was a function of the company location at the time of auditing. No attempt was made to collect an equal number of samples in each county since companies may have performed work in more than one county on any given day. Furthermore, the location of the construction sites was not expected to be a determining factor of worker safety performance. Samples collected outside of the six-county area, including Weld (n=19) and Larimer (n=4) counties, were used as control subjects.

Companies were audited while constructing several types of residential structures. Over 90% (n=340) of the audits were performed in single family homes. Similar to the county selection, the majority of audits were performed on single family projects because most companies were engaged in this type of construction at the time of auditing.

Several variables on the audit were selected for analysis using data from the matched audits. The selected variables included knowledge of the name 'HomeSafe', hard hat use, occurrence of employee safety training and/or meetings, condition of electrical power cords, and exposure to open holes and unprotected sides and edges. Although a significant relationship was found between worker knowledge of the name 'HomeSafe' and audits in the posttest group, a previous study conducted by Bigelow et al. (in-press) found that knowledge of the name was not associated with safety performance. However, it is interesting to note that nearly 40% of posttest companies had not heard the name, although they had been members of the program for at least four months.

Analysis of employee hard hat use indicated no association between use of the protective equipment and test group (p=0.502). However, a smaller percentage of companies in the posttest group (33.3%) scored a 'yes' on this item than the pretest group (39.6%). In a study conducted by Dedobbeleer and German (1987), 65% of employees were observed wearing hard hats. Although this is nearly twice as high as the results found in the HomeSafe evaluation, it should be noted that the study conducted by Dedobbeleer and German was performed on non-residential construction sites, where work practices are much more regimented and regulated than on residential construction sites (Bigelow et al., in-press). Therefore, results from the study may not be comparable to the residential construction industry. Regardless, it is still disappointing to see that there was a decrease in hard hat usage between the pretest and posttest groups.

Analysis of the occurrence of company safety training/meetings among the matched audits indicated that companies in the posttest group received a greater percentage of training/meetings (76.2%) compared to companies in the pretest group (73.0%). However, the association between test group and safety training/meetings was not statistically significant (p=0.682). Information regarding the content of the safety training/meetings, who conducted them, or how long the sessions lasted, was not obtained from the workers. Perhaps future data collection and analysis will show a continuing trend in the increase of companies participating in safety training/meetings.

No association between cord condition and the matched test groups was found (p=0.307). However, observation of acceptable cords among the posttest audits was 10% greater than the pretest audits. Several criteria related to cord condition were used on the audit form to determine if the cord was damaged. These factors included the presence of a ground plug, electrical flow through the cord, condition of the cord insulation, and condition of cord splices. Although a company may have been using several cords at one job site, the presence of only one defective cord was sufficient to obtain the 'damaged' rating. Among both the test groups, the percentage of companies that were observed using damaged cords was greater than those using undamaged cords.

A total of 60 audits were analyzed among the matched pretest and posttests companies that had exposures to open holes and unprotected sides and edges, all having fall distances six feet or greater. Exposures to these hazards were most commonly observed during the framing stage. A common practice among the frame construction companies was to cut a hole into the floor into which the stairs leading into the basement would be placed. However, the stairs were not always installed immediately after the hole was cut and workers were exposed to a serious fall hazard if the hole was left unguarded. Another common hazard during the framing stage was exposure to falls through window openings that had an outside fall distance six feet or greater. The lower edge of the window opening must have been three feet or less from the floor to be considered hazardous. Similarly, openings with the windows installed were not considered hazardous. To score a 'yes' on the item referring to protection of open holes and unprotected sides and edges, the fall exposures must have been properly guarded. Although there was no association between test group and protection of the exposures (p=0.672), both the pretest and posttest groups had a higher percentage of companies that did not provide protection (58.3% and 52.8%, respectively). It should be noted that the posttest group had a slightly greater percentage of companies that provided protection for open holes and unprotected sides and edges.

No significant inter-relationship was found between audit scores, test group, and trade type (p=0.440). This means that no significant difference in mean scores was found between the pretest and posttest groups among any of the trades. Additionally, there was no difference in mean scores between the two test groups when all the trades were combined (p=0.513). Although the mean audit scores among the trades were significantly different when averaged over the test groups (0.005), this finding, although interesting, does not address the impact of the HomeSafe Program.

Since no significant difference in mean scores between the matched and unmatched audits was found, the groups were combined. The pretest group increased by 34 audits, while the posttest group increased by 20 audits. The same analysis described above was conducted and similar results were obtained; no significant difference in mean scores was found between the pretest and posttest groups among any of the trades (p=0.640).

Although the sample size in many of the trades was too small for purposeful individual analysis, the data does indicate interesting variations in safety performance. Among the 15 trades listed, 8 experienced an improvement in safety performance. Roofing companies had the greatest improvement (9.33%), and this result was nearly significant (p=0.083). Flatwork concrete companies experienced a reduction in safety performance (-27.86%), but this was probably due to the small sample size in each test group (n=2 for both). The p-value shown on the 'total' row of the table reaffirms the results from the two-way ANOVA discussed above; there was no significant difference in mean scores between the pretest and posttest groups when the trades were grouped together (p=0.72).

One-way ANOVA was used to evaluate differences in mean scores between the three test groups. Although one-way ANOVA indicated a significant difference among mean scores for these test groups (p=0.036), results of the LSD method showed that the significance was due to differences between the posttest and control groups (p=0.022). The posttest mean score was approximately 4% greater than the control group. The LSD method also indicated that the difference in mean scores between the pretests and controls was nearly significant (p=0.057). The pretests group mean score was approximately 3% greater than the control group mean score. Because both mean scores of the pretest and posttest groups were nearly identical and both were greater than the control group score, HomeSafe participants may have been slightly 'safer' than control companies even before entering the program.

This finding may be described by the phenomenon of self-selection bias. HomeSafe companies made the choice to join the program; thus, there was potential selection bias in the study. A more thorough discussion about the theory of selection bias is presented by Rossi et al. (1979). Wolford, Larson, Merrick, Andrews, and Tillett (1997), in a study that compared safety and health training among painters, found that voluntary safety programs tended to attract companies that were mainly "true believers", or companies that had previous training, better protective practices, and lower exposure risks. Companies that were interested in enhancing their safety programs were most likely to view the HomeSafe program as attractive and beneficial. These companies were most likely to become program participants. The motivation of these companies to maintain a safety program and participate in HomeSafe may have resulted in elevated scores compared to companies that did not choose to be members.

Calculation of the audit scores that each company received was similar to the scoring procedure used by Chhokar and Wallin (1984) who used the percent of employees working safely among all employees for that company. In the HomeSafe evaluation, the behaviors of the employees were scored rather than the number of employees behaving safely. Chhokar and Wallin stated that this type of measure had a positive connotation by focusing on safe behavior rather than on unsafe behavior. Safe and unsafe behaviors were considered mutually exclusive. Thus, if an increase in safe behaviors occurred, a corresponding and consequent decrease in unsafe behaviors would follow (Chhokar and Wallin, 1984).

Individual behaviors and characteristics of each site were scored all-or-none (AON), which was similar to methods used in a study conducted by Chhokar and Wallin (1984). Cooper et al. (1993) argued that the AON rating scale did not detect slight improvements in safety behaviors and characteristics that did not meet 100% compliance. The Proportional Rating Scale (PRS), as described by Cooper et al. (1993), attempted to detect improvement in safety by noting the proportion of unsafe situations and behaviors for any given topic in an audit. For example, assume that out of 15 scaffolds, only 12 are constructed properly. This would score higher than only 10 out of 15 scaffolds being constructed properly. The purpose of the HomeSafe evaluation was not to determine if employees were 'almost' or 'usually' safe. Using the example above, employees would still be exposed to safety hazards on those scaffolds that were not completely safe. Any safety hazard, no matter what the proportion safe/unsafe, was still a safety hazard and had the potential for causing injury or death. In addition, the PRS scale would not be useful in the residential construction setting as in the commercial setting because there were, at most, only two or three pieces of the same equipment on each site.

Due to the sampling protocol and high employee turnover in the construction industry, matching between the control group and HomeSafe participants was not possible. This difficulty has been previously reported by Dedobbeleer and German (1987), who conducted a study to investigate construction workers' safety practices in relation to individual and situational factors. Control group participants were randomly selected and only one audit was administered to each company. Ideally, the control group companies would have been matched to the participating companies by factors such as trade, number of employees, and location of work site. Because this matching was not possible, comparisons of safety performance among the pretest, posttest, and control groups could only be made using unmatched statistical analysis.

The power of analyses between pretest and posttest group performances was improved by analyzing only audits given to companies that had been administered both pretests and posttests. In total, 64 pretest audits were matched with 74 posttest audits. As described in the results section, the matching method used in this study was not one-to-one matching by individual company, which would have been ideal. Matching of this type would have required the pretest and posttest audits to be performed on the same employees and at the same construction site to ensure that the exposures were the same for the two tests. There are several reasons why one-to-one matching was not used in this study. First, communication with company representatives was a difficult task. Often, company representatives were unavailable at the times the study investigator needed information regarding the location of their work sites. Other times, the company representatives were not sure where employees could be found. Second, many trades in the construction industry were prone to rapid employee turnover, a phenomenon that was also described by Ringen and Stafford (1996). Often, employees had moved to other companies by the time posttesting was conducted. Third, most construction projects lasted only a few months. Ringen et al. (1995) also found this to be a common characteristic of the construction industry. Rarely was the same company observed during a pretest working at the same site during the posttest. Regardless of the lack of one-to-one matching, the units of analysis for this study were the companies, not the individual employees.

Although the pretest/posttest matching was not ideal, the methods served the purpose of this study. The purpose of this study was not to analyze differences in safety performance among individual companies. Rather, it was to determine differences within the residential construction industry as a whole. The HomeSafe Program was developed for the entire residential construction industry. The matching procedure used in this study allowed for a powerful analysis of differences among the pretests and posttest groups in the sample. How individual companies varied in safety performance while participating in the program was not as important as how the entire industry was affected.

Bias associated with the 'Hawthorne effect' was not able to be quantified. Fortunately, however, Hawthorne effects have rarely ever proven to be significant (Rossi et al., 1979). Although some companies expressed a true interest in participating in the HomeSafe evaluation and were encouraged by the site audits, most were impartial to their participation in the study. Therefore, significant improvements in safety performance among the HomeSafe participants due to the 'Hawthorne effect' were not expected to be a factor in the analysis.

Perhaps more important than the Hawthorne effect was bias associated with notifying the HomeSafe participants before the inspections were performed. Although company representatives were asked not to notify their employees that the HomeSafe auditor would be arriving on site, there was no way to verify that the representative complied. Companies that were notified that the auditor was arriving may have made certain preparations to the work sites and employees that may have increased the scores on the audit. This bias (in addition to the self-selection bias) may help to explain the differences in safety performance between the pretest and control groups, which was nearly significant (p=0.057).

On many occasions, the study investigator noted that employees would behave differently while the audit was conducted. These behaviors included donning of hard hats, replacing pinned-up guards on saws, and erecting guardrails around open holes and windows. Most of these actions were readily identifiable and those that were observed were not considered as improvements in safety performance during the auditing process. Employees of both HomeSafe participating companies and control companies were observed performing these 'quick-fix' behaviors. Therefore, any bias associated with this factor of the auditing process likely showed a slight and equal improvement in the safety performance scores among the three test groups.

An issue concerned with data collection in this study was the probability of observing unsafe behaviors and site characteristics during the time that an audit was performed. The audit took only 20 to 30 minutes to complete, depending on the number of hazards present. Thus, each company was scored solely on observations made within that time period. This chance observation was particularly problematic in the residential construction industry where workers often completed a variety of jobs in the course of the day. A design change, lack of supplies, or inclement weather may determine the daily schedule a company follows (Bhattacharya et al., 1997). Ideally, individual companies would be observed for a period of time long enough to evaluate all characteristics of a particular trade; unfortunately, study constraints necessarily limited the observation period. However, this limitation may have been compensated through the increased sample size by providing more opportunities to observe unsafe behaviors.

Lipsey (1996) stresses that statistical results must be interpreted to some practical meaningfulness to be useful. The scores on the HomeSafe audits were percentages of the number of items that were applicable. The highest score a company could receive was 100%, meaning that the employees were working safely on all of the items on the audit applicable to their activity at the time of the observation. Determining at what percentage companies are no longer considered to be working safely is problematic. The goal is obviously 100% safety, but does a score of 85% expose workers to unacceptable risk? At this time, no specific 'permissible' score has been set. Scores are currently being compared on a relative basis. Similar to this study, Cooper et al. (1993) used an 'average percent safety performance' to score safety on construction sites. The authors did not address a cutoff percentage for what they determined to be safe. Further research needs to be conducted to develop a safety measurement standard.

Published research specifically addressing hazard exposure and accident, injury, and mortality rates in the residential construction industry is sparse.

Several papers have described hazard exposure and injury and death rates for the commercial and residential construction industries combined, but none specifically addressed these issues for the residential industry (Cattledge et al., 1996; Helander, 1991; Hunting et al., 1994; Kisner and Fosbroke, 1994; Ore and Casini, 1996; Pollack et al., 1996; Robinson et al., 1995; Sorock et al., 1993; Stanevich and Middleton, 1988; Suruda, 1992; Suruda et al., 1988; Waller et al., 1989; Zwerling et al., 1996). Although no studies were found that documented the differences in safety hazards between the residential and commercial construction industries, a couple of sources noted the unique nature of residential construction with respect to the work practices and materials utilized (Fowler, 1997; Gilkey et al., 1998). Our findings indicate that workers in the residential construction industry were exposed to many of the same hazards as workers in the commercial industry. For example, falls were indicated as the primary cause of fatalities in the commercial construction industry (Kisner and Fosbroke, 1994; Pollack et al., 1996; Sorock et al., 1993; Suruda, 1992). In comparison, falls were also the primary cause of fatalities in the residential construction industry (Swanson, 1996). Nearly all trades observed in this study utilized scaffolds, ladders, electrical equipment, and power tools, which were all commonly associated with injuries and fatalities in the commercial industry. In fact, all ten sections of the HomeSafe Program were identified as major causes of injuries and fatalities in the commercial industry. Unfortunately, safety rules and regulations are not as well enforced in home building, and additional research needs to be conducted specifically addressing this industry.

Development of the safety audit was difficult. Every attempt was made to reduce the need for subjective judgement while collecting data. The use of all-or-none scoring helped to maintain objectivity in determining the presence of hazards or unsafe behaviors. Following the recommendations of Sulzer-Azaroff and Felner (1984) to increase validity, items on the audit were direct measures of worker safety performance and site characteristics that were proxy measures for the incidence of injuries and fatalities. Most of these proxy measures were established by other studies (Chhokar and Wallin, 1984; Cooper et al., 1993; Fitch et al., 1976; Geller, 1994, 1995; Goldenhar and Schulte, 1994; Hinze and Figone, 1988b; Hoyos and Ruppert, 1995; Komaki et al., 1978; Tarrants, 1970; and Vojtecky and Schmitz, 1986). In addition, reliability of the study results was high since both the implementation of the HomeSafe Program and the measurement protocol were well standardized. This was in agreement with Rossi et al. (1979), who recommended that intervention implementation and the evaluation procedures be standardized to increase the reliability of results. Although inter-auditor differences due to individual biases were eliminated by having only one investigator collect data, the results may reflect some biases of the study investigator. To eliminate the potential for this bias, the investigator was familiarized with the OSHA construction standards and trained in the regulations of the HomeSafe Program. Additionally, several safety professionals from the HBA, OSHA, and CSU were available for consultation when questions arose regarding the auditing process.

The overall results of this study did not provide evidence to support the relationship between the safety performance of companies audited before participating in the HomeSafe Program and the safety performance of companies audited after joining the program. Reasons why no significant difference was found are speculative. Perhaps companies were not implementing the program as expected, as indicated by the 37% of participating companies that still had not provided any safety training and/or meetings four months after the HomeSafe orientation, or by the 40% of participating companies that had employees who had never heard the name 'HomeSafe'. It was not possible to determine how companies implemented the program. The results above may indicate that some companies were not using the program. Additionally, there may be a problem with the assumption that the general contractors and mid-contractors were training their subcontractors using the HomeSafe Program. On several occasions during the auditing process, subcontractors indicated no knowledge of the HomeSafe Program even though their general contractor or mid-contractor was a participant. It seems ironic that some general and mid-contractors that joined the program to improve safety performance on their work sites had not given the program to their workers who were most at risk to safety and health hazards. Yet, there was the possibility that the audit was not sensitive enough to record the changes in safety performance, but this was not likely. The audit was designed to measure changes in safety performance that were promoted by the HomeSafe Program.

The results of this study are preliminary and some data does indicate that improvements in safety performance among the HomeSafe participants were observed. Except for hardhat use, all other tests conducted on the selected variables indicated a positive trend in safety performance in the posttest group (Table 23). Even the overall mean scores showed that companies in the posttest group performed slightly better than companies in the pretest group. These results may indicate that HomeSafe is working and that the theory of the program is sound. The HomeSafe Program is young and this study took place during the initial stages of implementation. A repeat of this study is recommended to determine if HomeSafe is successful in causing significant improvements in worker safety performance.

Table 23
Summary Table of Study Results Indicating Safety Performance Among the Pretest, Posttest, and Control Groups

	Pre vs. Post*	**Control vs. Pre***	**Control vs. Post***
Wearing Hardhat	↓		
Frequency of Safety Training	↑		
Knowledge of 'HomeSafe'	↑		
Open Holes Protected	↑		
Acceptable Cord Condition	↑		
Overall Group Scores	↑	↑	↑

Note. Asterisk indicates group with change in performance relative to comparison group

The HBA has already benefited from the results of this study. For example, data indicating that subcontractors were not receiving HomeSafe training from their general contractors and mid-contractors prompted the development of a program called 'Tailgate Talks'. This program provides general contractors and mid-contractors with the necessary tools to train their subcontractors in the rules of the HomeSafe Program. Preliminary data from several of the major contractors in Denver indicate that Tailgate Talks are very successful and that subcontractors are reacting favorably to HomeSafe.

Implementation of the HomeSafe Program is expected to continue through the year 2000. Evaluation of the program will continue as well. The residential construction industry is in dire need of a useful and adequate safety program. The Denver Home Builders Association and OSHA have taken bold steps to make this happen. Hopefully, the HomeSafe Program will be effective in improving safety and health conditions.

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APPENDIX A

EXAMPLE OF PAGES TAKEN FROM THE HOMESAFE BOOKLET

Construction employees on the job site must use proper PPE when hazards exist or when there is potential for injury.

Many serious injuries that have happened to construction workers could have been prevented, or at least the severity of the injury would have been reduced, if the victim had been wearing one or more protective devices. (See illustrations.)

The following items must be worn according to company policy:

- Hard hat

Personal Protective Equipment (PPE)

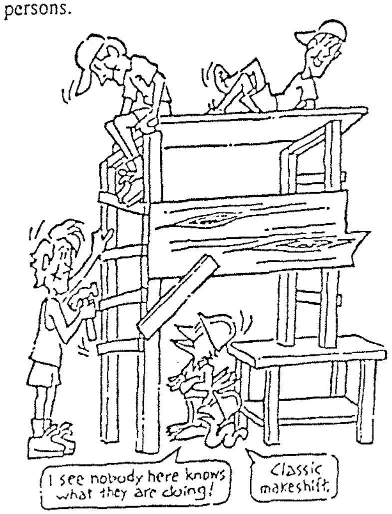
When used, scaffolding must be suitable for the job and adequate for the load.

Types of Scaffolds:

- Job-Built Wood

  This type may be used for erection of trusses and for drywall where conventional scaffold cannot be used.

- No scaffold shall be erected, moved, dismantled, or altered except under the supervision of competent persons.

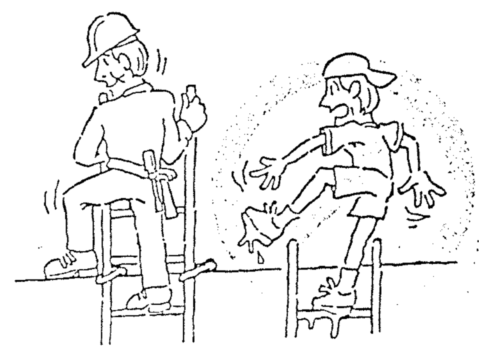


Scaffolding

Ladders must be adequate for the job and properly maintained (i.e. the right ladder for the job).

Guidelines for Use:

- No job built ladders
- Clear scrap and material away from the base and top of the ladder, since getting on and off the ladder is relatively hazardous.
- Always face the ladder when climbing up or down and while working from it.
- Maintain 3-point contact when climbing up or down; that means two hands and one foot or two feet and one hand on the ladder at all times.
- Keep your center of gravity between the side rails. Your belt buckle should never be outside the side rails.



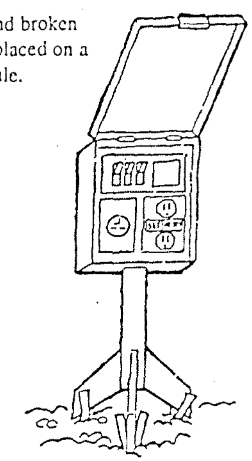
Ladders

All temporary 110-volt construction power must be on a GFCI system.

- Temporary power poles must be securely staked prior to and during use.

Any split of 220-volt power to 110-volt must be protected through GFCI and properly wired.

- Power pole duplex and 220v must be free of all defects.
- All panels must be complete to include cover, dead front and GFCI.
- All defective and broken components replaced on a monthly schedule.



Construction Electrical Power & Power Cords

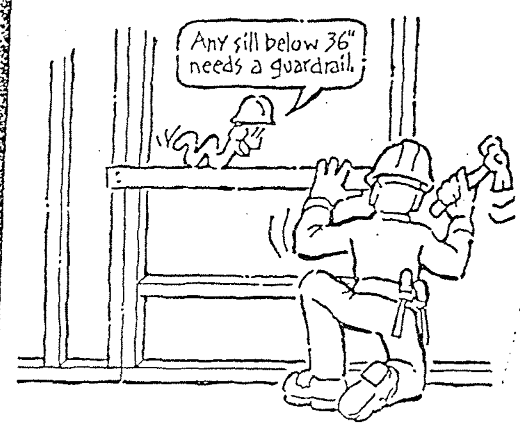
Working areas must be free of excess debris.

- Working areas must have a designated disposal site and a daily cleaning schedule.

Access/Housekeeping

Open-sided floors and holes, such as stairwells, door and window openings, and skylights (that have a fall distance of more than 6 feet) must be protected by use of guardrails or covers as soon as a hazard is created.

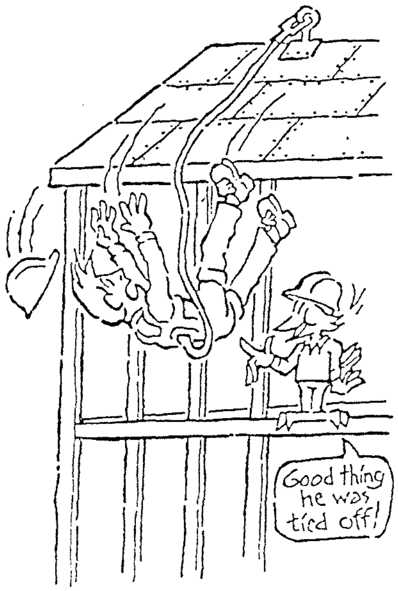
- Windows and doors not used for access will have guardrails.
- Any window with a sill below 36" requires a guardrail at 42".



Open Holes & Unprotected Sides & Edges

All workers exposed to falls of 6' or greater must be protected by the use of conventional fall protection (i.e. guardrails, personal fall arrest systems, or slide guards.)

Refer to manufacturer's specifications for proper installation.

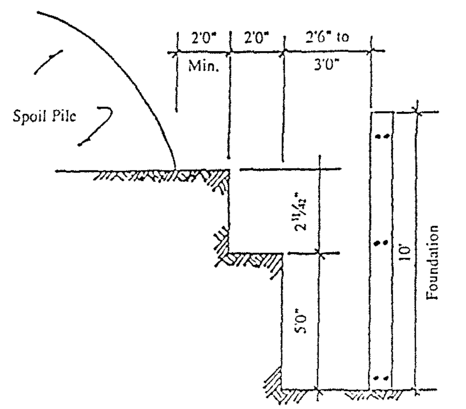


Fall Protection

Excavation:

Foundation excavations shall be sloped and/or benched to the extent possible.

- Limited by property lines and utilities.
- When the house excavation exceeds $7\frac{11}{12}$ feet in depth, benching or sloping must start at a depth of 5 feet.
- Ramps or ladders must be available to enter or exit the excavation.
- The minimum horizontal width (excavation face to formwork/wall) at the bottom of the excavation is as wide as practicable but not less than two (2) feet.



Excavations/Trenching

Employees using power tools and motorized equipment must be properly trained in the use and operation of that equipment.

- Take the saw to the material. Never place the saw in a fixed, upside-down position and feed material into it. Use a table saw instead.
- If a cut gets off line, don't force the saw back onto the line. Doing so may cause the wood or saw to kick back with tremendous force, causing major injuries to abdomen, legs, and hands. Withdraw the blade and either start over on the same line or begin on a new line.

Power Tools & Motorized Equipment

APPENDIX B

HOMESAFE SAFETY COMMITTEE AUDIT FORM

HBA of Metro Denver: HomeSafe Self Audit

Job Site / Project /Address	Job Site Point of Contact:	Date:
	# at Job Site:	Name of Person Conducting Audit:

Safety Program	Score
• Written safety program	
• Training	
Personal Protective Equipment	**Score**
• Hard hats	
• Eye protection	
• Respiratory protection	
• Hearing protection	
Scaffolding	**Score**
• Proper planking	
• Properly erected per manufacturer	
• Mudsills	
• Pole bracing	
• Poles	
• Ladder jack	
• Access	
• Proper load	
Ladders	**Score**
• No job-built ladders	
• Proper ladder for the job	
• 1:4 lean ratio	
• Properly secured at top & bottom	
• 3 foot extension access	
• Proper use of step ladders	
Construction Electrical Power & Power Cords	**Score**
• Proper GFCI provided at post	
• Power poles secured/staked	
• 220V split GFCI protected	
• Proper electrical junction boxes	
• Electrical cords in good condition	
Access & Housekeeping	**Score**
• Free of excess debris	
• Passage ways kept clear	
• Ramps: required - 19" or greater	
• Proper ramps	
• Trash containers supplied	

Open Holes & Unprotected Sides & Edges	Score
• Open-sided floors/holes (e.g., stairwells; doors; window openings; skylights): protected by guardrails or covers	
• Standard guardrail: 2'x 4': top rail at 42"; mid-rail at 21"; upright at 8' intervals	
• Window w/sill below 36" requires guardrail at 42" Toeboard when someone below	
Fall Protection	**Score**
• PFAS being used	
• PFAS being used properly	
• CAZ proper procedures	
• Properly used slide guards	
Excavation & Trenching	**Score**
• Proper slope or bench	
• Spoil set back 2'	
• Access ladder provided every 25'	
• Competent person present	
Power Tools & Motorized Equipment & Powder Actuated Tools	**Score**
• Safety devices in place	
• Being used properly	
• Proper electrical	
Other Concerns	**Score**
•	
•	
•	
•	
•	
•	
•	

TOTAL SCORE	
# ITEMS SCORED	
AVERAGE SCORE	

SCORING		
	NA	NOT APPLICABLE
	3	HAZARD CONTROLLED (In full compliance with HomeSafe), e.g., PFAS used
	2	HAZARD CONTROLLED (NOT in full compliance with HomeSafe) e.g., Slide guard used but not fully extended.
	1	IMMINENT DANGER EXISTS ((NOT in full compliance with HomeSafe e.g., worker on roof with no fall protection

INSTRUCTIONS: *Upon Completion of this form, MAIL or FAX to -*
Mail form to: Sheila Stanley, HBA of Metro Denver, 1400 S. Emerson St, Denver, CO 80210
or Fax to: Sheila Stanley at 303/733-9440

CONFIDENTIAL: *Data you provide will be used by the HBA Safety Committee for general data compilation ONLY.*

Rev: 04/16/98

HBA of Metro Denver - HomeSafe Self-Audit
CORRECTION ACTION REPORT

Job Site / Project /Address:	Date of Self-Audit:
Name of Person Completing Correct Action Report:	Date of Corrective Action Taken:

NON-CONFORMANCE	CORRECT ACTION TAKEN
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.
6.	6.
7.	7.
8.	8.
9.	9.
10.	10.
11.	11.
12.	12.

INSTRUCTIONS: Specify corrective action to take on non-conformance identified in the Self-Audit Form.

Rev: 04/16/98

APPENDIX C

OSHA FATALITY DATA

Causes of Fatalities in the Residential Home Building Industry January 1, 1995 Through December 31, 1995	
Cause	Number of fatalities
Fall from finished roof	12
Contact with overhead power line (ladder, gutter, tools)	10
Trench cave-in	9
Fall from ladder	8
Fall from unsecured ladder	7
Fall from roof truss/rafter	6
Contact with existing electric power during remodeling or repairs	5
Fall from scaffold	4
Scaffold/work platform collapse	4
Tree fell on employee during land clearing	4
Fall off planking or platform	3
Crush between vehicle/equipment and wall, etc.	3
Health problems (heart attack and/or seizure)	3
Equipment turnover	3
Equipment or truck back over employee	2
Truss/rafters fell over	2
Working on Alive@ electric circuit during remodeling	2
Electric shock from tools	2
Propane gas or other explosion or fire	2
Fall through railing	1
Total	92
Taken from Swanson, 1996	

APPENDIX D

HOMESAFE AUDIT FORM

ID NUMBER: __________ SESSION # : __________

English spoken? Yes No

EVALUATION CODE *Pre-Evaluation* *Post-Evaluation* *Non-Participant* *Participant*

Date: Training Session Date: Evaluator Name:

Location of Site:

Type of Dwelling: Stage of Construction:

On-Site Company Name: Company Trade:

Pre-Evaluation *Post-Evaluation* *Control* *Participant*

Number of employees working at site (including partners):_____

Number of total employees working for company:_____Employee Job Title: Owner Supervisor/Foreman Labor

General Contractor Name (if applicable):

Pre-Evaluation *Post-Evaluation* #______ *Control* *Participant*

Immediate Contractor Name (if applicable):

Pre-Evaluation *Post-Evaluation* #_____ *Non-subject* *Participant*

Questions	**Instructions for Evaluator**	**Score**
SAFETY PROGRAM		
1. Has employee heard of the HomeSafe program?	Question not scored.	1=no 2=yes
2. Has employee or company been trained using the HomeSafe program? Specify details of training (Know about 10 pts? Seen booklet? Know concept of program?	Score 'NA' if this is a Pretest or Control. Question not scored.	1=no 2=familiar 3=trained
3. Specify frequency of safety and health training employee has had with the current employer.	1=none 2=weekly GC 3=weekly company 4=monthly GC 5=monthly company 6=misc. GC 7=misc. company 8=other 9=weekly IC 0=monthly IC 11=misc. IC. Question not scored.	
4. Does employee know who the safety program coordinator is?	Question not scored.	1=no 2=yes
5. Determine if the employees are exposed to chemicals.	If the employee is not exposed to chemicals, score 'no' and skip to question 8. Question not scored.	1=no 2=yes
6. Does the employee know the location of the MSDS book?	Ask the employee for the location of the MSDS book. Score 'no' if employee does not know the location. Question not scored.	1=no 2=yes
7. Are all containers of chemical labeled with the identity of the chemicals and appropriate warnings that provide at least general information regarding the hazards of the chemicals?	Question not scored.	1=no 2=yes 0=NA

PERSONAL PROTECTIVE EQUIPMENT

8. Are employees properly wearing a hard hat when working in areas where there is possible danger of head injury?	Score 'NA' if there is no head hazard. Score 'no' if employee is not wearing a hard hat when the possibility for head injury exits.	1=no 2=yes 0=NA
9. Are the employees wearing good, sturdy boots (or appropriate footwear if roofer)?	Score 'no' if the employees are wearing court shoes (including high-top shoes), and 'cowboy' style boots. A boot is defined as rugged, outdoor footwear that fully covers the ankle. Roofers may wear court shoes	1=no 2=yes
10. Are the employees exposed to any eye hazards?	Inspect the work areas that employees of the contractor work in for tools such as sanders, grinders, saws, and welding equipment. NOTE: the eye hazard needs only to exist. The employee does not have to be currently exposed. Question not scored. If employees are not exposed to any eye hazards, score 'no' and skip to question 14.	1=no 2=yes
11. Do the employees have proper eye protection even if they do not need to wear it at this moment?	Ask to see the eye protection that the employees use. If the employees are observed wearing corrective lenses in an environment hazardous to the eyes, ask if they are approved safety lenses. If employee does not have eye protection or the protection is improper, score 'no' and go to question 14.	1=no 2=yes
12. Is the eye protection properly maintained?	Score 'no' if eyewear is so dirty that vision is impaired or if it is damaged.	1=no 2=yes
13. Are the employees wearing eye protection at all times in areas where there is a risk of eye injuries due to flying objects and intense light exposure such as grinding and welding operations?	Score 'NA' if the employees are not exposed to any eye hazards.	1=no 2=yes 0=NA
14. Determine if employees are exposed to respiratory hazards. type of hazard: ______________________________	Inspect the work site for work situations that require the use of respiratory protection. If such a situation exists, briefly describe what the hazard is in the space provided. Question not scored. NOTE: the respiratory hazard needs only to exist. The employee does not have to be currently exposed. If no respiratory hazards are present, score 'NA' and skip to the scaffolding section. Otherwise, continue on to the next question.	1=NA 2=spray 3=partic
15. Are the employees **using** the appropriate respiratory protection when they are exposed to respiratory hazards?	Score 'NA' if you do not observe a work situation where employees are required to wear respiratory protection.	1=no 2=yes 0=NA
16. Is the respiratory protection properly maintained and in a sanitary condition and ready for use?	Inspect respirators for signs of damage and excessive wear. Respirators must be clean and in a sanitary condition. Score 'NA' if unable to inspect respirator.	1=no 2=yes 0=NA

17. Have the employees been trained in proper use of the respirator? Last training session was ____ months ago	Score 'NA' if the employees do not speak English. Question not scored.	1=no 2=yes 0=NA

SCAFFOLDING

General Requirements

18. Are scaffolds used by the contractor?	If there are no scaffolds used by the contractor, score 'NA' and go to the ladders section. Question not scored.	1=no 2=yes
19. Are all scaffolds erected plumb?	Use your best visual judgment.	1=no 2=yes
20. Is all scaffold footing secure?	This means that the scaffold shall have base plates and mud sills, unless it is sitting on a stable concrete foundation. Unstable objects shall not be used to support the scaffold.	1=no 2=yes
21. Is the scaffold fully planked between uprights?	Each platform unit shall be installed so that the space between adjacent units and the space between the platform and the uprights is no more than 1 inch, except when employer can demonstrate that a wider space is necessary	1=no 2=yes 0=NA
22. Are the scaffold planks 'scaffold grade'?	Inspect the planks for any structural defects.	1=no 2=yes
23. Is proper access to the scaffold provided (ladder, ramp, or walkway) and are employees accessing the scaffold properly?	The cross braces may not be used as a means for accessing the scaffold. Integral specs: Length = 8"; uniform; line up vertically; max. height = 16.75"	1=no 2=yes 0=NA
24. Dose the scaffold appear to be able to hold 4 times its intended weight capacity?	Visually estimate this. If it seems obvious that the scaffold is not capable to carry 4 times its intended load, score 'no'.	1=no 2=yes
25. Is the front edge of the platform 14 inches or less (18 inches or less for plastering and lathing operations) away from the face of the work unless guardrails or personal fall arrest systems are used to prevent the employee from falling?	Score 'NA' if work is being conducted overhead or there is otherwise no 'face' of work that the scaffold is near.	1=no 2=yes 0=NA
26. If a scaffold is greater than 10 feet high, are guardrails properly installed?	If scaffold is 10 feet high or greater, continue to the next question. **If guardrails are not used at all, skip to 28.** If the scaffold is not 10 feet or higher, score 'NA' and go to question 20.	1=no 2=yes 0=NA
27. Are the guardrails installed along all open sides and ends of the platforms?	**Skip this question if guardrails are not used at all.**	1=no 2=yes 0=NA
28. Does the scaffold have a toeboard if there are employees walking/working below it?	If it is likely that employees are working or walking below the scaffold even though you can't see it now and no toeboard is installed, score 'no'. Score 'NA' if no one works/walks below the scaffold.	1=no 2=yes 0=NA
29. Is the scaffold platform a minimum of 18 inches in width, **except** ladder jacks and pump jacks which are minimum 12 inches in width, **and** job-built types (sawhorse and wood pole) which are a minimum 10 inches in width?		1=no 2=yes

30. For wooden platforms only, does the end of each platform, unless cleated or otherwise restrained by hooks or equivalent means, extend over the centerline of its support at least 6 inches?	Score 'NA' if the platform is not wooden or the scaffold is job-built and skip to the job-built wood scaffolding section below.	1=no 2=yes 0=NA
31. For wooden platforms 10 feet or **less in length**, does the platform extend 12 inches or **less** over the centerline of the last support, unless the platform is designed and installed so that the cantilevered portion of the platform is able to support employees and/or materials without tipping, or has guardrails which block employee access to the cantilevered end?		1=no 2=yes 0=NA
32. For wooden platforms **greater** than 10 feet in **length**, does the platform extend 18 inches or **less** over the centerline of the last support, unless the platform is designed and installed so that the cantilevered portion of the platform is able to support employees and/or materials without tipping, or has guardrails which block employee access to the cantilevered end?		1=no 2=yes 0=NA

Job-Built Scaffolding (sawhorse and wood pole scaffolding)

33. Is this type of scaffolding used only where conventional scaffolding cannot be used, such as the erection of trusses and drywall?	If no job-built wood scaffolding (sawhorse or wood pole) is being used by the company, score 'NA' and go to the next section.	1=no 2=yes 0=NA
34. Do the planks span 8 feet or less?		1=no 2=yes
35. Are the planks secured from movement?		1=no 2=yes
36. Do the cleats span 3 studs, 2 X 6 or equal, and are they secured with three 16-penny nails or 3 inch screws in each stud?	Score 'NA' if cleats are not necessary.	1=no 2=yes 0=NA
37. If plank are lapped, does each plank lap its support by at least 12 inches?	Score 'NA' if none of the planks are lapped.	1=no 2=yes 0=NA

Tubular Welded (metal frame) Scaffolds

38. Is the scaffold properly braced (cross-bracing used)?	If a tubular welded scaffold is not being used, score 'NA' and go to the next section.	1=no 2=yes 0=NA

Pump Jack Scaffolds

39. Are the pole, legs, or uprights plumb and securely braced with **metal** braces or collars to prevent swaying and/or displacement?	If pump jack scaffolding is not being used, score 'NA' and go to the next section.	1=no 2=yes 0=NA
40. If wood poles are used, is intermediate bracing used at a minimum of 10 foot intervals?	Score 'yes' if intermediate bracing is provided at intervals less than 10 feet. If wood poles are not used, score 'NA' and skip to question 43.	1=no 2=yes 0=NA
41. Are the poles made of straight grain wood?		1=no 2=yes
42. If 2 X 4's are used to make poles, does each pole consist of 2- 2 X 4's nailed together at the center and on both sides, the seam parallel to the bracket, and spaced at a minimum of 12 inch intervals?		1=no 2=yes
43. Are at least two pole braces used per pole (one at top and one at bottom of pole)?		1=no 2=yes

Ladder Jack

44. Is each employee on the ladder jack scaffold that is 6 feet or higher protected by guardrails or a personal fall arrest system (includes an anchorage, connectors, and a body belt or body harness)?	If a ladder jack is not used by the employee, score 'NA' and go to the next section. Score 'NA' if the scaffold is less than 6 feet in height.	1=no 2=yes 0=NA

LADDERS

45. Are ladders being used by the contractor?	If there are no ladders used by the contractor score 'NA' and go to the access/housekeeping section. Question not scored.	1=no 2=yes 0=NA
46. Are the ladders manufactured properly?	Score 'no' if a job built ladder is being used. **If you score 'no' to this question, skip to the access/housekeeping section.**	1=no 2=yes

Extension ladders

47. Is the area around the top and bottom of the ladder clear of obstructions?	Score 'NA' if extension ladders are not being used and go to the step ladder section.	1=no 2=yes 0=NA
48. Is the ladder set 1 foot out for every 4 feet up?	Score 'no' if the ladder is set either more or less than 1 foot out for every 4 up.	1=no 2=yes
49. When the ladder is used to access an upper landing surface, do the side rails of the ladder extend a minimum 3 feet above the upper landing surface to which the ladder is used to gain access or is a grasping device provided to assist employees, such as a handrail, and is the ladder at least level with the top of the resting surface?	If the ladder is not used to access an upper landing surface, score 'NA' and go to question 51.	1=no 2=yes 0=NA
50. Is the ladder secured at its rest point when it is used for access to an upper landing surface?		1=no 2=yes
51. Is the ladder used only for the purpose it was designed?	The ladder should not be used as a ramp or walkway.	1=no 2=yes
52. Does the employee use the ladder properly?	Score 'NA' if you do not see the employee use the ladder. The ladder should not be 'walked' or extended while an employee is standing on it. Employee must face ladder when using Employee must not be carrying load up/down ladder The employee must not stand higher than the fourth rung from the top.	1=no 2=yes 0=NA
53. Is the ladder free of oil, grease, water, and other slipping hazards?		1=no 2=yes
54. Is the ladder free of structural defects?	Inspect the ladder for visible damage signs of wear and strain.	1=no 2=yes
55. Is the ladder secured or barricaded if it is set in an area where it can be displaced by workplace activities or traffic?	Score 'NA' if the ladder is **not** set in an area that where it can be displaced.	1=no 2=yes 0=NA
56. If the ladder is placed within 10 feet of exposed energized electrical equipment, does it have nonconductive side rails?	Score 'NA' if ladder is not exposed in this manner.	1=no 2=yes 0=NA
57. Is the ladder set on a firm and level surface?		1=no 2=yes
58. Is the top of the ladder placed with the two rails supported equally unless it is equipped with a single support attachment?		1=no 2=yes

Step ladders

59. Is the area around the top and bottom of the ladder clear of obstructions?	Score 'NA' if step ladders are not being used and go to the next section.	1=no 2=yes 0=NA
60. Is the ladder used only for the purpose it was designed?	The ladder should not be used as a ramp or walkway.	1=no 2=yes
61. Does the employee use the ladder properly?	Score 'NA' if you do not see the employee use the ladder. Employees should not stand on the top two steps of the ladder or 'walk' the ladder while it is being utilized.	1=no 2=yes 0=NA
62. Is the ladder free of oil, grease, water, and other slipping hazards?		1=no 2=yes
63. Is the ladder free of structural defects?	Inspect the ladder for visible signs of wear and strain.	1=no 2=yes
64. If the ladder is placed within 10 feet of exposed energized electrical equipment, does it have nonconductive side rails?	Score 'NA' if ladder is not exposed in this manner.	1=no 2=yes 0=NA
65. Is the ladder set on a firm and level surface?		1=no 2=yes

ACCESS/HOUSEKEEPING

66. Are all work areas free of excess debris or other unnecessary hazards?	Inspect the grounds on which the construction is taking place. Note any excess debris or 'garbage' that may be littering the site and hazards such as nails sticking out of boards that are laying on the ground.	1=no 2=yes
67. Are containers provided for the collection of waste?	Score 'NA' if no waste is generated by the contractor.	1=no 2=yes 0=NA
68. Are there ramps or stairways provided when breaks in elevation of 19 inches or higher occur at areas used for access?	This question only refers to points of access and egress that employees are utilizing. If there are no breaks in elevation of 19 inches or more, score 'NA'.	1=no 2=yes 0=NA

OPEN HOLES/UNPROTECTED SIDES AND EDGES

This section pertains only to work areas that employees utilize. Do not evaluate areas that are not accessed by the employees.

69. Are all open sided floors and holes (such as stairwells, door openings not used for access, and skylights) that have a fall distance of more than 6 feet protected by guardrails or covers? **(scaffolds are not included in this question)**	Roof work such as sheathing and truss work, and erection of exterior walls are covered in the fall protection section. Even if the employees are not exposed to any fall hazards at this moment, investigate the work area for potential fall hazards that the employees would be exposed to. If the employees are not exposed to any open holes or unprotected sides and edges, score 'NA'.	1=no 2=yes 0=NA
70. Are all guardrails constructed with 2 X 4's or equivalent, with a top rail at 42 inches, mid-rail at 21 inches, uprights at 8 foot intervals, toeboards if persons work or pass below, and built sturdy?	Inspect the employees work areas for guardrails. Score 'NA' if no guardrails are used by the contractor.	1=no 2=yes 0=NA
71. Is a guardrail provided (42 inches high) at all window openings which have an inside bottom edge below 36 inches and an outer fall distance of 6 feet or greater?	Score 'NA' if there are no window openings with an inside bottom edge below 36 inches or the fall distance is less than 6 feet.	1=no 2=yes 0=NA

FALL PROTECTION

72. Are the employees exposed to fall distances of 6 feet or greater on any surfaces such as roof work, walkways, and runways?	Even if the employees are not currently exposed to any fall hazards, investigate the work area for potential fall hazards. Question not scored. If the employees are not exposed to any fall hazards, score 'NA' and go to the excavations/trenching section.	1=no 2=yes
73. Are employees using conventional fall protection properly?	If you score 'yes', skip the rest of this section and go to the excavation/trenching section.	1=no 2=yes 0=NA
74. Are only trained workers allowed to work on the top of the foundation wall/formwork and only as necessary to complete the construction of the wall?	This question and its subparts apply only to alternate safe work practices that apply to work on **foundation walls and related concrete formwork.** Skip to question 79 if this type of work is not being performed.	1=no 2=yes 0=NA
75. Is all formwork adequately supported before any employee works on top of the foundation/formwork?		1=no 2=yes
76. When adverse weather (such as high winds, rain, snow, or sleet) is creating a hazardous condition, are operations suspended until such time as the hazardous condition no longer exists unless safe footing can be ensured for workers on top of the foundation wall/formwork?	Score 'NA' if no adverse weather conditions are present.	1=no 2=yes 0=NA
77. Are materials and equipment for the work being performed conveniently located to the workers on the top of the foundation/formwork?	Score 'NA' if no equipment or materials are being used.	1=no 2=yes 0=NA
78. Are materials and other objects which could pose impalement hazards kept out of the area below where workers are working or are they properly guarded?		1=no 2=yes 0=NA
79. Are only trained workers allowed to work in attics and on elevated surfaces and only as necessary to complete the construction of the system being installed?	This question and its subparts apply only to alternate safe work practices for workers installing the following while working in **attics** or on **elevated surfaces** including the following: 1. Drywall 2. Insulation 3. HVAC systems 4. Electrical systems 5. Plumbing 6. Carpentry 7. Painting If this type of work is not being performed, skip to question 86	1=no 2=yes 0=NA
80. Is a CAZ properly identified and controlled by signs, wires, tape, ropes, or chains?	This question only applies to alternate safe work practices for workers setting and bracing roof trusses and rafters, installing floor sheathing and joists, and erecting exterior walls	1=no 2=yes 0=NA
81. Is a painted line six feet from the perimeter clearly marked prior to any wall erection activities to warn of the approaching unprotected edge?	This question applies only to workers erecting exterior walls using alternate safe work practices	1=no 2=yes 0=NA
82. While attic or roof work is in progress, are workers that are not involved in such work **not** standing or working below or adjacent to any openings in the ceiling where they could be struck by falling objects?		1=no 2=yes 0=NA

83. Are materials and equipment for the work being performed located conveniently close to the workers?	Score 'NA' if no materials or equipment are being used.	1=no 2=yes 0=NA
84. Are materials and other objects which could pose impalement hazards kept out of the area below where workers are working or are they properly guarded?		1=no 2=yes
85. When adverse weather (such as high winds, rain, snow, or sleet) is creating a hazardous condition, are operations suspended until such time as the hazardous condition no longer exists unless safe footing can be ensured for workers on top of the roof?	Score 'NA' if no adverse weather condition exists. After answering this question, to go the Excavations/Trenching section.	1=no 2=yes 0=NA
86. Are only authorized employees allowed onto the roof?	This question applies to alternate safe work practices for all roofing work including **roof sheathing, roofing removal, repair, and new roofing installation on roofs with a slope of 8/12 or less and a fall distance less than 25 feet from the eave, or any work done on a roof.** Ask the employees if they have been trained in the alternative methods of fall protection. Skip to 62h if the slope of the roof is greater than 8/12 or the fall distance from the eave is greater than 25 feet. Skip to the excavation/trenching section if no roof work is being performed.	1=no 2=yes 0=NA
87. If the employee works on a roof with a slope 8/12 or greater and all slopes with fall distances greater than 25 feet, are conventional methods of fall protection used?	This question applies to roofs with a slope greater than 8/12 or a fall distance greater than 25 feet. Score 'NA' if the slope is less than 8/12 and the roof height is less than 25 feet at any slope, go to the next question. If you score 'yes' or 'no' on this question, go the to Excavations/Trenching section.	1=no 2=yes 0=NA
88. Is the roof free of slipping hazards or are measures taken to prevent employee exposure to such hazards?		1=no 2=yes 0=NA
89. When adverse weather (such as high winds, rain, snow, or sleet) is creating a hazardous condition, are operations suspended until such time as the hazardous condition no longer exists unless safe footing can be ensured for workers on top of the roof?	Score 'NA' if no adverse weather condition exists.	1=no 2=yes 0=NA
90. If the employee works on a roof with a slope less than 6/12 and a fall distance less than 25 feet, are slide guards installed extending the width of the eave?	Score 'NA' if the slope of the roof is greater than 6/12 or the fall distance is greater than 25 feet.	1=no 2=yes 0=NA
91. If the employee works on a roof with a slope 6/12 to 8/12 and a fall distance less than 25 feet, are slide guards installed at intervals not exceeding 8 feet with the bottom row extending the width of the eave and the additional rows placed directly below the workers?	Score 'NA' if the slope of the roof is less than 6/12, greater than 8/12, or the fall distance is greater than 25 feet.	1=no 2=yes 0=NA
92. If slide guards are used, are they constructed using a 2 X 4 as the base and a 2 X 6 as the edge, and are they securely fastened to the roof?	Score 'NA' if slide guards are not being used.	1=no 2=yes 0=NA

93. Are supplies and materials **not** stored within 6 feet of the rake edge, or three feet where tile roof systems are being installed?	Score 'NA' if no supplies or materials are stored on the roof.	1=no 2=yes 0=NA
94. Is the area below the eaves and rakes kept clear of materials and other objects which could pose impalement or other hazards or are they properly guarded?		1=no 2=yes 0=NA

EXCAVATIONS/TRENCHING

95. Are the employees exposed to any excavations on the work site?	Inspect the work site for any excavations that the company's employees have worked in or will work in the future. Question not scored. If the employees will not be exposed to any excavation, score 'no' and go to the Tools and Equipment section.	1=no 2=yes
96. For excavations greater than 7.5 ft. in depth, is sloping provided starting at the bottom of the excavation at a ratio of 1 up and 1.5 across or benching provided at least two feet horizontally for every five feet or less of vertical height?	.	1=no 2=yes 0=NA
97. If the excavation is below 7.5 ft in depth do the following conditions apply? A. Protective measures been taken (e.g., sloping, benching, boxing) **OR** B. There no water, surface tension cracks, nor other environmental conditions present that reduce the stability of the excavation **AND,** C. There is no heavy equipment operating in the vicinity that causes vibration to the excavation while employees are in the excavation **AND,** D. Work crews in the excavation are the minimum number needed to perform work		1=no 2=yes 0=NA
98. If the excavation is greater than 4 foot in depth, are ramps or ladders provided to access the excavation?	Score 'NA' if the excavation is 4 foot in depth or less.	1=no 2=yes 0=NA
99. If the excavation is greater than 25 feet in length and greater than 4 feet in depth, is there a ladder/ramp provided at every 25 feet of lateral travel?	Score 'NA' if the excavation is less than 25 feet in length or 4 feet in depth.	1=no 2=yes 0=NA
100. Is the face of the excavation at the bottom a minimum of 2 feet away from formwork, walls, and foundations?		1=no 2=yes
101. Is the spoil pile placed a minimum of 2 feet from the top of the slope?		1=no 2=yes 0=NA
102. Are vehicles, heavy equipment and other heavy loads other than the spoil pile kept at a distance from the edge of the excavation equal to or greater than its depth?		1=no 2=yes 0=NA

TOOLS AND EQUIPMENT

103. Are power tools used by the employees?	If no power tools are used, score 'no' and skip to the electrical and power cord section. Question not scored.	1=no 2=yes
104. On all power tools, is all the manufacturer's safety devices (e.g. guarding) in place and operational?	Any missing, damaged or altered safety devices score a 'no'. Score 'NA' if the power tool does not require any safety devices, such as a drill or if the tool cannot be inspected.	1=no 2=yes 0=NA
105. Not considering the safety devices, are power tools and attached power cords properly maintained in a safe condition?	Inspect the tools that the employee used for any obvious defects/damage that may be a safety concern. Score 'no' if any defects/damage is found Score 'NA' if you can't inspect the tool.	1=no 2=yes 0=NA
106. Are all portable electric hand tools equipped with a three-wire cord (regardless of the presence of a ground prong), **OR** are the tools double insulated **and** labeled "Double Insulated"		1=no 2=yes 0=NA
107. Are all power tools used in the manner they were intended?	Tools should only be used for the purpose they were designed. Score 'NA' if you don't see the employees using the tools Score 'NA' if no hand tools are used and skip to the electrical power and cords section.	1=no 2=yes 0=NA

CONSTRUCTION ELECTRICAL POWER AND POWER CORDS

108. Are all utility cords construction grade and have the ground prongs in place?	This section does not include cords directly attached to power tools-score this in the tools section above. If no cords are used by the employee, score 'NA' and skip the rest of this section.	1=no 2=yes 0=NA
109. Is the path to ground from circuits, equipment, and enclosures permanent and continuous?	To test the ground continuity from the power supply to a tool, plug a GFCI tester into the distal end of a utility power cord that is plugged into a GFCI system. Score 'NA' if the cord is not in use (not plugged in) or unable to check or the ground plug is missing on cord.	1=no 2=yes 0=NA
110. Do all cords have the outer insulation properly maintained so that it provides strain relief and protection to the internal wires?	Inspect cords for such things as fraying, improper repairs (e.g. taping exposed wires), and exposed wires.	1=no 2=yes
111. If any cords are spliced, are they a flexible cord number 12 or larger and so spliced that the cord retains the insulation, outer sheath properties, and usage characteristics of the cord being spliced?	Score 'NA' if none of the cords have been spliced.	1=no 2=yes 0=NA
112. Are all electrical junction boxes construction grade and waterproof?	Score 'NA' if no junction boxes are used.	1=no 2=yes 0=NA
113. Is the contractor using a temporary source of power?	If the contractor is not using a temporary source of power, score 'no' and skip the rest of this section.	1=no 2=yes
114. Is all **temporary** 110-volt construction power on a properly functioning Ground Fault Circuit Interrupter (GFCI) system?	Test the GFCI system with an appropriate testing device. Do not test the power supply if the house has already been wired for power. Score 'NA' if the 110-volt outlet is not being utilized by the contractor.	1=no 2=yes 0=NA
115. Is any split of a **temporary** 220-volt power supply to 110-volt protected through GFCI and properly wired?	Score 'NA' if a 220-volt power supply is **not** being used. Continue to the next question.	1=no 2=yes 0=NA
116. Are all temporary power poles securely staked?	Wooden plugs driven into holes in masonry, concrete, plaster, or similar materials is not permitted.	1=no 2=yes
117. Do all temporary power panels include a cover and a dead front?		1=no 2=yes