DEVELOPMENT AND EVALUATION OF SAFETY TRAINING FOR HURRICANE RECONSTRUCTION

By

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A THESIS PRESENTED TO THE GRADUATE SCHOOL
OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT
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To my family, for without their encouragement and support this thesis would not be possible

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The purpose of this thesis was to create an effective training course (or curricula) for workers performing post-hurricane reconstruction activities. Hurricanes are associated with strong winds and water damage and often create construction hazards not encountered on typical construction sites. Construction hazards and safe remediation efforts associated with post-hurricane reconstruction work were researched and identified in a combined effort from the University of Florida OSHA Susan Hardwood Training Grant team (Dr. Hinze, Dr. Grosskopf, Josh Casart and this researcher). The intent of this thesis was not only to create an effective training course, preparing workers to perform work safely in disaster stricken areas, but also to evaluate the effectiveness of the training curricula created. An instructor evaluation form, a pre-test, and a post- test were created as assessment instruments to evaluate the effectiveness of the training curricula. The data from the assessment instruments were collected from eleven seminars in which the training course was presented to members of the construction industry. From the analysis of the data, it was concluded that the training course was effective as an educational module. Information was also obtained on areas in the curricula that would be improved through additional modifications.

CHAPTER 1
INTRODUCTION

Statement of the Problem

In the wake of natural disasters that have occurred in recent years, the built environment has experienced damage on an unprecedented scale. Construction remediation efforts related to hurricane stricken areas are accompanied by unique hazards resulting from damage caused by a combination of strong winds and water. Significant damage to structures and building systems have created significant confined space, fall, electrocution, caught-in/between and struck-by hazards. Also, water and residue originating from floodwaters or storm surges have a strong potential to cause illness because of the presence of hazardous debris, and high-risk biological and chemical contaminants. Unfortunately, the availability of training material related to the inherent hazards associated with post-hurricane remediation efforts is limited.

Objective

The main objective of this thesis was to contribute positively to the safety of the construction industry by creating an effective training course for post-hurricane reconstruction. Training workers about the unique hazards of natural disasters is of utmost importance. This thesis was to consider the identified hazards related to post-hurricane construction remediation efforts and create a half-day (approximately four hours) training curricula consisting of modules that included an Overview, General Health and Safety Precautions, Focus-Four Hazards, Chemical and Biological Hazards and Equipment Hazards. The training presentation was to be developed in Microsoft PowerPoint. In addition to creating a training course, the effectiveness of the training curricula presented was evaluated through data analysis from assessment instruments such as pre-tests, post-tests and instructor evaluation forms.

CHAPTER 2
LITERATURE REVIEW

Introduction

Understanding the extent and nature of specific construction hazards resulting from hurricanes was derived from reading a technical proposal prepared by the University of Florida for an OSHA Susan Hardwood Training Grant Program. The technical proposal provided the framework for this thesis. Because this thesis deals with the development and evaluation of a training course, multiple areas of literature were reviewed. Information related to the training curricula itself was contributed by all members of the Susan Hardwood Training Grant team. Aside from the information presented in the training curricula, adult learning strategies, Hispanic worker safety, and evaluating continuing education were additional areas of focus for review.

Training Curricula

Data from OSHA interventions made in Florida, Alabama and Mississippi between August 31, 2005 and March 10, 2006 provided information on the percentages and types of hazardous situations employees encountered during hurricane response efforts following Hurricanes Katrina, Rita and Wilma. This information is important because it identified the most hazardous areas for which safety training is needed. A total of 129 Situation Reports (SitReps) were examined. These are summarized as follows:

- Roof Inspection, Tarping, and Repair (26%)
- Debris Collection and Removal (26%)
- Tree Trimming (8%)
- Restoring Electrical Utilities (7%)
- Debris Reduction, Recycling, and Disposal (6%)
- Assessment, Cleanup, and Repair of Structures (2%)
- Restoring Communication Systems (2%)
- Restoring Water and Sewer Systems (1%)
- All others (21%)

Note: "All others" includes operations that did not exceed 1% of the interventions or could not be classified.

These interventions consisted of "providing literature and guidance to individual employees and employers, to having employers remove employees from imminently dangerous situations," as stated by OSHA. The information represented in the SitReps suggested employers and employees, involved in post-hurricane remediation efforts, have not historically taken the necessary safety precautions critically needed to create the safest work environment possible ("*Part I: Summary of Safety and Health Intervention Information from OSHA Situation Reports*", 2006). It was also noted that most of the interventions were related to activities that pertained to work that was performed on the exterior of buildings or on the site. This is where work conditions are most unlike those commonly encountered on new construction sites. The training curricula related to this thesis is intended to pay particular attention to these activities.

After Hurricane Katrina, the Louisiana Department of Health and Hospital, Center for Disease Control and Prevention, and functioning emergency treatment resources combined their resources in order to monitor possible outbreaks of disease and post-hurricane illnesses and injuries. This information was presented in a "Morbidity and Mortality Weekly Report." A total of 7,508 reports comprised this monitoring effort that was put forth. This resulted in data being used to identify injury patterns resulting from hurricanes. This information was used to establish a message for relief workers and residents of disaster stricken areas concerning their safety. Of these 7,508 reports, 55.6% were related to illnesses, 26.9% were injuries and 17.5% were non-acute health related events (*Surveillance for Illness and Injury After Hurricane Katrina – New Orleans, Louisiana, September 8-25*, 2005)**.** These reports related to residents and relief workers in the disaster stricken area. It is important to understand the high percentage of illnesses that were reported. Because flood waters created a "soup" of possible infectious diseases, sewage,

hazardous waste and other contaminated substances, the importance of dealing with floodwaters is a major concern.

The Centers for Disease Control and Prevention (CDC) offered specific illness prevention topics that were related to post-natural disaster exposures, such as remedial work following hurricanes or floods. Even though not all of these suggestions were tailored specifically for construction workers, they still provide relevant concerns when dealing with post-hurricane disaster stricken areas. Relevant topics that will be discussed in greater detail include the following:

- Animals & Insects
- Carbon Monoxide Poisoning
- Chain Saw Injuries
- Immunizations

Animals & Insects

Wild or stray animals are to be avoided in a disaster stricken area. Authorities should be contacted to deal with these animals. Carcasses need to be removed in order to avoid rodent and disease infestation. Contact with mosquitoes should be actively avoided through the use of DEET containing insect repellents, screens on dwellings, long pants, socks and long-sleeved shirts. Diseases can be spread through mosquitoes, so any standing water outdoors in open containers should be drained in order to control mosquito populations. Rodents also carry disease and should be controlled by removing food sources, water and items which could provide shelter for them. Snakes are a major concern as they may be poisonous. Found in water and on land (debris piles), snakes should be avoided if discovered. Long-pants, boots and gloves offer protection from being bit. If bitten, it is helpful to remember the color of the snake and the shape of its head as this will be helpful in determining the proper treatment measures for the victim. Regardless, medical attention should be sought immediately and in a calm manner. Keeping the

bite victim calm helps slow down the spread of the poison (*Prevent Illness After a Disaster*, n.d.).

Carbon Monoxide Poisoning

The loss of power will stimulate the use of portable generators and other internal combustion engine driven devices. Such devices should never be operated indoors or in confined spaces. Carbon monoxide is a colorless, odorless gas that causes death or illness if inhaled. Outside in a well-ventilated area is the only place to run such machines (*Prevent Illness After a Disaster*, n.d.**).**

Chain Saw Injuries

The CDC stated, "Each year, approximately 36,000 people are treated in hospital emergency departments for injuries from using chain saws. The potential risk of injury increases after hurricanes and other natural disasters, when chain saws are widely used to remove fallen or partially fallen trees and tree branches." To avoid such injury, one should follow the chain saw manufacturer's instructions regarding operation, adjustment and maintenance. Also, properly sharpened and lubricated blades adjusted to the correct tension yield the safest results. It is important to make sure that the correct size of chain saw is used for the job at hand. Protective equipment is also necessary, including hard hats, safety glasses, hearing protection, heavy gloves, boots, chain saw chaps and a face mask in some instances. Bystanders need to keep a safe distance from one using a chain saw as injury from the release of bent trees or branches is a major concern (*Prevent Illness After a Disaster*, n.d.).

Immunizations

Information related to immunizations for post-disaster stricken areas is specific to relief workers. Prior to travel, it is recommended that an assessment by a health-care professional be administered at least 4-6 weeks before travel. In the case of immediate travel, there still is value

in seeking a medical assessment. Beyond evaluating the general health of a relief worker, up-to-date immunizations are necessary (tetanus/diphtheria, polio, measles, influenza, typhoid, hepatitis and rabies). Some of these immunizations can be administered in a single dose while others require a series of injections. (*Prevent Illness After a Disaster*, n.d.).

Audience

Because the training course being developed was intended to be presented to adults, understanding adult learning strategies was of interest and importance. One theory describing adult learning is the sensory stimulation theory that describes how senses must be used in the adult learning process for change to occur (Galbraith, n.d.). In the case of creating a training curricula, pictures could appeal to the participant's sense of sight, thereby emphasizing safety techniques. For example, pictures of chainsaw injuries inform workers or supervisors immediately about the seriousness of adequate pre-task safety training and personal protective equipment in order to avoid such gruesome injuries.

Photos of this type were available from many sources. One of the most accessible sources was the Internet. Some of these photos were obtained by students who were fulfilling a homework assignment. Photos related to specific construction safety topics were obtained from junior and senior students enrolled in a construction safety class at the University of Florida, School of Building Construction, during the spring semester of 2008 (Hinze, 2007). Photos related to the following safety topics were incorporated because they are particularly relevant to post-hurricane reconstruction and assist in adult learning:

- Personal Protective Equipment
- Ladders and Scaffolding
- Equipment Safety
- Reptiles, Insects and Animals
- Chainsaws
- Wood Chippers

- Generators

An interesting passage from Principles of Adult Learning: Application to Safety Training (n.d.) reinforced the importance of creating an effective training module. D.D. Galbraith stated, "Each year, more than 40 million adults participate in educational activities including safety sessions. Effective training is an important competitive differentiator and those companies that focus an adult education may benefit financially. To address the impeding shortage of skilled workers, engaging adults through relevant training will help mitigate these deficiencies."

Hispanic workers account for 17% of the construction workforce. This figure is up from 15.1% in 1999 and 10.3% in 1995. With such a growing number of Spanish-speaking construction workers, there is a high potential of Hispanic audience members participating in the training. Hispanics workers also experience more dangerous working conditions than non-Hispanic workers and yield an injury rate 2 to 3 times higher than the average construction worker. As stated by Dr. Maria J. Brunette, "Hispanics are underrepresented in the ways that the scientific, research, and academic communities reach them with appropriate safety and health research, education, and information." Hispanic construction laborers ranked among the top three occupations with the most nonfatal injuries resulting in time away from work. Thus, it is extremely important to have an effective safety training curricula targeting Hispanic workers. Hispanic workers, on average, typically have a very low level of education, if any, and speak little or no English (Brunette, 2005). To address these problems, specific measures need to be taken to ensure the creation of an effective training course for Hispanics.

It is important to understand the cultural backgrounds of Hispanic workers when creating training curricula for them. Usually, Hispanics come to the U.S. with no understanding of health and safety standards enforced by the government. Latin American countries do not have the

infrastructure socially to protect workers from chemical or biological hazards. As a result, Hispanic workers do not trust or place any reliance in government agencies intended to protect their rights. Hispanic workers are generally accustomed to unsafe working conditions such as exposure to dangerous tools and equipment, lack of personal protective equipment and abusive supervisors. Needless to say, they have little to no safety and health training. Since some Hispanic workers are working illegally in the U.S., they are often hesitant to "speak up" about unsafe working conditions for fear of being fired or deported. By incorporating Hispanics in the creation of the training course, these cultural issues must be taken into consideration when developing the most effective training curricula possible (Brunette, 2005).

Often, there is variability in the quality of training material targeted to Hispanic workers because the information presented is an inaccurate translation from English. Beyond the use of graphics, photos and workers' images, a method for creating effective training material was suggested by Dr. Maria J. Brunette. Brunette recalls an effective method which she used, "All materials were first developed in English (because of the required technical and specific terminology) and then translated into Spanish. Focus groups allowed the Spanish versions to be tested among Hispanic workers. After their feedback was incorporated into a second Spanish version, the original English version was modified into a second version. A Spanish translation was made of this later English version and, again, tested among the workers. Generally, at this point the Spanish version was correct and no additional changes were made to the English version." This method takes time because of the continual evaluation of the material; however, it is useful in creating effective training curricula (Brunette, 2005).

Evaluation of Training Curricula

Information on evaluating continuing education was reviewed. Knox stated in Evaluation For Continuing Education (2002), "Analyze data to produce useful conclusions. Data analysis

typically results in evaluation conclusions that are useful for planning, improvement, and accountability. This entails interpretation of major trends that reflect both descriptive information and value judgments. The intent of most evaluations is to judge the value of one or more program aspects. Value is reflected in quality, effectiveness, and benefits." This information is important as it confirmed the need for evaluating the value of the training course because quality and effectiveness were goals of the course. This quote also helped describe the intent and benefits of data analysis. If data analysis could represent the effectiveness of a training course by revealing major trends, areas of improvement, and quality of the course, the teaching potential of the curricula could be strengthened.

The intent of assessing the learning process was discussed in Assessing Adult Learning (1997). Moran stated, "Assessing the learning process is one of the more intriguing and one of the more neglected aspects of informal assessment. The goal is to identify which aspects of the learning process are promoting and which are inhibiting learning." What is meant here by *informal assessment* refers to an assessment that is conducted by an educator that does not involve standardized published procedures for administering, scoring, and interpreting tests. The main point of this statement is related to how understanding promoting and inhibiting factors of training curricula is important. This is how a training course can grow to become increasingly effective. An instructor evaluation fits this assessment and could help in the evolution of creating a successful course.

After the significance of evaluating training curricula was understood, further methods of creating an effective way of evaluating the curricula were reviewed. Moran also stated, "The first step toward a successful test is integrating the planning of the test with the planning of the learning activities. The integration begins by stating the learning objectives that the learners are

to pursue." This statement coincided with the idea of creating a pre- and post-test for the training module. Areas desired to be taught should be incorporated in both the training module and pre- and post-test. Moran continued, "Multiple-choice items are extremely versatile. They can be used to measure knowledge, comprehension, application, and analysis at least as easily as other types of items. They are also among the most difficult to write." Despite the difficulty of writing a multiple-choice pre- and post-test, this is a very viable means by which to determine whether or not a class participant gained knowledge and/or understood the module being presented. These items are extremely important when teaching. If a class participant learned something from the presentation of training curricula, the training course presented was effective and the goal of the educator was accomplished.

CHAPTER 3
RESEARCH METHODOLOGY

Weekly Work Meetings

The first step of this thesis was reading the technical proposal for the Susan Hardwood Training Grant Program. After the issue at hand was clear and understood, work began. Weekly work meetings were held by the University of Florida Susan Hardwood Training Grant Program team. These weekly work meetings consisted of valuable brainstorming sessions necessary in developing the structure for the training curricula and course evaluation instruments.

Course Development

The training course was to be presented with the use of Microsoft PowerPoint. Formatting this PowerPoint presentation consisted of logistically displaying the information and data of the training curricula in an effective manner. An extensive assortment of post natural disaster hazards were identified through classroom assignments in which students were asked to prepare a Job Hazard Assessment (JHA) of different aspects of post natural disaster reconstruction activities. This JHA database, prepared in a Microsoft Excel spreadsheet, provided most of the input information and data incorporated into the training curricula. Through mutual independent research efforts by the members of the University of Florida Susan Hardwood Training Grant Program team, hazards were identified related to post-hurricane reconstruction. Beyond identifying these hazards, safe remediation measures were developed for each identified hazard. By utilizing the JHA database, additional classroom assignments consisted of the preparation of PowerPoint presentations on the identified hazards and the remediation of those hazards. These PowerPoint presentations were prepared by juniors and seniors in an undergraduate construction safety class at the University of Florida, BCN 3735, in the spring semester 2008. These presentations provided specialized information on topics that

were pertinent to this thesis. These presentations also contributed to the data/photo input for the course. When preparing the presentations for delivery as part of the Susan Harwood training grant, the undergraduate PowerPoint presentations had to be reformatted and reduced in scope so only the most valuable and pertinent information was incorporated, such as photos and researched facts. The following safety topics were specifically incorporated as they were deemed relevant to post-hurricane reconstruction work:

- Personal Protective Equipment
- Ladders & Scaffolding
- Equipment Safety
- Reptiles, Insects and Animals
- Chainsaws
- Wood Chippers
- Generators.

Photos

Photos were selected by the Susan Harwood Training Grant Program team as they were deemed important to incorporate into the training curricula, especially as a way to sustain the attention of the audience. Photos that were incorporated as part of the undergraduate BCN 3735 safety training PowerPoint presentations were used as a resource for creating the training course. In addition to the photos obtained from the undergraduate students, personal photos taken after Hurricanes Katrina and Ivan were obtained from fellow UF students. Photos were also obtained from a training class that the Associated General Contractors had prepared on a previous Susan Harwood Training Grant. Cumulatively, these photos showed the devastation that hurricanes have on the built environment and also the remediation efforts that accompany post natural disaster reconstruction activities. Photos were an excellent way of showing firsthand the hazards one may encounter in a post-natural disaster stricken area. These photos were inserted strategically into relevant sections of the training course.

Course Evaluation

Pre-tests were developed to provide information on the audience's general understanding of the training course information prior to attending the session (Reference Appendix B). The question development process took place during the weekly work meetings held by the University of Florida Susan Hardwood Training Grant Program team. Important or key points taught in the training course were used as a basis for the test questions. The pre-test consisted of 20 multiple-choice questions.

The pre-test questions were also used for the post-test. The post-test was designed to assess the level of learning that resulted from the training curricula. Each test was graded with a score assigned to reflect the number of correctly answered questions (out of 20). The results from these tests were graphed for each training session showing trend lines and the averages of both tests. Also, an analysis of each question asked in the pre-test and post-test was done in order to determine whether or not any questions were unclear or possibly not sufficiently emphasized in the training curricula.

Instructor evaluations provided feedback on the quality of the information presented in the training curricula along with feedback on the performance of the instructor(s) in delivering the course (See Appendix C for the instructor evaluation form). For each question on the instructor evaluation form, a score of "1 to 5" was solicited with "1" being poor and "5" being excellent. The score related to each question was averaged for the evaluations. The overall average was then computed to derive an overall instructor evaluation score for each course that was presented.

Strengths and weaknesses of the training curricula were identified from the instructor evaluations. Attributes of the training course examined in the instructor evaluation forms were scored and averaged for all the training sessions in order to calculate an average score

representing that attribute as a whole. By doing this, attributes with a low average score would be viewed as a weakness for the course and attributes with a high average score would be viewed as a strength. The attributes addressed in the evaluation forms were:

- The speaker's knowledge of the subject
- Style of presentation
- Quality of information
- Ease of understanding
- Clearity of presention
- Usability of ideas
- Quality of handouts
- Presentation method
- Interest of information

CHAPTER 4
RESULTS

Training Course

The training course was developed with five modules: an overview, general health and safety, focus-four hazards, chemical and biological hazards and equipment hazards. In each of these modules, the inherent hazards and adverse conditions associated with post-hurricane reconstruction efforts were identified and suggestions were offered regarding safe work procedures and practices. The resulting training course was a result of mutual contributions from the entire Susan Hardwood Training Grant team. Thus, not all the course information was referenced in the Literature Review for this thesis. Refer to Appendix A to view the training course.

Overview

An overview was provided for the entire training course. This began with a description of the General Duty Clause. The General Duty Clause requires employers to "furnish to each of his (or her) employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his (or her) employees." The General Duty Clause is not in the OSHA regulations, but rather it is in the Occupational Safety and Health Act. This clause can be interpreted as saying that any known hazards must be addressed by employers, whether or not they are mentioned in the OSHA regulations. For post hurricane conditions, it would be difficult for all the possible hazards to be anticipated and included in the OSHA regulations, including all the physical, chemical and biological hazards to which workers might be exposed. Despite the fact that many of these hazards are not specifically addressed in the OSHA regulations, employers must be aware of and anticipate these hazards as it is not acceptable to send workers into known unsafe work

conditions. Reconstruction work performed in post-hurricane areas is usually done by many small contractors and in many cases with a large percentage of non-English speaking workers. The inability to effectively communicate with the workers could be a hazard in itself when performing post-hurricane reconstruction work.

Statistics were provided on the common types of work tasks for which OSHA interventions were implemented when performing post-hurricane work. Interventions were required when safety compliance was not satisfactory. Debris removal accounted for 32% of the interventions, roofing 26%, utilities 10%, tree trimming 8%, building repair 2% and other post-hurricane work 22%. It was important to identify these areas by percentage in order to understand those areas of work that are likely candidates for increased injury occurrences. These were also the areas that warranted additional attention during the class presentations.

Post-hurricane work is different from typical construction activities. A synopsis of these differences was presented last in the overview section of the training course. These differences are as follows:

- Presence of floodwater.
- Buildings may be structurally unstable.
- Debris will be everywhere.
- Power lines may be down (power may be out) and generators may be needed.
- Floodwater may be contaminated with fuels, oil, sewage, and other chemical or biological hazards.
- Trees may have been blown down.
- Many roofs need to be made watertight with temporary membranes.
- Mold growth is a concern.
- Asbestos may be encountered.
- Animals or reptiles may be displaced from their natural habitats.

Understanding these differences in the post-natural disaster work environment compared to a typical construction site was an important focus of the training curricula. It was deemed important to emphasize these differences because many of these hazards are not experienced, to

any great extent, when performing construction activities on conventional construction projects. Preparing for these new and often unusual hazards is crucial when undertaking work after a natural disaster. The Overview module of the training course concluded with a brief summary of the contents of the remaining four training modules or sections.

General Health and Safety Precautions

The second module of the training curricula was related to general health and safety precautions. It was important to begin this section of the training course by defining a competent person. A competent person is a person who:

- Is capable of identifying existing and predictable hazards in the surroundings or working conditions that are unsanitary, hazardous, or dangerous to employees, and…
- Has the authority to take prompt corrective measures to eliminate them.

It is mandatory that a competent person be assigned to the project. Of course, the focus of the competent person must also be on unsafe behavior, not just unsafe conditions. Safety professionals generally agree that unsafe behavior accounts for 90% of all accidents, as unsafe work conditions are rarely the sole cause. Beyond identifying unsafe work conditions, a competent person should identify unsafe behaviors and thus take corrective measures to ensure the safety of all workers. It is widely accepted that supervisors have a significant impact on worker safety. Consequently, supervisors must be diligent in their efforts to bolster jobsite safety. Nonetheless, it is the workers themselves who must ultimately assume a responsible role in helping to ensure their own safety. While supervisors can influence safety performance, ultimately it is the workers who control their own actions and impact their own safety.

After the introductory topics, the general health and safety section of the training module began to focus more specifically on the preparations that are to be made before entering a post-hurricane work area. For example, the workers that are to be deployed to an area struck by

disaster are to be healthy. Medical evaluations are important as physical fitness, immunizations and drug testing contributes to the safety of workers. Evaluating physical fitness is necessary to ensure that each worker is fit to safely perform potentially hazardous or stressful work. Also, pre-event medical screening can provide a "baseline" for assessing health effects in workers returning from post-hurricane work. Immunizations can protect workers from polio, measles, influenza, tetanus, diphtheria, hepatitis A and B, encephalitis, rabies and cholera. If floodwaters are present, immunizations are especially important as these waters could contain chemical or biological contaminates.

To more fully understand the conditions that are present in a post-hurricane work area, a reconnaissance survey is advised. By sending a scout to assess work conditions, pre-deployment planning can be structured accordingly. The reconnaissance should assess the availability of food supplies, potable water, shelter, sanitary services, local electrical power, first aid and emergency services, fuel, laundry services, construction materials, etc. Even when the public water supply is functioning, it might be advisable to bring safe drinking water and food to the work area. If potable water is not available, bottled, boiled, or disinfected water is the solution. Food needs to be carefully selected to avoid the risk of gastrointestinal illnesses or chemical poisoning. MREs (meals ready to eat), canned and instant foods are recommended as agricultural food products or those requiring refrigeration should be avoided. Since temporary shelter may not be available after a hurricane, daily travel to and from the work site to tents, RVs or trailers may be necessary. Portable toilets, clothes washers and showers all may need to be provided in order to have adequate sanitary services. Portable power is often required and may be provided through portable electric, propane, gasoline and diesel generators. First aid emergency services are vital to ensure the well being of reconstruction workers. If emergency

services have been disrupted (e.g. 911), temporary emergency services may be provided by other agencies. Still, it is essential to be equipped and have trained individuals on site to provide first aid and a means of evacuation if emergencies occur. Cell phones and hand crank-operated radios are required as a means to provide communication and the means to deal with unforeseen circumstances. All of these issues are extremely important and should be well thought out and prepared for before a work force mobilizes into a post-hurricane work area.

Properly stocking workers with personal gear ("kits") and personal protective equipment (PPE) are suggested pre-deployment practices. "Kits" should include an extensive first aid kit, hygiene kit, insect repellant, sunscreen, and standard work and protective clothing. Personal protective equipment should consist of eye and face protection, hearing protection, head protection, hand protection, foot protection, respiratory protection and fall protection. Because 10% of all construction worker injuries are eye injuries, safety glasses, goggles or face shields should be worn when working with harmful chemicals or when exposed to potential flying objects. Hearing damage can occur with extended exposure to noise at or above 90 decibels. Ear plugs and ear muffs should be used when exposed to noise from heavy and hand-held equipment. Hard hats provide protection from falling debris, overhead obstructions and accidental head contact with electrical hazards. Hand injuries account for about 22% of all injuries and many of these injuries could easily be avoided with appropriate hand protection. Gloves should fit snug and be applicable to the type of work being preformed. Foot protection should be slip resistant with puncture resistant soles and be safety-toed.

The type of respirator used depends on the contaminate exposure. Because of life safety issues, separate training should be provided when respirator protection will be required. Dust masks are not designed to offer protection from hazardous atmospheres, but instead should be

used for comfort from allergens. Dust masks are filtering face-pieces that offer protection from dust and mists, however, they do not provide protection from lead, asbestos, gases or vapors. Half-face negative-pressure respirators can protect from most vapors and gases. The filter cartridge for these respirators should be changed regularly. Powered air-purifying respirators (PAPR) have a battery powered fan for breathing comfort and should also have the filter cartridges changed regularly. Self-contained breathing apparatus (SCBA) is a closed system with bottled air and usually consists of a full-face respirator used for entry and escape from atmospheres that are immediately dangerous or oxygen deficient. These PPE's will not only help save lives, but also protect workers from potential injuries.

Special conditions encountered in post-hurricane work areas were described as a conclusion to the general health and safety section of the training module. Personal hygiene, heat stress, and critters (animals, insects and snakes) made up these special concerns. Personal hygiene is important because floodwaters can be potentially contaminated with microorganisms, sewage, industrial waste, chemicals and other substances that can cause illness and even death. Hand washing and disinfecting is mandatory. Soap and clean water, and waterless alcohol hand rubs should be used after performing clean-up or decontamination work, after toilet use, before work breaks, before handling food and when eating to prevent disease transmission. Bleach-disinfected water and rubbing alcohol with water can be used for hand washing and disinfection. Wounds need to be washed immediately and if they become infected, medical attention should be sought right away. Tools, surfaces and equipment may need decontamination which can be accomplished by using bleach disinfected water. Bleach disinfected water should be labeled "bleach disinfected water – DO NOT DRINK."

Heat stress was another special concern in post-hurricane work areas. When the body is unable to cool itself, heat exhaustion and heat stroke can occur. By providing shaded break areas, frequent breaks, ventilation (e.g. fans), sufficient potable water, and having lightweight, light-colored, loose-fitting clothes, heat stress can be prevented. Alcohol, caffeine and heavy meals can also contribute to heat stress. Proper hydration is perhaps the single most important preventative technique. It is also important to recognize the initial symptoms of heat exhaustion.

Animals, insects and snakes were the last of the special concerns described in the general health and safety section of the training module. Dead and live animals can spread diseases directly (bite or scratches) or indirectly (fleas, ticks and feces). Sometimes wild animals become displaced from their home areas and are forced to seek shelter elsewhere (higher ground). When major structural damage has occurred to buildings that provide access to animals, these animals might seek refuge in them. When the reconstruction workers show up and enter these damages buildings, they should anticipate the possibility of encountering these new inhabitants.

The presence of standing water in warm climates is the breeding ground for a common nemesis - mosquitoes. While the bite of a mosquito is a nuisance in itself, a greater problem looms. Mosquitoes are a common vector for waterborne disease transmission. Venomous spiders and poisonous snakes could be concealed under debris. A wooden probe (e.g. stick or pole) should be used to check locations where these hazards may exist. Heavy gloves, boots, long pants and long sleeves all can provide protection from a potential bite. The proper identification of the poisonous spiders and snakes was included in the training.

Focus-Four Hazards

OSHA categorizes the basic causes of injury accidents. After collecting injury data for decades, four particular causes have been found to be associated with most construction injuries. These are known as focus-four hazards and include injuries/fatalities resulting from electrical

shocks, struck-by accidents, caught-in/between accidents and falls. In construction work, focus-four hazards account for 79% of all fatalities.

Fatalities from electrocution can be caused by poorly maintained power cords and tools, contact with live circuits in panels, or contact with overhead (or downed) power lines. Ground-fault circuit interrupters (GFCI) are devices that have been developed to prevent electric shock accidents. GFCIs monitor the current flow between the hot and neutral wires, and the GFCI will trip (cut off power) between 4-6 mA in $1/40^{th}$ of a second and thereby protect workers from potential shock. GFCIs are to be used in virtually all construction operations where electrical power tools are used.

Buildings damaged by hurricanes should be de-energized and locked out until inspections and repairs deem the electrical distribution system safe. Downed power lines are of considerable concern after hurricanes. Never approach a downed power line because the electrical current can potentially radiate outward through the ground causing voltage differentials ("step voltage"). Note that it is also possible for measurements of a downed power line to indicate that there is no power in the line, but power may be re-introduced automatically. Never drive over downed power lines. Downed or low hanging power lines can energize other objects, even without touching them (equipment, vehicles, buildings, trees, fencing, telephone lines, entangled debris, the ground or pipes). It is important to know that circuits do not always open (turn off) when a power line falls into a tree or on the ground.

Struck-by hazards are mostly caused by falling objects or by moving vehicles or equipment. Tree cutting causes falling objects and is pertinent to post-hurricane remediation efforts. Backing incidents and traffic are two common causes of vehicles and equipment striking workers who are on foot. Shadows can hide workers on foot, so workers should always

wear high visibility clothing. High visibility clothing (reflective garments) should be worn whenever the work place contains hazards related to low visibility or when workers perform their duties near vehicles or moving equipment. Because of the nature of post-hurricane reconstruction work, much debris is hauled off using heavy equipment. People who were displaced from their damaged homes are also likely to be frequent visitors to the neighborhood to monitor progress. There are also instances where people who have no business being in the neighborhoods just drive through devastated areas to sight-see. These conditions can increase traffic considerably and preparations are needed to properly address these conditions.

. Caught-in/between hazards constitute another focus four hazard. Trenching is the major cause of death in caught-in/between fatalities. This is of particular concern when working in post-hurricane areas because of possible saturated soil conditions that increase the chances of cave-ins. Trench boxes can be used when excavating (e.g. placing new utilities) in order to protect workers from possible collapse of trench walls. While trenching in a post-hurricane area is a concern, there is generally not very much trenching work that is done until a considerable time after the hurricane. Equipment rollover hazards, also included in caught in/between accidents, also have a greater chance of occurrence due to saturated soil. When there are roll-over hazards, there must be a seat belt for the operator of the machine. Always wear the seat belt and only ride in the seat provided.

The most common of the focus four hazards are falls. Fall hazards were the fourth and last of the focus-four hazards discussed. The potential for falls should be a major concern during post-hurricane reconstruction efforts. Causes of fall-related fatalities are unprotected sides, edges and holes; improperly constructed walking/working surfaces; improper use of access equipment; failure to properly use body harnesses and lanyards; and slips and trips. Hurricanes

are known for their strong winds and how these wind forces destroy roofs. These damaged roofs are an enormous safety concern. Blue tarps are commonly used on roofs as a quick and temporary means to keep rainwater out of buildings. These tarps can be very slippery and are an inherent potential fall hazard. Protective footwear with deck shoe or "sneaker" skid resistant soles is recommended when working on a roof. Never step or walk on roof tarps, especially if wet.

Building demolition hazards were also presented in the focus-four hazard section of the training module. All focus-four hazards could potentially be encountered when performing post-hurricane demolition work. There is a particularly increased risk of struck-by and caught-in/between hazards.

Chemical and Biological Hazards

The third module of the training curricula described chemical and biological hazards. High water levels resulting from a hurricane can create a "soup" of infectious bacterial organisms, infectious viral organisms and agricultural and industrial chemicals. Never assume water in flooded areas is safe. Safe floodwater removal was discussed in the module, followed by decontamination procedures, confined space considerations, and potential exposure to lead, asbestos and mold.

Confined spaces may exist in forms that are not commonly encountered. A confined space has limited or restricted openings for entry and exit and is not designed for continuous worker occupancy. Implementing fall protection, air monitoring, ventilation, lighting, two-way communication and rescue procedures all need to be considered when dealing with a confined space. The major concern when working in confined spaces is that the environment may be oxygen deficient or it might contain toxins. The toxic gases of particular concern include hydrogen sulfide and carbon monoxide. Hydrogen sulfide is a colorless, flammable, extremely

hazardous gas with a “rotten egg” smell. It is commonly associated with the presence of sewage. Carbon monoxide is a colorless, odorless and toxic gas that is produced by gasoline-powered tools and equipment. When carbon monoxide is generated in spaces without adequate ventilation, severe injuries or fatalities can occur. Never use gasoline-powered tools in enclosed or partially enclosed spaces (e.g. garages).

Although most uses of lead and asbestos have been banned, lead-based products and asbestos products remain in many older homes and buildings. Exposure to lead and asbestos is possible and even likely when performing reconstruction work. Lead fumes, such as cutting materials coated with lead-based paint, are a particular concern. Lead can be immediately harmful to the exposed worker. The potential for asbestos in any older building (built before the early 1980s) is high. Asbestos can cause lung cancer and mesothelioma, cancer of the lining of the lung. It is best to expect asbestos to be everywhere in a building and in any building material. Significant asbestos exposure can occur when asbestos products are removed or disturbed. Smokers have a higher risk of lung cancer when exposed to asbestos. Symptoms of exposure and preventative measures for lead and asbestos were identified and described in the training module. Also, workers must understand that lead and asbestos can be taken off site on workers’ clothes, hair, skin, tools and vehicles.

Mold is a common problem when moist conditions exist. The potential harm of mold for healthy workers has not been conclusively established. There may be more media hype to the ill-effects of mold than actually exists. It is important not to breathe in mold spores. Molds have the potential to compromise the health of persons with asthma and other respiratory and immunity disorders. Symptoms of exposure and prevention measures for mold were also identified and described in the curricula.

Equipment Hazards

Equipment hazards were described in the last module presented in the safety training course for hurricane reconstruction. Cranes and aerial lifts, portable generators, wood chippers, chainsaws, portable electric powered tools and ladders were all discussed to some extent.

Cranes and aerial lifts should always be kept a minimum of 10 feet away from power lines. If it is difficult for an operator to see the power lines, designate a spotter. If adequate clearance cannot be kept from a power line, the contractor needs to insulate the line or the power company should move or de-energize the line. Cranes must be operated by qualified and trained personnel, as struck-by and caught-in/between incidents are potential hazards.

Portable gas powered generators are commonly used to generate electricity in post-hurricane areas. Carbon monoxide poisoning is the biggest hazard because of possible confined spaces. Fuel should never be stored indoors, generators should be cool (5 minutes) before refueling and one should never smoke while refueling.

Wood chippers pose considerable hazards if they are not properly used. Wood chippers receive wide use as vegetative debris comprises 50%-90% of all hurricane debris. Chippers can cut tree limbs into small chips or mulch, reducing truck volume and allowing on-site disposal. Hazards include being caught-in blades and discs resulting in amputation or death; struck-by debris being drawn into or discharged from the machines; hearing loss; and face, eye, head or hand injuries. Manufacturer's guidelines should be carefully followed to avoid injuries. Trained and experienced workers are critical to ensure safety when dealing with wood chippers.

When dealing with tree trimming and removal, it is important to anticipate the worst. It is important to always work in pairs so someone is there to assist and strategize how a tree or limb might fall. Chainsaws are commonly selected for this type of work, but they are also one of the most dangerous portable power tools. The average chainsaw injury averages 110 stitches.

Chainsaw chaps can eliminate the severity of many injuries to the legs. Injury prevention measures were suggested in detail in the training course.

Portable electric tools that pose potential hazards are saws, drills, grinders, welding equipment and nailers. Electrical shock, the absence of a protective guard or safety device, and unsafe techniques or practices are potential hazards when using a portable electric tool. Injury prevention measures associated with the use of portable electric tools were discussed for each tool in the curricula.

Ladders were the last subject presented in the safety training course for hurricane reconstruction. Most new ladders contain sufficient warning labels that an entire training class could be held by using this information as a class outline. Warning labels on ladders are there for a reason. These should be carefully followed. Failure to read and follow instructions on a ladder may result in injuries or death. Obey the labels!

Training Sessions

The training course was evaluated in depth after eleven sessions had been conducted. These training sessions were presented in 2008 on May 27, June 24, June 25, June 26, July 31, August 1, August 8, August 26, August 27, September 11 and September 16. The assessment of the training course was made on the basis of the pre-tests, post-tests and instructor evaluations.

Pre-Test/Post-Test Charts

Each test was scored on the basis of the number of correct answers for the 20 questions in the pre-test and post-test. The average pre-test score and the post-test score for each training session is shown on a vertical axis (See Chart 4-1). A total of 298 pre-tests and 259 post-tests provided the data for analysis. The number of tests differs from pre-test to post-test as some class participants simply chose not to participate in the post-test. As one can see, the post-test trend line is higher than the pre-test trend line. The overall average score on the pre-test was

12.96 and the average score on the post-tests was 16.29 (See Chart 4-2). There is a 3.33 question improvement in the post-test scores versus the pre-test scores, an improvement of 25.7 percent.

The data in Chart 4-1 shows the linear plot of the test scores from session to session. This average score of the participants shows a general decline on June 25 and August 27 classes. Upon closer examination, it is evident that the lower test scores for the June 25 participants occurred because several of the participants were weak in English. Some had the questions translated for them from English to Spanish. By oversight, the instructors had forgotten to bring copies of the Spanish version of the pre-test and post-test. As for the August 27 training session, the training participants comprised of mostly inexperienced workers instead of managers which might explain their lower scores on the standardized tests. Perhaps these workers were not as well acquainted with standardized tests compared to safety managers who have most likely had a formal education and more experience with test taking. When taking this into account, it appears as if all classes performed comparably on the tests. Most notably, the post-test scores of all classes improved.

A statistical test of two means was run between the average pre- and post-test scores and concluded it is highly unlikely that chance caused the differnce between pre- and post-test averages. There was strong confidence (99.9%) that training improved the knowledge base of the class attendants.

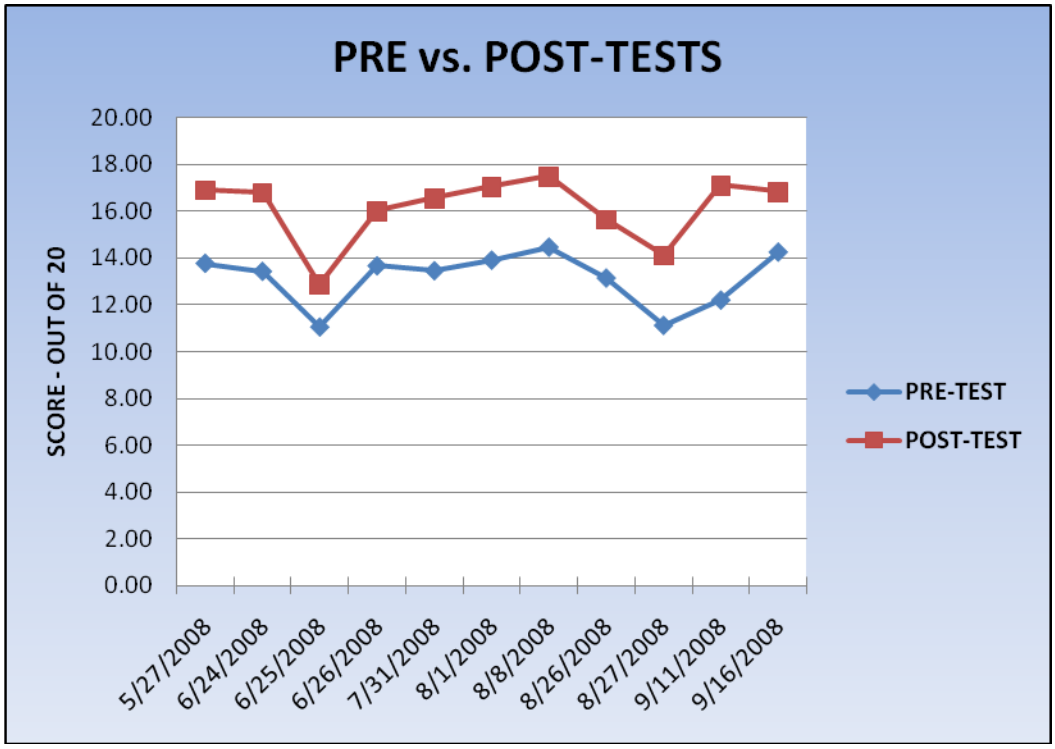


Figure 4-1. Pre-test vs. post-test

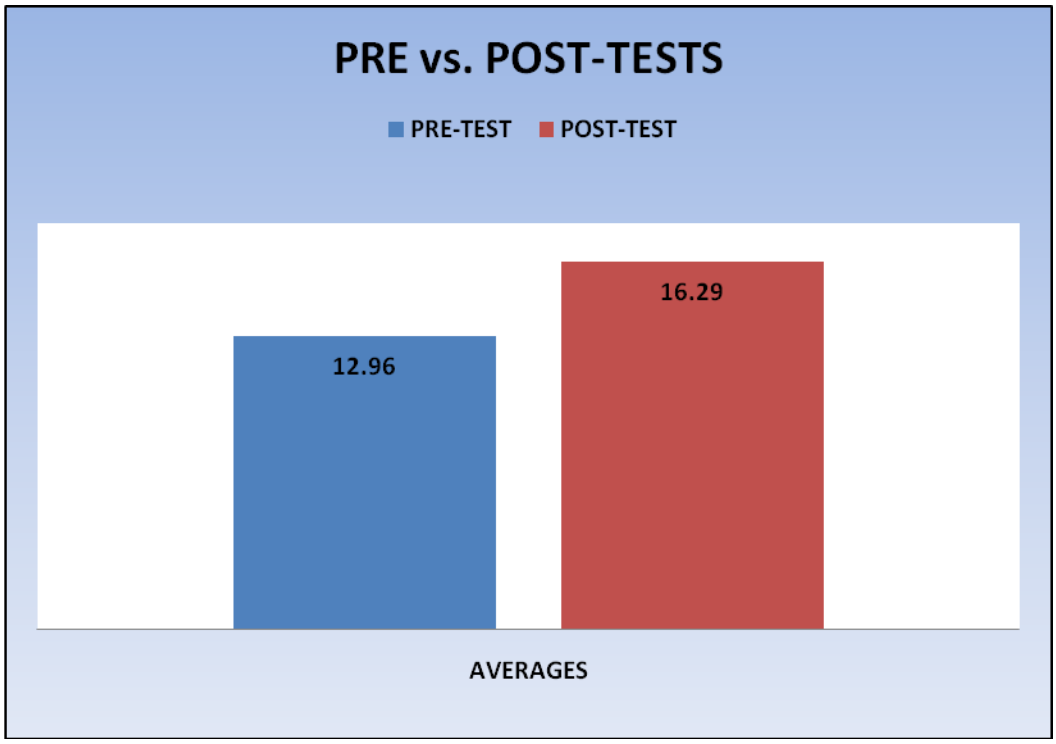


Figure 4-2. Test averages - number of correct answers for 20 questions

Missed Question Totals Chart

The answers provided for each question in the pre/post-tests were examined to determine how many times each question was missed (See Chart 4-3). The horizontal axis represents each of the 20 questions for the pre-test and post-test. The vertical axis represents the percentage of times the question was missed in total. Because the number of class participants varied between the pre-test and post-test, percentages were used to compare tests. Class participants missed more questions on the post-test than on the pre-test for questions 3 and16.

3. What major hazard is posed by standing stagnant water?

   a. Disease carrying mosquitoes
   b. Electrical shock hazards
   c. Toxic/bacteria contaminated water
   d. All of the above

16. When fall arrest equipment is used, employers must assure that _____.

   a. All equipment is properly inspected before each use
   b. Users have calculated total fall distance
   c. A rescue plan is in place to rescue a fallen employee
   d. All of the above

These two questions were missed slightly more often on the post-test than on the pre-test, but overall were missed a small percentage of times in total and thus this was not considered to be an issue of concern. On the other hand, question 19 was a bigger concern.

19. Who has the most impact on improving safety at construction sites?

   a. Employers
   b. Employees
   c. OSHA
   d. Owners/Architects/Engineers

This question was considered a major concern because, despite the improvement particpants exhibited on overall test scores, the question expressed inaccurate information. The correct answer for this question was assumed to be b. Employees. Because most class participants turned out to be safety managers (not employees), this question shifted responsibility

from them (managers) to employees. Even though employees do have the most impact on improving safety on an ongoing basis, it is ineffective to emphasize to the audience that they do not have the most impact on safety. Instead, it makes most sense to inform the audience they do have the most impact, in order to emphasize the importance of their knowledge and safe work practices. Questions 15 and 18 were also questions of some concern.

20. Guardrails used for perimeter fall protection must have toe boards when _____.
    a. People work near the guard rails
    b. People are working in or entering into the lower level near the area
    c. Toe boards are not required on perimeter protection
    d. All the time
21. The best way to protect workers from being struck by rotating equipment is to _____.
    a. Barricade swing radiuses
    b. Have the operator warn workers
    c. Use audible swing alarms
    d. All of the above

Questions 15 and 18 were a concern as a high percentage of class participants missed the correct answers on the post-test and the pre-test. Even so, there was still a noticable improvement on the post-test on these questions. Questions 6,11 and 17 were not a major concern despite the small improvement on the post-tests.

22. What is a major concern of being exposed to mold?
    a. Rash from skin contact
    b. Inhalation of spores
    c. Stomach disease from ingestion
    d. Slipping on slick surfaces
23. Which diseases would be major concerns when working in a post-natural disaster areas in the U.S.?
    a. Small Pox & Polio
    b. Hepatitis B, Tetanus and Diptheria
    c. Measles & Chicken Pox
    d. Alzheimer's & Parkinson's
24. To prevent worker run-over accidents, which of the following should be used?
    a. Back-up alarms
    c. Spotters for equipment

b. High visibility clothing d. All of the above

Approximatly the same percentage of participants missed questions 6,11 and 17 on the pre-test and post-test. Because less than 10% of total participants missed these three questions for both pre-test and post-test, they were not of major conern.

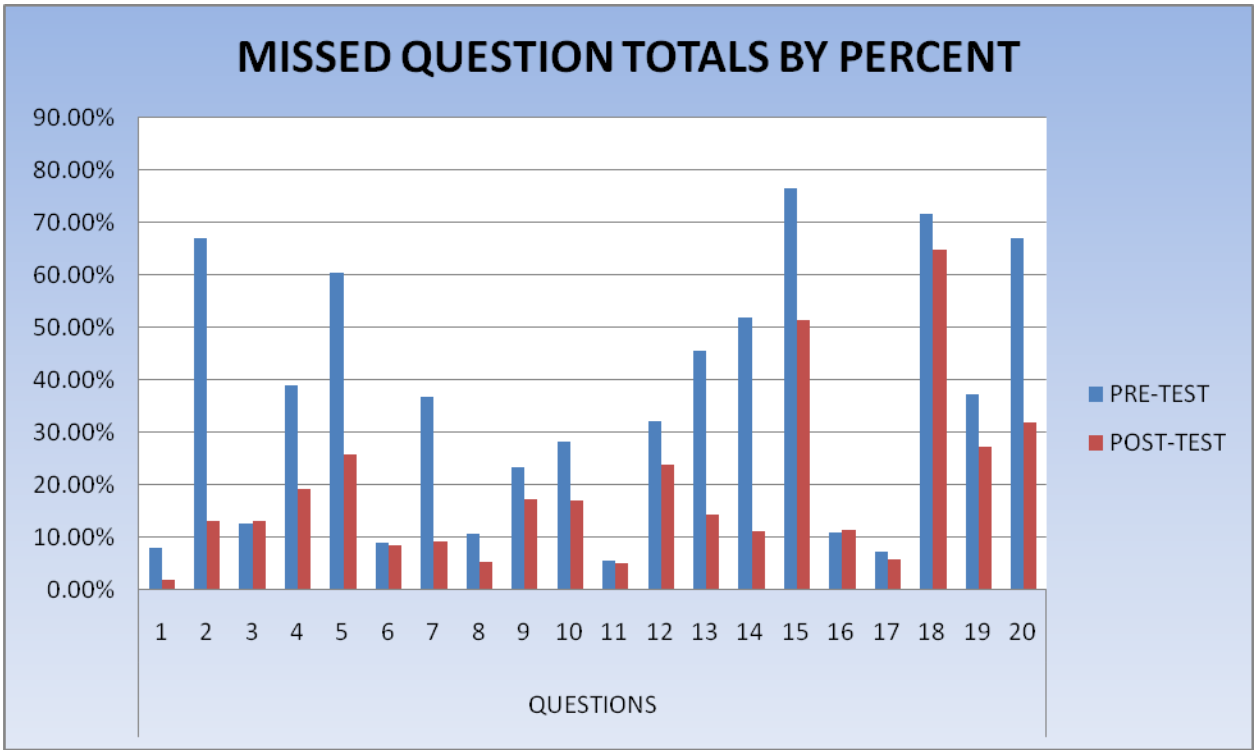


Figure 4-3. Missed question totals by percent

Instructor Evaluations

Two hundred and fifty-six instructor evaluations were completed which rated the training module and the instructor's abiltiy to deliver it. Attributes of the instructor evaluation form addressed:

- The speaker's knowledge of the subject
- Style of presentation
- Quality of information
- Ease of understanding
- Clarity of presention
- Usability of ideas
- Quality of handouts

- Presentation method
- Interest of information

The intructor evaluations were used to identify any weaknesses of the training curricula (See Table 4-1). Each attribute in the instructor evaluation was averaged representing that attribute for analysis for all eleven training sessions. Because each atttribute scored between 4.3 and 4.5, there were no major weaknesses. To support this, a cumulative average evaluation score of 4.4 was computed (out of a possible 5) for all eleven training sessions administered.

The instructor evaluations also asked the training participants whether or not they had any post-natural disaster construction remediation work experience and if the presentation of the training module met their expectations. The last 10 training sessions provided data for this portion of the instructor evaluations. Approximately 43% of the 191 participants stated they did have experience related to the training course and the remaining approximate 57% of the participants stated they did not. Approximately 88% of the participants responded that their expectations had been met by the presentation of the training curricula with the remaining participants stating their expectations had not been met.

Table 4-1. Instructor evaluations

INSTRUCTOR EVALUATIONS									
Date	**Knowledge**	**Style**	**Information**	**Understanding**	**Clarity**	**Useful**	**Handouts**	**Presentation**	**Interest**
5/27/2008	4.6	4.5	4.5	4.6	4.6	4.5	4.4	4.4	4.4
6/24/2008	4.6	4.4	4.7	4.6	4.6	4.8	4.7	4.6	4.6
6/25/2008	4.6	4.4	4.5	4.5	4.5	4.3	4.7	4.6	4.4
6/26/2008	5.0	4.8	4.8	4.8	5.0	4.8	4.8	5.0	4.5
7/31/2008	4.5	4.5	4.5	4.5	4.5	4.3	4.5	4.5	4.5
8/1/2008	4.2	3.8	4.0	4.3	4.2	4.1	4.3	4.2	4.0
8/8/2008	4.5	4.3	4.3	4.4	4.5	4.4	4.2	4.5	4.5
8/26/2008	4.7	4.6	4.7	4.6	4.5	4.6	4.5	4.5	4.6
8/27/2008	4.4	4.0	4.1	4.3	4.4	4.1	4.1	4.2	3.9
9/11/2008	4.4	4.3	4.4	4.3	4.5	4.5	4.5	4.5	4.2
9/16/2008	4.6	4.3	4.3	4.6	4.6	4.5	4.3	4.6	4.5
Averages	**4.5**	**4.2**	**4.3**	**4.5**	**4.5**	**4.4**	**4.4**	**4.4**	**4.3**

CHAPTER 5
CONCLUSIONS

Course Effectiveness

Results showed that the training participants did learn from the training course. Trend lines analyzed from Chart 4-1 and test averages from Chart 4-2 confirmed this. Because the training curricula were informative, the class participants learned something from it and were able to perform better on the post-test. A 25.7% learning improvement was achieved after the training course was presented.

Missed Questions

The answers provided to the questions given in the pre/post tests were analyzed (see Chart 4-3). Because questions 6, 11 and 17 were seldom missed in both tests, even though they had more wrong answers on the post-test, they were a minor concern. Question 19 was a greater concern because the question emphasized false information. Questions 15 and 18, which were missed most often on both the pre- and post-tests, were also a concern because the class participants still did not absorb the information related to the questions in the training course. An ideal result of the post-test answers to question 15 and 18 would have shown a significant improvement in this knowledge, similar to the result of question 2 displayed on chart 4-3. Even though question 2 was missed a high percentage of times on the pre-test, a significant improvement occurred on the post-test, conveying that the training participants learned the material.

Instructor Evaluations

Overall, a 4.4 score representing all the instructor evaluations (out of 5) is a good sign the course was interesting, informative and delivered well to the audience. Since approximatley

88% of the class participants had their expectations met, the presentation of the training course was deemed a success.

Weaknesses of the training course were identified from the instructor evaluation averages for each attribute. Because each attribute was rated at an average of more than 4, no real weaknesses could be identified in the training curricula or in the presentation of the information.

CHAPTER 6
RECOMMENDATIONS

Course Modifications: The development of additional customized training courses to prepare construction workers for post-natural disaster construction safety is needed. As more training sessions take place, further analysis and critique of the training curricula could serve as a guide for evolving the module into even more meaningful and relevant training sessions. Information addressed in Questions 6, 11, and 17 needs to be emphasized more in the presentation of the training module.

6. What is a major concern of being exposed to mold?
   - a. Rash from skin contact
   - b. Inhalation of spores
   - c. Stomach disease from ingestion
   - d. Slipping on slick surfaces

11. Which diseases would be major concerns when working in a post-natural disaster area in the U.S.?
   - a. Small Pox & Polio
   - b. Hepatitis B, Tetanus & Diptheria
   - c. Measles & Chicken Pox
   - d. Alzheimer's & Parkinson's

17. To prevent worker run-over accidents, which of the following should be used?
   - a. Back-up alarms
   - b. High visibility clothing
   - c. Spotters for equipment
   - d. All of the above

Including additional information pertaining to these questions can enhance the training class. Enhancing information can be done by emphasizing the information in the fonts used in the presentation, presenting the information through specific question and answer sessions with participants, or simply adding information to the presentation. Questions 15 and 18 both need significantly more attention and emphasis, compared to questions 6, 11 and 17. Lastly, question 19 should be replaced with a question that pertains more to the mainstream information presented in the training course.

15. Guardrails used for perimeter fall protection must have toeboards when _____.
    a. People work near the guard rails
    b. People are working in or entering into the lower level near the area
    c. Toe boards are not required on perimeter protection
    d. All the time

18. The best way to protect workers from being struck by rotating equipment is to _____.
    a. Barricade swing radiuses
    b. Have the operator warn workers
    c. Use audible swing alarms
    d. All of the above

19. Who has the most impact on improving safety at construction sites?
    a. Employers
    b. Employees
    c. OSHA
    d. Owners/Architects/Engineers

By emphasizing this info in the module, the teaching potential of the training course can be strengthened. Also, if the pre- and post-tests were longer, say 30 or more questions in total, a better measure of the curricula effectiveness could be achieved with more data becoming available for analysis.

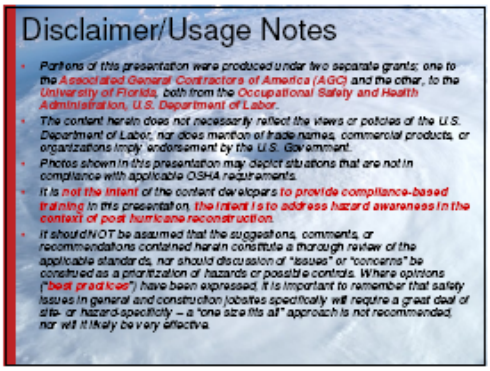
Sitting for four hours while someone lectures can be quite taxing on individuals who are not accustomed to sitting for any duration. Pictures, video clips, question and answer sessions, breakout sessions, and so on can help to increase the interest of the training course. The unfortunate reality in that these techniques, while effective, can consume additional time which would extend the training duration.

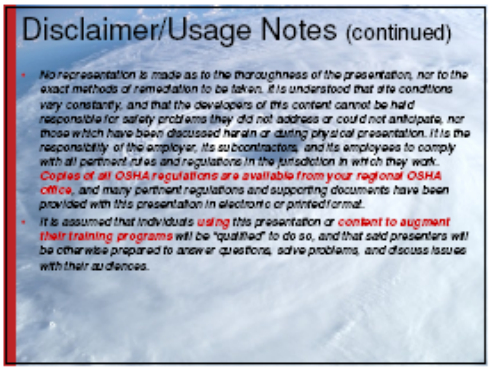
A voice dub over for each slide in the PowerPoint training course needs to incorporated to give the training curricula an extended life after training sessions have ended. Also, a training module translated into Spanish is strongly recommended to help protect the Spanish work force supplying post natural disaster reconstruction labor.

Lastly, by attaching CEU's (Continuing Education Units) to the training session, an added benefit will be received by the training participants. In order for Florida contractors to

renew their licenses, every two years they must obtain 14 CEUs (equivalent to 14 hours) of in-class course work taught by approved providers. If the safety training course for hurricane reconstruction was approved to provide CEUs to contractors, there would be added motivation for attendance at such sessions. Also, this would lend additional seriousness to the audience perception of the curricula for this training course. This would bolster the main objective of this thesis, to contribute positively to the safety of the construction industry. If more attendants perceive this training course critical, more members of the construction industry would be better prepared for post-natural disaster reconstruction work. This could help protect workers from injury and most importantly it could save lives.

APPENDIX A
TRAINING MODULE





Steps Preceding a Hurricane

Have an Emergency Plan
- Assign responsibilities
- Monitor storm path (assigned person)
- Decide promptly when to act (alert)
  - Maintain storage indoors (insulation, drywall, etc.)-keep secure
  - JIT material delivery (minimum storage)
  - Decide promptly when to act (sound alert)
  - Empty the dumpsters (or lock down the lids)

Steps Preceding a Hurricane

- Tie down all potential flying debris (anything that can become airborne; trash, lumber, plywood, sheetmetal, roofing materials, etc.)
- Cover/protect windows
- Cover items that need to stay dry
- Reinforce form supports, signs, etc.
- Reinforce free-standing masonry walls
- Consider extra bracing, if warranted.
- Know where everyone will be
- Lower the crane booms
- Free-wheel the tower cranes

Have supplies for during the storm
- Water
- Food (for 2-3 days)
- Flashlights
- Portable television and radio
- Extra batteries
- Adequate fuel
- Clear communications

Post Natural Disaster Agenda

1. Overview
2. General Health and Safety
3. Physical "Focus-Four" Hazards
4. Chemical and Biological Hazards
5. Equipment Hazards

OVERVIEW

Occupational Safety and Health Act (the General Duty Clause)

- Requires employers to "*furnish to each of his (or her) employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his (or her) employees.*"
- For post-disaster conditions, it is difficult to anticipate all of the **physical**, **chemical** and **biological** hazards a worker may be exposed to.

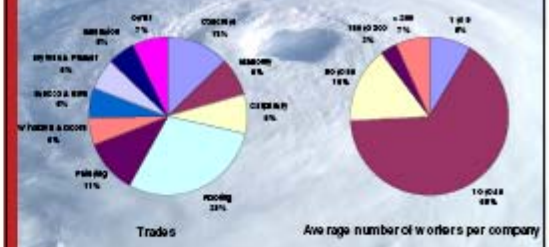
Worker Injuries and Fatalities

- Majority of disaster-related injuries and illnesses occur during clean-up and reconstruction activities.
  - **Electrocution** from downed power lines
  - **Falls** from heights and through openings
  - **Struck-by** impacts from falling debris
  - **Exhaustion** from working extended shifts in PPE
  - **Heat stress** from overexertion and dehydration
  - **Illness** from chemical and biological hazards
  - **Struck-by/Caught-in-Between** trauma from heavy and hand-held equipment

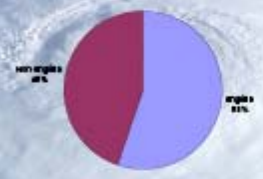
Contractor Survey

- A 2008 survey was administered by the University of Florida to trade contractors in OSHA regions 4 and 6 that either had been involved or, would likely be involved in storm reconstruction in the hurricane-prone southeast U.S.
- Contractors responding to the survey included those trades largely responsible for structural repair and weather-proofing of the building envelope.

Contractor Survey



Contractor Survey



- 100,000 Hispanic workers moved to Gulf coast after Katrina
- Half of all workers in New Orleans were Hispanic; half of these were undocumented

Hazards

- OSHA Region 4; Aug05' – Mar06' (KY, TN, MS, AL, FL, GA, SC, NC)
- 18 fatalities
- 9,500 OSHA interventions
  - Work zone and traffic hazards
  - Missing or improperly used PPE
  - Fall hazards
  - Struck-by object, equipment or vehicle
  - Improper use of aerial lifts

Activities – Post Hurricane Work

Distribution of OSHA Interventions by activity

Post-Disaster Work is Different

- Presence of Floodwater
- Buildings may be Structurally Unstable
- Debris will be everywhere
- Power lines may be down (power may be out) and generators may be needed
- Floodwater may be contaminated with fuels, oil, sewage, and other chemical or biological hazards
- Trees may have been blown down
- Roofs need to be made watertight – quick (tarps)
- Mold growth is a concern
- Asbestos may be encountered
- Critters.

General Health and Safety

- Competent person
- Medical evaluation
  - Physical fitness, immunizations, drug testing
- Deployment planning
  - Safe food and water, shelter, sanitary services, first aid and emergency services
- Personal gear
  - First aid kit, hygiene kit, insect repellant, sunscreen, protective clothing
- Personal protective equipment (PPE)
  - Eye, ear, head, hand, foot and respiratory protection

General Health and Safety

- Personal hygiene
  - Hand hygiene, first aid, decontamination
- Heat stress
  - Heat exhaustion, heat stroke, sunburn, dehydration
- Animals and insects
  - Venomous and disease-carrying animals and insects

Physical (*Focus 4*) Hazards

- Electrocution
  - Downed power lines
- Caught-in-between
  - Trench cave-in
  - Equipment rollovers
- Struck-by
  - Work zone and traffic
  - Structural collapse, falling debris
- Falls
  - Falls from heights and through openings
  - Guardrails and fall arrest systems
  - Roofing

Chemical & Biological Hazards

in Flood water and in Confined Spaces

- Decontamination
- Hydrogen sulfide
- Carbon monoxide
- Lead
- Asbestos
- Mold
- Silica and nuisance dust
- Discovered unknown chemicals
- Human and animal remains
- Cleaning agents

Equipment Hazards

- Equipment of Particular Concern
  - Cranes
  - Aerial lifts
  - Wood chippers
- Portable equipment
  - Portable generators
  - Chain saws
  - Portable power tools
  - Pneumatic tools
  - Ladders

General Health and Safety Precautions

Competent Person (must be assigned to the project)

- A competent person is someone who:
  - Is capable of identifying existing and predictable hazards in the surroundings or working conditions that are unsanitary, hazardous, or dangerous to employees, and…
  - Has the authority to take prompt corrective measures to eliminate them

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Workers

- 90% of accidents are caused by unsafe behavior. Unsafe conditions are rarely the sole cause of accidents.
- Workers have the most impact on improving safety on the jobsite. While supervisors can influence safety performance, ultimately it is the Workers who control their own actions and impact their own safety.

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Ensure that Workers are Fit

Medical Evaluation

- Physical fitness
  - Necessary to evaluate a worker's fitness to safely perform potentially hazardous or stressful work
  - Pre-event medical screenings may also provide a "baseline" for assessing health effects in workers returning from disaster work
- Immunizations
  - Critical in areas affected by floodwater
  - Polio, measles, influenza, tetanus, diphtheria, hepatitis A and B, encephalitis, rabies and cholera
- Drug testing

Reconnaissance May be Needed

Pre-Deployment Planning

- Safe food and water
  - Natural disasters can disrupt food and water supplies
  - Provisions for safe drinking water and food should be made in advance of a deployment to a disaster area
  - If a trusted source of potable water is not available, water should be bottled, boiled or disinfected
  - Food should be carefully selected (to avoid the risk of gastrointestinal illnesses or chemical poisoning); avoid agricultural food products or those requiring refrigeration; use MREs, canned, instant foods, etc.
  - Workers should avoid using improvised surfaces (e.g., racks from damaged or abandoned refrigerators) for cooking food or for boiling water to avoid exposure to heavy metals

Pre-Deployment Planning

- Shelter
  - Temporary shelter may not be available after a hurricane, requiring significant daily travel to and from the work site; trailers, RVs and even tents
- Sanitary services
  - Natural disasters such as hurricanes can disrupt and even damage sewage systems and other basic sanitary services; make provisions for sanitary and solid waste (e.g. portable toilets, clothes washers and showers)
- Portable power
  - Portable electric generators
  - Propane, gasoline, diesel

Pre-Deployment Planning

- First aid and emergency services
  - Emergency services (e.g., 911) may be disrupted
  - Identify agencies providing temp emergency services
  - Be equipped and trained to provide first aid and means of evacuation
  - Provide adequate number and type of tested fire extinguishers
  - Cell phones, hand crank operated radios

Properly Equip the Workers

Personal Gear ("Kits")

- First aid kit (perhaps more extensive than typical)
- Hygiene kit
- Insect repellant
- Sunscreen
- Standard work and protective clothing

Properly Equip the Workers

Personal Protective Equipment

Eye and face protection
Hearing protection
Head protection
Hand protection
Foot protection
Respiratory protection
Fall protection

Personal Protective Equipment

- Eye and face protection
  - 10% of all construction worker injuries are eye injuries
  - Safety glasses or face shields when working with harmful chemicals or when exposed to flying objects
- Hearing Protection
  - Hearing damage can occur at 90db
  - Ear plugs and ear muffs when exposed to noise from heavy and hand-held equipment
  - Clean or replace regularly
- Head Protection
  - Hard hats when exposed to falling debris, overhead obstructions and accidental head contact with electrical hazards

Hand Safety

- About 22% of all injuries are to the Hands
- Hand Protection
  Snug fit
  Heavy duty rubber gloves for concrete work
  Insulated gloves and sleeves for electrical work
- Protective gloves
  - Thick, cut resistant, water-proof material
  - Combination of gloves
    - Inner cut resistant, washable nitrile
    - Outer disposable latex (4-8mil thickness)

Personal Protective Equipment

- Foot protection
  - Slip resistant, puncture resistant soles
  - Safety-toed when working with heavy equipment or when exposed to falling objects
- Respirators
  - Type depends on contaminant exposure
  - NIOSH approved
  - Medical evaluation and training prior to use

Respirators

- Dust masks
  - Not NIOSH approved
  - Not for hazardous atmospheres
  - Comfort from allergens
- Filtering face-pieces
  - Protection from dust and mists
  - Do not provide protection from LEAD or ASBESTOS
  - Do not provide protection from gases or vapors
- Half-face respirators
  - Can protect from most vapors and gases
  - Change filter cartridge regularly

Respirators

A.

B.

C.

D.

Respirators

- Powered air purifying respirators (PAPR)
  - Battery-powered fan for breathing comfort
  - Helmet or hood
  - Change filter cartridge regularly
- Self-contained breathing apparatus (SCBA)
  - Closed system with bottled air
  - Usually full face and body protection
  - Entry and escape from atmospheres that are immediately dangerous or oxygen deficient

Special Concerns in Hurricane Areas

Personal Hygiene

- Floodwater can be contaminated with microorganisms, sewage, industrial waste, chemicals and other substances that can cause illness and death.

Personal Hygiene

- Hand washing and disinfecting
  - Soap and clean water or waterless alcohol hand rub
  - After clean-up or decontamination work, toilet use
  - Before work breaks, food preparation and eating
  - Prevents disease transmission
- Hand washing
  - Non-potable water can be bleach disinfected with ¼ teaspoon of bleach per gallon of water
  - Allow solution to stand for 30 minutes
  - Label containers "bleach disinfected water – DO NOT DRINK"
- Hand disinfection
  - 3 quarts rubbing (isopropyl) alcohol to 1 quart water
  - Apply using spray bottle, allow hands to air dry

Personal Hygiene

- First aid
  - Wash wounds immediately with soap and clean water or waterless, alcohol based hand rub
  - Seek immediate medical attention if wound becomes infected – e.g., red, swollen or emits discharge
- Decontamination
  - Tools, surfaces and equipment
  - Soap and clean water (preferred; minimize corrosion)
  - ¼ cup of bleach per 1 gallon of water if only contaminated water is available; allow to stand 30 min
  - Prepare fresh solutions at least daily just before use
  - Wipe objects thoroughly and let stand for 10 min before drying
  - Label containers "bleach disinfected water – DO NOT DRINK"

Heat Stress

- When the body is unable to cool itself, heat exhaustion and heat stroke can occur.
- Risk Factors
  - High temperature (>70F) and humidity
  - Direct sun or heat
  - Limited air movement
  - Physical exertion
  - Poor physical condition
  - Some medications
  - Acclimation

Heat Stress

- Heat exhaustion
  - Headaches, dizziness, fainting
  - Weakness and moist skin
  - Irritability and confusion
  - Nausea
  - May lead to heat stroke
- Heat stroke
  - Dry, hot skin
  - Loss of consciousness
  - Seizures or convulsions
  - May lead to death

Heat Stress

- Prevention
  - Shaded work areas or break areas
  - Frequent breaks
  - Ventilation (e.g. fans)
  - Potable water; 1 cup every 15-20 min
  - Lightweight, light colored, loose fitting clothing
  - Avoid alcohol, caffeine, heavy meals
- First aid (heat stroke)
  - Call 911* immediately
  - Loosen or remove outer clothing
  - Provide cool drinking water
  - Fan and mist (or wet) the person with cool water

Heat Stress

- Sunburn
  - Can cause extreme discomfort and subsequent cataracts and skin cancer, including often fatal melanoma
  - Wraparound sunglasses that provide 100% ultraviolet (UV) ray protection should be worn for eye protection
  - A broad-spectrum UVA and UVB sunscreen and lip screen with at least SPF 15 should also be used
- Dehydration

Animals and Insects

- Rodents and wild or stray animals
  - Dead and live animals can spread diseases directly (bites, scratches, etc.) or indirectly (fleas, ticks, feces, etc.)
  - Avoid live animals; remove dead animals immediately
  - Immediate first aid to avoid primary and secondary infection
- Insects, spiders and ticks
  - Long pants, sleeves, socks and gloves
  - Repellants containing DEET or Picaridin
  - Immediate first aid to avoid secondary infection
  - Severe allergic reactions (severe swelling, nausea, difficulty breathing, etc.)

Animals and Insects

- Mosquitoes
  - Waterborne disease transmission
- Fire ants
  - Highly aggressive, swarming
  - Wound pathway for infection, severe allergic reactions
- Venomous spiders
  - Brown recluse and black widow
  - Concealed locations
  - Symptoms may include nausea, profuse perspiration, tremors, labored breathing, restlessness, increased blood pressure and fever
  - Clean bite area, apply ice to slow venom absorption, elevate and immobilize extremity, seek medical attention immediately

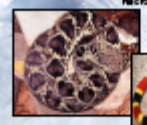
Animals and Insects

Animals and Insects

- Snakes
  - Often displaced by flood water; concealed under debris
  - Striking distance ½ length of body
  - Avoid all contact; allow snake to escape
  - Wear heavy gloves and boots at least 10" high
- If bitten…
  - Call 911* immediately
  - Note color and shape of head
  - Keep victim calm
  - Lower bite area as low as possible below the heart
  - Cover bite area with clean dry dressing
  - Do not attempt to cut the wound or attempt to suck out the venom

Snakes

Necrotic tissue from hemotoxin



Cottonmouth (water moccasin)
- Very aggressive
- Near aquatic environments
- Triangular shaped head
- Dark brown or nearly black
- Can bite up to 1 hour after "death"

Worksite Hazards Control Plan

- Conduct a preliminary worksite inspection before entering a damaged building or operating vehicles or equipment on roadways
- Report obvious hazards (downed power lines, gas leaks, etc.) to appropriate authorities before entering a site or a severely damaged or flooded building; immediately evacuate the site.
- Enter buildings or other enclosed spaces using only battery-powered equipment; do not use electric or ignition source lighting, tools or equipment.
- Use a wooden probe (e.g. stick or pole) to check flooded areas for pits, holes, and protruding objects.

Worksite Hazards Control Plan

- Use life-vests when engaged in activities that could result in deep water exposure.
- Only a registered professional engineer or architect should certify structural stability.
- Immediately disconnect electrical power and gas or propane to avoid fire, electrocution, or explosions.
- Develop and emergency site evacuation plan.
- Use extreme caution when handling containers holding unknown or known toxic substances.
- Contact the Environmental Protection Agency (EPA) for information on disposal (800) 424-8802.

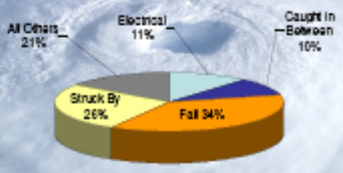
PHYSICAL (Focus Four) HAZARDS

Focus Four Hazards

- 911 2,998 (deaths)
- Katrina 1,836
- Iraq 4,079
  8,913
- U.S. Construction; 8,851 deaths (2001-2008)
- On average, 1,000-1,200 construction workers are killed in the U.S. each year
- 80% of fatalities are caused by *focus-four* hazards

Fatality Data of Focus Four Causes

2003 – 2006; 3720 Total Fatalities



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Source: Bureau of Labor Statistics

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Top 11 Focus Four Citations (FY 2007)

Subpart	Citations	Total Dollar Value	Description
1926.451	9,118	$7,733,380	Scaffolding
1926.501	6,649	$6,929,663	Fall Protection Scope/Applications/Definitions
1926.1053	2,938	$1,338,379	Ladders
1926.453	1,785	$1,009,618	Aerial Work Platforms
1926.503	1,742	$791,487	Training Requirements – Fall Protection
1926.20	1,701	$1,149,144	General safety and health provisions – Construction
1926.100	1,617	$877,947	Head protection
1926.651	1,469	$1,877,868	Specific excavation requirements
1926.454	1,338	$379,638	Training requirements – Scaffolding
1926.404	1,137	$886,638	Electrical, Wiring Design and Protection
1926.652	1,118	$2,864,699	Excavations, Requirements for Protective Systems

Citation statistics from Federal OSHA data for OSHA fiscal year 2007

Fatality Statistics

- 85% of all citations and 90% of dollars applied as fines are related to the Focus Four Hazards
- 79% of all fatalities are related to the Focus Four Hazards
- Many activities involve two or more focus four hazards

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NIOSH FACE

- NIOSH Fatality Assessment and Control Evaluation program (FACE) examples of fatalities caused by the Focus Four hazards
  - Electrocution
  - Struck-by
  - Caught-in/Between
  - Fall

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Electrical Hazards

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Causes of Electrocution Fatalities

- Contact with overhead (or downed) power lines
- Contact with live circuits in panels
- Poorly maintained cords and tools
- Lightning strikes

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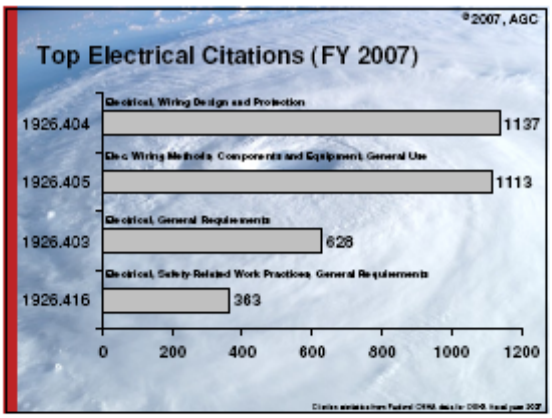
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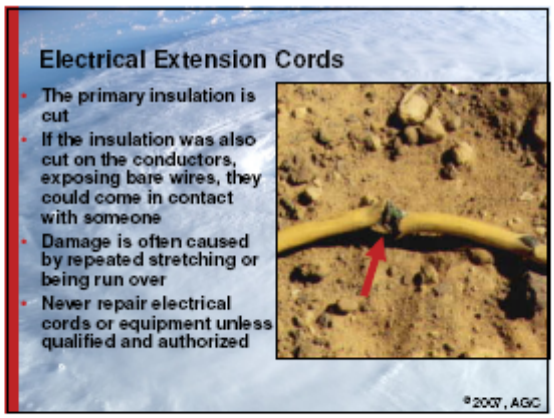
Top Electrical Citations (FY 2007)
Electrical, Wiring Design and Protection
1926.404
1137
Elec Wiring Methods, Components and Equipment, General Use
1926.405
1113
Electrical, General Requirements
1926.403
628
Electrical, Safety-Related Work Practices, General Requirements
1926.416
363
0
200
400
600
800
1000
1200


Electrical Extension Cords
The primary insulation is cut
If the insulation was also cut on the conductors, exposing bare wires, they could come in contact with someone
Damage is often caused by repeated stretching or being run over
Never repair electrical cords or equipment unless qualified and authorized
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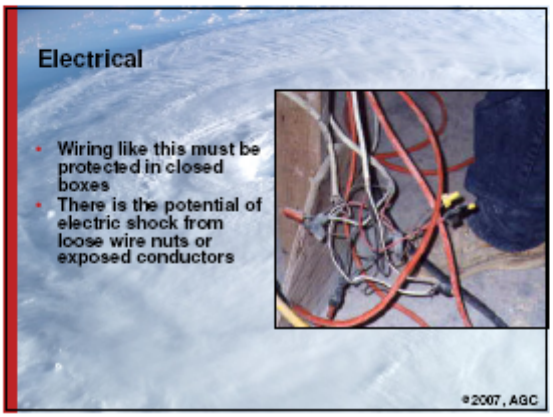
Electrical
Wiring like this must be protected in closed boxes
There is the potential of electric shock from loose wire nuts or exposed conductors
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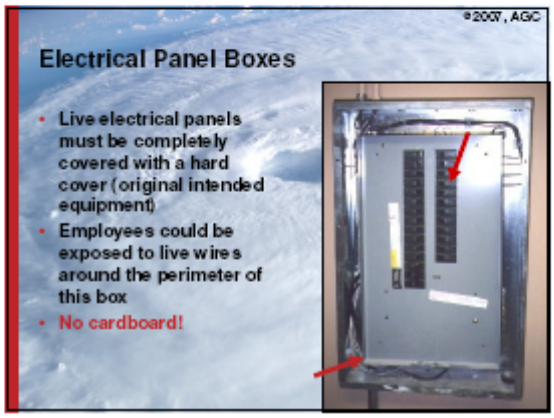
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Electrical Panel Boxes
Live electrical panels must be completely covered with a hard cover (original intended equipment)
Employees could be exposed to live wires around the perimeter of this box
No cardboard!

An Electric Arc

- Typically lasts less than a second
- Has extremely high radiant (heat) energy
- Is explosive in nature (exerts great force)
- Can ignite or melt conventional work clothing

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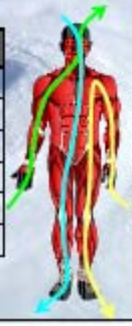
Electrical Harm

Estimated Effects of AC Currents (U.S. Standard 60 Hz)	
1 milliamp (mA)	Barely perceptible
16 mA	Maximum current an average man can grasp and "let go"
20 – 30 mA	Paralysis of respiratory muscles
100 mA	Ventricular fibrillation threshold
2 Amps	Cardiac standstill and internal organ damage
15/20/30 Amps	Common U.S. household breakers



PATH: Harm is related to the path by which current passes through the body.

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Electrical Damage to the Body

- When touching a power line, electricity will attempt to travel to ground
- When electricity travels through the body, it heats up and burns body tissue internally
- Electricity leaves the body violently, causing burns or even blowing an exit hole

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Ground-Fault Circuit Interrupters (GFCI)

- Monitors current flow between the hot and neutral wires
- Trip between 4-6 mA in 1/40th of a second
- Required by the NEC…
  - On all temporary power circuits
  - When there are wet conditions
  - On portable generators over 5,000 watts
- Must be tested regularly

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Assured Equipment Grounding Program

- Inspection is your primary protection
- Best practice recommends documented testing every 3 months
- Color coding most common:

Winter | Spring | Summer | Fall

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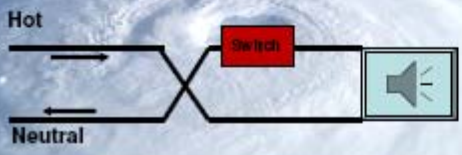
Reverse Polarity Diagram



Tool could be hot with the switch off

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Reverse Polarity

- Hot wire and neutral wire are reversed
- Even though a switch is off, the circuit could be hot
- GFCIs may not protect from reverse polarity

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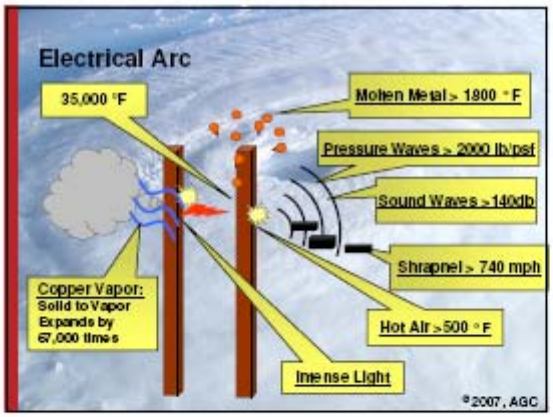
Electrical Arc
35,000 °F
Molten Metal > 1800 °F
Pressure Waves > 2000 lb/psf
Sound Waves > 140db
Shrapnel > 740 mph
Copper Vapor:
Solid to Vapor
Expands by
67,000 times
Hot Air > 500 °F
Intense Light
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The Best Way to Work on Energized Electrical Equipment?
DON'T!
• Shut it down and lock it out
• Establish an electrically safe working condition
• Buildings damaged by hurricanes or floods should be de-energized and locked out until inspections and repairs deem the electrical distribution system safe.
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Lock-out / Tag-out
DANGER
DANGER
DO NOT THROW SWITCH
A LIFE IS ON THE LINE
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The Best Way to Work on Energized Electrical Equipment?

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Lock-out / Tag-out

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Downed Power Lines

- Never assume a circuit is de-energized because it does not emit sounds or sparks
- Never assume coated wire is safe
  - Coating does not always mean wire is telephone, CATV or fiber optic
  - Coating may only be for weatherproofing, not insulation
- Never approach a downed power line
  - Potential can radiate outward through the ground causing voltage differentials; "step voltage"

Downed Power Lines

- Never drive over downed power lines
- If contact is made by vehicle with a power line…
  - Remain calm
  - Stay in vehicle (unless on fire)
  - Call for help
  - Warn non-emergency personnel to keep away


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Downed Power Lines
Assume all power lines and electrical equipment are energized
Downed or low hanging power lines can energize other objects (even without touching)
– Equipment, vehicles, buildings, trees, fencing, telephone or CATV lines, entangled debris, ground, pipes, etc.
Circuits do not always open (turn off) when a power line falls into a tree or on the ground
ROAD CLOSED TO THRU TRAFFIC


Struck-By Hazards
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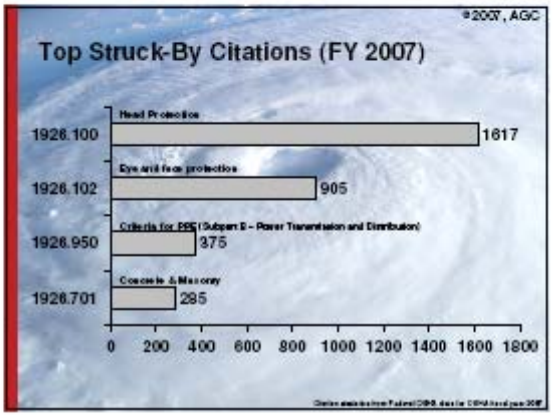
©2007, AGC
Top Struck-By Citations (FY 2007)
Head Protection
1926.100
1617
Eye and face protection
1926.102
905
Criteria for PPE (Subpart S – Power Transmission and Distribution)
1926.950
375
Concrete & Masonry
1926.701
285
0 200 400 600 800 1000 1200 1400 1600 1800

Causes of Struck-by Fatalities

- Falling Objects
  - Rigging failure
  - Loose or shifting materials
  - Equipment tip-over or malfunction
  - Lack of overhead protection
- Vehicle and Equipment Strikes
  - Backing incidents
  - Workers on foot
- Flying Objects

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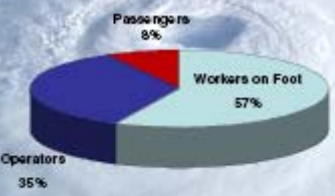
Highway Equipment Related Fatalities



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Equipment & Vehicle Hazards

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Striking Workers on Foot

- Shadows can hide workers
- Workers should always wear high visibility clothing

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High Visibility Clothing

- High visibility clothing (reflective garments) should be worn whenever their work place contains hazards related to low visibility or when they work near vehicles or moving equipment

Caught-In-Between Hazards

Causes of Caught-in Fatalities

- Trench/excavation collapse
- Rotating equipment
- Unguarded parts
- Equipment rollovers
- Equipment maintenance

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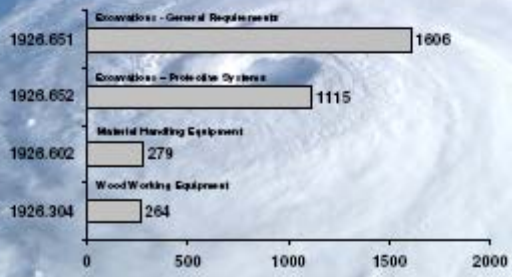
Top Caught-in-Between Citations (FY 2007)



Poor Worker Position

- This worker is out of the driver's mirror view
- Workers should never get into blind spots of operators and should never get between pieces of equipment unless the equipment is secured.

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Maintenance Hazards

Workers under equipment that is insufficiently supported

Pinned In/Under Equipment

- A truck driver was working between the frame and dump box of a dump truck
- The dump box dropped suddenly, crushing his head
- Truck boxes should always be independently blocked

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Preventing Maintenance Hazards

- Lockout equipment
  - Place an energy-isolating device over the energy source
  - Bleed off stored energy
  - Lock it until the repair/maintenance work is completed
- Tag out the equipment
  - Place a tag over the energy source and start-up mechanisms
  - Label it with a written warning that remains in place until the work is done
  - Block disabled equipment

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Equipment Rollover
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Equipment Rollover
When there is a roll-over hazard, there must be a seat belt
Always wear the seat belt
Only ride in the seat provided
No riding in buckets, on fenders or on steps
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Exiting Equipment

- Do not jump from equipment
- Use three point contact at all times
- Be sure of your footing
- Do not strain your shoulders
- Be sure steps are clear of mud and debris

Transporting and Unloading Materials

- Pipes, stacks of material, etc., can roll off a truck when bindings are removed
- Unsecured material can fall from forklifts and other equipment

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- No more than 4:1 height to base ratio
- Secure all loads
- Stack, block, and interlock
- Keep at least 6' back from edges
- Be prepared for adverse weather

Operating Equipment in Reverse

- Have audible back-up alarms
- Have a spotter with reflective vest to direct the operator if view is restricted
- Keep adequate clearance behind the vehicle
- Always pay attention to backing equipment

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Transporting Equipment

- Trailer secure and on a level surface
- Inspect the deck for debris, blocking or chains
- Have a spotter help properly align the equipment up the ramps
- Be sure equipment is properly secured

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Trench & Excavation

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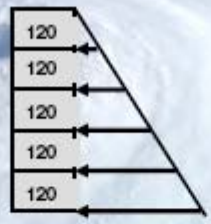
Utility Strikes

Soil Mechanics

- Soil weighs about 100 – 140 lb/cu.ft.
- Each foot of depth adds more side pressure
- Once the pressure exceeds the ability of the soil to support itself, failure is possible
- Most cave-ins are "shallow" and occur after drying of soil banks (e.g. after work breaks)



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Basic Requirements

- CFR 1926.650-654
- Work must be supervised by a competent person Protection is required over 5 feet deep or if there is a possibility of a cave-in
- Excavations must be inspected daily and/or with changes
- Access/Egress is required over 4 feet deep and no greater than 25 feet of horizontal travel
- A rescue plan must be in place

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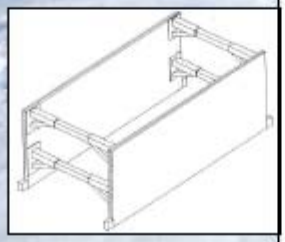
Trench Shields or Boxes

- Can be used with all classes of soils
- Can be moved horizontally with workers inside
- Worker must not venture out the shields
- Trench boxes must extend at least 18 inches above the ground
- Spoils and equipment back at least 2 feet



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Barricade Excavations

Excavations more than 6 feet deep must be barricaded or marked if they are not readily visible

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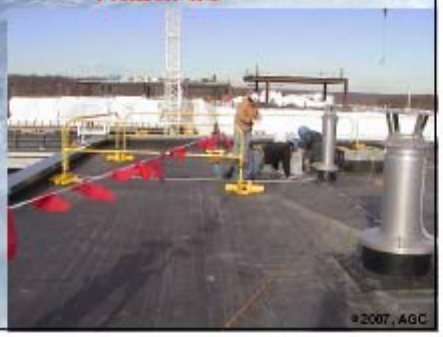
Rescue

- Rescue plan must be in place
- Rescue of a buried worker is a slow, tedious and dangerous process
- Avoid secondary casualties

You are on your own...

Fall Hazards



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Causes of Fall-Related Fatalities

- Unprotected sides, edges and holes
- Improperly constructed walking/working surfaces
- Improper use of access equipment
- Failure to properly use PFAS
- Slips and trips (housekeeping)

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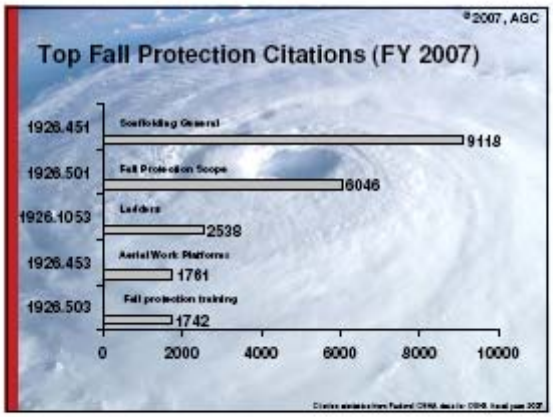
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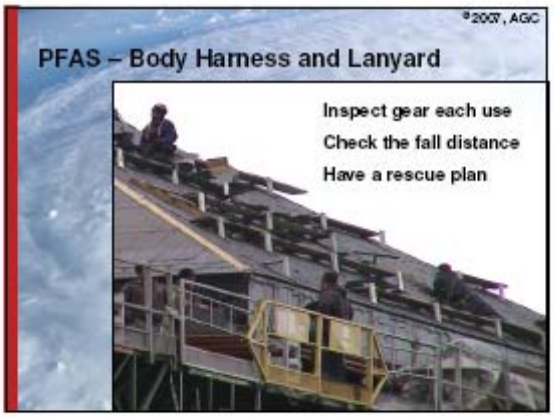
Top Fall Protection Citations (FY 2007)
1926.451
Scaffolding General
9118
1926.501
Fall Protection Scope
6046
1926.1053
Ladders
2539
1926.453
Aerial Work Platforms
1761
1926.503
Fall protection training
1742
0
2000
4000
6000
8000
10000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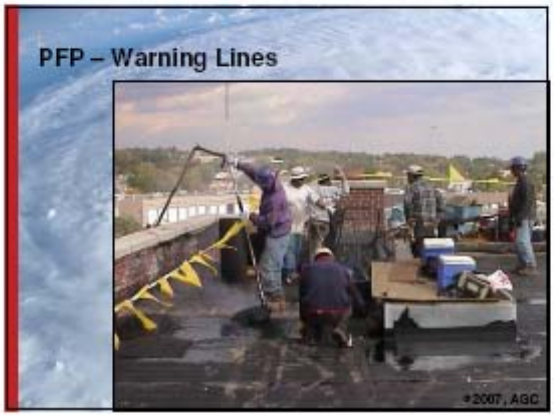
PFAS – Body Harness and Lanyard
Inspect gear each use
Check the fall distance
Have a rescue plan


PFP – Warning Lines
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Warning Lines
Fall restraint
– Employees performing roofing work outside warning lines must be protected by fall restraint or positive fall protection systems
– Parapet up to at least 39 inches
Safety monitors
– OSHA allows the use of safety monitors in certain instances
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Open Sided Floors

- Open edges on decks, roof, mezzanines, etc. over 6 feet high must be protected
- Guarded wall openings above 6 feet:
  - Work occurs on stepladders near a window opening with 42" sill height or less.
  - The window sill is less than 39" above the floor.
  - Wall studs are on 24" spacing.

Edges

- Stay away from edges unless work requires it
  - Some work practices, such as precast concrete erection, allow employees to work under a fall protection plan without being positively protected
  - Employees must be properly trained and equipped to work in these instances
- Always face the edge
- Work from your knees

PFP - Guardrails

Entanglement

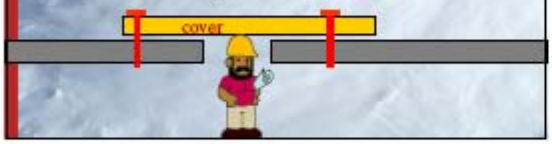
Covers for Roof and Floor Openings (2"+ in least dimension)

Covers shall support 2 times the weight of employees, equipment and materials that may be imposed on the cover

Skylights must meet the strength requirements

Covers are to be secured

Covers are to be clearly marked "Hole" or "Cover"



Penetrations

- Covers
  - Any signage used onsite should be adequately communicated to all employees, including those who may not speak or read English
- Guardrails
  - Openings may also be protected with guardrails 42 inches high

Access Ways

- Proper guardrails and handrail systems should be installed and maintained throughout the project
- Offset guardrails are recommended
  - Offset guardrail systems are an ideal way to protect areas where access must be made through perimeter protection.
- Watch for tripping hazards at tops of ladders and stairs

Building Demolition

Building Demolition

- Involves similar hazards that arise during other construction activities
- Hazards
  - Increased risk of struck-by/caught-in-between; exposure to lead and asbestos
- Prevention
  - Engineering survey to determine possibility for unplanned collapse
  - Use appropriate PPE
  - Shut-off or cap all utilities
  - Brace or shore floors, walls and ceilings that have been damaged and which workers must enter
  - Guard wall openings to a height of 42 inches

Building Demolition

- Prevention
  - Cover and secure floor openings; floor openings used for disposal must not be more than 25% of floor area; opening must be protected with barricades 42 inches high and 6 feet from edge
  - Inspect all stairs, passageways and ladders; illuminate stairways
  - Use enclosed chutes with gates on the discharge end for debris disposal
  - Determine types of hazardous or flammable chemicals or materials that may have been used in the structure
  - Demolition must proceed from the top down; structural or load-bearing members on any floor must not removed until all stories above have been removed

Building Demolition

- Prevention
  - Post signage at the demolition site warning of falling materials
  - Protect entrances with canopies for a minimum of 8 feet from building and no less than 2 feet wider than the entrance; canopies must be able to support 150psf
  - Falling debris or debris piles must not exceed the design load of any floor
  - No wall section one story or higher shall be permitted to stand alone without lateral bracing unless designed to stand alone

Building Demolition

- Prevention
  - All walls must be left in stable condition after each work shift
  - Walkways or ladders must be provided to allow workers to safely reach or leave any scaffold or wall
  - No worker is permitted in any area using mechanical demolition (e.g., headache ball, clamshell) except those necessary to perform such operations
  - The weight of a wrecking ball must not exceed 50% of the crane's rated capacity
  - The ball must be connected to the load line with a swivel connection to prevent twisting of the load line
  - Demolition must be continuously supervised by a competent person

Material Handling Plat-Forms & Hoist Areas

- Material handling platforms must have guardrails
- When the guardrails are opened to receive material, workers must be tied off
- Gates are preferred to removable rails

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Slip and Trip Hazards

- Watch trip hazards
- Here trash creates a trip hazard for everyone in the building
- Practice good housekeeping!

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Stairways

- Stair pans should not be used for access until poured, and until guardrails and handrails installed
- Be sure all debris is removed immediately

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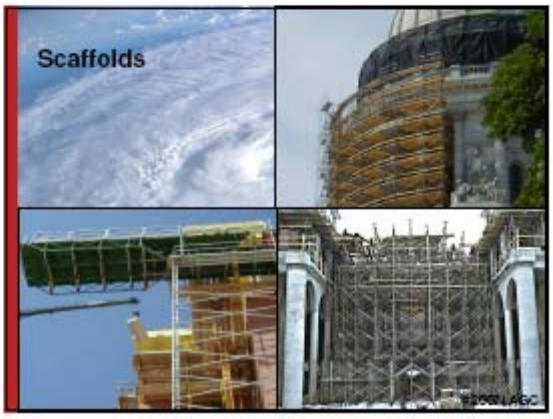
Scaffolds



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Scaffold Requirements

- Be on a firm foundation with base plates
- Be plumb, square and adequately braced
- Have a fully planked work deck
- Have guardrails over 10 feet
- Be tied-in over 4:1 height to base ratio
- Have an adequate means of access and egress

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Access

Do not access scaffolding by means of the cross braces

- Stair tower for access, with guardrails

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Access

Ladder platform | Ladder frame | Ladder tower with gate

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Baker-type Scaffolds

- Baker scaffolds can be unstable
- Never use a double stack without outriggers
- A minimum of three wheels must be locked when employees are working on the platform.
- Consider when scissor lifts are more appropriate.
- Bottom rung of access ladder cannot be more than 24 inches high

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Falling Object Protection 1926.451(h)

- Guard rails 38"-45"
- Toe boards (3½") at edges of platforms
  - Required when people are working in or entering into the lower level near the area
- Use panels or screens when accessed from below
- Barricade areas below
- Use canopies where walkways cross underneath

Roof Tarping and Repair

Roof Tarping and Repair

- First 100 days following Hurricane Katrina
  - Corp of Engineers oversaw the installation of blue plastic sheeting/tarps on over 107,000 roofs
  - Fall protection interventions at 75% of the work sites
  - Safety-monitoring systems were not established and fall protection (harnesses, lanyards, life lines, connectors, anchorages, and anchorage points) was not used or was used improperly
  - Improper use of ladders, shock hazards from power lines and power tools, and hazards from nail guns
  - Steep, slippery and deteriorating roof surfaces

Roof Tarping and Repair

- General PPE
  - Hard hat for overhead impact or electrical hazards
  - Eye protection with side shields
  - Gloves chosen for job hazards expected (e.g., heavy-duty leather work gloves for handling debris with sharp edges)
  - ANSI-approved protective footwear with deck shoe or "sneaker" skid resistant soles

Roof Tarping and Repair

- Falls
  - Limit access/set up controlled access zones
  - Residential roofs where the fall distance < 25 feet measured from the eave to ground level and the roof pitch < 9:12
    - Use conventional fall protection system, safety monitoring system (monitors and warning lines), or roof slide guards
    - Slide guards on roofs with greater than 6:12 pitch should have a maximum of 8 feet spacing

Roof Tarping and Repair

- Falls
  - Roofing work on low-slope commercial roofs (< 4:12) with unprotected sides and edges 6 feet or more above lower levels:
    - Workers must be protected from falling by guardrail systems, safety net systems, or personal fall arrest systems, or a combination thereof
    - On roofs that are <50 feet in width, the use of a safety monitoring system alone is permitted
  - Roofing work on steep pitched roofs (> 4:12) with unprotected sides and edges 6 feet or more above lower levels:
    - Workers must be protected from falling by guardrail systems with toe boards, safety net systems, or personal fall arrest systems

Roof Tarping and Repair

- Falls
  - Cover or guard holes and openings as soon as they are created. Covers must support two times the weight (body, equipment, materials) that may be imposed
  - Permanently mark covers over holes "Danger – Roof Opening"
  - When installing plastic sheeting on roofs, permanently mark areas where structural support is inadequate "Danger – No Step"
  - Control access both outside and inside the structure; keep occupants out of spaces where roofs are being worked overhead

Roof Tarping and Repair

- Temporary tarping
  - Select tarps constructed of sheeting that is non-reflective and has a textured surface to reduce slips
  - Roll tarp up on ground
  - Lap tarp at roof, intersection or seam edge
  - Roll tarp out walking backwards in front of tarp; nail off to wood furring strips
  - Do not step or walk on tarp, especially if wet

Chemical and Biological HAZARDS

Floodwater

- Infectious bacterial organisms
  - E. coli, Salmonella, Shigella (intestinal bacteria)
  - Hepatitis A, typhoid, paratyphoid and tetanus*
  - Ingestion
  - Nausea, vomiting, diarrhea, abdominal cramps, muscle aches and fever within hours of exposure
  - * also transmitted by soil through broken areas of skin; affects nervous system causing severe muscle spasms over a period of weeks and death if untreated
- Infectious viral organisms
  - Encephalitis*, West Nile virus
  - Stagnant waterborne pathogens from mosquito bites
  - Fever, headache, flu-like symptoms followed by severe neurological maladies and often death after incubation period (days to weeks)
  - * also bacterial and protozoan variants

Floodwater

- Agricultural and industrial chemicals
  - Carried great distances from source
  - Toxic, poisonous, flammable or explosive
  - Ingestion, inhalation and absorption through skin
  - Symptoms and severity vary widely by chemical (or combinations of chemicals) and dose exposure
  - Non-acute symptoms may include headaches, skin rashes, dizziness, nausea, excitability, weakness and fatigue
  - Disinfection (boiling, bleach, etc.) does not remove chemicals

Floodwater

- Never assume water in flooded area is safe
  - Ensure all workers entering flooded areas have up-to-date immunizations (*tetanus* within last 10 years)
  - Ensure all workers have proper PPE and flood water safety training
  - Provide bottled drinking water and sealed food from outside of flooded areas and areas surrounding
  - Never consumer agricultural products from potentially exposed areas
  - Do not use potentially contaminated water for cooking, cleaning dishes, brushing teeth, making ice, etc.
  - If food or drinking water has potentially been exposed to floodwater, it must be disposed of

Floodwater Removal

Floodwater Removal

- Workers involved in floodwater removal or initial building entry into previously flooded buildings regardless of trade.
  - Contaminated floodwater, debris or buildings; fuels, oil, sewage, and other chemical or biological substances
  - Dangerous animals
  - Explosive, flammable and toxic atmospheres; see 'hydrogen sulfide'
  - Unstable structures, falling debris and confined spaces
  - Floodwater equipment hazards; pumps, generators, etc.
  - Drowning and entrapment hazards; submerged debris

Floodwater Removal

- General PPE
  - Hard hat for overhead impact
  - Eye protection with side shields
  - Gloves chosen for job hazards expected (e.g., heavy-duty leather work gloves for handling debris with sharp edges and watertight protective gloves
  - ANSI-approved waterproof footwear
  - Respiratory protection as necessary
    - N, R, or P95, filtering face pieces for nuisance dusts (e.g., dried mud, dirt and silt) and mold
    - Respirators for environments not immediately dangerous to life and health (IDLH)
    - SCBA for IDLH (oxygen deficient, toxic) environments

Floodwater Removal

- Limit access and set up controlled access zones
- Inspect the work area for downed or damaged power lines, electrical equipment or gas leaks; notify utility and EMS; immediately evacuate site
- Verify location of all utilities
  - Shut off, lock-out or disconnect utilities; notify utility before controlling their utilities
- Purge lines, tanks, and equipment containing hazardous materials before repair work
  - Use air monitoring equipment to determine if any hazardous conditions remain
  - Use forced ventilation and respiratory protection (PPE)

Floodwater Removal

- Ensure that a competent person inspects building before entry; identify hazardous conditions
  - Use a wooden probe (e.g. stick or pole) to check flooded areas for pits, holes, and protruding objects.
  - Use life-vests when engaged in activities in or near floodwater of unknown depth
  - Assume all floodwater to be chemically and biologically contaminated
- Assess the presence, contents, and condition of tanks and equipment that might contain hazardous materials; avoid disturbing until after the assessment is done and a plan of action determined

Floodwater Removal

- Pump remaining floodwater to storm (not sanitary!) sewer or approved onsite run-off and retention (R/R)
  - Avoid using electric or open ignition (spark) source lighting, tools or equipment including portable generators
  - Do not use gasoline or diesel fueled pumps in enclosed or poorly ventilated spaces
  - Stay upwind of water discharge areas; wear proper face, body and respiratory PPE for splashing and aerosolized discharge
- Ensure that good hygiene, especially hand washing, is practiced before eating, drinking, and smoking
- Ensure that cuts and bruises are protected from contact with contaminated water

Floodwater Removal

- Install temporary structural support
- Provide safe walkways to avoid floodwater or use of exposed building elements or debris
  - Walkways should be at least 18 inches wide and formed using 2x thick wood with lateral support as needed
- Maintain confined space precautions (see 'confined spaces')
- Consider the potential for contact with asbestos, lead or other hazardous debris mobilized by floodwater (see 'asbestos', 'lead', 'mold')
  - Structures built before 1980 are more likely to contain Asbestos Containing Materials (ACM)

Decontamination

- Hand decontamination
  - Soap and clean, running water or alcohol rub
  - ¼ teaspoon bleach per gallon non-potable water
  - 3 parts rubbing alcohol to 1 part water
- Clothing, tools and equipment
  - Soap and clean water if available
  - ¼ cup bleach per gallon non-potable water; allow 10 minutes contact before drying
  - Do not immerse electrical or battery-powered tools; wipe exterior thoroughly with solution soaked rag

Decontamination

- Severe surface decontamination (mold, feces, etc.)
  - 1½ cups bleach per gallon water
  - Douse surface and allow 3 minutes contact
  - Wipe contamination from surface with a paper towel
  - Douse surface again with hand washing solution
  - Wipe remaining residual with a paper towel
- Considerations
  - Do not mix bleach with ammonia
  - Allow all solutions to stand for 30 minutes prior to use
  - Prepare solutions daily if not more frequently
  - Label "bleach disinfected water – DO NOT DRINK"
  - Wear proper PPE; water-proof gloves, eye protection
  - Use N-95 respirator for poorly ventilated or mold infected areas

Confined Spaces

- A confined space has limited or restricted openings for entry and exit and is not designed for continuous worker occupancy
- Permit required
  - May contain potentially hazardous atmosphere
  - May contain converging walls, floors or ceilings that slope inward which could trap or asphyxiate an entrant
  - May contain serious physical hazards
- Utility vaults, tanks, manholes, pipelines, etc.

Confined Spaces

- Identify physical hazards before entry
- Monitor air
  - Oxygen content
  - Combustible gases
  - Toxic gases and vapors
- Layered atmospheres
  - 4 feet in front and to each side of worker
- Implement fall protection, air monitoring, ventilation, lighting, two-way communication and rescue procedures
- Maintain contact at all times with trained attendant or entry supervisor

Hydrogen Sulfide

- Hydrogen sulfide (H_2S) is a colorless, flammable, extremely hazardous gas with a "rotten egg" smell
- Commonly associated with sewage
- Heavier than air and can collect in low-lying and enclosed areas; layered atmospheres
  - Sewer lines, manholes, utility vaults, basements
- Symptoms
  - Low concentrations; irritation to eyes, nose, throat or respiratory system
  - Moderate concentrations; headache, dizziness, nausea, coughing or difficulty breathing
  - High concentrations (>100 ppm); shock, convulsions, coma, death

Hydrogen Sulfide

- Prevention
  - Do not rely on the sense of smell to detect hydrogen sulfide; ability to smell declines with exposure; sense of smell can be lost immediately at 100 ppm or greater
  - Monitor and test air for presence and concentration of hydrogen sulfide by a qualified person
  - If gas is present, the space should be ventilated
  - If gas cannot be removed, use appropriate respiratory PPE, rescue procedures and two-way communications equipment
  - Concentrations above 100 ppm are considered immediately dangerous to life and health (IDLH) and a SCBA is required
  - Eliminate potential ignition sources

Carbon Monoxide

- Carbon monoxide (CO) is a colorless, odorless, toxic gas
- Caused by gasoline-powered tools and equipment in spaces without adequate ventilation
  - Portable generators, concrete saws, compressors, pumps, power trowels, space heaters, etc.
- Symptoms
  - Little or no warning
  - Headaches, dizziness, drowsiness, tightness in chest, nausea, death

Carbon Monoxide

- Prevention
  - Never use generators in enclosed or partially enclosed spaces (e.g. garages)
  - Ensure 3-4 feet clearance on all sides to ensure adequate ventilation
  - Do not use generators near doors, windows or air intake vents
  - Ventilate work areas with fresh outdoor air
  - Consider use of electric or battery-powered equipment

Lead

- Although many uses of lead have been banned, lead-based products remain in many older homes and buildings
  - Paints, plumbing fixtures, fittings and pipe materials, electrical solder and devices, and many metal alloys
- Significant lead exposure can occur when lead-based paint is removed or disturbed from surfaces
  - Demolition of structures (lead dust)
  - Abrasive sanders, scrapers and grinders (lead dust)
  - Heat guns, cutting torches and welding (lead fumes)
- Lead can be taken off site on workers' clothes, hair, skin, tools and vehicles

Lead

- Symptoms
  - Severe abdominal pain, headaches and loss of motor coordination
  - Damage to nervous system, reproductive system, kidneys and blood forming organs
- Prevention
  - Permissible exposure limit (PEL) of 50 micrograms of lead per m³ of air over an 8-hour period
  - Engineering controls and work practices
    - Restricted access to regulated areas
    - No smoking, eating or drinking in work areas
    - No wearing of PPE in break areas
    - Warning signage and labels

Lead

- Prevention
  - Engineering controls and work practices
    - Work upwind of any plume
    - Use "wet" methods to reduce dust
    - Ventilate and exhaust enclosed work areas; use dust containment, encapsulation and collection equipment
    - Record-keeping; medical, training, exposure measurements, etc.
  - Protective clothing, gloves and respiratory protection
    - Donned and doffed in a containment area
    - Tested and cleaned (or disposed of) between use

Lead

- Prevention
  - Good personal hygiene
    - Washing hands before breaks and eating
    - Removing clothes and showering before leaving worksite
  - Enrollment in a medical surveillance program
- Other resources
  - 29 CFR Part 1926.62
  - 29 CFR 1910.134
  - OSHA 3142

Asbestos

- Although nearly all uses of asbestos have been banned, asbestos products remain in many older homes and buildings
  - Asbestos-cement pipe, floor and roofing felts, dry wall, floor tiles, spray-on coatings and insulation
- Significant asbestos exposure can occur when asbestos products are removed or disturbed
  - Minute fibers released into the air
  - Difficult to see or feel when inhaled
- Asbestos can be taken off site on workers' clothes, hair, skin, tools and vehicles (see "Lead")
- Smokers at higher risk

Asbestos

- Symptoms
  - Asbestosis; a progressive and often fatal lung disease
  - Other lung diseases and cancers
- Prevention (see "Lead")
  - 29 CFR 1926.1101; exposure limits and safety procedures vary depending on the type of work, amount of asbestos, and other factors (Class I-IV)
  - PEL of 0.1 fiber of asbestos per cm^3 over 8-hour period
  - Excursion limit of 1.0 asbestos fibers per cm^3 over a 30-minute period
- Other resources
  - 29 CFR Part 1926.1101; 1910.134
  - OSHA 3096

Mold:

Don't Breathe the Spores

Mold

- Molds (fungi) are microscopic organisms found in both indoor and outdoor environments
- Molds require and organic food source, oxygen, temperatures between 40F-100F and moisture
- Molds have the potential to cause health effects in persons with asthma and other respiratory and immunity disorders
- Identification
  - Sight – usually appear as discolored areas on wall or ceiling surfaces
  - Smell – often produce a foul, musty odor

Mold

- Symptoms
  - Allergy symptoms; sneezing, eye irritation, runny nose, coughing, skin rash
- Prevention
  - Repair source of water entry
  - Remove water and excesses moisture
  - Clean non-porous, inorganic surfaces with detergent-water or bleach-water (corrosion resistant materials only) solution
  - ¼ cup of bleach per gallon of water
  - 1½ cup bleach per gallon of water if visible mold or floodwater contamination

Mold

- Prevention
  - Dispose of porous materials wetted for longer than 48 hours or porous material in contact with floodwater (e.g., drywall, insulation, carpeting, furnishings, etc.)
  - Dispose of all water damaged materials
  - Place mold infected materials in sealed plastic bags and transport directly to outdoors
  - Ventilate and maintain negative air pressure in mold affected areas to prevent spore movement and build-up of chlorine gas; exhaust to outside
  - Deactivate and seal off HVAC system
  - Dry wall and ceiling cavities before enclosing
  - Utilize proper PPE; eye protection, sleeve length gloves (rubber, latex, nitrile), respirator (N-95)

Mold Training

Equipment HAZARDS

Cranes and Aerial Lifts

Cranes and Aerial Lifts

- Electrocution often occurs when the crane boom, load line or load contacts power lines and shorts electricity to ground.
  - Over 90 percent of contacts occur on overhead distribution lines
  - Overhead lines are typically not insulated; any covering is generally a weather protection, not insulation
  - Operators are normally safe if they stay on the equipment
  - Ground personnel are over 8 times more likely to be killed

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Cranes and Aerial Lifts

Cranes and Aerial Lifts

- Maintain a minimum 10 foot clearance from 50 kV or less
- Add 1 foot for every 30 kV over 50 kV, so allow 11 feet clearance for 80 kV, 12 feet for 110 kV, etc.

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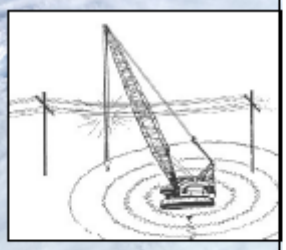
Cranes and Aerial Lifts

- Install flag warnings at proper distances
- If it is difficult for an operator to see the power lines, designate a spotter
- If you cannot maintain adequate clearances, you must have the power company insulate, move or de-energize the line
- Never lose awareness of overhead electrical hazards

Cranes and Aerial Lifts

- Electricity dissipates with the resistance of the ground
- As potential drops, fields develop around the electrified machine
- If you step across a line of unequal potential, you could be electrocuted; step voltage



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Cranes and Aerial Lifts

- Power distribution circuits
  - Will trip (open) for a short period or time (3-20 seconds) to allow faulted object (tree branch, animal, etc.) to clear
  - Relay will reset and re-energize circuit 3 or more times before lockout and manual reset
- If contact does occur…
  - Stay on the machine if possible
  - Warn all others to stay away
  - Notify power company immediately
  - Attempt to move away but assure line is not "connected"

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Cranes and Aerial Lifts

- Bailout procedure
  - Attempt to leave vehicle or equipment only if it is on fire
  - If you must get out, jump with your feet together
  - Do not touch the machine
  - Hop or shuffle out of the area with feet together at all times

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Cranes and Aerial Lifts

- Struck-by and caught-in/between incidents often occur when workers are…
  - Struck by the load
  - Caught inside of the swing radius
  - Fail to assemble or disassemble equipment properly
  - Equipment failure, roll-over or collapse

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Cranes and Aerial Lifts

- Struck by the load
  - Rigging equipment failure
  - Rigging equipment overload
  - Improper rigging technique
- Cranes are to be operated only by qualified and trained personnel
- Inspect equipment and controls prior to use
- Do not move load over workers

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Cranes and Aerial Lifts

- Inspect all rigging
  - Slings must be inspected before each use
  - Slings should have tags that indicate capacities
  - Do not wrap hoist lines around load

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Cranes and Aerial Lifts

- Equipment failure, roll-over or collapse
  - Soft ground, inadequate outrigger support
  - Overload
  - Crane out of level
  - Boom strike
- Ensure crane is on firm, stable surface and level
- Fully extend outriggers
- Do not remove pins unless boom sections are blocked and secure

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Cranes and Aerial Lifts

Cranes and Aerial Lifts

- Do not exceed load chart
  - Use correct load chart for equipment configuration, load weight and lift path
  - Raise load few inches, hold, test balance and braking
- Observe spotter hand signals
- Barricade swing radius
  - Maintain 2 feet distance from fixed objects
  - Barricade accessible areas inside equipment swing radius

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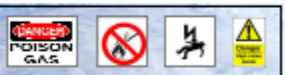
Cranes and Aerial Lifts

- Never move equipment with workers in an elevated platform unless permitted by manufacturer
- Never allow workers to position themselves between the equipment (e.g. railing on basket, snorkel bucket, etc.) and structural members; movement of the equipment can crush the worker (s)
- Use a body harness or restraining belt with a lanyard to prevent workers from being ejected or pulled from the lift.
- Set brakes and use chocks for wheeled equipment



Portable Generators

- Portable generators are commonly used to generate electricity in disaster areas
- Hazards
  - Carbon monoxide poisoning for inhalation of combustion gases in enclosed or partially enclosed spaces (The Consumer Product Safety Commission reports that between 1999 and 2004 portable generators caused 172 CO poisoning deaths in the U.S.)
  - Improper use of power or accidentally energizing other electrical systems (e.g. "back-feed")
  - Fire hazards from damaged fuel lines and improper fueling or fuel storage (fuel lines can become loosened or disconnected during transport and handling)

Portable Generators

- Prevention
  - Inspect generator for damage or loose fuel lines that may have occurred during transportation or handling
  - Keep generator dry; avoid use in wet areas
  - Shut down the generator and allow to cool (5 min) before refueling; do not smoke while refueling
  - Never store fuel indoors
  - Never operate a generator in an enclosed or partially enclosed space
  - Never attach a generator directly to the electrical system of a structure unless a transfer switch is properly installed
  - Ensure generator is bonded or grounded

Portable Generators

- Prevention
  - Ensure 3-4 feet clearance on all sides to ensure adequate ventilation
  - Do not use generators near doors, windows or air intake vents
  - Plug appliances and equipment directly into generator using manufacturer provided heavy-duty, three-prong (e.g. grounded) extension cords out of traffic areas
  - Do not overload generator capacity; RLA vs LRA
  - Use GFCIs
  - Use double insulated power tools
  - If a worker shows signs of CO poisoning – dizziness, headaches, nausea or tiredness, get to fresh air immediately and seek medical attention

Chipper Machines

- Vegetative debris comprises 50%-90% of all hurricane debris
- Chipper machines cut tree limbs into small chips or mulch, reducing truck volume and allowing on-site disposal
- Hazards
  - Caught-in blades and discs resulting in amputation or being drawn into machine (death)
  - Struck-by debris being drawn into or discharged from the machine
  - Hearing loss
  - Face, eye, head or hand injuries

Chipper Machines

- Prevention
  - Follow manufacturer's guidelines
  - Train and closely supervise new or inexperienced workers
  - Guard feed and discharge areas; maintain a safe distance from other workers
  - Avoid debris congestion around feed port to prevent tripping hazards
  - Chock wheels to prevent chipper movement
  - Avoid loose fitting clothing
  - Use PPE; earplugs, safety glasses, hard hats and gloves
  - Use a lockout system to ensure equipment is de-energized before servicing or "un-jamming" machine

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Tree Trimming and Removal

Tree Trimming and Removal

Tree Trimming and Removal

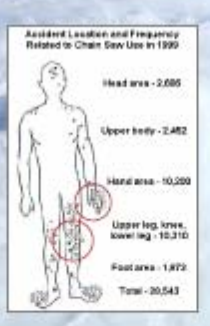
- Watch for power lines that may be in the way of the fall.
- Make sure the tree will fall completely. Hanging trees are very dangerous.
- Always work in pairs so someone is there to assist you and strategize the fall.
- Anticipate the worst

Chain Saws

- Chain saws are one of the most dangerous portable power tools
- Hazards
  - Severe lacerations, amputation, death
- Prevention
  - Check controls and chain tension
  - Fuel at least 10 feet away from ignition source
  - Do not smoke while refueling
  - Use a funnel or flexible hose to fuel saw
  - Never fuel a running or hot saw

Chain Saws

- 40,000 chainsaw injuries a year
- Average injury requires 110 stitches
- 4 weeks recovery is typically required
- Most of these injuries are preventable
- Most injuries are caused by kickback or falling



Chain Saws

Chain Saws

- Prevention
  - Keep both hands on saw and maintain secure footing
  - Clear a retreat path
  - Clear soil, rocks and other debris away from chain path
  - Look for nails, spikes and other metal in tree before cutting
  - PPE; eye, face, ear, head, hand, leg and foot protection
  - Do not wear loose fitting clothing
  - Ensure tree limb will not bind or spring back
  - Be prepared for kickback; utilize chain brake and tip guard
  - Do not cut directly overhead
  - Shut-off saw if carrying more than 50 feet

Chain Saws

- Chain saw chaps
  - Made of nylon or Kevlar
  - Capable of stopping a blade rotating at 2500 fpm
  - These can eliminate the severity of many injuries to the legs
  - Stops the blade by jamming it with fibers between the bar and sprocket

Portable Electric Powered Tools

- Saws, drills, sanders, grinders, welding equipment
- Hazards
  - Electrical shock
- Prevention
  - Never operate equipment while standing in water
  - Never repair electrical cords or equipment unless qualified and authorized
  - If working in damp locations, inspect cords and equipment and use GFCIs
  - Use heavy-duty, three-prong (e.g. grounded) extension cords and tools (do not remove ground prong)
  - Use double insulated power tools
  - Wear proper PPE

Machine Guarding

- Install and maintain all guards on tools and heavy equipment
  - Guards may only be removed when equipment is off and locked out

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Miter Saws

Guards must cover the blade and only retract as the blade cuts through material.

This guard is bolted open

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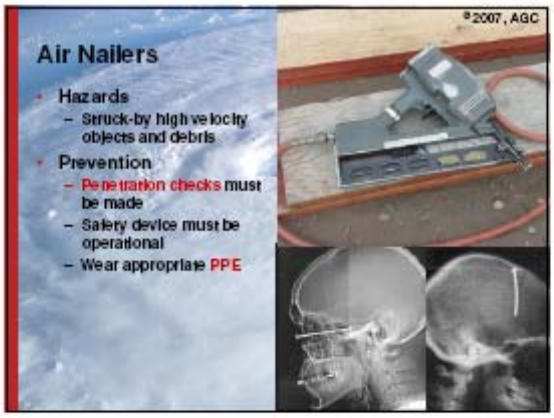
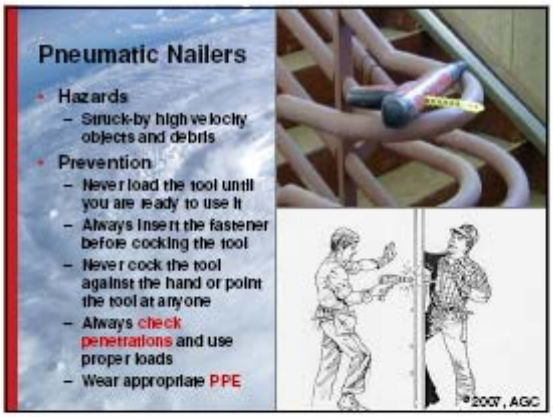
Grinders & Abrasive Saws

- Guards must remain in place and eye protection must be worn
- Use face shields and hearing protection


©2007, AGC
Air Nailers
Hazards
– Struck-by high velocity objects and debris
Prevention
– Penetration checks must be made
– Safety device must be operational
– Wear appropriate PPE


Pneumatic Nailers
Hazards
– Struck-by high velocity objects and debris
Prevention
– Never load the tool until you are ready to use it
– Always insert the fastener before cocking the tool
– Never cock the tool against the hand or point the tool at anyone
– Always check penetrations and use proper loads
– Wear appropriate PPE
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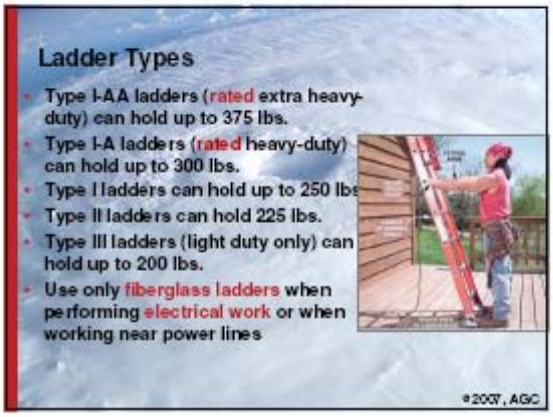
Ladders


Ladder Types
Type I-AA ladders (rated extra heavy-duty) can hold up to 375 lbs.
Type I-A ladders (rated heavy-duty) can hold up to 300 lbs.
Type I ladders can hold up to 250 lbs
Type II ladders can hold 225 lbs.
Type III ladders (light duty only) can hold up to 200 lbs.
Use only fiberglass ladders when performing electrical work or when working near power lines
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Ladder Placement

- Ladders should be set at 1 horizontal to 4 vertical
- Ladders must be secured on stable, level surface
- Ladder access ways must be guarded
- Ladders must extend 3 feet above the landing surface, or provide a grab-rail
- Avoid electrical hazards; look for overhead power lines, avoid use of metal ladders when working on or near electrical systems

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Warning Labels

- Labels are there for a reason!
- Use both hands to climb ladder; maintain three-point contact
- Always face the ladder
- Do not use the top two steps of a stepladder and the top four rungs on extension ladders
- Belt buckle rule

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Step Ladders

- Don't lean a step ladder or use in partially closed position
- The support leg can contact the ground causing the step leg to kick out
- Do not work from the top or second step
- Don't leave hand tools on top rung!

Step Ladders

Obey the Labels!!

NO!

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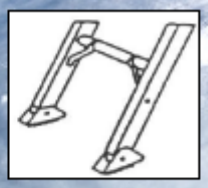
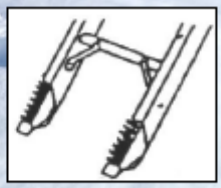
Extension Ladders



Firm Base
Set both feet level and on the pads



Soft Base
Set on the spikes and seat the ladder in the ground

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Working Above Protections

- When employees work above railings, they must be protected from falling over the railings
  - Workers should be provided PFAS when working on ladders above guardrails
  - Tie off on ladders when they are higher than and within 1.5 times the height of the ladder from the guardrail system

Summary

Incident Free

- Planning
- Proper equipment
- Training
- Regular Inspections
- Ongoing oversight
- Lessons learned
- Re-evaluation

✓ Use these steps to provide continuous improvement

Other Resources

- OSHA "quick cards", fact sheets and hurricane *eMatrix*.
  - Safety guidance on more than 50 identified clean-up and reconstruction activities and hazards.
  - English and Spanish translations.

http://www.osha.gov/OshDoc/hurricaneRecovery.html
http://www.osha.gov/SLTC/etools/hurricane/index.html


OSHA
Fall Protection Tips


Training Materials (English)
http://cp.dcp.ufl.edu/trainenglish.asp
Training Materials (Spanish)
http://cp.dcp.ufl.edu/trainspanish.asp
Dr. J.W. Hinze, PI
+1 352 273 1167
hinze@ufl.edu
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kgro@ufl.edu

APPENDIX B
INSTRUCTOR EVALUATION

Safety Training for Hurricane Reconstruction
INSTRUCTOR EVALUATION
Susan Harwood Grant Training Seminar

Location: _____
Instructor(s): _____

Did the information presented meet your expectations? YES____ NO____
What topics could have been explained in greater detail? _____

Seminar Assessment

	BEST	GOOD	AVERAGE	FAIR	POOR
Speakers' knowledge of the subjects	5	4	3	2	1
Speakers' style of presentation	5	4	3	2	1
Quality of information presented	5	4	3	2	1
Ease of understanding the information	5	4	3	2	1
Ideas and examples presented clearly	5	4	3	2	1
Were ideas usable to you	5	4	3	2	1
Quality of handout material	5	4	3	2	1
Slide/Power Point Program	5	4	3	2	1
Was the information interesting	5	4	3	2	1

Comments? (Please be specific)
_____

_____

Have you done any post-natural disaster remediation construction work? YES____ NO_____

_____

What other types of topics would you be interested in learning about? _____
_____

APPENDIX C
PRE/POST TEST

Pre/Post-Test

Circle the correct answer

1. What hazard should be considered when deciding on the location of a portable generator?

   a. Carbon monoxide poisoning
   b. Fall hazards
   c. Tripping hazards
   d. Methane poisoning

2. On an average, how many construction workers are killed at construction sites each year?

   a. 100 – 200
   b. 500 – 700
   c. 1,000 – 1,200
   d. 2,000 – 2,500

3. What major hazard is posed by standing stagnant water?

   a. Disease carrying mosquitoes
   b. Electrical shock hazards
   c. Toxic/bacteria contaminated water
   d. All of the above

4. What are the two of the top four causes of death in construction site accidents?

   _____ _____

5. What percentage of accidents is caused by unsafe behavior rather than by unsafe conditions?

   a. 50%
   b. 65%
   c. 80%
   d. 90%

6. What is a major concern of being exposed to mold?

   a. Rash from skin contact
   b. Inhalation of spores
   c. Stomach disease from ingestion
   d. Slipping on slick surfaces

7. Equipment such as cranes, forklifts, backhoes and scaffolding must maintain at least a _____ foot minimum clearance from overhead power lines.

   a. 6
   b. 12
   c. 10
   d. 20

8. Ground Fault Circuit Interrupters (GFCI) are required by the National Electrical Code:

   a. When there are wet conditions
   c. On portable generators over 5,000W

b. On all temporary power circuits
d. All of the above

9. When may guards be removed from powered equipment?

a. When proper PPE is used
c. When something is stuck in it
b. When equipment is off and locked out
d. All of the above

10. Excavations over 6 feet deep and not obviously visible must, at minimum, be _____.

a. Barricaded or marked
c. Protected by guardrails
b. Covered with traffic plates
d. No protection is required

11. Which diseases would be major concerns when working in a post-natural disaster areas in the U.S.?

a. Small Pox & Polio
c. Measles & Chicken Pox
b. Hepatitis B, Tetanus and Diptheria
d. Alzheimer's & Parkinson's

12. Wall openings over 6 feet above the ground must be guarded when _____.

a. The window sill is less than 39" above the floor.
b. Work occurs on stepladders near a window opening with a 42" sill height.
c. Wall studs are on 24" spacing.
d. All of the above

13. A floor hole wider than _____ must be protected.

a. 12 inches
c. 24 inches
b. 2 inches
d. 19 inches

14. What is the lowest noise level above which hearing damage can occur?

a. 30 decibels
c. 90 decibels
b. 60 decibels
d. 120 decibels

15. Guardrails used for perimeter fall protection must have toe boards when _____.

a. People work near the guard rails
b. People are working in or entering into the lower level near the area
c. Toe boards are not required on perimeter protection
d. All the time

16. When fall arrest equipment is used, employers must assure that _____.

a. All equipment is properly inspected before each use

b. Users have calculated total fall distance
c. A rescue plan is in place to rescue a fallen employee
d. All of the above

17. To prevent worker run-over accidents, which of the following should be used?

a. Back-up alarms
b. High visibility clothing
c. Spotters for equipment
d. All of the above

18. The best way to protect workers from being struck by rotating equipment is to _____.

a. Barricade swing radiuses
b. Have the operator warn workers
c. Use audible swing alarms
d. All of the above

19. Who has the most impact on improving safety at construction sites?

a. Employers
b. Employees
c. OSHA
d. Owners/Architects/Engineers

20. What percentage of all construction worker injuries are eye injuries?

a. 2%
b. 20%
c. 5%
d. 10%

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BIOGRAPHICAL SKETCH

Bradley David Hunter graduated from Boone High School in Orlando, Florida 2000. Classes at the University of Florida began shortly after, which eventually led to a Bachelor of Science in Business Administration, major in finance and Master of Science in Building Construction. Bradley will continue to strive for his Doctorate degree at the University of Florida in the College of Design, Construction and Planning with a focus on sustainable construction.