

BUILDING FOUNDATIONS OF CONSTRUCTION SAFETY



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This text was compiled on 10/23/2026

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Detailed Licensing

Licensing

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1: INTRODUCTION TO OSHA

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1.1: Introduction

Until 1970, there were no national laws for safety and health hazards. In 1970, the United States Congress and President Richard Nixon created the Occupational Safety and Health Administration (OSHA), a national public health agency dedicated to the basic proposition that no worker should have to choose between their life and their job. The creation of OSHA was a historic moment of cooperative national reform. Since OSHA's first day on the job, the agency has delivered remarkable progress for our nation. Workplace injuries, illnesses and fatalities have fallen dramatically. In 1970, an estimated 14,000 workers were killed on the job – about 38 every day. For 2021, the Bureau of Labor Statistics reports this number fell to about 5,190 or about 14 workers per day. Together with our state partners, OSHA has tackled fatal safety hazards and health risks. The rate of reported serious workplace injuries and illnesses has also dropped markedly, from 10.9 per 100 workers in 1972 to 2.7 per 100 workers in 2021.

OSHA has established common sense standards and enforced the law against those who put workers at risk. OSHA is committed to protecting workers from toxic chemicals and fatal safety hazards at work, ensuring that vulnerable workers in high-risk jobs have access to critical information and education about job hazards, and providing employers with vigorous compliance assistance to promote the best practices that can save lives.

1.2: OSHA's Mission

OSHA is part of the United States Department of Labor. The administrator for OSHA is the Assistant Secretary of Labor for Occupational Safety and Health. OSHA's administrator answers to the Secretary of Labor, who is a member of the cabinet of the President of the United States.

Congress created OSHA to assure safe and healthful conditions for workers by setting and enforcing standards and providing training, outreach, education and compliance assistance. Under the OSHA law, employers are responsible for providing a safe and healthful workplace for their workers.

OSHA's mission is to assure America's workers have safe and healthful working conditions free from unlawful retaliation. OSHA carries out its mission by setting and enforcing standards; enforcing anti-retaliation provisions of the OSH Act and other federal whistleblower laws; providing and supporting training, outreach, education, and assistance; and working collaboratively with our state OSHA programs as well as ensuring that they are at least as effective as federal OSHA, furthering a national system of worker safety and health protections.

1.3: OSHA Introduction

Coupled with the efforts of employers, workers, safety and health professionals, unions and advocates, OSHA and its state partners have dramatically improved workplace safety, reducing work-related fatalities by almost 63 percent.

OSHA's safety and health standards, including those for asbestos, fall protection, cotton dust, trenching, machine guarding, benzene, lead and bloodborne pathogens have prevented countless work-related injuries, illnesses and fatalities. Nevertheless, far too many preventable injuries and fatalities continue to occur. Significant hazards and unsafe conditions still exist in U.S. workplaces; each year more than 3.2 million workers suffer a serious job-related injury or illness. Millions more are exposed to toxic chemicals that may cause illnesses years from now.

In addition to the direct impact on individual workers, the negative consequences for America's economy are substantial. Occupational injuries and illnesses cost American employers more than \$97.4 billion a year in workers' compensation costs alone. Indirect costs to employers, including lost productivity, employee training and replacement costs, and time for investigations following injuries can more than double these costs. Workers and their families suffer great emotional and psychological costs, in addition to the loss of wages and the costs of caring for the injured, which further weakens the economy.

1.4: OSHA Coverage

The OSH Act provides workplace safety and health protection to most private sector employers and their workers, and federally covered public sector employers and workers in the 50 states and certain territories and jurisdictions. Those jurisdictions include the District of Columbia, Puerto Rico, the Virgin Islands, American Samoa, Guam, Northern Mariana Islands, Wake Island, Johnston Island, and the Outer Continental Shelf Lands as defined in the Outer Continental Shelf Lands Act.

Not Covered under the OSH Act

- The self-employed;
- Immediate family members of farm employers; and
- Workplace hazards regulated by another federal agency (for example, the Mine Safety and Health Administration, the Department of Energy, or the Coast Guard).

1.5: Rights and Responsibilities under OSHA Law

Employers have the responsibility to provide a safe workplace. Employers **MUST** provide their workers with a workplace that does not have serious hazards and must follow all OSHA safety and health standards. Employers must find and correct safety and health problems. OSHA further requires that employers must first try to eliminate or reduce hazards by making feasible changes in working conditions rather than relying on personal protective equipment such as masks, gloves, or earplugs. Switching to safer chemicals, enclosing processes to trap harmful fumes, or using ventilation systems to clean the air are examples of effective ways to eliminate or reduce risks.

Employers **MUST** also:

- Follow all relevant OSHA safety and health standards.
 - Find and correct safety and health hazards.
 - Prominently display the official OSHA Job Safety and Health – It’s the Law poster that describes rights and responsibilities under the OSH Act. This poster is free and can be downloaded from www.osha.gov.
 - Inform workers about chemical hazards through training, labels, alarms, color-coded systems, chemical information sheets and other methods.
 - Provide safety training to workers in a language and vocabulary they can understand.
 - Keep accurate records of work-related injuries and illnesses.
 - Perform tests in the workplace, such as air sampling, required by some OSHA standards.
 - Provide required personal protective equipment at no cost to workers.*
 - Provide hearing exams or other medical tests required by OSHA standards.
 - Post OSHA citations and injury and illness data where workers can see them.
 - Notify OSHA within 8 hours of a workplace fatality or within 24 hours of any work-related inpatient hospitalization, amputation or loss of an eye (1-800-321-OSHA [6742]).
 - Not retaliate against workers for using their rights under the law, including their right to report a work-related injury or illness.
- * Employers must pay for most types of required personal protective equipment.

Under OSHA law, workers are entitled to working conditions that do not pose a risk of serious harm. Workers have the right to:

- File a confidential complaint with OSHA to have their workplace inspected.
- Receive information and training about hazards, methods to prevent harm, and the OSHA standards that apply to their workplace. The training must be done in a language and vocabulary workers can understand.
- Receive copies of records of work-related injuries and illnesses that occur in their workplace.
- Receive copies of the results from tests and monitoring done to find and measure hazards in their workplace.
- Receive copies of their workplace medical records.
- Participate in an OSHA inspection and speak in private with the inspector.
- File a complaint with OSHA if they have been retaliated against by their employer as the result of requesting an inspection or using any of their other rights under the OSH Act.
- File a complaint if punished or retaliated against for acting as a “whistleblower” under the more than 20 federal laws for which OSHA has jurisdiction.

1.6: OSHA Standards

OSHA standards are rules that describe the methods employers are legally required to follow to protect their workers from hazards. Before OSHA can issue a standard, it must go through a very extensive and lengthy process that includes substantial public engagement, notice and comment. The agency must show that a significant risk to workers exists and that there are feasible measures employers can take to protect their workers.

OSHA's Construction, General Industry, Maritime and Agriculture standards protect workers from a wide range of serious hazards. Examples of standards include requirements for employers to:

- provide fall protection;
- prevent trenching cave-ins;
- prevent exposure to some infectious diseases;
- ensure the safety of workers who enter confined spaces;
- prevent exposure to harmful chemicals;
- put guards on dangerous machines;
- provide respirators or other safety equipment; and
- provide training for certain dangerous jobs in a language and vocabulary workers can understand.

Employers must also comply with the General Duty Clause of the OSH Act. This clause requires employers to keep their workplaces free of serious recognized hazards and is generally cited when no specific OSHA standard applies to the hazard.

1.7: Filing a Complaint

If a workplace has unsafe or unhealthful working conditions, workers may want to file a complaint. Often the best and fastest way to get a hazard corrected is to notify a supervisor or employer.

Workers or their representatives may file a complaint online or by phone, mail, email or fax with the nearest OSHA office and request an inspection. A worker may also ask OSHA not to reveal his or her name. To file a complaint, call 1-800-321-OSHA (6742) or contact the nearest OSHA regional, area, State Plan, or consultation office listed at www.osha.gov. The teletypewriter (TTY) number is (877) 889-5627.

Written, signed complaints submitted to OSHA area offices are more likely to result in an on-site OSHA inspection. Most online or unsigned complaints are resolved informally over the phone with the employer. Complaints from workers in states with an OSHA-approved State Plan will be forwarded to the appropriate State Plan for response.

If a worker believes working conditions are unsafe or unhealthful, OSHA recommends that he or she bring the conditions to the employer's attention, if possible. A worker may file a complaint with OSHA concerning hazardous working condition at any time. However, workers should not leave the worksite merely because they have filed a complaint. If the condition clearly presents a risk of death or serious physical harm, there is not sufficient time for OSHA to inspect, and, where possible, a worker has brought the condition to the attention of the employer, the worker may have a legal right to refuse to work in a situation in which he or she would be exposed to the hazard.

If a worker, with no reasonable alternative, refuses in good faith to expose himself or herself to a dangerous condition, he or she would be protected from subsequent retaliation. The condition must be of such a nature that a reasonable person would conclude that there is a real danger of death or serious harm and that there is not enough time to contact OSHA and for OSHA to inspect. Where possible, the worker must have also sought from his or her employer, and been unable to obtain, a correction of the condition. For more information, go to www.whistleblowers.gov/refusals.

1.8: OSHA Inspection Activities

OSHA is committed to strong, fair, and effective enforcement of safety and health requirements in the workplace. OSHA inspectors, called compliance safety and health officers, are experienced, well-trained industrial hygienists and safety professionals whose goal is to assure compliance with OSHA requirements and help employers and workers reduce on-the-job hazards and prevent injuries, illnesses, and deaths in the workplace. Normally, OSHA conducts inspections without advance notice. Employers have the right to require compliance officers to obtain an inspection warrant before entering the worksite.

OSHA has jurisdiction over approximately 7 million worksites. The agency seeks to focus its inspections resources on the most hazardous workplaces. Enforcement plays an important part in OSHA's efforts to reduce workplace injuries, illnesses, and fatalities. When OSHA finds employers who fail to uphold their safety and health responsibilities, the agency takes strong, decisive actions.

Inspections are initiated without advance notice, conducted using on-site or telephone and facsimile investigations, performed by highly trained compliance officers and scheduled based on the following priorities:

- Imminent danger situations – hazards that could cause death or serious physical harm receive top priority. Compliance officers will ask employers to correct these hazards immediately or remove endangered employees.
- Catastrophes – fatalities or hospitalizations;
- Worker complaints – allegations of hazards or violations also receive a high priority. Employees may request anonymity when they file complaints.
- Referrals of hazards from other federal, state, or local agencies, individuals, organizations or the media receive consideration for inspection.
- Targeted inspections – particular hazards, high injury rates; inspections aimed at specific high-hazard industries or individual workplaces that have experienced high rates of injuries and illnesses also received priority.
- Follow-up inspections – checks for abatement of violations cited during previous inspections are also conducted by the agency in certain circumstances.

On-site inspections can be triggered by a complaint from a current worker or their representative if they believe there is a serious hazard or that their employer is not following OSHA standards or rules. Often the best and fastest way to get hazard corrected is to notify your supervisor or employer.

Current workers or their representatives may file a written complaint and ask OSHA to inspect their workplace if they believe there is a serious hazard or that their employer is not following OSHA standards. Workers and their representatives have the right to ask for an inspection without OSHA telling their employer who filed the complaint. It is a violation of the OSH Act for an employer to fire, demote, transfer or in any way retaliate against a worker for filing a complaint or using other OSHA rights.

The on-site inspection begins with the presentation of the compliance officer's credentials. The compliance officer will explain why OSHA selected the workplace for inspection and describe the scope of the inspection process, walkaround procedures, employee representation and employee interviews. Following the opening conference, the compliance officer and the representatives will walk through portions of the workplace covered by the inspection, inspecting for hazards that could lead to worker injury or illness. After the walkaround, the compliance officer will hold a closing conference with the employer and the employee representative to discuss the findings.

When an inspector finds violations of OSHA standards or serious hazards, OSHA may issue citations and fines. A citation includes methods an employer may use to fix a problem and the date by which the corrective actions must be completed. Employers have the right to contest any part of the citation, including whether a violation actually exists. Workers only have the right to challenge the deadline by which a problem must be resolved. Appeals of citations are heard by the independent Occupational Safety and Health Review Commission (OSHRC). To contact the OSHRC, visit www.oshrc.gov or call (202) 606-5370.

OSHA provides a free service, On-Site Consultation, for small businesses with fewer than 250 workers at a site (and no more than 500 employees nationwide). On-site Consultation services are separate from enforcement and do not result in penalties or citations. Each year, OSHA makes more than 29,000 consultation visits to small businesses to provide free compliance assistance. By working with the OSHA Consultation Program, certain exemplary employers may request participation in OSHA's Safety and Health Recognition Program, SHARP.

If you send in a complaint requesting an OSHA inspection, you have the right to find out the results of the OSHA inspection and request a review if OSHA does not issue citations. When the OSHA inspector arrives, workers and their representatives have the

right to:

- Go along on the inspection;
- Talk privately with the OSHA inspector; and
- Take part in meetings with the inspector and the employer before and after the inspection is conducted.

1.9: OSHA's General Reporting and Recordkeeping Requirements

All employers must report to OSHA:

- The death of any worker from a work-related incident within 8 hours of learning about it;
- Any work-related inpatient hospitalization, amputation, or loss of an eye within 24 hours.

For more information, visit www.osha.gov/report.

In addition, employers must report all fatal heart attacks that occur at work. Fatal injuries from motor vehicle accidents on public streets (except those in a construction work zone) and in accidents on commercial airplanes, trains, subways or buses do not need to be reported.

These reports may be made by telephone or in person to the nearest OSHA area office listed at www.osha.gov or by calling OSHA's toll-free number, 1-800-321-OSHA (6742).

Tracking and investigating workplace injuries and illnesses play an important role in preventing future injuries and illnesses, and for that reason, OSHA requires certain covered employers in high-hazard industries to prepare and maintain records of serious work-related injuries and illnesses.

Employers with more than ten employees and whose establishments are not classified as partially exempt industry must record serious work-related injuries and illnesses using OSHA Forms 300, 300A and 301, which are available at www.osha.gov/recordkeeping/forms. A list of partially exempt industries, including establishments in specific low hazard retail, service, finance, insurance or real estate industries is available at www.osha.gov/recordkeeping/presentations/exempttable. Employers who are required to keep Form 300, the Injury and Illness log, must also post Form 300A, the Summary of Work Related Injuries and Illnesses, in the workplace every year from February 1 to April 30. For more information, visit www.osha.gov/recordkeeping.

Employers and workers need accurate, timely information to focus their prevention activities, and OSHA uses this information for many purposes, including inspection targeting, performance measurement, standards development and resource allocation. Injury and illness data also aid employers and workers in identifying possible safety and health hazards at the employer's establishment. OSHA encourages employers to review and investigate patterns of injuries and illnesses, and to conduct investigations of injuries and near misses to prevent similar events in the future.

OSHA is responsible for administering the recordkeeping system established by the OSH Act. OSHA's recordkeeping regulations provide specific recording and reporting requirements which comprise the framework for the nationwide occupational safety and health recordkeeping system. For more information about OSHA's recordkeeping requirements, visit www.osha.gov/recordkeeping.

OSHA has a variety of educational materials and electronic tools available on its website at These include utilities such as expert advisors, electronic compliance assistance, videos and other information for employers and workers. OSHA's software programs and eTools walk you through safety and health issues and common problems to find the best solutions for your workplace. OSHA's extensive publications help explain OSHA standards, job hazards, and mitigation strategies and provide assistance in developing effective safety and health programs.

Note: OSHA regulations, reporting requirements, and workplace injury statistics may change over time. Readers are encouraged to consult the official OSHA website (www.osha.gov) and current Bureau of Labor Statistics (BLS) publications for the most up-to-date standards, guidance, and injury data.

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1.10: Whistleblower Program

To help ensure that workers are free to participate in safety and health activities, Section 11(c) of the OSH Act prohibits any person from discharging or in any manner retaliating against any worker for exercising rights under the OSH Act. These rights include raising safety and health concerns with an employer, reporting a work-related injury or illness, filing a complaint with OSHA, seeking an OSHA inspection, participating in an OSHA inspection and participating or testifying in any proceeding related to an OSHA inspection.

If a worker believes an employer has retaliated against them for exercising their safety and health rights, they should contact their local OSHA office right away. You must file a retaliation complaint with OSHA within 30 calendar days from the date the retaliatory decision has been made both and communicated to the worker. No form is needed, but workers must contact OSHA within 30 days of the alleged retaliation (at 1-800-321-OSHA [6742]). For more information, please visit www.whistleblowers.gov.

Protection from retaliation means that an employer cannot retaliate by taking “adverse action” against workers, such as:

- Firing or laying off;
- Demoting;
- Denying overtime or promotion;
- Disciplining;
- Denying benefits;
- Failing to hire or rehire;
- Intimidation or harassment;
- Making threats;
- Reassignment to a less desirable position or actions affecting prospects for promotion (such as excluding an employee from training meetings);
- Reducing or changing pay or hours;
- More subtle actions, such as isolating, ostracizing, mocking, or falsely accusing the employee of poor performance;
- Blacklisting (intentionally interfering with an employee’s ability to obtain future employment);
- Constructive discharge (quitting when an employer makes working conditions intolerable due to the employee’s protected activity); or
- Reporting or threatening to report an employee to the police or immigration authorities.

The OSH Act protects workers who complain to their employer, OSHA or other government agencies about unsafe or unhealthful working conditions in the workplace or environmental problems. You cannot be transferred, denied a raise, have your hours reduced, be fired, or punished in any other way because you used any right given to you under the OSH Act. Help is available from OSHA for whistleblowers.

OSHA’s Whistleblower Protection Program enforces the provisions of more than 20 federal laws protecting employees from retaliation for, among other things, raising or reporting concerns about hazards or violations of various workplace safety and health, aviation safety, commercial motor carrier, consumer product, environmental, financial reform, food safety, health insurance reform, motor vehicle safety, nuclear, pipeline, public transportation agency, railroad, maritime, securities, tax, antitrust, and anti-money laundering laws. Employees who believe that they have experienced retaliation in violation of one of these laws may file a complaint with OSHA.

1.11: Review Questions

Multiple Choice Questions

1. When was OSHA established?
(a) 1965
(b) 1970
(c) 1982
(d) 1995
2. Who created OSHA?
(a) U.S. Supreme Court
(b) Department of Defense
(c) Congress and President Nixon
(d) The United Nations
3. Which of the following is NOT covered by the OSH Act?
(a) Self-employed individuals
(b) Employees in private sector
(c) Public sector employees in Guam
(d) Construction workers
4. What is the maximum time allowed to notify OSHA after a workplace fatality?
(a) 4 hours
(b) 8 hours
(c) 12 hours
(d) 24 hours
5. Which of the following actions could be considered employer retaliation under OSHA's Whistleblower Program?
(a) Providing hazard pay
(b) Promoting the worker
(c) Firing or demoting the worker for filing a complaint
(d) Offering safety training

True/False Questions

6. True/False: Workers can file a complaint with OSHA anonymously.
7. True/False: Employers must provide personal protective equipment at no cost to workers.
8. True/False: OSHA must give employers 48-hour notice before an inspection.
9. True/False: It is illegal for an employer to retaliate against an employee for filing a safety complaint.
10. True/False: OSHA provides educational tools and materials for workers.

Answer Key: 1(b), 2(c), 3(a), 4(b), 5(c), 6(True), 7(True), 8(False), 9(True), 10(True)

1.12: Sources

The content in chapter 1 is adapted from:

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2: RECOMMENDED PRACTICES FOR SAFETY AND HEALTH PROGRAMS IN CONSTRUCTION

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2.1: Introduction

Construction is a high hazard industry that comprises a wide range of activities involving construction, alteration, and/or repair. Construction workers engage in many activities that may expose them to serious hazards, such as heights, unguarded machinery, heavy construction equipment, electrocutions, silica dust, and asbestos. Therefore, establishing a safety and health program at your job site is one of the most effective ways of protecting your most valuable asset: your workers. Losing workers to injury or illness, even for a short time, can cause significant disruption and cost—to you as well as the workers and their families. It can also damage workplace morale, productivity, turnover, and reputation.

Safety and health programs foster a proactive approach to “finding and fixing” job site hazards before they can cause injury or illness. Rather than reacting to an incident, management and workers collaborate to identify and solve issues before they occur. This collaboration builds trust, enhances communication, and often leads to other business improvements. Employers who have implemented safety and health programs, including many who are in OSHA’s Voluntary Protection Programs (VPP) or the Safety and Health Achievement Recognition Program (SHARP) for small and medium-sized businesses, have also found that managing safety results in higher-quality product or output and higher profits.

The “find and fix” approach to workplace hazards refers to the “Hazard Identification” and “Hazard Prevention and Control” core elements. Because of the wide variety of site conditions, these two core elements should be implemented on a site-specific basis in order to effectively detect and correct hazards. The concept of continuous improvement is central to these recommended practices. As with any journey, the first step is often the most challenging. The idea is to begin with a basic program and grow from there. By initially focusing on achieving modest goals, monitoring performance, and evaluating outcomes, you can help your company progress over time along the path to higher levels of safety and health.

2.2: Management Leadership

Management provides the leadership, vision, and resources needed to implement an effective safety and health program. Establish a written policy signed by top management describing the organization's commitment to safety and health, and pledging to establish and maintain a safety and health program for all workers. By establishing specific goals and objectives, management sets expectations for managers, supervisors, and workers, and for the program overall. Management provides the resources needed to implement the safety and health program, pursue program goals, and address program shortcomings when they are identified. Management leads the program's effort by establishing roles and responsibilities and providing an open, positive environment that encourages communication about safety and health.

Action items:

1. **Communicate your commitment to a safety and health program:** A clear, written policy helps you communicate that safety and health is a primary organizational value—as important as productivity, profitability, product or service quality, and customer satisfaction. Establish a written policy signed by top management describing the organization's commitment to safety and health, and pledging to establish and maintain a safety and health program for all workers. Communicate the policy to all workers and, at appropriate times and places, to relevant parties, including contractors, subcontractors, staffing agencies, temporary workers at your worksite(s), suppliers and vendors, other businesses in a multi-tenant building, visitors, and customers. Reinforce management commitment by considering safety and health in all business decisions, including contractor and vendor selection, purchasing, and facility design and modification. Be visible in operations and set an example by following the same safety procedures you expect workers to follow. Begin work meetings with a discussion or review of safety and health indicators and any outstanding safety items on a “to do” list.
2. **Define program goals:** By establishing specific goals and objectives, management sets expectations for managers, supervisors, and workers, and for the program overall. The goals and objectives should focus on specific actions that will improve workplace safety and health. Establish realistic, measurable goals for improving safety and health. Goals emphasizing injury and illness prevention should be included, rather than focusing on injury and illness rates. Develop plans to achieve the goals by assigning tasks and responsibilities to particular people, setting timeframes, and determining resource needs.
3. **Allocate resources:** Management provides the resources needed to implement the safety and health program, pursue program goals, and address program shortcomings when they are identified. Estimate the resources needed to establish and implement the program. Allow time in workers' schedules for them to fully participate in the program. Integrate safety and health into planning and budgeting processes, and align budgets with program needs. Provide and direct resources to operate and maintain the program, meet safety and health commitments, and pursue program goals.
4. **Expect performance:** Management leads the program effort by establishing roles and responsibilities and providing an open, positive environment that encourages communication about safety and health. Identify a frontline person or persons who will lead the safety program effort, make plans, coordinate activities, and track progress. Define and regularly communicate responsibilities and authorities for implementing and maintaining the program, and hold people accountable for performance. Provide positive recognition for meeting or exceeding safety and health goals aimed at preventing injury and illness (e.g., reporting close calls/near misses, attending training, conducting inspections). Establish ways for management and all workers to communicate freely and often about safety and health issues, without fear of retaliation.

Top management demonstrates its commitment to continuous improvement in safety and health, communicates that commitment to workers, and sets program expectations and responsibilities. Managers at all levels make safety and health a core organizational value, establish safety and health goals and objectives and provide adequate resources and support for the program, and set a good example.

2.3: Worker Participation

To be effective, any safety and health program needs the meaningful participation of workers and their representatives. Workers have much to gain from a successful program, and the most to lose if the program fails. They also often know the most about potential hazards associated with their jobs. Successful programs tap into this knowledge base. Worker participation means participation in establishing, operating, evaluating, and improving the safety and health program. All workers at a worksite should participate.

Action items:

1. Encourage workers to participate in the program: By encouraging workers to participate in the program, management signals that it values their input into safety and health decisions. Give workers the necessary time and resources to participate in the program. Acknowledge and provide positive reinforcement to those who participate in the program. Maintain an open door policy that invites workers to talk to managers about safety and health and to make suggestions.
2. Encourage workers to report safety and health concerns: Workers are often best positioned to identify safety and health concerns and program shortcomings, such as emerging workplace hazards, unsafe conditions, close calls/near misses, and actual incidents. By encouraging reporting and following up promptly on all reports, employers can address issues before someone gets hurt or becomes ill. Establish a process for workers to report injuries, illnesses, close calls/near misses, hazards, and other safety and health concerns, and respond to reports promptly. Include an option for anonymous reporting to reduce fear of reprisal. Report back to workers routinely and frequently about action taken in response to their concerns and suggestions. Emphasize that management will use reported information only to improve workplace safety and health, and that no worker will experience retaliation for bringing such information to management's attention. Empower all workers to initiate or request a temporary suspension or shutdown of any work activity or operation they believe to be unsafe. Involve workers in finding solutions to reported issues.
3. Give workers access to safety and health information: Sharing relevant safety and health information with workers fosters trust and helps organizations make more informed safety and health decisions. Give workers the information they need to understand safety and health hazards and control measures in the workplace. Some OSHA standards require employers to make specific types of information available to workers, such as: Safety Data Sheets (SDSs), injury and illness data (may need to be redacted and aggregated to eliminate personal identifiers), results of environmental exposure monitoring conducted in the workplace (prevent disclosure of sensitive and personal information as required). Other useful information for workers to review can include: workplace job hazard analyses, chemical and equipment manufacturer safety recommendations, workplace inspection reports, incident investigation reports (prevent disclosure of sensitive and personal information as required).
4. Involve workers in all aspects of the program: including worker input at every step of program design and implementation improves your ability to identify the presence and causes of workplace hazards, creates a sense of program ownership among workers, enhances their understanding of how the program works, and helps sustain the program over time. Provide opportunities for workers to participate in all aspects of the program, including, but not limited to helping: develop the program and set goals, report hazards and develop solutions that improve safety and health, analyze hazards in each step of routine and nonroutine jobs, tasks, and processes, define and document safe work practices, conduct site inspections, develop and revise safety procedures, participate in incident and close call/near miss investigations, train current coworkers and new hires, develop, implement, and evaluate training programs, evaluate program performance and identify ways to improve it, and take part in exposure monitoring and medical surveillance associated with health hazards.
5. Remove barriers to participation: To participate meaningfully in the program, workers must feel that their input is welcome, their voices will be heard, and they can access reporting mechanisms. Participation will be suppressed if language, education, or skill levels in the workplace are not considered, or if workers fear retaliation or discrimination for speaking up (for example, if investigations focus on blaming individuals rather than the underlying conditions that led to the incident, or if reporting an incident or concern could jeopardize the award of incentive-based prizes, rewards, or bonuses). Ensure that workers from all levels of the organization can participate regardless of their skill level, education, or language. Provide frequent and regular feedback to show employees that their safety and health concerns are being heard and addressed. Authorize sufficient time and resources to facilitate worker participation; for example, hold safety and health meetings during regular working hours. Ensure that the program protects workers from being retaliated against for reporting injuries, illnesses, and hazards; participating in the program; or exercising their safety and health rights. Ensure that other policies and programs do not discourage worker participation. Post the 11(c) fact sheet (found at www.whistleblowers.gov) in the workplace or otherwise make it available for easy access by workers.

Throughout these recommended practices, OSHA emphasizes the importance of worker participation in the safety and health program. For a program to succeed, workers (and, if applicable, their representatives) must participate in developing and implementing every element of the safety and health program. This emphasis on worker participation is consistent with the OSH Act, OSHA standards, and OSHA enforcement policies and procedures, which recognize the rights and roles of workers and their representatives in matters of workplace safety and health. Several action items described in these recommended practices rely on perspectives, expertise, and input that can come only from workers and their representatives.

2.4: Hazard Identification and Assessment

In construction, unanticipated hazards can arise due to changes in project timelines, sequence of events, and the fast pace of some construction projects. Hazard identification and assessment is a crucial part of an effective safety and health program. One of the “root causes” of construction injuries, illnesses, and incidents is the failure to identify or recognize hazards that are present, or that could have been anticipated. A critical element of any effective safety and health program is a proactive, ongoing process to identify and assess such hazards.

To identify and assess hazards, employers and workers: collect and review information about the hazards present or likely to be present in the workplace, conduct initial and periodic workplace inspections of the workplace to identify new or recurring hazards, investigate injuries, illnesses, incidents, and close calls/near misses to determine the underlying hazards, their causes, and safety and health program shortcomings, group similar incidents and identify trends in injuries, illnesses, and hazards reported, and consider hazards associated with emergency or nonroutine situations. For each hazard identification, determine the severity and likelihood of incidents that could result, and use this information to prioritize corrective actions. Some hazards, such as housekeeping and tripping hazards, can and should be fixed as they are found. Fixing hazards on the spot emphasizes the importance of safety and health and takes advantage of a safety leadership opportunity. Fixing other hazards identified using the processes described here will be addressed in the next section, “Hazard Prevention and Control.”

Action items:

1. Collect existing information about job site hazards: Information on workplace hazards may already be available to employers and workers from both internal and external sources. Collect, organize, and review information with workers to determine what types of hazards may be present and which workers may be exposed to or potentially exposed. Information available in the workplace may include: equipment and machinery operating manuals. SDSs provided by chemical manufacturers, self-inspection reports and inspection reports from insurance carriers, government agencies, and consultants, records of previous injuries and illnesses, such as OSHA 300 and 301 logs and reports of incident investigations. Workers’ compensation records and reports, patterns of frequently occurring injuries and illnesses, exposure monitoring results, industrial hygiene assessments, and medical records (appropriately redacted to ensure patient/worker privacy), existing safety and health programs (lockout/tagout, confined spaces, process safety management, PPE, etc.), input from workers, including surveys or minutes from safety and health committee meetings, and results of job hazard analyses (JHAs, also known as job safety analyses or JSAs).

2. Inspect the job site for safety hazards: Hazards can be introduced over time as workstations and processes change, equipment or tools become worn, maintenance is neglected, or housekeeping practices decline. Setting aside time to regularly inspect the workplace for hazards can help identify shortcomings so that they can be addressed before an incident occurs. Conduct regular inspections of all operations, equipment, work areas, and facilities. Have workers participate in the inspection team, and talk to them about hazards that they see or report. Be sure to document inspections so you can later verify that hazardous conditions are corrected. Take photos or video of problem areas to facilitate later discussion and brainstorming about how to control them, and for use as learning aids. Include all areas and activities in these inspections, such as storage and warehousing, facility and equipment maintenance, purchasing and office functions, and the activities of on-site contractors, subcontractors, and temporary employees. Regularly inspect both plant vehicles (e.g., forklifts, powered industrial trucks) and transportation vehicles (e.g., cars, trucks). Use checklists that highlight things to look for. Typical hazards fall into several major categories, such as those listed below; each workplace will have its own list: general housekeeping, slip, trip, and fall hazards, electrical hazards, equipment operation, equipment maintenance, fire protection, work organization and process flow (including staffing and scheduling), workplace violence, ergonomic problems, and lack of emergency procedures. Before changing operations, workstations, or workflow; making major organizational changes; or introducing new equipment, materials, or processes, seek the input of workers and evaluate the planned changes for potential hazards and related risks.

3. Identify health hazards: Identifying workers’ exposure to health hazards is typically more complex than identifying physical safety hazards. For example, gases and vapors may be invisible, often have no odor, and may not have an immediately noticeable harmful health effect. Health hazards include chemical hazards (solvents, adhesives, paints, toxic dusts, etc.), physical hazards (noise, radiation, heat, etc.), biological hazards (infectious diseases), and ergonomic risk factors (heavy lifting, repetitive motions, vibration). Reviewing workers’ medical records (appropriately redacted to ensure patient/worker privacy) can be useful in identifying health hazards associated with workplace exposures. Identify chemical hazards—review SDSs and product labels to identify chemicals in your workplace that have low exposure limits, are highly volatile, or are used in large quantities or in unventilated spaces. Identify activities that may result in skin exposure to chemicals. Identify physical hazards—identify any exposures to excessive noise (areas where you must raise your voice to be heard by others), elevated heat (indoor and outdoor), or

sources of radiation (radioactive materials, X-rays, or radiofrequency radiation). Identify biological hazards—determine whether workers may be exposed to sources of infectious diseases, molds, toxic or poisonous plants, or animal materials (fur or scat) capable of causing allergic reactions or occupational asthma. Identify ergonomic risk factors—examine work activities that require heavy lifting, work above shoulder height, repetitive motions, or tasks with significant vibration. Conduct quantitative exposure assessments, when possible, using air sampling or direct reading instruments. Review medical records to identify cases of musculoskeletal injuries, skin irritation or dermatitis, hearing loss, or lung disease that may be related to workplace exposures.

4. Conduct incident investigations: Workplace incidents—including injuries, illnesses, close calls/near misses, and reports of other concerns—provide a clear indication of where hazards exist. By thoroughly investigating incidents and reports, you will identify hazards that are likely to cause future harm. The purpose of an investigation must always be to identify the root causes (and there is often more than one) of the incident or concern, in order to prevent future occurrences. Develop a clear plan and procedure for conducting incident investigations, so that an investigation can begin immediately when an incident occurs. The plan should cover items such as: who will be involved, lines of communication, materials, equipment, and supplies needed, and reporting forms and templates. Train investigative teams on incident investigation techniques, emphasizing objectivity and open-mindedness throughout the investigation process. Conduct investigations with a trained team that includes representatives of both management and workers. Investigate close calls/near misses. Identify and analyze root causes to address underlying program shortcomings that allowed the incidents to happen. Communicate the results of the investigation to managers, supervisors, and workers to prevent recurrence.

5. Identify hazards associated with emergency and nonroutine situations: Emergencies present hazards that need to be recognized and understood. Nonroutine or infrequent tasks, including maintenance and startup/shutdown activities, also present potential hazards. Plans and procedures need to be developed for responding appropriately and safely to hazards associated with foreseeable emergency scenarios and nonroutine situations. Identify foreseeable emergency scenarios and nonroutine tasks, considering the types of material and equipment in use and the location within the facility. Scenarios such as the following may be foreseeable: fires and explosions, chemical releases, hazardous material spills, startups after planned or unplanned equipment shutdowns, nonroutine tasks, such as infrequently performed maintenance activities, structural collapse, disease outbreaks, weather emergencies and natural disasters, medical emergencies, and workplace violence.

6. Characterize the nature of identified hazards, identify interim control measures, and prioritize the hazards for control: The next step is to assess and understand the hazards identified and the types of incidents that could result from worker exposure to those hazards. This information can be used to develop interim controls and to prioritize hazards for permanent control (see “Hazard Prevention and Control”). Evaluate each hazard by considering the severity of potential outcomes, the likelihood that an event or exposure will occur, and the number of workers who might be exposed. Use interim control measures to protect workers until more permanent solutions can be implemented. Prioritize the hazards so that those presenting the greatest risk are addressed first. Note, however, that employers have an ongoing obligation to control all serious recognized hazards and to protect workers.

2.5: Hazard Prevention and Control

Effective controls protect workers from hazards; help avoid injuries, illnesses, and incidents; minimize or eliminate safety and health risks; and help employers provide workers with safe and healthful working conditions. The processes described in this section will help employers prevent and control hazards identified in the previous section.

Action items:

1. Identify control options: A wealth of information exists to help employers investigate options for controlling identified hazards. Before selecting any control options, it is essential to solicit workers' input on their feasibility and effectiveness. Review sources such as OSHA standards and guidance, industry consensus standards, NIOSH publications, manufacturers' literature, and engineering reports to identify potential control measures. Keep current on relevant information from trade or professional associations. Investigate control measures used in other workplaces and determine whether they would be effective at your workplace. Get input from workers who may be able to suggest and evaluate solutions based on their knowledge of the facility, equipment, and work processes. For complex hazards, consult with safety and health experts, including OSHA's On-site Consultation Program.

2. Select controls: Employers should select the controls that are the most feasible, effective, and permanent. Eliminate or control all serious hazards (hazards that are causing or are likely to cause death or serious physical harm) immediately. Use interim controls while you develop and implement longer-term solutions. Select controls according to a hierarchy that emphasizes engineering solutions (including elimination or substitution) first, followed by safe work practices, administrative controls, and finally PPE. Avoid selecting controls that may directly or indirectly introduce new hazards. Examples include exhausting contaminated air into occupied workspaces or using hearing protection that makes it difficult to hear backup alarms. Review and discuss control options with workers to ensure that controls are feasible and effective. Use a combination of control options when no single method fully protects workers.

3. Develop and update a hazard control plan: A hazard control plan describes how the selected controls will be implemented. An effective plan will address serious hazards first. Interim controls may be necessary, but the overall goal is to ensure effective long-term control of hazards. It is important to track progress toward completing the control plan, and periodically (at least annually and when conditions, processes, or equipment change) verify that controls remain effective. List the hazards needing controls in order of priority. Assign responsibility for installing or implementing the controls to a specific person or persons with the power or ability to implement the controls. Establish a target completion date. Plan how you will track progress toward completion. Plan how you will verify the effectiveness of controls after they are installed or implemented.

4. Select controls to protect workers during nonroutine tasks and emergencies: The hazard control plan should include provisions to protect workers during nonroutine operations and foreseeable emergencies. Depending on the workplace, these could include fires, explosions, chemical releases, hazardous material spills, unplanned equipment shutdowns, infrequent maintenance activities, natural and weather disasters, workplace violence, terrorist or criminal attacks, disease outbreaks (e.g., pandemic influenza), or medical emergencies. Nonroutine tasks, or tasks workers don't normally do, should be approached with particular caution. Prior to initiating such work, review JSAs/JHAs with any workers involved and notify others about the nature of the work, work schedule, and any necessary precautions. Develop procedures to control hazards that may arise during nonroutine operations (e.g., removing machine guarding during maintenance and repair). Develop or modify plans to control hazards that may arise in emergency situations. Procure any equipment needed to control emergency-related hazards. Assign responsibilities for implementing the emergency plan. Conduct emergency drills to ensure that procedures and equipment provide adequate protection during emergency situations.

5. Implement selected controls on the job site: Once hazard prevention and control measures have been identified, they should be implemented according to the hazard control plan. Implement hazard control measures according to the priorities established in the hazard control plan. When resources are limited, implement measures on a "worst-first" basis, according to the hazard ranking priorities (risk) established during hazard identification and assessment. (Note, however, that regardless of limited resources, employers have an obligation to protect workers from recognized, serious hazards.) Promptly implement any measures that are easy and inexpensive—such as general housekeeping, removal of obvious tripping hazards such as electrical cords, and basic lighting—regardless of the level of hazard they involve.

6. Follow up to confirm that controls are effective: To ensure that control measures are and remain effective, employers should track progress in implementing controls, inspect and evaluate controls once they are installed, and follow routine preventive

maintenance practices. Track progress and verify implementation by asking the following questions: Have all control measures been implemented according to the hazard control plan? Have engineering controls been properly installed and tested? Have workers been appropriately trained so that they understand the controls, including how to operate engineering controls, safe work practices, and PPE use requirements? Are controls being used correctly and consistently? Conduct regular inspections (and industrial hygiene monitoring, if indicated) to confirm that engineering controls are operating as designed. Evaluate control measures to determine if they are effective or need to be modified. Involve workers in the evaluation of the controls. If controls are not effective, identify, select, and implement further control measures that will provide adequate protection. Confirm that work practices, administrative controls, and PPE use policies are being followed. Conduct routine preventive maintenance of equipment, facilities, and controls to help prevent incidents due to equipment failure.

2.6: Hierarchy of Controls

Select controls according to a hierarchy that emphasizes engineering solutions (including elimination or substitution) first, followed by safe work practices, administrative controls, and finally PPE. Avoid selecting controls that may directly or indirectly introduce new hazards. Examples include exhausting contaminated air into occupied workspaces or using hearing protection that make it difficult to hear backup alarms. Use a combination of control options when no single method fully protects workers.

A system for selecting and implementing the most effective control solutions for workplace hazards that includes:

- Elimination
- Substitution
- Engineering controls
- Administrative controls
- Personal protective equipment

This is known as the “hierarchy of controls” because they should be considered in the order presented. Controls at the top of the hierarchy are potentially more effective and more protective than those lower in the hierarchy.

Elimination makes sure the hazard no longer exists. Examples: ending the use of hazardous material, doing work at ground level rather than at heights, and stopping the use of noisy processes. Substitution means changing out a material or process to reduce the hazard. Examples: switching to a less hazardous material, switching to a process that uses less force, speed, temperature, or electrical current. Engineering controls reduce exposure by preventing hazards from coming into contact with workers. They still allow workers to do their jobs, though. Examples: noise enclosures, local exhaust ventilation, guardrail system, machine guards, interlocks, and lift equipment. Administrative controls change the way work is done or give workers more information by providing workers with relevant procedures, training, or warnings. They are often used with high-level controls. They include: procedures, such as equipment inspections, planned preventive maintenance, checklists, lockout/tagout/tryout, infection prevention and control practices, changing work schedules, pre- and post-task reviews, and rotation of workers; training on topics such as hazard communication, permit-required confined space entry, lockout/tagout/tryout, and safe work procedures; warnings such as signs, backup alarms, smoke detectors, computer messages, mirrors, horns, labels, and instructions. Personal protective equipment (PPE) includes clothing and devices to protect workers. PPE needs constant effort and attention (including proper use and training) from workers. Higher-level controls are not always feasible, and PPE might be needed in conjunction with other control measures. Examples: safety glasses, personal fall protection systems and related equipment, hardhats, respirators, hearing protection, and protective clothing.

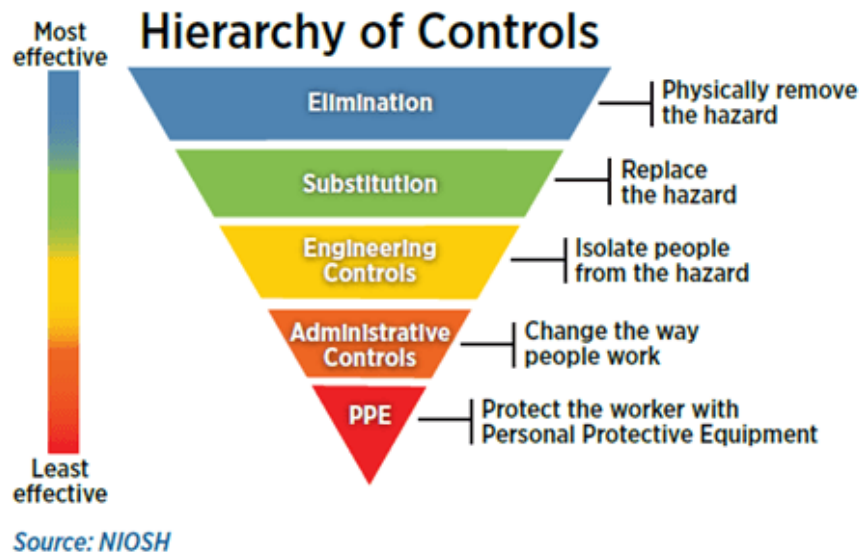


Figure 2:1 Hierarchy of Controls. (Source: National Institute for Occupational Safety and Health, Public Domain).

To decide if control is feasible, you need to know how well it can protect workers and whether it can be implemented successfully. Consider whether it is:

- Right for the hazard
- Appropriate, given how likely injuries/illnesses are
- Consistent with employer policies, laws, and regulations
- Not too burdensome to workers
- Recognized as an appropriate practice in the industry
- Effective, reliable, and durable
- Readily available
- Cost-effective, short- and long-term

How can you use the hierarchy of controls?

First you will need to identify the hazard(s) you are trying to control with workers and their representatives' participation.

Then, think about how you can block the path between the worker and the hazard. Brainstorm ways the hazard can be eliminated, substituted, engineered out, administratively controlled, or what PPE can be used with other controls. Ask yourself:

- What are the pros and cons of each method?
- Are the controls feasible in our workplace? Why or why not?
- Where do the feasible controls fall in the hierarchy?

Collaboratively choose the control(s) that falls highest on the hierarchy. If it takes time to implement, use one or more of the lower options you identified as interim controls until the permanent solution is in place. Remember that you may need a combination of control methods (such as engineering controls plus administrative controls) to provide the best level of protection. Be sure to comply with any workplace regulations which may require specific types of control for certain hazards.

2.7: Education and Training

Education and training are important tools for informing workers and managers about hazards and controls so they can work more safely and be more productive. Another role of education and training, however, is to provide workers and managers with a greater understanding of the safety and health program itself, so that they can contribute to its development and implementation.

Action items:

1. Provide program awareness training
2. Train employers, managers, and supervisors on their roles in the program
3. Train workers on their specific roles in the safety and health program
4. Train workers on hazard identification and controls

2.8: Program Evaluation and Improvement

Once a safety and health program is established, it should be evaluated initially to verify that it is being implemented as intended. After that, employers should periodically, and at least annually, step back and assess what is working and what is not, and whether the program is on track to achieve its goals. Whenever these assessments identify opportunities to improve the program, employers, managers, and supervisors—in coordination with workers—should adjust and monitor how well the program performs as a result. Sharing the results of monitoring and evaluation on the job site, and celebrating successes, will help drive further improvement.

Action items:

1. Monitor performance and progress
2. Verify that the program is implemented and is operating
3. Correct program shortcomings and identify opportunities to improve

2.9: Communication and Coordination for Employers on Multiemployer Worksites

Construction job sites typically have workers who are employed by a general contractor and other workers who are employed by a contractor or subcontractor, or workers from other sources. In these circumstances, it is important that each employer and contractor consider how their work and safety activities can affect the safety of other workers at the job site. Examples include electrical or mechanical contractors working for the general contractor at a building construction site. Several subcontractors working together on a job site (such as a subcontractor tying rebar and another subcontractor setting concrete formwork at the same job site) would be another example.

Action items:

1. Establish effective communication
2. Establish effective coordination

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2.10: 10 Easy Things to Get Your Program Started

1. Set safety and health as a top priority: Always set safety and health as the top priority. Tell your workers that making sure they finish the day and go home safely is the way you do business. Assure them that you will work with them to find and fix any hazards that could injure them or make them sick.
2. Lead by example: Practice safe behaviors yourself and make safety part of your daily conversations with workers.
3. Implement a reporting system: Develop and communicate a simple procedure for workers to report any injuries, illnesses, incidents (including near misses/close calls), hazards, or safety and health concerns without fear of retaliation. Include an option for reporting hazards or concerns anonymously.
4. Provide training: Train workers on how to identify and control hazards using, for example, OSHA's Hazard Identification Training Tool.
5. Conduct inspections: Inspect the workplace with workers and ask them to identify any activity, piece of equipment, or material that concerns them. Use checklists, such as those included in OSHA's Small Business Handbook, to help identify problems.
6. Collect hazard control ideas: Ask workers for ideas on improvements and follow up on their suggestions. Provide them time during work hours, if necessary, to research solutions.
7. Implement hazards controls: Assign workers the task of choosing, implementing, and evaluating the solutions they come up with.
8. Address emergencies: Identify foreseeable emergency scenarios and develop instructions on what to do in each case. Meet to discuss these procedures and post them in a visible location in the workplace.
9. Seek input on workplace changes: Before making significant changes to the workplace, work organization, equipment, or materials, consult with workers to identify potential safety or health issues.
10. Make improvements: Set aside a regular time to discuss safety and health issues, with the goal of identifying ways to improve the program.

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2.11: Review Questions

Multiple Choice Questions

1. Which of the following best describes the goal of a safety and health program?
 - (a) To document accidents after they occur
 - (b) To protect workers by preventing hazards before they cause harm
 - (c) To reduce insurance costs only
 - (d) To avoid legal inspections
2. The “find and fix” approach focuses on:
 - (a) Waiting for hazards to cause injury before acting
 - (b) Identifying and correcting hazards before incidents occur
 - (c) Increasing the use of PPE
 - (d) Outsourcing safety inspections
3. Which of the following is not part of management leadership in a safety program?
 - (a) Allocating resources
 - (b) Setting goals and expectations
 - (c) Ignoring work feedback
 - (d) Providing open communication about safety
4. Worker participation in a safety and health program should:
 - (a) Be limited to emergency situations
 - (b) Include only trained safety officers
 - (c) Involve all workers in establishing, operating, and improving the program
 - (d) Avoid direct input from workers
5. In hazard prevention and control, which method ranks highest in the hierarchy of controls?
 - (a) Personal protective equipment
 - (b) Engineering controls
 - (c) Substitution
 - (d) Elimination
6. Education and training in safety programs aim at:
 - (a) Inform workers about hazards and controls

- (b) Train only managers about their roles
- (c) Reduce program costs
- (d) Focus only on legal compliance

7. On multiemployer worksites, effective safety programs require:

- (a) Communication and coordination among employers
- (b) Each employer working independently
- (c) Only the general contractor being responsible for safety
- (d) Avoid overlapping in work schedules

8. A key benefit of implementing a safety and health program is:

- (a) Reducing workers' involvement in decision making
- (b) Encouraging a proactive approach to finding and fixing hazards
- (c) Focusing only on legal compliance
- (d) Avoiding communication with contractors

9. Which of the following is an example of elimination?

- (a) Installing local exhaust ventilation
- (b) Doing work at ground level rather than at heights
- (c) Wearing hearing protection
- (d) Providing work training

10. Which statement about PPE is true?

- (a) PPE eliminates hazards completely
- (b) PPE is the most effective control
- (c) PPE requires training and proper use to be effective
- (d) PPE replaces the need for other controls

11. Which of the following best represents the purpose of management leadership in a safety and health program?

- (a) Enforcing disciplinary actions for safety violations only
- (b) Provide vision, commitment, and resources for safety initiatives
- (c) Delegating all safety responsibilities to contractors
- (d) Avoiding worker input in program design

12. Which is one of the first steps in developing a safety and health program?

- (a) Creating a complex incident reporting system
- (b) Setting unrealistic productivity goals

- (c) Establishing a written policy signed by top management
 - (d) Conducting surprise inspections without notice
13. Which of the following actions demonstrates worker participation?
- (a) Submitting anonymous hazard reports
 - (b) Ignoring near-miss incidents
 - (c) Waiting for management to act before raising concerns
 - (d) Refusing to attend safety meetings
14. Incident investigations should primarily aim to
- (a) Identify individuals responsible for accidents
 - (b) Determine root causes and prevent recurrence
 - (c) Penalize workers who report hazards
 - (d) Delay corrective action until the next inspection
15. What should employers do after implementing hazard controls?
- (a) Stop monitoring unless an incident occurs
 - (b) Verify and evaluate the effectiveness of the controls
 - (c) Assume all risks have been eliminated
 - (d) Wait for work complaints to arise
16. The main advantage of effective communication and coordination on multi-employers worksites is:
- (a) Reducing the number of workers involved
 - (b) Preventing overlapping safety responsibilities
 - (c) Ensuring all employers are aware of each other's safety activities
 - (d) Limiting access to safety information

True/False Questions

17. True/False: Management leadership involves providing resources, setting goals, and fostering open communication about safety and health.
18. True/False: The “find and fix” approach to hazards only applies after an accident has already occurred.
19. True/False: Engineering controls are generally more effective than administrative controls or PPE.
20. True/False: Program evaluation and improvement should only occur once, immediately after the program is established.
21. True/False: The “hierarchy of controls” begins with personal protective equipment as the most effective method.
22. True/False: Education and training should inform workers about hazards, controls, and the safety program itself.
23. True/False: A written policy signed by top management is essential to show commitment to and build accountability.

24. True/False: All workers should be involved in establishing, operating, and improving the program.

25. True/False: Safety glasses, respirators and hard hats are examples of PPE.

26. True/False: Substitution involves replacing a hazardous material or process with a safer one

27. True/False: Continuous improvement is a key principle of safety and health programs.

28. True/False: Administrative controls completely eliminate hazards.

29. True/False: The goal of incident investigation is to assign blame to workers.

30. True/False: Collecting existing information about hazards helps identify potential risks faster.

Answer Key: 1(b), 2(b), 3(c), 4(c), 5(d), 6(a), 7(a), 8(b), 9(b), 10(c), 11(b), 12(c), 13(a), 14(b), 15(b), 16(c), 17(True), 18(False), 19(True), 20(False), 21(False), 22(True), 23(False), 24(True), 25(True), 26(True), 27(True), 28(False), 29(False), 30(True).

2.12: Sources

The content in Chapter 2 is adapted from:

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3: FALL PROTECTION IN CONSTRUCTION

- 3.1: Why is fall protection important?
- 3.2: What can be done to reduce falls?
- 3.3: Statistics
- 3.4: 1926 Subpart M – Fall Protection
- 3.5: Examples of Fall Protection Requirements for Certain Construction Activities
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- 3.10: Protection from Falling Objects
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3.1: Why is fall protection important?

Falls are among the most common causes of serious work related injuries and deaths. Historically, falls are the leading cause of fatalities in construction, accounting for about one-third of all fatalities in the industry. For example, the Bureau of Labor Statistics reported that there were 291 fatal falls to a lower level in construction in 2013, out of 828 total fatalities. OSHA recognizes that incidents involving falls are generally complex events, frequently involving a variety of factors. Consequently, the standard for fall protection deals with both the human and equipment-related issues in protecting workers from fall hazards. This chapter is intended to help workers and employers better understand the Fall Protection in Construction standard's requirements and the reasons behind them.

Preventing falls can mean the difference between life and death. Hundreds of workers die from falls each year. You can prevent such deaths by planning to get the job done safely, providing the right fall protection equipment, and training all workers to use the equipment safely. Many construction workers perform tasks at a height that require protection from fall hazards. Having a serious injury or death occur at work affects everyone at a worksite. A fall can occur in a split second without any time for the worker to react.

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3.2: What can be done to reduce falls?

Employers must set up the workplace to prevent employees from falling off of overhead platforms, elevated workstations or into holes in the floor and walls. OSHA requires that fall protection be provided at elevations of four feet in general industry workplaces, five feet in shipyards, six feet in the construction industry and eight feet in longshoring operations. In addition, OSHA requires that fall protection be provided when working over dangerous equipment and machinery, regardless of the fall distance.

To prevent employees from being injured from falls, employers must:

- Guard every floor hole into which a worker can accidentally walk (using a railing and toe-board or a floor hole cover).
- Provide a guard rail and toe-board around every elevated open sided platform, floor or runway.
- Regardless of height, if a worker can fall into or onto dangerous machines or equipment (such as a vat of acid or a conveyor belt) employers must provide guardrails and toe-boards to prevent workers from falling and getting injured.
- Other means of fall protection that may be required in certain jobs include safety harness and line, safety nets, stair railings and handrails.

OSHA requires employers to:

- Provide working conditions that are free of known dangers.
- Keep floors in work areas in a clean and, so far as possible, a dry condition.
- Select and provide required personal protective equipment at no cost to workers.
- Train workers about job hazards in a language that they can understand.

3.3: Statistics

BLS found the leading causes of worker deaths in the construction industry were: falls, struck-by object, caught-in or -between, and electrocution. These "Fatal [Focus] Four" were responsible for nearly three out of five (59%) construction worker deaths in 2009, BLS reports. In 2009, falls accounted for more than one third of fatal occupational injuries in construction (34%). Nearly half (48%) of all fatal falls in private industry involved construction workers.

Data from a long-term study indicates the types of falls that are causing worker deaths. In the period 1992-2005, about one-third of the fatal falls in construction were from roofs, 18% were from scaffolding or staging, 16% were from ladders, and 8% were from girders or structural steel. The other 25% of fatal falls includes falls through existing floor openings, from nonmoving vehicles, from aerial lifts, etc. Occupational fatalities caused by falls are a serious concern. This lesson will help you identify fall hazards at construction worksites so that you can be protected.

3.4: 1926 Subpart M – Fall Protection

Subpart M lays out the requirements and criteria for fall protection in construction workplaces. For example, it applies when workers are working at heights of 6 feet or more above a lower level. It also covers protection from falling objects, falls from tripping over or falling through holes, and protection when walking and working around dangerous equipment without regard to height. Subpart M provisions do not apply, however, to workers inspecting, investigating, or assessing workplace conditions prior to the actual start of work or after all construction work has been completed.

Initially, employers must assess the workplace to determine if walking or working surfaces have the necessary strengths and structural integrity to safely support the workers. Once it is determined that the work surfaces will safely support the work activities, the employer must determine whether fall protection is required.

Subpart M requires the use of fall protection when construction workers are working at heights of 6 feet or greater above a lower level. It applies at heights of less than 6 feet when working near dangerous equipment, for example, working over machinery with open drive belts, pulleys or gears or open vats of degreasing agents or acid. Generally, fall protection can be provided through the use of guardrail systems, safety net systems, or personal fall arrest systems. OSHA refers to these systems as conventional fall protection. Other systems and methods of fall protection may be used when performing certain activities. For example, when working on formwork, a positioning device system could be used. OSHA encourages employers to select systems that prevent falls of any kind, such as guardrails designed to keep workers from falling over the edge of a building.

3.5: Examples of Fall Protection Requirements for Certain Construction Activities

Leading Edges: Each worker constructing a leading edge 6 feet or more above a lower level must be protected by guardrail systems, safety net systems, or personal fall arrest systems.

Overhand Bricklaying and Related work: When workers perform overhand bricklaying and related work 6 feet or more above a lower level, they must be protected by guardrail systems, safety net systems, personal fall arrest systems, or they must work in a controlled access zone (CAZ). All workers reaching more than 10 inches below the level of the walking or working surface on which they are working must be protected by a guardrail system, safety net system, or personal fall arrest system.

Roofing Work on Low-Slope Roofs: A low-slope roof has a slope less than or equal to 4 in 12 (vertical to horizontal). When engaged in roofing work on a low-slope roof that has one or more unprotected side or edge 6 feet or more above lower levels, workers must be protected from falling by: Guardrail systems, Safety net systems, Personal fall arrest systems, A combination of conventional fall protection systems and warning line systems, or A warning line system and a safety monitoring system. When engaged in roofing work on low-slope roofs 50 feet or less in width, the use of a safety monitoring system without a warning line system is permitted.

Working on Steep Roofs: A steep roof has a slope greater than 4 in 12 (vertical to horizontal). When working on a steep roof that has one or more unprotected side or edge 6 feet or more above lower levels, each worker must be protected by: Guardrail systems with toe boards, safety net systems, or personal fall arrest systems.

Residential Construction: Workers engaged in residential construction 6 feet or more above lower levels must be protected by conventional fall protection (i.e., guardrail systems, safety net systems, or personal fall arrest systems) unless another provision in 29 CFR 1926.501(b) provides for an alternative fall protection measure.

Other Walking or Working Surfaces: As a general matter, each worker on a walking or working surface 6 feet or more above a lower level must be protected from falling by a guardrail system, a safety net system, or a personal fall arrest system.

3.6: Conventional Fall Protection Systems

Guardrail Systems

Guardrail systems are barriers erected to prevent workers from falling to lower levels. If the employer chooses to use guardrail systems to protect workers from falls, the following provisions apply:



Properly installed guardrail system.

Image 3:1 Properly Installed Guardrail System (Source: www.osha.gov, Public Domain).

- Top rails, or equivalent guardrail system members, must be 42 inches plus or minus 3 inches above the walking or working level. When workers are using stilts, the top edge of the top rail, or equivalent member, must be increased to an amount equal to the height of the stilts.
- Screens, midrails, mesh, intermediate vertical members, or equivalent intermediate structural members must be installed between the top edge of the guardrail system and the walking or working surface when there are no walls or parapet walls at least 21 inches high.
- When midrails are used, they must be installed at a height midway between the top edge of the guardrail system and the walking or working level.
- When screens and mesh are used, they must extend from the top rail to the walking or working level and along the entire opening between top rail supports. When necessary, screens and/or mesh must be installed in a manner to prevent a worker from falling underneath.
- When intermediate members (such as balusters) are used between posts, they must not be more than 19 inches apart.
- Other structural members (such as additional midrails and architectural panels) must be installed so that there are no openings in the guardrail system more than 19 inches wide.
- Guardrail systems must be capable of withstanding a force of at least 200 pounds applied within 2 inches of the top edge, in any outward or downward direction, at any point along the top edge.
- Midrails, screens, mesh, intermediate vertical members, solid panels, and equivalent structural members must be capable of withstanding a force of at least 150 pounds applied in any downward or outward direction at any point along the midrail or other member.
- Guardrail systems must have a surface to protect workers from punctures or lacerations and to prevent clothing from snagging.
- The ends of top rails and midrails must not overhang terminal posts, except where an overhang poses no projection hazard.
- Steel and plastic banding cannot be used as top rails or midrails.
- Top rails and midrails of guardrail systems must have a nominal diameter or thickness of at least 1/4 inch to prevent cuts and lacerations.
- If wire rope is used for top rails, it must be flagged at not more than 6-foot intervals with high-visibility material.

- When guardrail systems are used at hoisting areas, a chain, gate, or removable guardrail section must be placed across the access opening between guardrail sections during those times when hoisting operations are not taking place.
- When guardrail systems are used at holes, they must be set up on all unprotected sides or edges. When a hole is used for the passage of materials, it must not have more than two sides with removable guardrail sections. When the hole is not in use, it must be covered or provided with a guardrail system along all unprotected sides or edges.
- If guardrail systems are used around holes being used as access points (such as ladderways), gates must be used. Alternatively, the point of access must be offset to prevent workers from accidentally walking straight into the hole.
- If guardrails are used on ramps and runways, they must be erected on each unprotected side or edge.
- Manila, plastic, or synthetic rope used for top rails or midrails must be inspected as frequently as necessary to ensure its strength and stability.

Safety Net Systems

When safety nets are used, they must be installed as close as practicable under the walking or working surface on which workers are working and never more than 30 feet below that level. When nets are used on bridges, the potential fall area from the walking or working surface to the net must be unobstructed. All safety nets must be installed with sufficient clearance underneath to prevent a falling body from hitting the surface or structure below the net. Drop-testing is required to ensure that safety nets and safety net installations are working properly. If an employer can demonstrate that it is unreasonable to perform a drop-test, then the employer or a designated competent person must certify that the net and its installation is in compliance with the standard.



Safety nets used in construction sites.

Image 3:2 Safety Nets Used in Construction Sites (Source: www.osha.gov, Public Domain).

- Do not use defective nets. Inspect nets at least once a week for wear, damage, or deterioration of components such as net connection points.
- Remove materials, tools, and other items as soon as possible from the net and at least before the next work shift.
- To work properly, a safety net must have safe openings. Mesh openings must not exceed 36 square inches, and must not be longer than 6 inches on any side. Each opening, measured center-to-center of mesh ropes or webbing, must not exceed 6 inches.
- All mesh crossings must be secured to prevent the openings from enlarging.
- Use safety net (or section of net) with a border rope possessing a minimum breaking strength of 5,000 pounds.
- Do not allow one weak link to compromise a safety net. Use connections between safety net panels that are as strong as integral net components and spaced no more than 6 inches apart.

Personal Fall Arrest System

A personal fall arrest system is a system used to safely stop (arrest) a worker who is falling from a working level. It consists of an anchorage, connectors, and body harness. It also may include a lanyard, deceleration device, lifeline, or suitable combinations of these. When employers choose to use a personal fall arrest system as a means of worker fall protection they must:

- Limit the maximum arresting force on a worker to 1,800 pounds when used with a body harness.
- Be rigged so that a worker can neither free fall more than 6 feet nor contact any lower level.
- Bring a worker to a complete stop and limit the maximum deceleration distance a worker travels to 3.5 feet.
- Have sufficient strength to withstand twice the potential impact energy of a worker free falling a distance of 6 feet or the free fall distance permitted by the system, whichever is less.
- Be inspected prior to each use for wear, damage, and other deterioration. Defective components must be removed from service.

Personal Fall Arrest System Components

Snaphooks: Snaphooks must be the locking type and designed and used to prevent disengagement from any component part of the personal fall arrest system. Locking type snaphooks may also be used when designed for the following connections: directly to webbing, rope, or wire rope; to each other; to a Dee-ring to which another snaphook or other connector is attached; to a horizontal lifeline; or to any object which is incompatibly shaped or dimensioned in relation to the snaphook, such that unintentional disengagement could occur by the connected object being able to depress the snaphook keeper and release itself.

Horizontal Lifelines: On suspended scaffolds or similar work platforms with horizontal lifelines that may become vertical lifelines, the devices used to connect to a horizontal lifeline must be capable of locking in both directions on the lifeline. Horizontal lifelines must be designed, installed, and used under the supervision of a qualified person, as part of a complete personal fall arrest system that maintains a safety factor of at least two.

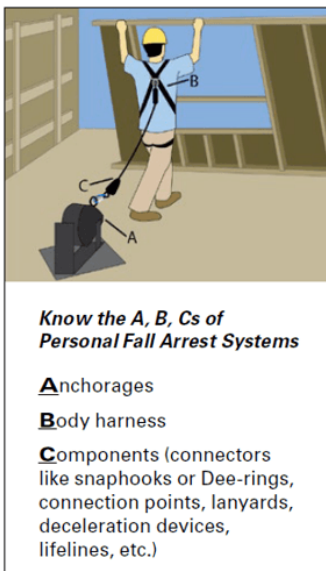


Image 3:3 Know the A, B, Cs of Personal Fall Arrest Systems (Source: www.osha.gov, Public Domain).

Vertical Lifelines and Lanyards: Vertical lifelines and lanyards must have a minimum breaking strength of 5,000 pounds. Lifelines must be protected against being cut or abraded.

Self-retracting Vertical Lifelines and Lanyards: Self-retracting lifelines and lanyards that automatically limit free fall distance to 2 feet or less must be capable of sustaining a minimum tensile load of 3,000 pounds applied to the device with the lifeline or lanyard in the fully extended position. Self-retracting lifelines and lanyards which do not limit free fall distance to 2 feet or less, ripstitch lanyards, and tearing and deforming lanyards must be capable of sustaining a minimum tensile load of 5,000 pounds applied to the device with the lifeline or lanyard in the fully extended position.

Ropes and Straps: Ropes and straps (webbing) used in lanyards, lifelines, and strength components of body belts and body harnesses must be made of synthetic fibers.

Anchorage: Anchorages used to attach personal fall arrest systems must be designed, installed, and used under the supervision of a qualified person, as part of a complete personal fall arrest system which maintains a safety factor of at least two. Alternatively,

the anchorages must be independent of any anchorage being used to support or suspend platforms and must be capable of supporting at least 5,000 pounds per worker attached or be capable of supporting at least twice the expected impact load.

Positioning Device Systems

OSHA defines a positioning device system as a body belt or body harness system rigged to allow a worker to be supported on an elevated vertical surface, such as a wall, and work with both hands free while leaning. Body belt or body harness systems are to be set up so that a worker can free fall no farther than 2 feet. Body belts or harnesses must be secured to an anchorage capable of supporting at least twice the potential impact load of a worker's fall or 3,000 pounds, whichever is greater.

Fall Restraint Systems

OSHA recognizes a fall restraint system as a means of prevention. The system, if properly used, tethers a worker in a manner that will not allow a fall of any distance. This system is comprised of a body belt or body harness, an anchorage, connectors, and other necessary equipment. Other components typically include a lanyard, a lifeline, and other devices. For a restraint system to work, the anchorage must be strong enough to prevent the worker from moving past the point where the system is fully extended, including an appropriate safety factor.

Warning Line Systems

OSHA defines a warning line system as a barrier erected on a roof to warn workers that they are approaching an unprotected roof side or edge, and to designate an area in which roofing work may take place without the use of guardrails, body harnesses, or safety net systems to protect workers in the area. Warning line systems consist of ropes, wires, or chains, plus supporting stanchions. If an employer chooses to use warning line systems, the following provisions apply:

- The warning line must be erected around all sides of roof work areas.
- When mechanical equipment is not being used, the warning line must be erected at least 6 feet from the roof edge.
- When mechanical equipment is being used the warning line must be erected: at least 6 feet from the roof edge parallel to the direction of mechanical equipment operation; and at least 10 feet from the roof edge perpendicular to the direction of mechanical equipment operation.
- The rope, wire, or chain must be flagged at not more than 6-foot intervals with high-visibility material.
- The rope, wire, or chain must be rigged and supported so that: the lowest point (including sag) is at least 34 inches from the walking or working surface; and its highest point is no more than 39 inches from the walking or working surface.
- Stanchions, after being rigged with warning lines, must be capable of resisting, without tipping over, a force of at least 16 pounds applied horizontally against the stanchion, 30 inches above the walking or working surface, perpendicular to the warning line and in the direction of the floor, roof, or platform edge.
- The rope, wire, or chain must have a minimum tensile strength of 500 pounds.
- The rope, wire, or chain must be attached to each stanchion in such a way that pulling on one section of the line between stanchions will not result in slack being taken up in the adjacent section before the stanchion tips over.

3.7: Controlled Access Zones

A controlled access zone is a work area in which certain types of work may take place without using conventional fall protection systems. Worker access to these areas must be carefully controlled. For example, a controlled access zone would be designated where overhand bricklaying was occurring without the protection of guardrails. In this example, only masons and other workers actually engaged in the bricklaying would be allowed in the controlled access zone. When used to control access to areas where leading edge and other operations are taking place, the controlled access zones must be defined by a control line or by any other means that restricts access. When control lines are used to define a controlled access zone, they must be erected at least 6 feet and no more than 25 feet from the unprotected or leading edge, except when precast concrete members are being erected. In the latter case, the control line is to be erected at least 6 feet and no more than 60 feet or half the length of the member being erected, whichever is less, from the leading edge. The control line must extend along the entire length of and approximately parallel to the unprotected side or leading edge and be connected on each side to a guardrail system or wall. When controlled access zones are used to limit access to areas where overhand bricklaying and related work are taking place: a control line must be erected to define the work zone and must be erected at least 10 feet and no more than 15 feet from the working edge. Control lines must consist of ropes, wires, tapes, or equivalent materials, and supporting stanchions.

3.8: Safety Monitoring Systems

A safety monitoring system is an alternative fall protection option for low-slope roofing work under 29 CFR 1926.501(b) (10). If employers elect to use a safety monitoring system, they must designate a competent person to monitor the safety of workers and to warn them when their work puts them close to a fall hazard.

The safety monitor must:

- Be competent in the recognition of fall hazards.
- Warn workers when it appears that they are unaware of fall hazards or when the workers are acting in an unsafe manner.
- Be on the same walking or working surfaces as the workers and be able to see them.
- Be close enough to the work operations to speak directly with workers.
- Have no other duties to distract them from their monitoring function.

Employers must ensure that:

- Mechanical equipment is not used or stored in areas where safety monitoring systems are being used to monitor workers engaged in roofing operations on low-slope roofs.
- No worker, other than one engaged in roofing work on low-slope roofs or one covered by a fall protection plan, enters an area where a worker is being protected by a safety monitoring system.
- All workers in a controlled access zone have been instructed to promptly comply with fall hazard warnings issued by safety monitors.

3.9: Other Hazards that Require Fall Protection

A construction environment poses many hazards requiring protection. Below are some fall hazards that cannot be overlooked.

Hoist Areas: Each worker in a hoist area must be protected from falling 6 feet or more by guardrail systems or personal fall arrest systems. There may be times when the guardrail systems (or chain, gate, or guardrail) must be removed in whole or part to facilitate hoisting operations. For example, during the landing of materials, a worker may need to lean through the access opening or out over the edge of the access opening to receive or guide equipment and materials. At such times a personal fall arrest system must be used to protect the worker from falling through the unprotected opening.

Holes: Each worker on walking or working surfaces must be protected from falling through holes (including skylights) that are more than 6 feet above lower levels, by personal fall arrest systems, covers, or guardrail systems erected around such holes. Each worker on a walking or working surface must be protected from tripping in or stepping into or through holes (including skylights) by covers.

Ramps, Runways, and Other Walkways: Each worker on a ramp, runway, or other walkway must be protected by guardrail systems against falling 6 feet or more.

Excavations: Each worker at the edge of an excavation 6 feet or more deep must be protected from falling by guardrail systems, fences, or barricades when the excavation cannot be readily seen because of plant growth or other visual barrier. Each worker at the edge of a well, pit, shaft, and similar excavation 6 feet or more deep must be protected from falling by guardrail systems, fences, or barricades, or covers.

Dangerous Equipment: When working 6 feet or more above dangerous equipment, each worker must be protected by guardrail systems, safety net systems, or personal fall arrest systems. When working less than 6 feet above dangerous equipment, each worker must be protected from falling into or onto the dangerous equipment by a guardrail system or equipment guards.

Wall Openings: Each worker working on, at, above, or near wall openings (including those with chutes attached), where the outside bottom edge of the wall opening is 6 feet or more above lower levels and the inside bottom edge of the wall opening is less than 39 inches above the walking or working surface, must be protected with a guardrail system, a safety net system, or a personal fall arrest system.

3.10: Protection from Falling Objects

Falling objects can also pose a hazard to workers. Falling object protection must comply with the following provisions:

Guardrails: When guardrail systems are used to prevent materials from falling from one level to another, any openings must be small enough to prevent passage of falling objects.

Overhand Bricklaying and Related Work: During overhand bricklaying and related work, no materials or equipment except masonry and mortar may be stored within 4 feet of working edges. Excess mortar, broken or scattered masonry units, and all other materials and debris must be kept clear of the working area by removal at regular intervals.

Roofing Work: During roofing work, materials and equipment must not be stored within 6 feet of a roof edge unless guardrail systems are erected at the edge. Any materials piled, grouped, or stacked near a roof edge must be stable and self-supporting.

Toeboards: When toeboards are used as protection from falling objects, they must be erected along the edges of the overhead walking or working surface for a distance sufficient to protect workers working below. Toeboards must be capable of withstanding, without failure, a force of at least 50 pounds applied in any downward or outward direction at any point along the toeboard. Toeboards must be at least 3.5 inches tall from their top edge to the level of the walking or working surface, must have no more than 0.25 inch clearance above the walking or working surface, and must be solid or have openings no larger than one inch in its greatest dimension. Where tools, equipment, or materials are piled higher than the top edge of a toeboard, paneling or screening must be erected from the walking or working surface or toeboard to the top of a guardrail system's top rail or midrail, for a distance sufficient to protect workers below.

Canopies: When used as protection from falling objects, canopies must be strong enough to prevent collapse and to prevent penetration by any objects that may fall onto them.

3.11: Elements of a Fall Protection Plan

- A fall protection plan must be prepared by a qualified person and developed specifically for the site where the work is being performed.
- The fall protection plan must be maintained and kept up to date.
- Any changes to the fall protection plan must be approved by a qualified person.
- A copy of the fall protection plan with all approved changes must be maintained at the job site.
- A competent person must supervise the implementation of the fall protection plan.
- The plan must document the reasons why the use of conventional fall protection is infeasible or would create a greater hazard.
- The plan must include a written discussion of other measures that will be taken to reduce or eliminate the fall hazard for workers who cannot be provided with protection using conventional fall protection systems. For example, the employer must discuss the extent to which scaffolds, ladders, or vehicle-mounted work platforms can be used to provide a safer working surface and thereby reduce the hazard of falling.
- The plan must identify each location where conventional fall protection methods cannot be used. These locations must then be classified as controlled access zones, and the employer must comply with the criteria in 29 CFR 1926.502(g) and 29 CFR 1926.502(k)(7).
- Where no other alternative measure has been implemented, the employer must implement a safety monitoring system that complies with 29 CFR 1926.502(h) and 29 CFR 1926.502(k)(8).
- The plan must include a statement which provides the name or other method of identification for each worker who is authorized to work in controlled access zones. No other workers may enter controlled access zones.
- In the event that a worker falls, or some other related, serious incident occurs (for example, a near miss), the employer must investigate the circumstances to determine if the fall protection plan needs to be changed. For example, the plan may need to add new practices, procedures, or training. The employer must implement the needed changes to prevent similar types of falls or incidents.

3.12: Fall Protection Training

Employers must provide a fall protection training program to workers who might be exposed to fall hazards. Training must include how to recognize fall hazards and how to minimize them. The employer must assure that each worker has been trained as necessary, by a competent person who is qualified in the following areas:

- The nature of fall hazards in the work area.
- The correct procedures for erecting, maintaining, disassembling, and inspecting the fall protection systems to be used.
- The use and operation of controlled access zones; guardrail, personal fall arrest, safety net, warning line, and safety monitoring systems, and other protection to be used.
- The role of each worker in the safety monitoring system when the system is used.
- The limitations on the use of mechanical equipment during the performance of roofing work on low-slope roofs.
- The correct procedures for equipment and materials handling and storage and the erection of overhead protection.
- The role of workers in fall protection plans
- OSHA's fall protection requirements

3.13: Definitions

Anchorage – a secure point of attachment for lifelines, lanyards, or deceleration devices.

Body belt (safety belt) – a strap with means both for securing it about the waist and for attaching it to a lanyard, lifeline, or deceleration device.

Body harness – straps which may be secured about the worker in a manner that will distribute the fall arrest forces over at least the thighs, pelvis, waist, chest, and shoulders, with means for attaching it to other components of a personal fall arrest system.

Buckle – any device for holding the body belt or body harness closed around the worker's body. *Competent person* – one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to workers, and who has authorization to take prompt corrective measures to eliminate them.

Connector – a device which is used to couple (connect) parts of the personal fall arrest system and positioning device systems together. It may be an independent component of the system, such as a carabiner, or it may be an integral component of part of the system (such as a buckle or Dee-ring sewn into a body belt or body harness, or a snaphook spliced or sewn to a lanyard or self-retracting lanyard).

Controlled access zone (CAZ) – an area in which certain work (for example, overhand bricklaying) may take place without the use of guardrail systems, personal fall arrest systems, or safety net systems; and where access to the zone is controlled.

Dangerous equipment – equipment (such as pickling or galvanizing tanks, degreasing units, machinery, electrical equipment, and other units) which, as a result of form or function, may be hazardous to workers who fall onto or into such equipment.

Deceleration device – any mechanism (such as a rope grab, rip-stitch lanyard, specially-woven lanyard, tearing or deforming lanyards, automatic self-retracting lifelines/ lanyards, etc.) which serves to dissipate a substantial amount of energy during a fall arrest, or otherwise limit the energy imposed on a worker during fall arrest.

Deceleration distance – the additional vertical distance a falling employee travels, excluding lifeline elongation and free fall distance, before stopping, from the point at which the deceleration device begins to operate. It is measured as the distance between the location of a worker's body belt or body harness attachment point at the moment of activation (at the onset of fall arrest forces) of the deceleration device during a fall, and the location of that attachment point after the worker comes to a full stop.

Equivalent – alternative designs, materials, or methods to protect against a hazard, which the employer can demonstrate will provide an equal or greater degree of safety for workers than the methods, materials, or designs specified in the standard.

Failure – load refusal, breakage, or separation of component parts. Load refusal is the point where the ultimate strength is exceeded.

Free fall – the act of falling before a personal fall arrest system begins to apply force to arrest the fall.

Free fall distance – the vertical displacement of the fall arrest attachment point on the worker's body belt or body harness between onset of the fall and just before the system begins to apply force to arrest the fall. This distance excludes deceleration distance and lifeline/lanyard elongation, but includes any deceleration device slide distance or self retracting lifeline/lanyard extension before they operate and fall arrest forces occur.

Guardrail system – a barrier erected to prevent workers from falling to lower levels.

Hole – a gap or void 2 inches or more in its least dimension, in a floor, roof, or other walking or working surface.

Infeasible – impossible to perform the construction work using a conventional fall protection system (that is, guardrail system, safety net system, or personal fall arrest system); or technologically impossible to use any one of these systems to provide fall protection.

Lanyard – a flexible line of rope, wire rope, or strap which generally has a connector at each end for connecting the body belt or

body harness to a deceleration device, lifeline, or anchorage.

Leading edge – the edge of a floor, roof, or formwork for a floor or other walking or working surface (such as the deck) which changes location as additional floor, roof, decking, or formwork sections are placed, formed, or constructed. A leading edge is considered to be an “unprotected side and edge” during periods when it is not actively and continuously under construction.

Lifeline – a component consisting of a flexible line for connection to an anchorage at one end to hang vertically (vertical lifeline), or for connection to anchorages at both ends to stretch horizontally (horizontal lifeline), and which serves as a means for connecting other components of a personal fall arrest system to the anchorage.

Low-slope roof – a roof having a slope less than or equal to 4 in 12 (vertical to horizontal).

Lower levels – those areas or surfaces to which a worker can fall. Such areas or surfaces include, but are not limited to, ground levels, floors, platforms, ramps, runways, excavations, pits, tanks, material, water, equipment, structures, or portions thereof.

Mechanical equipment – all motor- or human-propelled wheeled equipment used for roofing work, except wheelbarrows and mop carts.

Opening – a gap or void 30 inches or more high and 18 inches or more wide, in a wall or partition, through which workers can fall to a lower level.

Overhand bricklaying and related work – the process of laying bricks and masonry units such that the surface of the wall to be jointed is on the opposite side of the wall from the mason, requiring the mason to lean over the wall to complete the work. Related work includes mason tending and electrical installation incorporated into the brick wall during the overhand bricklaying process.

Personal fall arrest system – a system used to arrest a worker in a fall from a working level. It consists of an anchorage, connectors, and body harness. It may include a lanyard, deceleration device, lifeline, or suitable combinations of these.

Positioning device system – a body belt or body harness system rigged to allow a worker to be supported on an elevated vertical surface, such as a wall, and work with both hands free while leaning.

Qualified – one who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated his ability to solve or resolve problems relating to the subject matter, the work, or the project.

Rope grab – a deceleration device which travels on a lifeline and automatically, by friction, engages the lifeline and locks so as to arrest the fall of a worker. A rope grab usually employs the principles of inertial locking, cam/level locking, or both.

Roof – the exterior surface on the top of a building. This does not include floors or formwork which, because a building has not been completed, temporarily become the top surface of a building.

Roofing work – the hoisting, storage, application, and removal of roofing materials and equipment, including related insulation, sheet metal, and vapor barrier work, but not including the construction of the roof deck.

Safety-monitoring system – a safety system in which a competent person is responsible for recognizing and warning workers of fall hazards.

Self-retracting lifeline/lanyard – a deceleration device containing a drum-wound line which can be slowly extracted from, or retracted onto, the drum under slight tension during normal worker movement, and which, after onset of a fall, automatically locks the drum and arrests the fall.

Snaphook – a connector comprised of a hook-shaped member with a normally closed keeper, or similar arrangement, which may be opened to permit the hook to receive an object and, when released, automatically closes to retain the object. Snaphooks are generally one of two types: (1) The *locking* type with a self-closing, self-locking keeper which remains closed and locked until unlocked and pressed open for connection or disconnection; or (2) The *non-locking* type with a self-closing keeper which remains closed until pressed open for connection or disconnection. As of January 1, 1998, the use of a non locking snaphook as part of personal fall arrest systems and positioning device systems is prohibited.

Steep roof – a roof having a slope greater than 4 in 12 (vertical to horizontal).

Toeboard – a low protective barrier that will prevent the fall of materials and equipment to lower levels and provide workers protection from falls.

Unprotected sides and edges – any side or edge (except at entrances to points of access) of a walking or working surface (for example, floor, roof, ramp, or runway) where there is no wall or guardrail system at least 39 inches high.

Walking/working (walking or working) surface – any surface (whether horizontal or vertical) on which a worker walks or works, including but not limited to floors, roofs, ramps, bridges, runways, formwork and concrete reinforcing steel; but not including ladders, vehicles, or trailers, on which workers must be located in order to perform their job duties.

Warning line system – a barrier erected on a roof to warn workers that they are approaching an unprotected roof side or edge, and which designates an area in which roofing work may take place without the use of guardrail, body harness, or safety net systems to protect workers in the area.

Work area – that portion of a walking or working surface where job duties are being performed.

3.14: Summary

Each year, falls consistently account for the greatest number of fatalities in the construction industry. A number of factors are often involved in falls, including unstable working surfaces, misuse or failure to use fall protection equipment, and human error. Studies have shown that using guardrails, fall arrest systems, safety nets, covers and restraint systems can prevent many deaths and injuries from falls.

Consider using aerial lifts or elevated platforms to provide safer elevated working surfaces; erect guardrail systems with toeboards and warning lines or install control line systems to protect workers near the edges of floors and roofs; cover floor holes; and/or Use safety net systems or personal fall arrest systems (body harnesses).

3.15: Review Questions

Multiple Choice Questions

1. What is the primary purpose of fall protection?
 - (a) to reduce company insurance costs
 - (b) to comply with OSHA regulations
 - (c) to prevent workers from falling and minimize injury risks
 - (d) to increase worker productivity
2. Which of the following is the leading cause of fatalities in construction?
 - (a) Electrocution
 - (b) Falls
 - (c) Struck-by incidents
 - (d) Caught-in/between incidents
3. At what height must fall protection be provided in the construction industry?
 - (a) 4 feet
 - (b) 5 feet
 - (c) 6 feet
 - (d) 8 feet
4. What is the minimum height of a toeboard used for falling object protection?
 - (a) 2 inches
 - (b) 3.5 inches
 - (c) 6 inches
 - (d) 12 inches
5. Who must prepare a fall protection plan?
 - (a) competent person
 - (b) supervisor
 - (c) qualified person
 - (d) any worker
6. A safety monitoring system requires which of the following?
 - (a) A guardrail on all edges
 - (b) A competent person to monitor workers
 - (c) Fall restraint system
 - (d) Use of safety nets
7. Who is responsible for recognizing and warning workers of fall hazards in a safety monitoring system?
 - (a) supervisor
 - (b) qualified person
 - (c) competent person
 - (d) any worker nearby
8. Guardrail systems must withstand a force of at least:
 - (a) 100 pounds
 - (b) 150 pounds
 - (c) 200 pounds
 - (d) 300 pounds
9. A fall protection plan must be maintained:
 - (a) Only at the company headquarters
 - (b) On-site and up to date

- (c) Only during inspections
- (d) Once a year

10. Employers must train workers about fall hazards in:

- (a) English only
- (b) Any language the employer chooses
- (c) A language the worker can understand
- (d) Technical OSHA language

11. When a fall or near miss occurs, the employer must:

- (a) Report it to OSHA only
- (b) Investigate and revise the plan if needed
- (c) Restart the entire project
- (d) Blame the worker

True/False Questions

- 12. True/False: OSHA requires fall protection at elevations above 10 feet in the construction industry.
- 13. True/False: Guardrails, safety nets, and personal fall arrest systems are considered conventional fall protection.
- 14. True/False: A controlled access zone (CAZ) allows any worker to enter freely as long as they are wearing a harness.
- 15. True/False: Employers must provide fall protection training in a language that workers can understand.
- 16. True/False: Employers must update the fall protection plan whenever changes occur or a fall-related incident happens.
- 17. True/False: It is safe to work under concrete buckets while buckets are being elevated.
- 18. True/False: Warning line systems can be placed as close as 2 feet from a roof edge.
- 19. True/False: The safety monitor may have other duties while observing workers.
- 20. True/False: Each job site must keep a copy of the current fall protection plan on location.

Answer Key: 1(c), 2(b), 3(c), 4(b), 5(c), 6(b), 7(c), 8(c), 9(b), 10(c), 11(b), 12(False), 13(True), 14(False), 15(True), 16(True), 17(False), 18(False), 19(False), 20(True).

3.16: Sources

The content in this chapter is adapted from:

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4: ELECTRICAL HAZARDS IN CONSTRUCTION

- 4.1: Definition
- 4.2: The Basics of Electricity
- 4.3: How Electrical Shocks Occur
- 4.4: Preventive Measures for Workers to Consider
- 4.5: Tool safety tips
- 4.6: Safeguards
- 4.7: Factors on Extension Cord Safety
- 4.8: Electrical Safety Tips
- 4.9: Review Questions
- 4.10: Sources

4.1: Definition

An electrical hazard can be defined as a serious workplace hazard that exposes workers to the following: burns, electrocution, shock, arc flash/arc blast, fire, and explosions. A burn is the most common shock-related injury. Burns from electricity are one of three types: electrical, arc/flash or thermal contact. Electrocution is a fatal injury that occurs when a person is exposed to a lethal amount of electrical energy. Shock results when the body becomes part of the electrical circuit; current enters the body at one point and leaves at another. Electrical shock is defined as a reflex response to the passage of electric current through the body. An arc flash is the sudden release of electrical energy through the air when a high-voltage gap exists and there is a breakdown between conductors. An arc flash gives off thermal radiation (heat) and bright, intense light that can cause burns. Temperatures have been recorded as high as 35,000 °F. High-voltage arcs can also produce considerable pressure waves by rapidly heating the air and creating a blast. Most electrical distribution fires result from problems with "fixed wiring" such as faulty electrical outlets and old wiring. Problems with cords (such as extension and appliance cords), plugs, receptacles, and switches also cause electrical fires. An explosion can occur when electricity ignites an explosive mixture of material in the air. Note that although a) electricity is the source of these hazards, and b) all of these hazards are of equal importance, for this focus four module, this lesson focuses on electrocution hazards.

Examples

The following are examples of electrocutions that have occurred in the construction industry:

- Two workers were moving an aluminum ladder. One of them was electrocuted when the ladder came in contact with overhead power lines.
- A worker was raising a mast on a water well drilling truck when the mast came in contact with high voltage overhead lines, electrocuting the worker.
- Worker was electrocuted when the boom of a rotary drilling truck contacted an overhead power line. The victim and another worker had just finished drilling a water well at a residential property. The victim moved the truck away from the well. The victim was standing at the controls, lowering the boom and was thrown several feet away from the truck.
- Worker was fatally injured when he was electrocuted and fell to the concrete floor while working from an 8' fiberglass step ladder. Worker was changing an energized ballast on a two bulb florescent light fixture, located approximately 11'6" off the ground.
- The worker was electrocuted while connecting a replacement electrical service box to the electrical service drop to the building.

Statistics

Data from the U.S. Bureau of Labor Statistics (BLS) show that electrocution was the fourth leading cause of death in construction in 2005, after falls to a lower level, transportation injuries, and being struck by objects and equipment. Electrocutions caused 9% of 1,243 construction worker deaths, but accounted for less than 1% of reported recordable nonfatal injuries in 2005. For 2003-2005, the death rate from electrocutions for the construction industry was 1.1 per 100,000 full-time workers, for was an average of 121 electrocutions per year. The highest rates of death from electrocution were among electrical power installers and repairers and earth drillers.

4.2: The Basics of Electricity

Operating an electrical switch is like turning on a water faucet. Behind the faucet (or switch) there is a source of water (or electricity), a way to transport it, and pressure to make it flow. The faucet's water source is a reservoir or pumping station. A pump provides enough pressure for the water to flow through the pipes. The switch's electrical source is a power generating station. A generator provides the pressure (voltage) for the electrical current to travel through electrical conductors, or wires.

Electricity is the flow of an atom's electrons through a conductor; caused by a force (voltage) placed on the conductor. Electrons are the outer particles of an atom that contain a negative charge. When electrons flow through a conductor, the flow is called electric current. Electricity is produced in a generating plant. When electricity leaves a power plant, its voltage is increased in order to transmit it over long distances. The high-voltage power travels along transmission lines to a substation, then distributed through more lines to service drops that step down the voltage to levels between 240 and 480 volts. Voltage is the fundamental force or pressure that causes electricity to flow through a conductor and is measured in volts (V). Voltage is synonymous with electrical pressure. The more voltage present, the more force or pressure is pushing the electricity. An overhead power line uses high voltage (thousands of volts) to carry electricity over large distances, from generating stations to our communities and then to our homes and businesses.

Current is the flow of electrons from a source of voltage through a conductor and is measured in amperes (Amps). If the current flows back and forth (a cycle) through a conductor, it is called alternating current (AC). In each cycle the electrons flow first in one direction, then the other. In the United States, the normal rate is 60 cycles per second [or 60 Hertz (Hz)]. If current flows in one direction only (battery operated/cordless tools), it is called direct current (DC).

AC is most widely used because it is possible to step up or step down (i.e., increase or decrease) the voltage through a transformer. For example, when voltage from an overhead power line is run through a pole-mounted transformer, it can be stepped down to normal household voltage. Resistance is anything that impedes (blocks) the flow of electricity through a conductor and is measured in Ohms.

The term "ground" refers to a conductive body, usually the earth. "Grounding" a tool or electrical system means intentionally creating a low-resistance path to the earth. When properly done, current from a short or from lightning follows this path, thus preventing the buildup of voltages that would otherwise result in electrical shock, injury and even death.

An Arc Flash Hazard is defined as a source of possible injury or damage to health associated with the release of energy caused by an electric arc. The results are often violent and when a human is in close proximity to the arc flash, serious injury and even death can occur. Arc flash can be caused by dust, dropping tools, accidental touching, condensation, material failure, corrosion, and faulty installation. Three factors determine the severity of an arc flash injury: proximity of the worker to the hazard, temperature, time for circuit to break. Typical results from an arc flash include: burns (Non-FR clothing can burn onto skin), fire (could spread rapidly through building), flying objects (often molten metal), blast pressure (upwards of 2000 lbs./ft²), sound blast (noise can reach 140 dB – as loud as a handgun), and heat (upwards of 35,000 degrees F).

4.3: How Electrical Shocks Occur

Electricity travels in closed circuits, normally through a conductor. Typically, shock occurs when a person contacts one wire of an energized circuit and the ground, when a person contacts a metallic part in contact with an energized wire while the person is also in contact with the ground, when a person contacts both wires of an energized circuit.

Factors Affecting Severity of Electrical Shock

■ Amount of current flow ■ Path of current flow ■ Duration of current flow

Electrocution Triangle

The amount of current flowing through the body, the path the current takes through the body and the length of time that the body is in the circuit all have an effect on the severity of an injury; remove any one of these factors from the electrocution triangle, and the potential for injury is reduced.

Contact with Power Lines

Overhead and buried power lines are especially hazardous because they carry extremely high voltage. Fatalities are possible as electrocution is the main risk; however, burns and falls from elevations are also hazards that workers are exposed to while working in the vicinity of high voltage power lines. Workers may not realize that cranes are not the only equipment that reaches overhead power lines. Working on a ladder or in a man-basket suspended under or near power lines also poses a risk of electrocution. Important to note: The covering on an overhead power line is primarily for weather protection; therefore, workers need to know that if they touch a power line, covered or bare, death is probable.

Electrical power is brought to us through a three-part system: “high power transmission lines” running from generating stations to substations, “distribution lines”, the same lines that run through most of our neighborhoods and job sites, and “service drops” running from poles to utility customers. The majority of the power line contacts reported to OSHA involved overhead “distribution” lines. This is due to their proximity to most construction work and their frequency on the landscape.

Example 1:

Two workers were installing aluminum siding on a farmhouse when it became necessary to remove a 36-foot-high metal pole CB antenna. One worker stood on a metal pick board between two ladders and unfastened the antenna at the top of the house. The other worker, who was standing on the ground, took the antenna to lay it down in the yard. The antenna made electrical contact with a 7200-volt power transmission line 30 feet 10 inches from the house and 23 feet 9 inches above the ground. The worker handling the antenna received a fatal shock and the other worker a minor shock.



Transmission Line



Distribution Line



Service Drop Line

Image 4:1 Examples of Power Lines. (Source: www.osha.gov, Public Domain).

Example 2:

A lineman was electrocuted while working on grounded de-energized lines. He was working from a defective basket on an articulated boom aerial lift when the basket contacted energized lines which ran beneath the de-energized lines. The defective basket permitted current to pass through a drain hole cut into the body of the basket, then through the worker, and to ground via the de-energized line.

Example 3:

Two workers were spreading concrete as it was being delivered by a concrete pumper truck boom. The truck was parked across the street from the worksite. Overhead power lines ran perpendicular to the boom on the pumper truck. One worker was moving the hose (elephant trunk) to pour the concrete when the boom of the pumper truck came in contact with the overhead power line carrying 7,620 volts. One worker received a fatal electric shock and fell on the other worker who was assisting him. The second worker received massive electrical shock and burns.

Power Line Myth

Power lines are insulated. Wrong! Any covering you see on an overhead line is generally there for weather protection, not insulation.

Contact with Energized Sources

The major hazards regarding contact with energized sources are electrical shock and burns. Electrical shock occurs when the body becomes part of the electric circuit, either when an individual comes in contact with both wires of an electrical circuit, one wire of an energized circuit and the ground, or a metallic part that has become energized by contact with an electrical conductor.

The severity and effects of an electrical shock depend on a number of factors, such as the pathway through the body, the amount of current, the length of time of the exposure, and whether the skin is wet or dry. Water is a great conductor of electricity, allowing current to flow more easily in wet conditions and through wet skin.

Electrical burns can be arc burns, thermal contact burns, or a combination of burns. Electrical burns are among the most serious burns and require immediate medical attention. They occur when an electric current flows through tissue or bone, generating heat that causes tissue damage. The body cannot dissipate from the heat generated by current flowing through the resistance of the tissue therefore, burns occur. To further illustrate how easily a person can receive a fatal shock, consider a voltage that is

common to every location in the United States, 120-volts. Under average working conditions where the person is perspiring and has a resistance of only 1000-ohms from hand-to-hand, using the simple Ohm's Law formula (current equals the voltage divided by the resistance) the current flow will be 0.12 amperes or 120 mA.

If the power supply to electrical equipment is not grounded or the path has been broken, or if there are live parts or bare wires, a fault current may travel through a worker's body, causing electrical burns or death. Even when the power system is properly grounded, electrical equipment can instantly change from safe to hazardous because of extreme conditions and rough treatment.

Example 1:

The employee was attempting to correct an electrical problem involving two non-operational lamps. He proceeded to the area where he thought the problem was. He had not shut off the power at the circuit breaker panel nor had he tested the wires to see if they were live. He was electrocuted when he grabbed the two live wires with his left hand and then fell from the ladder.

(1,000 milliamperes = 1 amp; therefore, 15,000 milliamperes = 15 amp circuit)	
Current	Reaction
Below 1 milliampere	Generally not perceptible
1 milliampere	Faint tingle
5 milliampere	Slight shock felt; not painful but disturbing. Average individual can let go. Strong involuntary reactions can lead to other injuries.
6-25 milliamperes (women)	Painful shock, loss of muscular control
9-30 milliamperes (men)	The freezing current or "let-go" range. Individual cannot let go, but can be thrown away from the circuit if extensor muscles are stimulated.
50 150 milliamperes	Extreme pain, respiratory arrest, severe muscular contractions. Death is possible.
1,000 - 4,300 milliamperes	Rhythmic pumping action of the heart ceases. Muscular contraction and nerve damage occur; death likely.
10,000 milliamperes	Cardiac arrest, severe burns; death probable

Image 4:2 Electrical Current and Reaction. (Source: www.osha.gov, Public Domain).

Improper use of extension and flexible cords

Because power tools are so common in construction, workers are constantly exposed to a variety of hazards. The very tool that makes a job easy and efficient may one day be the cause of a tragic accident. The normal wear and tear on extension and flexible cords can loosen or expose wires, creating a hazardous condition. Cords that are not 3-wire type, not designed for hard-usage, or that have been modified, increase the risk of contacting electrical current. With the wide use of power tools on construction sites, flexible extension cords are often necessary. Because they are exposed, flexible, and unsecured, they are more susceptible to damage than fixed wiring. Hazards are created when cords, cord connectors, receptacles, and cord- and plug connected equipment are improperly used and maintained. To reduce hazards, flexible cords must connect to devices and to fittings in ways that prevent tension at joints and terminal screws. A flexible cord may be damaged by door or window edges, staples and fastenings, abrasion from adjacent materials, or simply by aging. If the electrical conductors become exposed, there is a danger of shocks, burns, or fire. When a cord connector is wet, electric current can leak to the equipment grounding conductor, and to anyone who picks up that connector if they provide a path to ground. Such leakage can occur not just on the face of the connector, but at any wetted portion.

Example 1:

A fan connected to a 120-volt electrical system via an extension cord provided ventilation for a worker performing a chipping operation from an aluminum stepladder. The insulation on the extension cord was worn through and exposed the bare, energized conductor made contact with the ladder. The ground wire was not attached on the male end of the cord's plug. When the energized conductor contacted the ladder, the path to ground included the worker's body, resulting in death.

Example 2:

An 18-year-old worker at a construction site was electrocuted when he touched a light fixture while descending from a scaffold for his afternoon break. The source of the electricity was apparently a short in a receptacle, but examination revealed that the electrical equipment used by the contractor was in such poor condition that it was impossible to make a certain determination of the source of the short. Extension cords had poor splices, no grounds, and reversed polarity. One hand drill was not grounded, and the other had no safety plate. Out of several possible scenarios, the most likely was contact between the exposed wires of an extension cord and a screw that protruded from the receptacle, which had its face plate removed. The light fixture, which served as ground, was known to be faulty for at least 5 months before the incident.

Maintain safe distance from overhead power lines

Staying away from power lines is the best option. The following table shows the safe power line clearance distance for various line voltages.

Power Line Clearance Distances

Table A – Minimum Clearance Distances	
Voltage (nominal, kV, alternating current)	Minimum clearance distance (feet)
Up to 50	10
Over 50 to 200	15
Over 200 to 350	20
Over 350 to 500	25
Over 500 to 750	35
Over 750 to 1000	45
Over 1000	(As established by the power line owner/operator or registered professional engineer who is a qualified person with respect to electrical power transmission and distribution)

Image 4:3 Power Line Clearance Distances. (Source: www.osha.gov, Public Domain).

4.4: Preventive Measures for Workers to Consider

Before work begins, be sure that the: (1) Equipment/activity is located within a safe working distance from power lines (2) Utility company has de-energized and visibly grounded the power lines or installed insulated sleeves on power lines (3) Flagged warning lines have been installed to mark horizontal and vertical power line clearance distances (4) Tools and materials used are nonconductive.

Be sure the utility company has confirmed the voltage and therefore the safe working distance from the power lines. Also, if applicable and feasible, use a/an: observer; insulated link; boom cage guard; proximity device. If provided, use installed rider posts under power lines to avoid working too close to the power lines. Use nonconductive ladders and be sure to retract them before moving. Ensure that no materials are stored under power lines. Use caution tape and signs to cordon off area under power lines. Locate and know what the markings from the local underground line locator service has marked before digging. Hand dig within three feet of cable location. Be aware that more than one underground cable may be buried in area of locator markings.

A ground fault circuit interrupter (GFCI) is a fast-acting circuit breaker that senses small imbalances in the circuit caused by current leakage to ground and, in a fraction of a second, shuts off the electricity. The GFCI continually matches the amount of current going to an electrical device against the amount of current returning from the device along the electrical path. Whenever the amount “going” differs from the amount “returning” by approximately 5 milliamps, the GFCI interrupts the electric power within as little as 1/40 of a second. A “GFCI” is a ground fault circuit interrupter that is designed to protect people from severe and sometimes fatal electrical shock. A GFCI detects ground faults and interrupts the flow of electric current, and is designed to protect the worker by limiting the duration of an electrical shock.

Example of the GFCI at work: An old drill that has a loose bare wire inside it touching the outer metal housing is being used. With the drill plugged in, the housing is charged with electricity. If it is used outside in the rain and the worker is standing on the ground, there is a path from the hot wire inside the drill through the worker to ground. If electricity flows from hot to ground through the worker, it could be fatal. The GFCI can sense the current flowing through you because not all of the current is flowing from hot to neutral as it expects -- some of it is flowing through the worker to the ground. As soon as the GFCI senses that, it trips the circuit and cuts off the electricity.

Workers need to inspect extension cords prior to their use for any cuts or abrasion. Extension cords may have damaged insulation. Sometimes the insulation inside an electrical tool or appliance is damaged. When the insulation is damaged, exposed metal parts may become energized if a live wire inside touches them. Electric hand tools that are old, damaged, or misused may have damaged insulation inside. Flexible cords used with temporary and portable lights shall be designed for hard or extra-hard usage. They shall be marked with usage type designation size and number of conductors. The cord could be marked with a 14/3 meaning the conductor size (AWG) is 14 and the number of conductors is 3.

4.5: Tool safety tips

Workers should use power tools and equipment as designed. Workers using power tools and equipment should follow tool safety tips to avoid misusing equipment.

- Never carry a tool by the cord
- Never yank the cord to disconnect it
- Keep cords away from heat, oil, and sharp edges
- Disconnect when not in use and when changing accessories such as blades and bits
- Avoid accidental starting. Do not hold fingers on switch button while carrying a plugged-in tool.
- Use gloves and appropriate footwear
- Store in dry place when not using
- Don't use in wet/damp environments
- Keep working areas well lit
- Ensure that cords do not cause a tripping hazard
- Remove damaged tools from use
- Use double-insulated tools.

Hand-held tools manufactured with non-metallic cases are called double-insulated. If approved, they do not require grounding under the National Electrical Code. Although this design method reduces the risk of grounding deficiencies, a shock hazard can still exist. Such tools are often used in areas where there is considerable moisture or wetness. Although the user is insulated from the electrical wiring components, water can still enter the tool's housing. Ordinary water is a conductor of electricity. If water contacts the energized parts inside the housing, it provides a path to the outside, bypassing the double insulation. When a person holding a hand tool under these conditions contacts another conductive surface, then an electric shock occurs.

Common examples of misused equipment

- Using multi-receptacle boxes designed to be mounted by fitting them with a power cord and placing them on the floor.
- Fabricating extension cords with ROMEX wire.
- Using equipment outdoors that is labeled for use only in dry, indoor locations.
- Attaching ungrounded, two-prong adapter plugs to three-prong cords and tools.
- Using circuit breakers or fuses with the wrong rating for over-current protection, e.g., using a 30-amp breaker in a system with 15 or 20 amp receptacles. Protection is lost because it will not trip when the system's load has been exceeded.
- Using modified cords or tools, i.e., removed ground prongs, face plates, insulation, etc.
- Using cords or tools with worn insulation or exposed wires.

Workers need to know that even when the power system is properly grounded, electrical equipment can instantly change from safe to hazardous because of extreme conditions and rough treatment. Lockout/tagout is an essential safety procedure that protects workers from injury while working on or near electrical circuits and equipment. In addition, lockout/tagout prevents contact with operating equipment parts such as, blades, gears, shafts, etc. Also, lockout/tagout prevents the unexpected release of hazardous gases, fluids, or solid matter in areas where workers are present.

To protect against being electrocuted, workers need to follow lockout/tagout procedures. When performing lockout/tagout on circuits and equipment, the following checklist can be used:

- Identify all sources of electrical energy for the equipment or circuits in question
- Disable backup energy sources such as generators and batteries
- Identify all shut-offs for each energy source
- Notify all personnel that equipment and circuitry must be shut off, locked out, and tagged out (turning a switch off is not enough)
- Shut off energy sources and lock switch gear in the OFF position. Each worker should apply his/her individual lock and keys kept with the worker
- Test equipment and circuitry to ensure they are de-energized. This must be done by a qualified person
- Deplete stored energy (for example, in capacitors) by bleeding, blocking, grounding, etc.
- Apply a lock or tag to alert other workers that an energy source or piece of equipment has been locked or tagged out
- Make sure all workers are safe and accounted for before equipment and circuits are unlocked and turned back on. Only a qualified person may determine when it is safe to re-energize circuits.

Only qualified persons may work on electric circuit parts or equipment that has not been deenergized. Such persons must be capable of working safely on energized circuits and must be familiar with the proper use of special precautionary techniques, PPE, insulating and shielding materials, and insulated tools.

Example: An electrician was removing a metal fish tape from a hole at the base of a metal light pole. (A fish tape is used to pull wire through a conduit run.) The fish tape became energized, electrocuting him.

4.6: Safeguards

Ensure Overhead Power Line Safety

Overhead power lines must be deenergized and grounded by the owner or operator of the lines, or other protective measures must be provided before work is started such as PPE (rubber insulating gloves, hoods, sleeves, matting, blankets, line hose, and industrial protective helmets.) Protective measures (such as guarding or insulating the lines) must be designed to prevent contact with the lines. Employers should train workers regarding power line hazards and about the available protective measures. Workers need to be fully informed about what jobs may have electrical hazards, and the measure(s) they will take to control the hazards. Also, workers should be reminded that they should always ask questions if they have any doubts about maintaining safe working conditions.

Isolate Electrical Parts

Electrical parts, conductors entering boxes, cabinets, or fittings shall be protected from abrasion, and openings through which conductors enter and shall be effectively closed. Unused openings in cabinets, boxes, and fittings shall also be effectively closed. All pull boxes, junction boxes, and fittings shall be provided with covers. Metal covers shall be grounded. In energized installations each outlet box shall have a cover, faceplate, or fixture canopy. Covers of outlet boxes having holes through which flexible cord pendants pass shall be provided with bushings designed for the purpose or shall have smooth, well-rounded surfaces on which the cords may bear.

Lockout/Tagout

Lockout device: A device that utilizes a positive means such as a lock, either key or combination type, to hold an energy-isolating device in the safe position and prevent the energizing of a machine or equipment. Included are blank flanges and bolted slip blinds.

Tagout device: A prominent warning device, such as a tag and a means of attachment, which can be securely fastened to an energy-isolating device in accordance with an established procedure, to indicate that the energy-isolating device and the equipment being controlled may not be operated until the tagout device is removed.

Tagout devices shall warn against hazardous conditions if the machine or equipment is energized and shall include a legend such as the following: Do Not Start. Do Not Open. Do Not Close. Do Not Energize. Do Not Operate.

Locks, tags, chains, wedges, key blocks, adapter pins, self-locking fasteners, or other hardware shall be provided by the employer for isolating, securing or blocking of machines or equipment from energy sources.

Supply GFCI

OSHA ground-fault protection rules and regulations have been determined necessary and appropriate for worker safety and health. Therefore, it is the employer's responsibility to provide either: (a) ground-fault circuit interrupters on construction sites for receptacle outlets in use and not part of the permanent wiring of the building or structure; or (b) a scheduled and recorded assured equipment grounding conductor program on construction sites, covering all cord sets, receptacles which are not part of the permanent wiring of the building or structure, and equipment connected by cord and plug which are available for use or used by workers. Receptacles at the ends of extension cords must be protected by GFCIs. Also, there are GFCI circuit breakers. These protected circuit breakers are installed on the main circuit board. It protects an entire circuit.

Establish and implement an assured equipment grounding conductor program

The assured equipment grounding conductor program covers all cord sets, receptacles which are not a part of the permanent

wiring of the building or structure, and equipment connected by cord and plug which are available for use or used by employees. OSHA requires that a written description of the employer's assured equipment grounding conductor program, including the specific procedures adopted, be kept at the jobsite. This program should outline the employer's specific procedures for the required equipment inspections, tests, and test schedule.

The required tests must be recorded, and the record maintained until replaced by a more current record. The written program description and the recorded tests must be made available, at the jobsite, to OSHA and to any affected employee upon request. The employer is required to designate one or more competent persons to implement the program. Electrical equipment noted in the assured equipment grounding conductor program must be visually inspected for damage or defects before each day's use. Any damaged or defective equipment must not be used by the employee until repaired.

Two tests are required by OSHA. One is a continuity test to ensure that the equipment grounding conductor is electrically continuous. It must be performed on all cord sets, receptacles which are not part of the permanent wiring of the building or structure, and on cord- and plug-connected equipment which is required to be grounded. This test may be performed using a simple continuity tester, such as a lamp and battery, a bell and battery, an ohmmeter, or a receptacle tester.

Ensure power tools are maintained in safe condition

The employer needs to ensure that all power tools and equipment are maintained in a safe condition to: (1) Ground power supply systems, electrical circuits, and electrical equipment (2) Frequently inspect electrical systems to ensure path to ground is continuous (3) Ensure workers understand how to inspect electrical equipment prior to use (4) Ensure ground prongs are not removed from tools or extension cords (5) Ground exposed metal parts of equipment.

Ensure proper guarding

Guarding involves locating or enclosing electrical equipment to ensure workers do not accidentally come into contact with its live parts. Effective guarding requires equipment with exposed parts operating at 50 volts or more to be placed where they are accessible only to authorized people qualified to work with/on the equipment. Recommended locations are a room, vault, or similar enclosure; a balcony, gallery, or elevated platform; or a site elevated 8 feet or more above the floor. Sturdy, permanent screens can also serve as effective guards

Provide training

Workers need to be trained in and familiar with the safety-related work practices that pertain to their respective job assignments. Train workers working with electric equipment in safe work practices to: (1) Deenergize electric equipment before inspecting or repairing (2) Use cords, cables, and electric tools that are in good repair (3) Lockout / Tagout recognition and procedures (4) Use appropriate protective equipment.

Ensure proper use of flexible cords

These ratings are derived from the National Electrical Code, and are required to be indelibly marked approximately every foot along the length of the cord. Examples of these codes are: S, ST, SO, and STO for hard service, and SJ, SJO, SJT, and SJTO for junior hard service. Extension cords must be 3-wire type so they may be grounded, and to permit grounding of any tools or equipment connected to them. Limit exposure of connectors and tools to excessive moisture by using watertight or sealable connectors.

4.7: Factors on Extension Cord Safety

With the wide use of power tools on construction sites, flexible extension cords often are necessary. Hazards are created when cords, cord connectors, receptacles, and cord- and plug connected equipment are improperly used and maintained. Here are some factors on extension cord safety noted by OSHA.

Strain Relief: To reduce hazards, flexible cords must connect to devices and to fittings in ways that prevent tension at joints and terminal screws. Flexible cords are finely stranded for flexibility, so straining a cord can cause the strands of one conductor to loosen from under terminal screws and touch another conductor.



Image 4:4 Extension Cord Safety Hazard Examples. (Source: www.osha.gov, Public Domain).

Cord Damage: A flexible cord may be damaged by door or window edges, by staples and fastenings, by abrasion from adjacent materials, or simply by aging. If the electrical conductors become exposed, there is a danger of shocks, burns, or fire. Replace frayed or damaged cords. Avoid running cords over sharp corners and edges.

Do not repair extension cords by replacing the ends. This will cause the cord to not maintain its approval for its intended use. For example, what was once “W” (moisture and sunlight resistant) will no longer be water-tight if the plug was replaced. Never use an adapter that will make a three-prong cord fit into a two prong receptacle.

Durability: The OSHA construction standard requires flexible cords to be rated for hard or extra-hard usage. These ratings are derived from the National Electrical Code, and are required to be indelibly marked approximately every foot along the length of the cord. Examples of these codes are: S, ST, SO, and STO for hard service, and SJ, SJO, SJT, and SJTO for junior hard service.

Grounding: Extension cords must be 3-wire type so they may be grounded, and to permit grounding of any tools or equipment connected to them.

If the power supply to the electrical equipment at your site is not grounded, or the path has been broken, fault current may travel through a worker's body, causing electrical burns or death. Even when the power system is properly grounded, electrical equipment can instantly change from safe to hazardous because of extreme conditions and rough treatment.

Wet Conditions: When a cord connector is wet, electric current can leak to the equipment grounding conductor, and to anyone who picks up that connectors if they provide a path to ground. Such leakage can occur not just on the face of the conductor, but at any wetter portion. Limit exposure of connectors and tools to excessive moisture by using watertight or sealable connectors.

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4.8: Electrical Safety Tips

- Do not use cords that are worn, cut, or frayed. Do not use a plug if it has deformed or missing pins. Do not use tools that have cords pulled out from strain relief. Do not use a receptacle if there is evidence of damage.
- Assume that all overhead wires are energized at lethal voltages. Never assume that a wire is safe to touch even if it is down or appears to be insulated.
- Never touch a fallen overhead power line. Call the electric utility company to report fallen electrical lines.
- Stay at least 10 feet away from overhead wires during cleanup and other activities. If working at heights or handling long objects, survey the area before starting work for the presence of overhead wires.
- If an overhead wire falls across your vehicle while you are driving, stay inside the vehicle and continue to drive away from the line. If the engine stalls, do not leave your vehicle. Warn people not to touch the vehicle or the wire. Call or ask someone to call the local electric utility company and emergency services.
- Never operate electrical equipment while you are standing in water.
- Never repair electrical cords or equipment unless qualified and authorized.
- Have a qualified electrician inspect electrical equipment that has gotten wet before energizing it.
- If working in damp locations, inspect electric cords and equipment to ensure that they are in good condition and free of defects, and use a ground-fault circuit interrupter (GFCI).
- Always use caution when working near electricity.
- If electrical equipment is used in ways for which it is not designed, then the safety features built in by the manufacturer are unreliable. This may damage equipment and cause employee injuries.
- Do not repair electrical cords with tape! Any repairs must return the equipment to the state in which it was initially approved.
- Do not use multi-receptacle boxes designed to be mounted by fitting them with a power cord and placing them on the floor.
- Accident prevention tags shall be used as a temporary means of warning employees of an existing hazard, such as defective tools. As part of an ongoing accident prevention program, employers should have a system in place that allows employees to identify tools that are in disrepair. Without such a program, employees may grab a tool that is defective and try to use it.
- An energy isolating device is capable of being locked out if it has a hasp or other means of attachment to which, or through which, a lock can be affixed, or it has a locking mechanism built into it. Other energy isolating devices are capable of being locked out, if lockout can be achieved without the need to dismantle, rebuild, or replace the energy isolating device or permanently alter its energy control capability.

4.9: Review Questions

Multiple Choice Questions

- 1: How can I protect myself from electrocution hazards?
- (a) maintain a safe distance from overhead power lines
 - (b) use ground-fault circuit interrupters (GFCI)
 - (c) inspect portable tools and extension cords
 - (d) follow lockout/tagout procedures
 - (e) all the above
2. Which of the following is NOT a type of burn caused by electricity?
- (a) electrical burn
 - (b) arc/flash burn
 - (c) thermal contact burn
 - (d) chemical burn
3. When using ladders or man-baskets near overhead power lines, the primary risk is:
- (a) falling due to imbalance
 - (b) contact with energized lines
 - (c) overexertion injuries
 - (d) slipping in wet conditions
4. A Ground Fault Circuit Interrupter (GFCI) protects workers by:
- (a) stopping power surges
 - (b) detecting ground faults and cutting electricity
 - (c) preventing short circuits in fixed wiring
 - (d) replacing fuses in circuits
5. Lockout/Tagout procedures are designed to:
- (a) ensure only licensed electricians work on circuits
 - (b) prevent unexpected energization of circuits and equipment
 - (c) provide backup power during maintenance
 - (d) reduce trip hazards from cords
6. Which of the following is an improper use of equipment?
- (a) using multi-receptacle boxes as intended
 - (b) carrying a tool by its handle
 - (c) using two-prong adapters on three-prong cords
 - (d) disconnecting cords when changing blades
7. What should workers do before using an extension cord?
- (a) test it with a voltmeter
 - (b) inspect for cuts or abrasions
 - (c) wash it with water
 - (d) ensure it is the longest cord available
8. Which factor does not affect the severity of an electric shock?
- (a) amount of current flow
 - (b) path of current through the body
 - (c) duration of current flow
 - (d) voltage rating of the circuit breaker
9. In the event of power line contact with a crane, what is the safest action for the operator?
- (a) jump out immediately

- (b) remain inside the cab unless fire or explosion is imminent
- (c) climb onto the load to escape
- (d) call for help and wait for instructions

10. What three factors form the “Electrocution Triangle”?

- (a) voltage, resistance, temperature
- (b) current, path, duration
- (c) PPE, training, voltage
- (d) voltage, ground, path

11. Which is an example of improper use of electrical equipment?

- (a) using a GFCI with power tools
- (b) repairing extension cords with tape
- (c) inspecting cords daily
- (d) using double-insulated tools

12. Which condition increases the severity of an electric shock?

- (a) Dry skin
- (b) Wearing rubber-soled boots
- (c) Wet or sweaty skin
- (d) Standing on a wooden platform

13. What is the most effective first step before working on electrical circuits?

- (a) Checking wire insulation
- (b) Deenergizing and locking out the circuit
- (c) Wearing gloves and safety glasses
- (d) Using double-insulated tools

14. A worker receives a mild electric shock when touching a metal ladder. What should be done first?

- (a) Continue working and monitor for pain
- (b) Tag and remove the ladder from service for inspection
- (c) Apply electrical tape to the ladder
- (d) Move the ladder closer to the power source

15. Why are metal ladders discouraged near overhead power lines?

- (a) They are unstable in windy conditions
- (b) They can conduct electricity if contact occurs
- (c) They are heavier than fiberglass ladders
- (d) They require frequent maintenance

16. What does a GFCI primarily detect?

- (a) Overcurrent
- (b) Short circuit
- (c) Ground fault leakage
- (d) Overvoltage surge

17. Which statement best describes “Arc flash”?

- (a) A sudden discharge of electrical energy through the air
- (b) A gradual buildup of static electricity
- (c) A type of electromagnetic radiation from power lines
- (d) A safety test for electrical continuity

True/False Questions

18. True/False: Electrocution refers to non-fatal shocks that cause injury but not death.

19. True/False: The covering on overhead power lines provides complete insulation, making them safe to touch.

20. True/False: Extension cords that have worn insulation or exposed wires can create risks of shocks, burns, or fire.

21. True/False: A GFCI protects workers by increasing the circuit voltage during overload conditions.

22. True/False: OSHA requires flexible cords on construction sites to be two-wire type, since grounding is optional.
23. True/False: It is safe to operate electrical equipment while standing in water if the equipment is double-insulated.
24. True/False: Proper guarding involves enclosing electrical equipment so that workers cannot accidentally contact live parts.
25. True/False: Proper training includes teaching workers to deenergize equipment, use cords in good repair, and follow lockout/tagout.
26. True/False: Look for overhead power lines when operating any equipment.
27. True/False: Do not operate portable electric tools unless they are grounded or double insulated.
28. True/False: Workspaces, walkways, and similar locations shall be kept clear of cords.
29. True/False: Worn or frayed electric cords or cables shall not be used.
30. True/False: Removing the ground pin from a plug to fit a two-prong outlet is acceptable if done carefully.
31. True/False: Electrical tape repairs are an acceptable method for fixing damaged extension cords.
32. True/False: Workers are permitted to perform tasks near energized circuits without PPE if they feel confident
33. True/False: If an overhead power line contacts a crane, the ground personnel should approach the crane to rescue the operator.
34. True/False: Running cords through doorways helps prevent extension cord damage.
35. True/False: It is unsafe to wrap electrical tape around a damaged cord, because it increases voltage in the conductor.

Answer Key: 1(e), 2(d), 3(b), 4(b), 5(b), 6(c), 7(b), 8(d), 9(b), 10(b), 11(b), 12(c), 13(b), 14(b), 15(b), 16(c), 17(a), 18(False), 19(False), 20(True), 21(False), 22(False), 23(False), 24(True), 25(True), 26(True), 27(True), 28(True), 29(True), 30(False), 31(False), 32(False), 33(False), 34(False), 35(False).

4.10: Sources

The content in this chapter is adapted from:

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5: STRUCK-BY HAZARDS IN CONSTRUCTION

5.1: Definition

5.2: Struck-by Descriptions

5.3: Protecting Yourself

5.4: Summary

5.5: Review Questions

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5.1: Definition

Definition

Struck-by injuries are produced by forcible contact or impact between the injured person and an object or piece of equipment. Having said that, it is important to point out that in construction, struck-by hazards can resemble caught-in or -between hazards.

There is a distinction which is best explained by looking at the key factor in making a determination between a *Caught* event and a *Struck* event, ask: Was it the impact of the object alone that caused the injury? When the impact alone creates the injury, the event is considered as *Struck*. On the other hand, when the injury is created more as a result of crushing injuries between objects, the event is considered as *Caught*.

Struck-by hazards are categorized as follows: (1) Struck-by flying object (2) Struck-by falling object (3) Struck-by swinging object and (4) Struck-by rolling object.

Struck-by Examples

Struck-by hazards in construction cause accidents such as the following:

- A construction worker was hoisting bricks in a bucket to the top of a building. The bucket tilted, and the bricks spilled out of the bucket, striking the worker in the head. The worker suffered blunt force trauma to his head, and he died at the hospital eight days later.
- Four workers were installing signs on a highway, when a pick-up truck changed several lanes and entered the work area. The truck struck one of the workers, knocking him off the road and over a bridge rail. He fell approximately 18 ft and died.
- Four workers were struck by an exterior wall while attempting to lift it in place. Three of the workers received bruises and contusions. One of the workers received a fractured leg and was hospitalized.
- A construction inspector was crossing an equipment vehicle route at an interstate highway bridge construction site. He walked into the path of the end loader traveling the route, was run over, and killed. The loader operator was unaware that he struck the inspector.
- Worker was struck by the counterweight and revolving superstructure of an excavator when he walked between the excavator and a hillside.
- Workers were pulling 60 foot sections of pipe out of a hole, using a hoist to stack them on the derrick floor. One of the workers let go of a pipe section before it was secured. As he bent over, the pipe swung around and struck him on the head, killing him.
- A worker was maneuvering an overhead crane when a metal plate weighing approximately 7,330 lbs. separated from the lifting clamp and fell, striking and killing the worker.

Statistics

Occupational fatalities caused by struck-by hazards are a serious concern. According to the Bureau of Labor Statistics (BLS) report titled "Manner in which fatal work injuries occurred, 2009" preliminary data, the category of "Contact with objects and equipment is 17% of the total 4,340 fatal work injuries. Of that 17% the sub-category of "Struck-by object" was 10% [more than half]. In the table below, the 2008 numbers are shown for "Crane-Related Deaths" which shows that when working with cranes, the struck-by death and injury count represents 28% of the total.

Causes of Construction Worker Crane-Related Deaths & Injuries, Jan. 1–Dec. 31, 2008*

Cause	# Incidents (%)	Deaths	Injuries
Crane collapses	34 (39%)	25	59
Overhead power line contacts	12 (14%)	10	8
Struck by crane load	12 (14%)	6	10
Struck by other crane parts	10 (11%)	6	7
Other causes*	20 (23%)	7	16
Total	88	54	100

* Includes 7 highway incidents, 6 falls, 3 caught in/between, 3 struck by non-crane falling objects, and 1 struck by lightning incident

Image 5:1 Causes of Construction Worker Crane-Related Deaths & Injuries. Source: www.osha.gov, Public Domain).

5.2: Struck-by Descriptions

Struck-by flying object

Flying object hazard exists when something has been thrown, hurled, or is being propelled across space. It can include instances when a piece of material separates from a tool, machine or other equipment, striking a worker, resulting in injuries or fatality. Also a hazard exists if an object is ejected under power by a tool or equipment usually designed for that purpose such as, a nail from a nail gun: The nail is propelled from the gun by force, it is discharged. This force can be either pneumatic or powder-actuated. Powder-actuated tools are particularly hazardous due to the force behind the fastener. These fasteners are designed to go through wood, concrete and steel and they can certainly go through worker. Using compressed air can also cause flying object hazards. Compressed air is commonly used to power tools and clean surfaces.

Examples:

- Worker was removing a frozen bolt from the track of a caterpillar front end loader and was struck-by a bolt that entered his forehead.
- Worker was freeing a pump component under pressure and was impaled by the pump component.
- A worker was killed when a blast of compressed air from a gas pipeline struck him. A compressor was started to fill the pipeline with compressed air in an effort to push out a "pig." when the pipeline suddenly cleared, the employee was still in the way and was killed. The area should have been cleared before the compressor was started.
- The victim was in the process of using an 8-foot step ladder to gain height to nail a strap onto a

residential home single story construction project. The victim used a nail gun with a 16d nail to affix the strap to the exterior wall. Using his right hand for the gun, he leaned over to the left and tried to place a nail into the strap. The nail ricocheted and hit him on the left side of his head just above the left ear. He fell to the ground and eventually passed out. Fellow workers transported him to the hospital. He died approximately two days later.

Struck-by falling object

When the source of injury is falling from an elevation to a lower level, including instances where the injured person is crushed, pinned, or caught under a falling object, other than collapsing material or structures, resulting from being struck by a falling object or equipment.

Examples:

- Worker was tearing down a transmission structure using a digger-derrick when a pole broke and struck him on the head.
- Worker was struck by a load of wall panels that fell off his truck.
- Four workers rebuilding a bridge that had washed out by floods were injured when a crane

boom cable broke, and the boom fell on them.

- Worker was engaged in cutting an 8,000-lb boiler in sections with a cutting torch. The section being cut, fell off allowing the remaining section, 5000 lbs, to flip over onto its bottom and land on the worker.

- A worker was assisting a rigger who had attached a load to the block hook of a wheel mounted crane. The crane operator was positioned in the cab and waiting for the hand signal to make the lift. During this process, the jib of the crane fell from its stowed position on the boom and struck the worker. The worker died later at the scene. It was discovered that the pin used to secure the jib to the boom was missing thus allowing the jib to be displaced. The crane was not inspected prior to use.

Struck-by swinging object

When materials are mechanically lifted, they have the potential to swing and strike workers. As the load is lifted, the materials may swing, twist or turn. This movement can catch workers by surprise and they could be hit by the swinging load. Windy conditions are especially hazardous because the load will swing more. Depending on where the worker is standing and the force behind the load, the worker may fall to another level after being struck and sustain even greater injuries. In addition to swinging, loads can slip from their riggings and strike workers. Loads must be rigged properly to prevent slippage.

When the source of injury has been referred to objects which are not free standing, they are attached at some point or are being held by the worker. This includes instances where a hinge-like motion retracts creating swinging motion in which the worker is struck-by a slamming or swinging motion.

Examples:

- Worker was working within the swing radius of a barge-mounted crane used in dredging operations. He was hit and killed.
- Two workers were instructed by their foreman to set up on a ground slab in the southeastern

corner of a building. They were to land and place reinforcing steel using a crane. A truck crane was positioned at street level, 30 ft higher in elevation than the ground slab and approximately 162 ft from the landing area. The landing area was approximately 40 ft beyond the radius limit for the crane, as specified by the manufacturer. The 24 piece bundle of 28 1/2 ft long #9 rebar that was to be picked up and loaded onto the crane's hoist line was at street elevation, 50 ft in front of the crane. The operator made the pickup and was swinging around and lowering it to his left using hand signals when the right pennant line broke at the yoke/bridle. The boom collapsed, striking one of the workers on the head and killing him.

Struck-by rolling object

Struck-by rolling object is when an object which is rolling, moving, or sliding on the same level at which the worker is located. Includes instances in which the worker is struck or run over by a moving vehicle without being caught under it or instances in which the worker is struck-by a sliding object or equipment on the same level.

Examples:

- While walking along track, worker was struck by unmanned rail car at airport.
- Worker (security guard) was struck by tractor trailer and dragged, resulting in fatal injuries
- Worker suffered fatal injuries after being struck by a moving semi-truck while loading/unloading freight.
- Worker was performing repair operations on an impact attenuator and was struck by a truck.
- Worker was flagging traffic and was struck by a truck.
- A four-person ground crew was working with a mobile under-hung bridge crane. The crane ran over one of the crew members, who had walked too close to the wheel of the crane. The employee died of his injuries.
- A worker was setting traffic cones at a paving project. A steel wheel roller was compressing the asphalt, and the traffic cones were being moved so that they would be in the path of the roller. The worker was injured when he was struck by an automobile. He was thrown over the hood of the car and into another lane of traffic, where he was struck by another automobile. He was dragged 141 ft by the second vehicle. He was pronounced dead at the hospital.

5.3: Protecting Yourself

How can I protect myself from Heavy equipment [cranes, excavators, etc.]?

- Stay away from heavy equipment when it's operating – In fact, be alert to the location of all heavy equipment whether in use or not
- Stay clear of lifted loads and never work under a suspended load
- Beware of unbalanced loads
- Workers should confirm and receive acknowledgement from the heavy equipment operator that they are visible
- Be aware of the swing radius of cranes and backhoes and do not enter that zone
- Drive equipment [or vehicles] on grades or roadways that are safely constructed and maintained
- Make sure that all workers and other personnel are in the clear before using dumping or lifting devices
- Lower or block bulldozer and scraper blades, end-loader buckets, dump bodies, etc., when not in use, and leave all controls in neutral position.
- Haulage vehicles that are loaded by cranes, power shovels, loaders etc., must have a cab shield or canopy that protects the driver from falling materials
- Do not exceed a vehicle's rated load or lift capacity
- Do not carry personnel unless there is a safe place to ride

How can I protect myself from motor vehicles [trucks, cars, etc.]?

Vehicle safety practices must be observed at construction sites to limit worker exposure to struck-by hazards such as struck-by swinging backhoes, struck-by falling/overturning vehicles, and struck-by trucks or cars.

To avoid these types of hazards, workers should:

- Wear seat belts when provided
- Check vehicles before each shift to assure that all parts and accessories are in safe operating condition
- Do not drive a vehicle in reverse gear with an obstructed rear view, unless it has an audible reverse alarm, or another worker signals that it is safe
- Set parking brakes when vehicles and equipment are parked, and chock the wheels if they are on

an incline

- All vehicles must have adequate braking systems and other safety devices
- Use traffic signs, barricades or flaggers when construction takes place near public roadways
- Workers must be highly visible in all levels of light. Warning clothing, such as red or orange vests, are required; and if worn for night work, must be of reflective material

When working on or near any construction zone:

- Wear high-visibility reflective clothing
- Do not put yourself at risk of being struck by a vehicle and do not get caught in a situation where there's no escape route
- Do not direct traffic unless you are the flagger
- Check that necessary warning signs are posted
- Never cross the path of a backing vehicle
- Follow “Exit” and “Entry” worksite traffic plan

General Safe Work Practices

When working with compressed air: ► Reduce air pressure to 30 psi if used for cleaning, and use only with appropriate guarding and proper protective equipment; and ► Never clean clothing with compressed air

- When working with hand tools: ► Do not use tools with loose, cracked or splintered handles; and ► Do not use impact tools with mushroomed heads
- When working with machines, such as jack hammers, pavement saws: ► Be sure to be trained on safe operation of machinery. Inspect machinery; ► Ensure all guards are in place and in working order; and ► Protect feet, eyes, ears and hands; wear hearing protection
- When performing overhead work: ► Secure all tools and materials; ► Use toeboards, screens, guardrails and debris nets. Barricade the area and post signs; and ► Be sure materials stored in buildings under construction are placed farther than 6 feet of hoist way / floor openings, and more than 10 feet from an exterior wall
- When working with powder-actuated tools: ► Be sure to be trained and licensed to operate these tools if required
- When working with power tools, such as saws, drills, grinders: ► Be sure to be trained on how to safely use the power tool. Inspect tool(s) before each use; ► Wear safety goggles; ► Operate according to manufacturer's instructions; and ► Ensure that all required guards are in place
- When pushing or pulling objects that may become airborne: ► Stack and secure materials to prevent sliding, falling or collapse; ► Keep work areas clear; and ► Secure material against wind gusts

Personal Protective Equipment (PPE)

Eye and face protection:

- Use based on anticipated hazards
- Safety glasses or goggles should be worn any time work operations present an eye hazard – for example, during welding, cutting, grinding, nailing (or when working with concrete and/or harmful chemicals or when exposed to flying particles)

Head protection

- Wear hard hats where there is a potential for objects falling from above, bumps to the head from fixed objects
- Hard hats: Routinely inspect for dents, cracks or deterioration; replace after a heavy blow; maintain in good condition

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5.4: Summary

Struck-by objects are another leading cause of construction-related deaths. Approximately 75% of struck-by fatalities involve heavy equipment such as trucks or cranes.

Safety and health programs must take into account the many ways struck-by accidents can occur. The following related hazards cause the most struck-by injuries:

(1) Vehicles

If vehicle safety practices are not observed at your site, you risk being pinned between construction vehicles and walls, struck by swinging backhoes, crushed beneath overturned vehicles, you risk being struck by trucks or cars.

How Do I Avoid Hazards?

- Wear seat belts that meet OSHA standards, except on equipment that is designed only for standup operation, or that has no rollover protective structure.
- Check vehicles before each shift to assure that all parts and accessories are in safe operating condition.
- Do not drive a vehicle in reverse gear with an obstructed rear view, unless it has an audible reverse alarm, or another worker signals that it is safe.
- Drive vehicles or equipment only on roadways or grades that are safely constructed and maintained.
- Make sure that you and all other personnel are in the clear before using dumping or lifting devices.
- Lower or block bulldozer and scraper blades, end-loader buckets, dump bodies, etc., when not in use, and leave all controls in neutral position.
- Set parking brakes when vehicles and equipment are parked, and chock the wheels if they are on an incline.
- All vehicles must have adequate braking systems and other safety devices.
- Haulage vehicles that are loaded by cranes, power shovels, loaders etc., must have a cab shield or canopy that protects the driver from falling materials.
- Do not exceed a vehicle's rated load or lift capacity.
- Do not carry personnel unless there is a safe place to ride.
- Use traffic signs, barricades or flaggers when construction takes place near public roadways.
- Workers must be highly visible in all levels of light. Warning clothing, such as red or orange vests, are required; and if worn for night work, must be of reflective material.

(2) Falling/flying objects

You are at risk from *falling* objects when you are beneath cranes, scaffolds, etc., or where overhead work is being performed. There is a danger from *flying* objects when power tools, or activities like pushing, pulling, or prying, may cause objects to become airborne. Injuries can range from minor abrasions to concussions, blindness, or death.

How Do I Avoid Hazards?

General

- Wear hardhats.
- Stack materials to prevent sliding, falling, or collapse.
- Use protective measures such as toeboards and debris nets.

Power Tools, Machines, etc.

- Use safety glasses, goggles, face shields, etc., where machines or tools may cause flying particles.
- Inspect tools, such as saws and lathes, to insure that protective guards are in good condition.
- Make sure you are trained in the proper operation of powder actuated tools.

Cranes and Hoists

- Avoid working underneath loads being moved.
- Barricade hazard areas and post warning signs.
- Inspect cranes and hoists to see that all components, such as wire rope, lifting hooks, chains, etc., are in good condition.
- Do not exceed lifting capacity of cranes and hoists.

Overhead Work

- Secure tools and materials to prevent them from falling on people below.
- Barricade hazard areas and post warning signs.
- Use toeboards, screens, or guardrails on scaffolds to prevent falling objects, *or*,
- Use debris nets, catch platforms, or canopies to catch or deflect falling objects.

Compressed Air

- Reduce compressed air used for cleaning to 30 psi, and only use with appropriate guarding and protective equipment.
- Never clean clothing with compressed air.

(3) Constructing masonry walls

Constructing concrete and masonry walls is especially dangerous because of the tremendous loads that need to be supported. There are risks of major accidents, and even death, when jacks or lifting equipment are used to position slabs and walls, or when shoring is required until structures can support themselves.

How Do I Avoid Hazards?

- Do not place construction loads on a concrete structure until a qualified person indicates that it can support the load.
- Adequately shore or brace structures until permanent supporting elements are in place, or concrete has been tested to assure sufficient strength.
- Only allow those who are essential to and actively engaged in construction or lifting operations to enter the work area.
- Take measures to prevent unrolled wire mesh from recoiling, such as securing each end or turning the roll over.
- Do not load lifting devices beyond their capacity.
- Use automatic holding devices to support forms in case a lifting mechanism fails.

5.5: Review Questions

Multiple Choice Questions

1. Struck-by hazards are defined as:
 - (a) Being trapped between two objects
 - (b) Forcible contact or impact between a person and an object/equipment
 - (c) Only being hit by falling tools
 - (d) Only hazards involving vehicles
2. Which of the following is NOT a category of struck-by hazards?
 - (a) flying object
 - (b) falling object
 - (c) swinging object
 - (d) explosive object
3. A load swinging from a crane is an example of:
 - (a) Struck-by flying object
 - (b) Struck-by falling object
 - (c) Struck-by swinging object
 - (d) Struck-by rolling object
4. Which of the following is a safe practice around heavy equipment?
 - (a) Standing under a suspended load if the crane is certified
 - (b) Confirming that the operator has seen you before entering their work zone
 - (c) Walking between counterweights and fixed objects
 - (d) Riding on a load if balanced
5. Employers must provide which of the following to protect workers from struck-by hazards?
 - (a) PPE and proper training
 - (b) Barriers, warning signs, and inspections
 - (c) Equipment in safe operating condition
 - (d) All of the above
6. Which of the following is safe work practice with hand tools?
 - (a) Use tools with mushroomed heads if carefully handled
 - (b) Repair splintered handles with tape
 - (c) Inspect tools for cracks or loose parts before use
 - (d) Share tools without inspection
7. Employers must provide:
 - (a) Head protection against falling objects
 - (b) Eye and face protection during grinding, welding, or cutting
 - (c) PPE that meets ANSI standards
 - (d) All of the above
8. Which of the following best describes a struck-by rolling object hazard?
 - (a) A worker hit by a nail fired from a nail gun
 - (b) A worker crushed between a wall and a backhoe
 - (c) A worker run over by a moving vehicle on the same level
 - (d) A worker struck by falling objects from above
9. What factor most increases the risk of struck-by swinging object incidents?
 - (a) Wet ground conditions
 - (b) Poorly maintained tools

- (c) Windy weather and improper rigging
- (d) Excessive lighting at the site

10. Which statement about PPE is true for struck-by hazard prevention?

- (a) Only supervisors are required to wear PPE
- (b) PPE is optional if equipment is properly maintained
- (c) Eye and head protection should always be worn when there is a risk of flying or falling objects
- (d) PPE is only required when OSHA conducts inspections

11. Which of the following is NOT a safe practice when working near heavy equipment?

- (a) Entering the operator's blind spot without communication
- (b) Waiting for acknowledgement from the operator before approaching
- (c) Staying out of the swing radius of cranes
- (d) Ensuring the operator has a clear view before signaling movement

12. Why is visibility critical when working near moving vehicles?

- (a) It helps identify workers' seniority
- (b) It allows drivers and operators to see workers and avoid collisions
- (c) It improves air circulation on site
- (d) It reduces fatigue caused by glare

True/False Questions

13. True/False: Struck-by hazards occur only when an object falls from above.

14. True/False: Powder-actuated tools can cause flying object hazards because their fasteners can penetrate wood, concrete, or steel.

15. True/False: Windy conditions increase the risk of struck-by swinging object incidents.

16. True/False: Wearing reflective high-visibility clothing is required for workers near public roadways.

17. True/False: Hard hats must be replaced only when lost, not when damaged.

18. True/False: Toeboards and guardrails should be used during overhead work to prevent tools and materials from falling.

19. True/False: Employers are required to provide PPE, but workers must purchase replacements themselves.

20. True/False: It is acceptable to use powder-actuated tools without training as long as they are inspected daily.

21. True/False: Never position yourself between moving and fixed objects.

22. True/False: Wearing high-visibility clothes near equipment/vehicles helps to prevent struck-by hazards.

23. True/False: A worker inside the swing radius of a crane is safe as long as the operator is certified.

Answer Key: 1(b), 2(d), 3(c), 4(b), 5(d), 6(c), 7(d), 8(c), 9(c), 10(c), 11(a), 12(b), 13(False), 14(True), 15(True), 16(True), 17(False), 18(True), 19(False), 20(False), 21(True), 22(True), 23(False).

5.6: Sources

The content in this chapter is adapted from:

Occupational Safety and Health Administration. (n.d.). Struck-by hazards — Construction eTool. [Struck-by hazards — Construction eTool](#). [www.osha.gov]

Occupational Safety and Health Administration. (n.d.). Construction: Struck-by Hazards — Instructor guide. [Construction: Struck-by Hazards — Instructor guide](#) [www.osha.gov]

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6: CAUGHT-IN OR BETWEEN HAZARDS IN CONSTRUCTION

6.1: Definition

6.2: Caught In or Between Descriptions

6.3: Safeguards

6.4: What is my employer required to do to protect workers from caught-in or -between hazards?

6.5: Review Questions

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6.1: Definition

The key factor in making a determination between a *Caught* event and a *Struck* event is whether the impact of the object alone caused the injury. When the impact alone creates the injury, the event should be recorded as *Struck*. When the injury is created more as a result of crushing injuries between objects, the event should be recorded as *Caught*.

Events that should be classified as *Caught* include:

- Cave-ins (trenching)
- Being pulled into or caught in machinery and equipment (this includes strangulation as the result of clothing caught in running machinery and equipment)
- Being compressed or crushed between rolling, sliding, or shifting objects such as semi-trailers and a dock wall, or between a truck frame and a hydraulic bed that is lowering

Examples

Caught- in or -between hazards in construction cause accidents such as the following:

- A worker was ripping a 6-inch piece of wood on an unguarded compound miter saw. His left thumb was caught in the saw and amputated.
- An employee was performing diagnostic work on a water truck at a construction site. The worker crawled under the operating truck. The employee's work shirt collar and coveralls became caught on a projecting set screw on the rotating pump shaft. The set screw pulled him into the pump shaft. The employee died en route to the hospital.
- A worker climbed onto an I-beam to clean muck off the tail pulley of a conveyor belt attached to a separator. While the conveyor system was energized and in operation, the employee reached between the feed and return of the belt in front of the tail pulley with his hand to brush the muck off the belt. He was caught by the moving belt, and his hand and arm were pulled into a pinch point in the tail pulley. The employee's arm was fractured.
- A worker was at the bottom of a 9.5-foot deep trench, setting grade for concrete pipe while the employer was installing additional shoring. During the shoring installation, the west wall at the south end of the excavation caved-in and covered the worker. There was no shoring or protective system at the location of the trench. The employee was dug out by coworkers and the fire department and survived.
- An employee and a co-worker were working in a 9-foot deep excavation installing water pipes, when the south side of the excavation caved in on the employee and buried him. The employee was killed.
- Two laborers were framing out footing for foundation walls in an excavation 100-foot long by 45-foot wide by 10-foot deep. The adjacent property along the north wall of the excavation consisted of seven garages, with a 10-foot high cinderblock wall. The cinderblock wall was undermined approximately 2 feet and was not supported. The wall collapsed, crushing the laborers. One was killed and the other was taken to the hospital for back and shoulder injuries.
- A worker was operating a road grader when the engine died, and the vehicle began to roll toward a small ravine. The employee jumped off the grader but was pulled under the grader as it overturned. He was killed when he was crushed underneath the tires.
- An employee was working from an aerial lift, which was in the "up" position, under an I-beam.

He accidentally came into contact with the "drive/steer" lever, which made the manlift move. The employee was killed when he was pinned between the I-beam and manlift control panel.

- A worker was cleaning an asphalt paving spreader. Another worker was repairing a pavement roller. The roller was accidentally

put into motion, and it rolled toward the spreader. The first employee was injured when he was pinned between the two machines.

■ An employee was placing dunnage underneath the sheet metal. A coworker was operating a powered industrial forklift loading sheet metal onto a flatbed truck. As the coworker was loading the sheet metal onto the flatbed truck, one of the bands holding the sheet metal together either broke or the clamp was not properly secured. The back band failed, and the load of sheet metal slid forward onto the employee, pinning him under the sheet metal and against a dumpster. The employee was hospitalized and treated for a fractured leg and a dislocated knee.

Statistics

In 2008, the Bureau of Labor Statistics (BLS) reported that the total number of fatal work injuries involving caught-in or –between hazards remained about the same for all of private industry as in 2007. However, the number of such fatalities has increased by approximately 10% since 2003. In 2008, the private construction industry alone accounted for 92 of the caught-in or –between fatalities, or approximately 23% of the total.

The number of fatalities involving caught-in or – between hazards in the private construction industry has decreased by about 20% since 2003. The biggest decrease in caught-in or –between fatalities in the private construction industry has been in excavation or trenching cave-ins. There were 44 such fatalities in 2003 and only 16 in 2008.

Altogether, 975 private-industry construction workers died on the job in 2008, with 92 of them (9%) killed as a result of caught-in or –between hazards.

Occupational fatalities caused by caught in- or – between hazards are serious concerns. This lesson will help you identify these hazards at your worksite so that you can be protected.

Some of the working conditions that contribute to caught in- or –between hazards include: Machinery that has unguarded moving parts or that is not lockedout during maintenance; unprotected excavations and trenches; heavy equipment that tips over, collapsing walls during demolition; and working between moving materials and immovable structures, vehicles, or equipment.

Machinery that has unguarded moving parts

Almost all sites use machinery that has moving or rotating parts or that requires maintenance or repair at some point during construction. If machinery is not properly guarded or de-energized during maintenance or repair, injuries from caught-in or –between hazards may result, ranging from amputations and fractures to death. When machines or power tools are not properly guarded, workers can get their clothing or parts of their body caught in the machines. If machines are not de-energized (locked-out) when they are being repaired, they may cycle or otherwise start up and catch a worker's body part or clothing and cause injury or death.

Workers can be trapped and crushed under heavy equipment that tips, especially if they are thrown from the equipment.

Example 1: A three-man crew was installing an underground telephone cable in a residential area. They had just completed a bore hole under a driveway using a horizontal boring machine. The bore hole rod had been removed from the hole. While the rod was still rotating, the operator straddled it and stooped over to pick it up. His trouser leg became entangled in the rotating rod and he was flipped over. He struck tools and materials, sustaining fatal injuries.

Example 2: A laborer was steaming a scraper. The bowl apron had been left in the raised position. The hydraulically controlled apron had not been blocked to prevent it from accidentally falling. The apron did fall unexpectedly, and the employee was caught between the apron and the cutting edge of the scraper bowl. The apron weighed approximately 2500 pounds.

Example 3: An employee was driving a front-end loader up a dirt ramp onto a lowboy trailer. The tractor tread began to slide off the trailer. As the tractor began to tip, the operator, who was not wearing a seat belt, jumped from the cab. As he hit the ground, the tractor's rollover protective structure fell on top of him, crushing him.

6.2: Caught In or Between Descriptions

Buried in or by

The major hazard related to buried in or by is cave-ins of unprotected trenches and excavations. Cave-ins crush or suffocate workers. In addition, trenches may contain hazardous atmospheres; workers can drown in water, sewage, or chemicals in the trenches; and if working around underground utilities, workers may also face burns, electrocution or explosions from steam, hot water, gas, or electricity. Workers who are working underneath large scaffolds may also be buried if the scaffolds collapse. Workers may be buried and crushed by walls that collapse during demolition.

Example 1: An employee was installing a small diameter pipe in a trench 3 feet wide, 12-15 feet deep and 90 feet long. The trench was not shored or sloped nor was there a box or shield to protect the employee. Further, there was evidence of a previous cave-in. The employee apparently reentered the trench, and a second cave-in occurred, burying him. He was found face down in the bottom of the trench.

Example 2: An employee was working in a trench 4 feet wide and 7 feet deep. About 30 feet away a backhoe was straddling the trench. The backhoe operator noticed a large chunk of dirt falling from the side wall behind the worker in the trench. He called out a warning. Before the worker could climb out, 6 to 8 feet of the trench wall had collapsed on him and covered his body up to his neck. He suffocated before the backhoe operator could dig him out. There were no exit ladders. No sloping or shoring had been used in the trench.

Pinned between

You can be pinned between equipment and a solid object, such as a wall or another piece of equipment; between materials being stacked or stored and a solid object, such as a wall or another piece of equipment; or between shoring and construction materials in a trench. These types of hazards can result in multiple broken bones, asphyxiation, or death.

Example 1: Contractor was operating a backhoe when an employee attempted to walk between the swinging superstructure of the backhoe and a concrete wall. The employee approached the backhoe from the operator's blind side; the superstructure crushed him against the wall.

Example 2: Four workers were in an excavation approximately 9 feet wide, 32 feet long and 7 feet deep. Steel plates being used as shoring, were placed vertically against the north and south walls of the excavation at a 30-degree angle [no horizontal braces between the plates]. The steel plate on the south wall tipped over, pinning (and killing) an employee between the steel plate and the pipe casing. The backhoe was being operated adjacent to the excavation.

6.3: Safegaurds

Use machinery that is properly guarded

Never remove a safety guard when a tool is being used. Hazardous moving parts of power tools and equipment need to be safeguarded. For example, belts, gears, shafts, pulleys, sprockets, spindles, drums, fly wheels, chains, or other reciprocating, rotating, or moving parts of equipment must be guarded if such parts are exposed to contact by workers. Be sure to avoid wearing loose clothing or jewelry that can be caught in moving parts.

Use other methods to ensure that machinery is sufficiently supported, secured or otherwise made safe

Make sure that your equipment is de-energized and cannot be started accidentally. First, disconnect tools when not in use, before servicing, and when changing accessories such as blades, bits, and cutters. Turn off vehicles before you do maintenance or repair work. If possible, lock out the power source to the equipment. The type of power source may be electric, pneumatic, liquid fuel, hydraulic, or powder-actuated. Lower or block the blades of bulldozers, scrapers, and similar equipment before you make repairs or when the equipment is not in use.

Protect yourself from being pinned between equipment, materials, or other objects

Be aware at all times of the equipment around you and stay a safe distance from it. Never place yourself between moving materials and an immovable structure, vehicle, or stacked materials. Make sure that all loads carried by equipment are stable and secure. Stay out of the swing radius of cranes and other equipment. Wear a seatbelt, if required, to avoid being thrown from a vehicle and then potentially being crushed by the vehicle if it tips over.

Protect yourself on excavation sites

Do not work in an unprotected trench that is 5 feet deep or more. The type of protection may be one of the following:

- Sloping or benching. Sloping is cutting back the sides of the trench to a safe angle, so it won't collapse. Benching uses a series of steps that approximate the safe sloping angle. The angle depends on the soil type.
- Trench box or shield. These do not prevent cave-ins but protect the workers who are in them if a cave-in happens.
- Shoring. Shoring are wooden structures or mechanical or hydraulic systems that support the sides of an excavation.

Enter or exit a trench or excavation only by using a ladder, stairway or properly designed ramp that is placed within the protected area of the trench.

Do not work outside of the confines of the protection system!

6.4: What is my employer required to do to protect workers from caught-in or -between hazards?

- Provide guards on power tools and other equipment with moving parts
- Support, secure or otherwise make safe equipment having parts that workers could be caught between
- Take measures to prevent workers from being crushed by heavy equipment that tips over
- Take measures to prevent workers from being pinned between equipment and a solid object
- Provide protection for workers during trenching and excavation work
- Provide means to avoid the collapse of structures scaffolds
- Provide means to avoid workers' crushed by collapsing walls during demolition or other construction activities
- Designate a competent person
- Provide training for workers

Provide guards on power tools and other equipment with moving parts

OSHA standards require your employer to ensure that hand-held power tools are fitted with guards and safety switches. The type of guard will be determined by the power source of the tool (electric, pneumatic, liquid fuel, hydraulic, or powder-actuated). Exposed moving parts of power tools, such as belts, gears, shafts, pulleys, etc. must be guarded. Points-of-operation– where the work is actually performed on the materials – must also be guarded. Power saws are a primary type of equipment that requires a point-of operation guard. In-running nip points, such as where the sanding belt runs onto a pulley in a belt sanding machine, must also be guarded.

Support, secure or otherwise make safe equipment having parts that workers could be caught between

Your employer should provide a lock-out/tag-out program or equivalent system to ensure that equipment is not accidentally energized during maintenance or repair. Lockout/tagout procedures are specifically required for equipment used in concrete and masonry operations. Bulldozer and scraper blades, end-loader buckets, dump bodies, and similar equipment must be blocked or fully lowered when being repaired or not in use.

Take measures to prevent workers being crushed by heavy equipment that tips over

The best way to prevent workers being crushed by heavy equipment that tips over is to prevent the equipment from tipping over in the first place. For examples, cranes can tip over if the load capacity is exceeded, or the ground is not level or too soft. OSHA requires that your employer designate a competent person to inspect crane operations to identify working conditions that are hazardous to workers, including ensuring that the support surface is firm and able to support the load. Your employer must make sure that material handling equipment is equipped with rollover protective structures. OSHA standards require that motor vehicles, forklifts, and earthmoving equipment must be equipped with seat belts. Your employer must require their use. The use of seat belts will prevent workers being thrown from a vehicle or equipment and subsequently being crushed when the vehicle or equipment tips over.

Take measures to prevent workers from being pinned between equipment and a solid object

Employers are required to take measures to prevent workers from being pinned between equipment and a solid object, such as a wall or another piece of equipment; between materials being stacked or stored and a solid object, between shoring and construction materials in a trench.

Example 1: During demolition operations, when balling or clamming is being performed, only the personnel absolutely necessary to the work must be allowed in the work area.

Example 2: Your employer must make sure that proper bracing is used between heavy plates used as shoring in a trench.

Example 3: Your employer must carefully arrange the path of travel when loading/unloading, stacking, and storing materials so that no workers will be caught between materials and moving equipment or between materials and a wall.

Provide protection for workers during trenching and excavation work

OSHA standards on trenching and excavation require your employer to designate a competent person to inspect the trenching operations. The competent person must be trained in and knowledgeable about soils classification, the use of protective systems, and the requirements of the OSHA standard. The competent person must be capable of identifying hazards, and authorized to immediately eliminate hazards. The employer must make sure all excavations and trenches 5 feet deep or more, but less than 20 feet, are protected by: sloping or benching, trench box or shield, or shoring, and that there are adequate means of access and egress from the excavation. If an excavation is more than 20 feet deep, a professional engineer must design the system to protect the workers. Workers must be protected from equipment or materials that could fall or roll into excavations. This could include spoils that could fall into the trench and bury the workers. Mobile equipment used near or over an excavation presents a hazard. When mobile equipment is operated adjacent to an excavation, or when such equipment is required to approach the edge of an excavation, and the operator does not have a clear and direct view of the edge of the excavation, a warning system must be utilized such as barricades, hand or mechanical signals or stop logs. If possible, the grade should be away from the excavation. If a crane or earthmoving equipment is operating directly over the top of a trench, workers should not be working underneath.

Provide means to avoid the collapse of structures scaffolds

Measures need to be taken by your employer to avoid the collapse of other structures, such as scaffolds, that could bury workers underneath them. Anytime there is inadequate support, improper construction, or a shift in the components of a scaffold (including the base upon which the structure is built), there is danger of collapse. Cinder blocks or other similar materials should not be used to support a scaffold because they could be crushed. OSHA standards require that scaffolds can only be erected, moved, dismantled or altered under the supervision of a competent person. The competent person selects and directs the workers who erect the scaffold. These workers must be trained by a competent person on correct procedures and hazards of scaffold erection.

Provide means to avoid workers' being crushed by collapsing walls during demolition or other construction activities

During demolition, any stand-alone wall that is more than one story must have lateral bracing, unless the wall was designed to be stand-alone and is otherwise in a safe condition to be self-supporting. Jacks must have a firm foundation. If necessary, the base of a jack must be blocked or cribbed. After a load has been raised, it must be cribbed, blocked, or otherwise secured at once.

Designate a competent person

OSHA defines a "competent person" as "one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them."

Your employer must designate a competent person for certain construction activities that may have caught-in or -between

hazards:

- Training for scaffold erection
- Inspections of excavations, the adjacent areas, and protective systems
- Engineering survey prior to demolition of a structure (and any adjacent structure where workers may be exposed) to determine the condition of the framing, floors, and walls, and possibility of unplanned collapse
- Continuing inspections during demolition to detect hazards resulting from weakened or deteriorated floors, or walls, or loosened material

Provide training for workers

OSHA's general training requirement for construction workers is:

- The employer shall instruct each employee in the recognition and avoidance of unsafe conditions and the regulations applicable to his work environment to control or eliminate any hazards or other exposure to illness or injury.
- Your employer must train you to perform your job and use the equipment provided safely.
- Construction activities that may have caught-in or -between hazards and that have specific training requirements in OSHA standards include
- Scaffolds – workers who are involved in erecting, disassembling, moving, operating, repairing, maintaining, or inspecting a scaffold

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6.5: Review Questions

Multiple Choice Questions

1. The key factor in distinguishing between a “Struck” event and a “Caught” event is:
 - (a) the type of machinery involved
 - (b) whether crushing injuries occurred
 - (c) whether the impact alone caused the injury
 - (d) the depth of the excavation
2. Which of the following is an example of a “caught-in or -between” hazard?
 - (a) being hit by a falling tools
 - (b) being crushed between a truck frame and lowering hydraulic bed
 - (c) slipping on a wet floor
 - (d) inhaling chemical fumes
3. What is the primary role of a “competent person” under OSHA standards?
 - (a) to operate heavy machinery safely
 - (b) to supervise workers during breaks
 - (c) to identify and eliminate hazards prompts
 - (d) to inspect employee safety equipment daily
4. A worker is pinned between a backhoe’s swinging superstructure and a wall. It is an example of:
 - (a) buried-in hazard
 - (b) pinned-between hazard
 - (c) electrocution hazard
 - (d) struck-by hazard
5. Employers must provide which of the following to protect workers from caught-in or -between hazards?
 - (a) guards on power tools
 - (b) measures to prevent equipment tip-overs
 - (c) protective systems in trenches
 - (d) training in hazard recognition
 - (e) all the above
6. Which of the following is not considered a caught-in or -between hazard?
 - (a) being pulled into a conveyor belt
 - (b) being buried in an unprotected trench cave-in
 - (c) being struck by a falling hammer
 - (d) being pinned between two machines
7. Which hazard is associated with being “buried in or by”?
 - (a) strangulation by moving machinery
 - (b) cave-ins and collapsing walls
 - (c) electric shocks from overhead power lines
 - (d) noise-induced hearing loss
8. Which situation best illustrates a caught-in hazard rather than a struck-by hazard?
 - (a) a worker hit by a falling hammer
 - (b) a worker’s glove pulled into a rotating drill press
 - (c) a worker struck by debris during demolition
 - (d) a worker exposed to chemical vapors
9. When working in a trench, what is the safest way to enter or exit?
 - (a) climbing on the trench box

- (b) jumping in and out carefully
- (c) using a ladder or ramp within the protected area
- (d) using the excavator bucket as a lift

10. A worker is crushed when heavy plates used as trench shoring fall over. Which safety measure would have prevented this?

- (a) Proper bracing between the plates
- (b) Wider excavation walls
- (c) Warning signs near the trench
- (d) Use of respirators

11. Which example best shows compliance with lockout/tagout procedures?

- (a) Leaving equipment running while adjusting settings
- (b) Disconnecting and tagging machinery before maintenance
- (c) Allowing maintenance while power remains on
- (d) Using verbal warnings instead of physical locks

12. To prevent being pinned between vehicles and structures, workers should:

- (a) Walk directly behind moving vehicles
- (b) Maintain a safe distance and clear communication with operators
- (c) Stand near the swing radius of cranes
- (d) Enter blind spots to speed up work

13. Why must seat belts be used on heavy equipment like loaders or graders?

- (a) They prevent workers from overheating in the cab
- (b) They keep operators from being ejected and crushed if the machine tips
- (c) They reduce engine vibration
- (d) They are required only for road vehicles

True/False Questions

14. True/False: Trench cave-ins are one of the leading causes of “buried in or by” fatalities.

15. True/False: OSHA requires that scaffolds be erected, moved, or dismantled only under the supervision of a competent person.

16. True/False: Trench boxes prevent soil from collapsing into a trench.

17. True/False: Cave-ins, machinery entanglements, and collapsing walls are all examples of caught-in or -between hazards.

18. True/False: Employers are not required to train workers about caught-in or -between hazards as long as they provide protective equipment.

19. True/False: Workers should never place themselves between moving equipment and an immovable object.

20. True/False: Removing machine guards is acceptable if it speeds up construction tasks.

21. True/False: A “competent person” must have both knowledge of hazards and authority to correct them.

22. True/False: Workers should never enter an unprotected trench or excavation 5 feet or deeper without an adequate protective system in place.

Answer Key: 1(c), 2(b), 3(c), 4(b), 5(e), 6(c), 7(b), 8(b), 9(c), 10(a), 11(b), 12(b), 13(b), 14(True), 15(True), 16(False), 17(True), 18(False), 19(True), 20(False), 21(True), 22(True).

6.6: Sources

The content in this chapter is adapted from:

Occupational Safety and Health Administration. (n.d.). Caught-in or -between hazards — Instructor guide. [Caught-in or -between hazards — Instructor guide](#) [www.osha.gov]

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7: PERSONAL PROTECTIVE EQUIPMENT (PPE)

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7.1: Introduction

Hazards exist in every workplace in many different forms: sharp edges, falling objects, flying sparks, chemicals, noise and a myriad of other potentially dangerous situations. The Occupational Safety and Health Administration (OSHA) requires that employers protect their employees from workplace hazards that can cause injury.

Controlling a hazard at its source is the best way to protect employees. Depending on the hazard or workplace conditions, OSHA recommends the use of engineering or work practice controls to manage or eliminate hazards to the greatest extent possible. For example, building a barrier between the hazard and employees is an engineering control; changing the way in which employees perform their work, (e.g., through job rotations) is an administrative control.

When engineering, work practice, and administrative controls are not feasible or do not provide sufficient protection, employers must provide personal protective equipment (PPE) to their employees and ensure its use. Personal protective equipment, commonly referred to as “PPE”, is equipment worn to minimize exposure to a variety of hazards. Examples of PPE include such items as gloves, foot and eye protection, protective hearing devices (earplugs, muffs) hard hats, respirators and full body suits. PPE is designed to protect workers from serious workplace injuries or illnesses resulting from contact with chemical, radiological, physical, electrical, mechanical, or other workplace hazards.

7.2: The Requirement for PPE

To ensure the greatest possible protection for employees in the workplace, the cooperative efforts of both employers and employees will help in establishing and maintaining a safe and healthful work environment.

In general, employers are responsible for:

- Performing a “hazard assessment” of the workplace to identify and control physical and health hazards.
- Identifying and providing appropriate and adequate PPE for employees.
- Training employees in the use and care of the PPE.
- Maintaining PPE, including replacing worn or damaged PPE.
- Periodically reviewing, updating and evaluating the effectiveness of the PPE program.

In general, employees should:

- Properly wear PPE,
- Attend training sessions on PPE,
- Care for, clean and maintain PPE, and
- Inform a supervisor of the need to repair or replace PPE. Specific requirements for PPE are presented in many different

The Hazard Assessment

A first critical step in protecting employees is to use a “hazard assessment to identify physical and health hazards in the workplace. Potential hazards may be physical or health-related and a comprehensive hazard assessment should identify hazards in both categories. Examples of physical hazards include moving objects, fluctuating temperatures, high intensity lighting, rolling or pinching objects, electrical connections, and sharp edges. Examples of health hazards include overexposure to harmful dusts, chemicals or radiation.

The hazard assessment should begin with a walkthrough survey of the facility to develop a list of potential hazards in the following basic hazard categories:

- Fall hazards,
- Impact,
- Penetration,
- Compression (roll-over),
- Chemical,
- Heat/cold,
- Harmful dust,
- Light (optical) radiation, and
- Biologic.

In addition to noting the basic layout of the facility and reviewing any history of occupational illnesses or injuries, things to look

for during the walkthrough survey include:

- Sources of electricity.
- Sources of motion such as machines or processes where movement may exist that could result in an impact between personnel and equipment.
- Sources of high temperatures that could result in burns, eye injuries or fire.
- Types of chemicals used in the workplace.
- Sources of harmful dusts.
- Sources of light radiation, such as welding, brazing, cutting, furnaces, heat treating, high intensity lights, etc.
- The potential for falling or dropping objects.
- Sharp objects that could poke, cut, stab or puncture.
- Biologic hazards such as blood or other potentially infectious material.
- Unprotected edges where fall hazards may exist.

When the walkthrough is complete, the employer should organize and analyze the data so that it may be efficiently used in determining the proper types of PPE required at the worksite.

The employer should become aware of the different types of PPE available and the levels of protection offered. It is definitely a good idea to select PPE that will provide a level of protection greater than the minimum required to protect employees from hazards.

Then periodically reassess the workplace for any changes in conditions, equipment or operating procedures that could create occupational hazards. This periodic reassessment should also include a review of injury and illness records to spot any trends or areas of concern and taking appropriate corrective action. The suitability of existing PPE, including an evaluation of its condition and age, should be included in the reassessment.

Documentation of the hazard assessment is required through a written certification that includes the following information:

- Identification of the workplace evaluated
- Name of the person conducting the assessment
- Date of the assessment
- Identification of the document certifying completion of the hazard assessment.

Selecting PPE

All PPE clothing and equipment must be of safe design and construction, and be maintained in a clean and reliable fashion. Employers should take the fitness and comfort of PPE into consideration when selecting appropriate items for their workplace.

PPE that fits well and is comfortable to wear will encourage employee use. Most protective devices are available in multiple sizes and care should be taken to select the proper size for each employee. If several different types of PPE are worn together, make sure they are compatible. If PPE does not fit properly, it can make the difference between being safely covered or dangerously exposed. It may not provide the level of protection desired and may discourage employee use.

Training Employees in the Proper Use of PPE

Employers are required to train each employee who must use PPE. Employees must be trained to know at least the following:

- When PPE is necessary.
- What PPE is necessary.
- How to properly put on, take off, adjust and wear the PPE.
- The limitations of the PPE.
- Proper care, maintenance, useful life, and disposal of PPE.

Employers shall make sure that each employee demonstrates an understanding of the PPE training (i.e., in a language they understand) as well as the ability to properly wear and use PPE before they are allowed to perform work requiring the use of the PPE. If an employer believes that a previously trained employee is not demonstrating the proper understanding and skill level in the use of PPE, that employee should receive retraining. Other situations that require additional or retraining of employees include changes in the workplace or in the type of required PPE that make the prior training obsolete.

7.3: Eye and Face Protection

Employees can be exposed to a large number of hazards that pose danger to their eyes and face. OSHA requires employers to ensure that employees have appropriate eye or face protection when exposed to eye or face hazards from flying particles, molten metal, liquid chemicals, acids or caustic liquids, chemical gases or vapors, potentially infected material or potentially harmful light radiation.

Many occupational eye injuries occur because employees are not wearing any eye protection while others result from wearing improper, inadequate, or poorly fitting eye protection. Employers must be sure that their employees wear appropriate eye and face protection and that the selected form of protection is appropriate to the work being performed and properly fits each employee exposed to the hazard.

Eye Protection for Exposed Employees

OSHA requires that eye protection be routinely considered for use by carpenters, electricians, machinists, mechanics, millwrights, plumbers and pipefitters, sheet metal employees and tinsmiths, assemblers, sanders, grinding machine operators, welders, labors, chemical process operators and handlers, sawyers, timber cutting and logging workers. Employers of employees in other job categories should decide whether there is a need for eye and face PPE through a hazard assessment.

Examples of potential eye or face hazards include:

- Dust, dirt, metal or wood chips contacting or entering the eye from activities such as chipping, grinding, sawing, hammering, using power tools, or from sources such as strong winds.
- Chemical splashes from corrosive substances, hot liquids, solvents or other hazardous solutions.
- Objects swinging into the eye or face, such as tree limbs, chains, tools or ropes.
- Radiant energy from welding, harmful rays from the use of lasers or other radiant light (as well as heat, glare, sparks, splash and flying particles).

Types of Eye Protection

Selecting suitable eye and face protection for employees should take into consideration the following elements:

- Ability to protect against specific workplace hazards.
- Should fit properly and be reasonably comfortable to wear.
- Should provide unrestricted vision and movement.
- Should be durable and cleanable.
- Should allow unrestricted functioning of any other required PPE.

The eye and face protection selected for employee use must clearly identify the manufacturer. Any new eye and face protective devices must comply with any of the following; ANSI Z87.1-2010, ANSI Z87.1-2003, or ANSI Z87.1-1989(R1998) or be at least as effective as this standard requires.

Some of the most common types of eye and face protection include the following:

■ Safety spectacles.

These protective eyeglasses have safety frames constructed of metal or plastic and impact-resistant lenses. Side shields are available on some models.

■ Goggles.

This tight-fitting eye protection completely covers the eyes, eye sockets, and the facial area immediately surrounding the eyes and provide protection from impact, dust and splashes. Some goggles will fit over corrective lenses.

■ Welding shields.

Constructed of vulcanized fiber or fiberglass and fitted with a filtered lens, welding shields protect eyes from burns caused by infrared or intense radiant light; they also protect both the eyes and face from flying sparks, metal spatter and slag chips produced during welding, brazing, soldering and cutting operations. OSHA requires filter lenses to have a shade appropriate to protect against the specific hazards of the work being performed in order to protect against harmful light radiation.

■ Laser safety goggles.

These specialty goggles protect against intense concentrations of light produced by lasers. The type of laser safety goggles an employer chooses will depend upon the equipment and operating conditions in the workplace.

■ Face shields.

These transparent sheets of plastic extend from the eyebrows to below the chin and across the entire width of the employee's head. Some are polarized for glare protection. Face shields protect against potential splashes or sprays of hazardous liquids, droplets, and particles but will not provide adequate protection against impact hazards. Face shields used in combination with goggles or safety spectacles will provide additional protection against splash and impact hazards.

Each type of protective eyewear is designed to protect against specific hazards. Employers can identify the specific workplace hazards that threaten employees' eyes and faces by completing a hazard assessment as outlined in the earlier section.

7.4: Head Protection

Protecting employees from potential head injuries is a key element of any safety program. A head injury can impair an employee for life or it can be fatal. Wearing a safety helmet or hard hat is one of the easiest ways to protect an employee's head from injury. Hard hats can protect employees from impact and penetration hazards as well as from electrical shock and burn hazards.

Employers must ensure that their employees wear head protection if any of the following apply:

- Objects might fall from above and strike them on the head;
- They might bump their heads against fixed objects, such as exposed pipes or beams; or
- There is a possibility of accidental head contact with electrical hazards.

Some examples of occupations in which employees should be required to wear head protection include construction workers, carpenters, electricians, linemen, plumbers and pipefitters, timber and log cutters, and welders. Whenever there is a danger of objects falling from above, such as working below others who are using tools or working under a conveyor belt, head protection must be worn. In general, protective helmets or hard hats should do the following:

- Resist penetration by objects.
- Absorb the shock of a blow.
- Be water-resistant and slow burning.
- Have clear instructions explaining proper adjustment and replacement of the suspension and headband.

Hard hats must have a hard outer shell and a shock-absorbing lining that incorporates a headband and straps that suspend the shell from 1 to 1 1/4 inches (2.54 cm to 3.18 cm) away from the head. This type of design provides shock absorption during an impact and ventilation during normal wear.

Types of Hard Hats

There are many types of hard hats available in the marketplace today. In addition to selecting protective headgear that meets ANSI standard requirements, employers should ensure that employees wear hard hats that provide appropriate protection against potential workplace hazards. It is important for employers to understand all potential hazards when making this selection, including electrical hazards. This can be done through a comprehensive hazard analysis and an awareness of the different types of protective headgear available.

Hard hats are divided into three industrial classes:

- Class A hard hats provide impact and penetration resistance along with limited voltage protection (up to 2,200 volts).
- Class B hard hats provide the highest level of protection against electrical hazards, with high-voltage shock and burn protection (up to 20,000 volts). They also provide protection from impact and penetration hazards by flying/falling objects.
- Class C hard hats provide lightweight comfort and impact protection but offer no protection from electrical hazards.

Another class of protective headgear on the market is called a "bump hat," designed for use in areas with low head clearance. They are recommended for areas where protection is needed from head bumps and lacerations. These are not designed to protect against falling or flying objects and are not ANSI approved. It is essential to check the type of hard hat employees are using to ensure that the equipment provides appropriate protection. Each hat should bear a label inside the shell that lists the manufacturer, the ANSI designation and the class of the hat.

Size and Care Considerations

Head protection that is either too large or too small is inappropriate for use, even if it meets all other requirements. Protective headgear must fit appropriately on the body and for the head size of each individual. Most protective headgear comes in a variety of sizes with adjustable headbands to ensure a proper fit (many adjust in 1/8-inch increments). A proper fit should allow sufficient clearance between the shell and the suspension system for ventilation and distribution of an impact. The hat should not bind, slip, fall off or irritate the skin.

Some protective headgear allows for the use of various accessories to help employees deal with changing environmental conditions, such as slots for earmuffs, safety glasses, face shields and mounted lights. Optional brims may provide additional protection from the sun and some hats have channels that guide rainwater away from the face. Protective headgear accessories must not compromise the safety elements of the equipment.

Periodic cleaning and inspection will extend the useful life of protective headgear. A daily inspection of the hard hat shell, suspension system and other accessories for holes, cracks, tears or other damage that might compromise the protective value of the hat is essential. Paints, paint thinners and some cleaning agents can weaken the shells of hard hats and may eliminate electrical resistance. Consult the helmet manufacturer for information on the effects of paint and cleaning materials on their hard hats. Never drill holes, paint or apply labels to protective headgear as this may reduce the integrity of the protection. Do not store protective headgear in direct sunlight, such as on the rear window shelf of a car, since sunlight and extreme heat can damage them.

Hard hats with any of the following defects should be removed from service and replaced:

- Perforation, cracking, or deformity of the brim or shell;
- Indication of exposure of the brim or shell to heat, chemicals or ultraviolet light and other radiation (in addition to a loss of surface gloss, such signs include chalking or flaking).

Always replace a hard hat if it sustains an impact, even if damage is not noticeable. Suspension systems are offered as replacement parts and should be replaced when damaged or when excessive wear is noticed. It is not necessary to replace the entire hard hat when deterioration or tears of the suspension systems are noticed.

7.5: Foot and Leg Protection

Employees who face possible foot or leg injuries from falling or rolling objects or from crushing or penetrating materials should wear protective footwear. Also, employees whose work involves exposure to hot substances or corrosive or poisonous materials must have protective gear to cover exposed body parts, including legs and feet. If an employee's feet may be exposed to electrical hazards, non-conductive footwear should be worn. On the other hand, workplace exposure to static electricity may necessitate the use of conductive footwear.

Examples of situations in which an employee should wear foot and/or leg protection include:

- When heavy objects such as barrels or tools might roll onto or fall on the employee's feet;
- Working with sharp objects such as nails or spikes that could pierce the soles or uppers of ordinary shoes;
- Exposure to molten metal that might splash on feet or legs;
- Working on or around hot, wet or slippery surfaces; and
- Working when electrical hazards are present.

Protective footwear must comply with any of the following consensus standards; ASTM F-2412-2005, "Standard Test Methods for Foot Protection," and ASTM F-2413-2005, "Standard Specification for Performance Requirements for Protective Footwear", ANSI Z41-1999, "American National Standard for Personal Protection - Protective Footwear", or ANSI Z41-1991, "American National Standard for Personal Protection - Protective Footwear", or provide equivalent protection. All ANSI-approved footwear has a protective toe and offers impact and compression protection, but the type and amount of protection is not always the same. Different footwear protects in different ways. Check the product's labeling or consult the manufacturer to make sure the footwear will protect the user from the hazards they face.

Foot and leg protection choices include the following:

- Leggings protect the lower legs and feet from heat hazards such as molten metal or welding sparks. Safety snaps allow leggings to be removed quickly.
- Metatarsal guards protect the instep area from impact and compression. Made of aluminum, steel, fiber or plastic, these guards may be strapped to the outside of shoes.
- Toe guards fit over the toes of regular shoes to protect the toes from impact and compression hazards. They may be made of steel, aluminum or plastic.
- Combination foot and shin guards protect the lower legs and feet, and may be used in combination with toe guards when greater protection is needed.
- Safety shoes have impact-resistant toes and heat-resistant soles that protect the feet against hot work surfaces common in roofing, paving and hot metal industries. The metal insoles of some safety shoes protect against puncture wounds. Safety shoes may also be designed to be electrically conductive to prevent the buildup of static electricity in areas with the potential for explosive atmospheres or nonconductive to protect employees from workplace electrical hazards.

Special Purpose Shoes

Electrically conductive shoes provide protection against the buildup of static electricity. Employees working in explosive and hazardous locations such as explosives manufacturing facilities or grain elevators must wear conductive shoes to reduce the risk of static electricity buildup on the body that could produce a spark and cause an explosion or fire. Foot powder should not be used in conjunction with protective conductive footwear because it provides insulation, reducing the conductive ability of the shoes. Silk, wool and nylon socks can produce static electricity and should not be worn with conductive footwear. Conductive shoes must be removed when the task requiring their use is completed. Note: Employees exposed to electrical hazards must never wear conductive shoes.

Electrical hazard, safety-toe shoes are nonconductive and will prevent the wearers' feet from completing an electrical circuit to the ground. These shoes can protect against open circuits of up to 600 volts in dry conditions and should be used in conjunction with other insulating equipment and additional precautions to reduce the risk of an employee becoming a path for hazardous electrical energy. The insulating protection of electrical hazard, safety-toe shoes may be compromised if the shoes become wet, the soles are worn through, metal particles become embedded in the sole or heel, or employees touch conductive, grounded items. Note: Nonconductive footwear must not be used in explosive or hazardous locations.

7.6: Hand and Arm Protection

If a workplace hazard assessment reveals that employees face potential injury to hands and arms that cannot be eliminated through engineering and work practice controls, employers must ensure that employees wear appropriate protection. Potential hazards include skin absorption of harmful substances, chemical or thermal burns, electrical dangers, bruises, abrasions, cuts, punctures, fractures and amputations. Protective equipment includes gloves, finger guards and arm coverings or elbow-length gloves.

Employers should explore all possible engineering and work practice controls to eliminate hazards and use PPE to provide additional protection against hazards that cannot be completely eliminated through other means. For example, machine guards may eliminate a hazard. Installing a barrier to prevent employees from placing their hands at the point of contact between a table saw blade and the item being cut is another method.

Types of Protective Gloves

There are many types of gloves available today to protect against a wide variety of hazards. The nature of the hazard and the operation involved will affect the selection of gloves. The variety of potential occupational hand injuries makes selecting the right pair of gloves challenging. It is essential that employees use gloves specifically designed for the hazards and tasks found in their workplace because gloves designed for one function may not protect against a different function even though they may appear to be an appropriate protective device.

The following are examples of some factors that may influence the selection of protective gloves for a workplace.

- Type of chemicals handled.
- Nature of contact (total immersion, splash, etc.).
- Duration of contact.
- Area requiring protection (hand only, forearm, arm).
- Grip requirements (dry, wet, oily).
- Thermal protection.
- Size and comfort.
- Abrasion/resistance requirements.

Gloves made from a wide variety of materials are designed for many types of workplace hazards. In general, gloves fall into four groups:

- Gloves made of leather, canvas or metal mesh;
- Fabric and coated fabric gloves;
- Chemical- and liquid-resistant gloves;
- Insulating rubber gloves (See 29 CFR 1910.137 and the following section on electrical protective equipment for detailed requirements on the selection, use and care of insulating rubber gloves).

Leather, Canvas or Metal Mesh Gloves

Sturdy gloves made from metal mesh, leather or canvas provide protection against cuts and burns. Leather or canvas gloves also protect against sustained heat.

- Leather gloves protect against sparks, moderate heat, blows, chips and rough objects.
- Aluminized gloves provide reflective and insulating protection against heat and require an insert made of synthetic materials to protect against heat and cold.
- Aramid fiber gloves protect against heat and cold, are cut- and abrasive-resistant and wear well.
- Synthetic gloves of various materials offer protection against heat and cold, are cut- and abrasive-resistant and may withstand some diluted acids. These materials do not stand up against alkalis and solvents.

Fabric and Coated Fabric Gloves

Fabric and coated fabric gloves are made of cotton or other fabric to provide varying degrees of protection.

- Fabric gloves protect against dirt, slivers, chafing and abrasions. They do not provide sufficient protection for use with rough, sharp or heavy materials. Adding a plastic coating will strengthen some fabric gloves.
- Coated fabric gloves are normally made from cotton flannel with napping on one side. By coating the unnapped side with plastic, fabric gloves are transformed into general-purpose hand protection offering slip-resistant qualities. These gloves are used for tasks ranging from handling bricks and wire to chemical laboratory containers. When selecting gloves to protect against chemical exposure hazards, always check with the manufacturer or review the manufacturer's product literature to determine the gloves' effectiveness against specific workplace chemicals and conditions.

Chemical- and Liquid-Resistant Gloves

Chemical-resistant gloves are made with different kinds of rubber: natural, butyl, neoprene, nitrile and fluorocarbon (viton); or various kinds of plastic: polyvinyl chloride (PVC), polyvinyl alcohol and polyethylene. These materials can be blended or laminated for better performance. As a general rule, the thicker the glove material, the greater the chemical resistance, but thick gloves may impair grip and dexterity, having a negative impact on safety.

Some examples of chemical-resistant gloves include:

- Butyl gloves are made of a synthetic rubber and protect against a wide variety of chemicals, such as peroxide, rocket fuels, highly corrosive acids (nitric acid, sulfuric acid, hydrofluoric acid and red-fuming nitric acid), strong bases, alcohols, aldehydes, ketones, esters and nitro compounds. Butyl gloves also resist oxidation, ozone corrosion and abrasion, and remain flexible at low temperatures. Butyl rubber does not perform well with aliphatic and aromatic hydrocarbons and halogenated solvents.
- Natural (latex) rubber gloves are comfortable to wear, which makes them a popular general-purpose glove. They feature outstanding tensile strength, elasticity, and temperature resistance. In addition to resisting abrasions caused by grinding and polishing, these gloves protect employees' hands from most water solutions of acids, alkalis, salts, and ketones. Latex gloves have caused allergic reactions in some individuals and may not be appropriate for all employees. Hypoallergenic gloves, glove liners and powderless gloves are possible alternatives for employees who are allergic to latex gloves.
- Neoprene gloves are made of synthetic rubber and offer a range of protect against hydraulic fluids, gasoline, alcohols, organic acids and alkalis. They generally have chemical and wear resistance properties superior to those made of natural rubber.
- Nitrile gloves are made of a copolymer and provide protection from chlorinated solvents such as trichloroethylene and perchloroethylene. Although intended for jobs requiring dexterity and sensitivity, nitrile gloves stand up to heavy use even after prolonged exposure to substances that cause other gloves to deteriorate. They offer protection when working with oils, greases, acids, caustics and alcohols but are generally not recommended for use with strong oxidizing agents, aromatic solvents, ketones and acetates.

7.7: Body Protection

Employees who face possible bodily injury of any kind that cannot be eliminated through engineering, work practice or administrative controls must wear appropriate body protection while performing their jobs. In addition to cuts and radiation, the following are examples of workplace hazards that could cause bodily injury:

- Temperature extremes;
- Hot splashes from molten metals and other hot liquids;
- Potential impacts from tools, machinery and materials;
- Hazardous chemicals.

There are varieties of protective clothing available for specific hazards. Employers are required to ensure that their employees wear personal protective equipment parts of the body exposed to possible injury. Examples of body protection include laboratory coats, coveralls, vests, jackets, aprons, surgical gowns and full body suits.

If a hazard assessment indicates a need for full body protection against toxic substances or harmful physical agents, carefully inspect the PPE before each use, ensure proper fit and that it properly functions for the purpose for which it is intended.

Protective clothing comes in a variety of materials, each effective against particular hazards, such as:

- Paper-like fiber is used for disposable suits to provide protection against dust and splashes.
- Treated wool and cotton adapts well to changing temperatures, is comfortable and fire-resistant and protects against dust, abrasions and rough and irritating surfaces.
- Duck is a closely woven cotton fabric that protects against cuts and bruises when handling heavy, sharp or rough materials.
- Leather is often used to protect against dry heat and flames.
- Rubber, rubberized fabrics, neoprene and plastics protect against certain chemicals and physical hazards. When chemical or physical hazards are present, check with the clothing manufacturer to ensure that the material selected will provide adequate protection against the specific hazard.

7.8: Hearing Protection

Certain operations generate noise requiring hearing protection. Employee exposure to excessive noise depends upon a number of factors, including:

- The noise level, as measured in decibels (dB).
- The duration of each employee's exposure to the noise.
- Whether employees move between work areas with different noise levels.
- Whether noise is generated from one or multiple sources.

Generally, the louder the noise, the shorter the exposure time before hearing protection is required. For instance, employees may be exposed to a noise level of 90 dB for 8 hours per day (unless they experience a Standard Threshold Shift) before hearing protection is required. On the other hand, if the noise level reaches 115 dB hearing protection is required if the anticipated exposure exceeds 15 minutes.

The table below shows permissible noise exposures at specific decibel levels for specific time periods. Noise exposure is considered continuous if the interval between occurrences of the maximum noise level is one second or less. Noises not meeting this definition are considered impact or impulse noises (loud momentary explosions of sound) and exposures to this type of noise must not exceed 140 dB. Examples of situations or tools that may result in impact or impulse noises are powder-actuated nail guns, the use of a punch press or drop hammers. Plain cotton is not an acceptable protective device.

Duration per day, in hours	Sound level in dB*
8	90
6	92
4	95
3	97
2	100
1 1/2	102
1	105
1/2	110
1/4 or less	115

Image 7:1 Permissible Noise Exposures at Specific Decibel Levels for Specific Time Periods. (Source: www.osha.gov, Public Domain).

Some types of hearing protection include:

- Single-use earplugs are made of waxed cotton, foam, silicone rubber or fiberglass wool. They are self-forming and, when properly inserted, they work as well as most molded earplugs.
- Pre-formed or molded earplugs are individually fitted by a professional and can be disposable or reusable. Reusable plugs should be cleaned after each use.
- Earmuffs require a perfect seal around the ear. Glasses, facial hair, long hair or facial movements such as chewing may reduce the protective value of earmuffs.

7.9: Personal Fall Protection Systems

If a workplace hazard assessment reveals that employees face potential injury from fall hazards, and engineering controls cannot be used to eliminate the hazard, personal fall protection systems are another option for employers. “Personal fall protection system” (PFPS) means a system (including all components) an employer uses to provide protection from falling or to safely arrest an employee’s fall if one occurs. Examples of personal fall protection systems include personal fall arrest systems, positioning systems, and travel restraint systems.

29 CFR 1910.140 sets forth requirements for personal fall protection systems. There are several types of these systems:

- Travel restraint systems consist of a combination of an anchorage, anchorage connector, lanyard (or other means of connection), and body support that an employer uses to eliminate the possibility of an employee going over the edge of a walking-working surface.
- A positioning system is a system of equipment and connectors that, when used with a body harness or body belt, allows an employee to be supported on an elevated vertical surface, such as a wall or windowsill, and work with both hands free. Positioning systems also are called “positioning system devices” and “work-positioning equipment.”
- A personal fall arrest system is a system used to arrest an employee in a fall from a walking-working surface. It consists of a body harness, anchorage, and connector. The means of connection may include a lanyard, deceleration device, lifeline, or a suitable combination of these.

Generally, components of PFPS must be compatible and meet certain strength requirements. Anchorages that PFPS attach to must be capable of supporting at least 5,000 pounds for each employee attached. If a fall occurs, components subjected to impact loading must be removed from service immediately and not used again until a competent person inspects the system or components and determines that it is not damaged and safe for use for employee personal fall protection. Body belts are prohibited as part of personal fall arrest systems. For more information and to see all the requirements for PFPS, please see 29 CFR 1910.140.

7.10: Summary

Personal protective equipment, commonly referred to as "PPE," is equipment worn to minimize exposure to hazards that cause serious workplace injuries and illnesses. These injuries and illnesses may result from contact with chemical, radiological, physical, electrical, mechanical, or other workplace hazards. Personal protective equipment may include items such as gloves, safety glasses and shoes, earplugs or muffs, hard hats, respirators, or coveralls, vests and full body suits.

Using personal protective equipment is often essential, but it is generally the last line of defense after engineering controls, work practices, and administrative controls. Engineering controls involve physically changing a machine or work environment. Administrative controls involve changing how or when workers do their jobs, such as scheduling work and rotating workers to reduce exposures. Work practices involve training workers how to perform tasks in ways that reduce their exposure to workplace hazards.

What can be done to ensure proper use of personal protective equipment?

All personal protective equipment should be safely designed and constructed, and should be maintained in a clean and reliable fashion. It should fit comfortably, encouraging worker use. If the personal protective equipment does not fit properly, it can make the difference between being safely covered or dangerously exposed. When engineering, work practice, and administrative controls are not feasible or do not provide sufficient protection, employers must provide personal protective equipment to their workers and ensure its proper use. Employers are also required to train each worker required to use personal protective equipment to know:

- When it is necessary
- What kind is necessary
- How to properly put it on, adjust, wear and take it off
- The limitations of the equipment
- Proper care, maintenance, useful life, and disposal of the equipment

If PPE is to be used, a PPE program should be implemented. This program should address the hazards present; the selection, maintenance, and use of PPE; the training of employees; and monitoring of the program to ensure its ongoing effectiveness.

7.11: Review Questions

Multiple Choice Questions

1. When are employers required to provide personal protective equipment (PPE) to employees?
 - (a) when administrative controls alone can manage hazards
 - (b) only if employees request it
 - (c) when engineering and work practice controls are not feasible or sufficient
 - (d) only during annual inspections
2. Which of the following is an employer's responsibility regarding PPE?
 - (a) performing a hazard assessment of the workplace
 - (b) training employees in the use and care of PPE
 - (c) maintaining and replacing damaged PPE
 - (d) all of the above
3. Eye protection is required when employees are exposed to which of the following?
 - (a) dust, dirt, or flying particles
 - (b) chemical splashes
 - (c) harmful light radiation
 - (d) all of the above
4. Which class of hard hat provides the highest level of protection against electrical hazards (up to 20,000 volts)?
 - (a) class A
 - (b) class B
 - (c) class C
 - (d) bump hats
5. At what noise level (in decibels) is hearing protection required if exposure is longer than 15 minutes?
 - (a) 85 dB
 - (b) 90 dB
 - (c) 100 dB
 - (d) 115 dB
6. What is the first critical step in protecting employees from hazards?
 - (a) training employees in PPE use
 - (b) providing PPE to every worker
 - (c) conducting a hazard assessment
 - (d) writing a safety policy
7. Which of the following is an employee's responsibility for PPE?
 - (a) provide replacement PPE when needed
 - (b) conduct hazard assessments regularly
 - (c) properly wear and maintain PPE
 - (d) approve PPE budget requests
8. Which type of hearing protection requires a perfect seal around the ear and may lose effectiveness due to facial hair or glasses?
 - (a) single-use earplugs
 - (b) pre-formed earplugs
 - (c) earmuffs
 - (d) foam plugs
9. Which factor most affects the level of hearing protection needed?
 - (a) The color of the PPE
 - (b) The number of employees wearing protection

- (c) The decibel level and exposure duration
- (d) The type of machinery used nearby

10. When selecting PPE, why is comfort and fit important?

- (a) It improves fashion appearance
- (b) It ensures employees are more likely to wear it
- (c) It reduces manufacturing costs
- (d) It shortens training time

11. What should an employer do if a PPE inspection reveals worn or damaged equipment?

- (a) Clean and continue using it
- (b) Reassign it to a less hazardous area
- (c) Replace or repair it immediately
- (d) Store it for future training use

12. Why should employees avoid painting or drilling holes in hard hats?

- (a) It may interfere with comfort
- (b) It can weaken the shell and reduce protection
- (c) It voids the manufacturer's warranty only
- (d) It increases glare for the wearer

True/False Questions

13. True/False: Employees are responsible for properly wearing PPE and reporting when it needs repair or replacement.

14. True/False: Conductive shoes should not be worn in explosive environments to prevent the buildup of static electricity.

15. True/False: Hearing protection is required at 90 dB if exposure exceeds 8 hours.

16. True/False: The comfort and proper fit of PPE are important because they encourage employees to use it.

17. True/False: Employees should never drill holes or paint hard hats, since this may reduce their protective integrity.

18. True/False: PPE that is too loose, too tight, or uncomfortable often leads to workers not wearing it consistently.

19. True/False: PPE should be treated as the first line of defense rather than the last resort.

20. True/False: Safety glasses or a face shield should be worn during any work task that may cause foreign objects to enter the eyes. For example, during welding, cutting, grinding, nailing.

21. True/False: Hard hats should be routinely inspected for dents, cracks or deterioration, and get replaced after a heavy blow or electrical shock.

22. True/False: Construction workers are supposed to use earplugs or earmuffs in high-noise work areas where chain saws or heavy equipment are used.

23. True/False: Personal protective equipment can protect employees from all workplace hazards.

24. True/False: Employer should provide PPE at no cost to the employee.

Answer Key: 1(c), 2(d), 3(d), 4(b), 5(d), 6(c), 7(c), 8(c), 9(c), 10(b), 11(c), 12(b), 13(True), 14(False), 15(True), 16(True), 17(True), 18(True), 19(False), 20(True), 21(True), 22(True), 23(False), 24(True).

7.12: Sources

The content in this chapter is as adapted from:

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8: HEALTH HAZARDS AND COMMUNICATION

8.1: Introduction

8.2: Safety Data Sheets (SDSs)

8.3: Steps to an Effective Hazard Communication Program

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8.1: Introduction

OSHA Hazard Communication Standard is designed to protect against chemical-source injuries and illnesses by ensuring that employers and workers are provided with sufficient information to anticipate, recognize, evaluate, and control chemical hazards and take appropriate protective measures. This information is provided through safety data sheets (SDSs), labels, and employee training. In order for SDSs, labels, and training to be effective, the hazard information they convey must be complete and accurate. Thus, it is critically important to obtain comprehensive and correct information about the hazards associated with particular chemicals.

Hazard classification is the process of evaluating the full range of available scientific evidence to determine if a chemical is hazardous, as well as to identify the level of severity of the hazardous effect. When complete, the evaluation identifies the hazard class(es) and associated hazard category of the chemical.

Hazard classification does not involve an estimation of risk. The difference between the terms hazard and risk is often poorly understood. Hazard refers to an inherent property of a substance that is capable of causing an adverse effect. Risk, on the other hand, refers to the probability that an adverse effect will occur with specific exposure conditions. Thus, a chemical will present the same hazard in all situations due to its innate chemical or physical properties and its actions on cells and tissues. However, considerable differences may exist in the risk posed by a chemical, depending on how the chemical is contained or handled, personal protective measures used, and other conditions that result in or limit exposure.

Risk is often expressed as the simple equation: $\text{Hazard} \times \text{Exposure} = \text{Risk}$

Construction workers may be exposed to many different hazards in their jobsite. Health hazards in construction fall into four categories: biological, physical, chemical, and ergonomic.

Biological Hazards

Biological hazards are diseases producing agents (pathogens) that can be transmitted to individuals through various routes of exposure (modes of transmission). Exposure to these hazards may result in acute or chronic health conditions. Examples of biological hazards include: Pathogens (bacteria, viruses), fungi, blood and bodily fluids, toxins (harmful substances from plants, animals), environmental hazards (mold, harmful plants, and animal waste).

Physical hazards

Physical hazards are classified as posing the following hazardous effects: explosive; flammable (gases, aerosols, liquids, or solids); oxidizer (liquid, solid or gas); self-reactive; pyrophoric (liquid or solid); self-heating; organic peroxide; corrosive to metal; gas under pressure; or in contact with water emits flammable gas.

Chemical Hazards

Chemical Hazards: There are four basic ways that chemicals can enter your body: direct contact on the skin or eyes, absorption through the skin, accidental ingestion through the mouth, and inhalation through the lungs. Chemicals consist of various types:

Substance – chemical elements and their compounds in the natural state or obtained by any production process, including any additive necessary to preserve the stability of the product and any impurities deriving from the process used, but excluding any solvent which may be separated without affecting the stability of the substance or changing its composition.

Element – the simplest form of matter. There are currently 118 known elements in the periodic table. Examples of elements are aluminum, carbon, chlorine, hydrogen, mercury and oxygen.

Chemical compound – a substance consisting of two or more elements combined or bonded together so that its constituent elements are always present in the same proportions.

Mixture – a combination of a solution composed of two or more substances in which they do not react.

Examples of Exposures and Chemical Hazards refer to any forms of chemicals including medications, solutions, gases, vapors, aerosols, and particulate matter that are potentially toxic or irritating to the body system. Routes of chemical exposure:

- **Inhalation:** Breathing gases, vapors, particulates, dust, or mist
- **Ingestion:** Accidentally eating or drinking hazardous substances
- **Percutaneous:** Permeation or absorbing a substance through the skin; piercing or penetration of skin with needle or other sharp device/instrument (e.g., scalpel or broken glass)
- **Dermal:** Contact with corrosive or sensitizing materials

Direct Contact = Surface

The cleaners and disinfectants we work with can burn or irritate the skin and eyes on contact, causing damage on the surface. Dermatitis (inflammation of the skin) and conjunctivitis (inflammation of the eye membrane) are two examples. Skin corrosion is the production of irreversible damage to the skin; namely, visible necrosis through the epidermis and into the dermis, following the application of a test substance for up to 4 hours. Corrosive reactions are typified by ulcers, bleeding, bloody scabs, and, by the end of observation at 14 days, by discoloration due to blanching of the skin, complete areas of alopecia, and scars.

Absorption = Penetration

Some chemicals can pass right through the skin undetected and enter the bloodstream. They are carried throughout the body, causing harm. Broken skin or puncture wounds greatly increase the rate at which chemicals are absorbed. Aspiration means the entry of a liquid or solid chemical directly through the oral or nasal cavity, or indirectly from vomiting, into the trachea and lower respiratory system. An asphyxiant is a vapor or gas that can cause unconsciousness or death by suffocation due to lack of oxygen. When the concentration of a particular gas increases, the fraction of inspired oxygen decreases, causing decreased oxygen in the blood. A decrease in the fraction of inspired oxygen to less than 19.5% causes inadequate oxygen supply within minutes after exposure to a simple asphyxiant, and may result in unconsciousness or death.

Absorption of Chemicals by Your Body

Chemicals can enter your system by being absorbed through the skin. In fact, as the chart below shows, when it comes to absorption through the skin, different parts of your body absorb chemicals at very different rates. (If you are working with chemicals you should wash your hands BEFORE and after using the bathroom!)

Don't Trust Your Nose. You can't rely on your sense of smell to protect you from exposure to toxic chemicals. Let's face it, your nose has some important limitations. Here are the basic ones: Some dangerous chemicals, such as carbon monoxide, are odorless. No nose can smell them. For some chemicals, you can only detect the smell when the toxin is around you in such large quantities that your health is being harmed by it. For example, by the time you can smell ethylene oxide (used in gas sterilizers), you're already in trouble. Our noses can become accustomed to chemicals. That means that after a while we can't smell even very powerful odors. For instance, our noses can learn to turn off strong odors like ammonia and bleach.

Ergonomic Hazards

Ergonomic Hazards are the science of fitting jobs to workers instead of trying to get the worker to fit the job. It focuses on designing workstations, tools & work tasks for safety, efficiency and comfort. Ergonomics seeks to decrease fatigue and injuries, along with increasing comfort, productivity, job satisfaction and safety, because work injuries are not inevitable and a well-designed job should not hurt you. Ergonomics is important because when you're doing a job and your body is stressed by an awkward posture, extreme temperature, or repeated movement your musculoskeletal system is affected. Your body may begin to have symptoms such as fatigue, discomfort, and pain, which can be the first signs of a musculoskeletal disorder.

Musculoskeletal disorders or MSDs are cumulative and chronic injuries of the soft tissue-muscles, tendons, ligaments, nerves, joints, and blood vessels. The body has limits and can fail or wear out when abused or misused. MSDs are defined as injuries to muscles, tendons, ligaments, joints, nerves and discs that are caused or aggravated by our actions and/or environment that does not follow safe and healthy work practices. A well-known MSD is carpal tunnel syndrome which occurs when the nerve, which runs from the forearm into the palm of the hand, becomes pressed or squeezed at the wrist. The carpal tunnel - a narrow, rigid passageway of ligament and bones at the base of the hand - houses the median nerve and tendons. Sometimes, thickening from irritated tendons or other swelling narrows the tunnel and causes the median nerve to be compressed resulting in pain, weakness,

loss of grip or numbness in the hand and wrist, radiating up the arm.

Symptoms of MSDs include: pain, weakness, stiffness, sensitivity, swelling, burning sensation, tingling, drowsiness, difficulty moving, clumsiness. Ergonomic risk factors are workplace situations that cause wear and tear on the body and can cause injury. These include repetition, awkward posture, forceful motion, stationary position, direct pressure, vibration, extreme temperature, noise, and work stress. Engineering improvements include rearranging, modifying, redesigning, or replacing tools, equipment, workstations, packaging, parts, or products. These improvements can be very effective because they may reduce or eliminate contributing factors. (For example, if your job requires sitting for long periods of time, having an adjustable seat or foot stool so that your knees are higher than your hips help protect your lower back.) Administrative improvements include changing work practices or the way work is organized, including providing variety in jobs, adjusting work schedules and work pace, providing recovery time (i.e., muscle relaxation time), modifying work practices, ensuring regular housekeeping and maintenance of work spaces, tools, and equipment, and encouraging exercise. Personal Protective Equipment: Safety gear, or personal protective equipment (PPE), includes gloves, knee and elbow pads, footwear, and other items that employees wear.

8.2: Safety Data Sheets (SDSs)

The Hazard Communication Standard (HCS) requires chemical manufacturers, distributors, or importers to provide Safety Data Sheets (SDSs) (formerly known as Material Safety Data Sheets or MSDSs) to communicate the hazards of hazardous chemical products. As of June 1, 2015, the HCS will require new SDSs to be in 16-section uniform format that includes section numbers, headings, and associated information under the headings below. Employers must ensure that SDSs are readily accessible to employees. Appendix D of 1910.1200 offers a detailed description of SDS contents.

Section 1:

Identification includes product identifier; manufacturer or distributor name, address, phone number; emergency phone number; recommended use; restrictions on use. This section identifies the chemical on the SDS as well as the recommended uses. It also provides the essential contact information from the supplier. The required information consists of:

- Product identifier used on the label and any other common names or synonyms by which the substance is known.
- Name, address, phone number of the manufacturer, importer, or other responsible party, and emergency phone number.
- Recommended use of the chemical (e.g., a brief description of what it actually does, such as flame retardant) and any restrictions on use (including recommendations given by the supplier).

Section 2:

Hazard(s) identification includes all hazards regarding the chemical; required label elements. This section identifies the hazards of the chemical presented on the SDS and the appropriate warning information associated with those hazards. The required information consists of:

- The hazard classification of the chemical (e.g., flammable liquid, category1).
- Signal word.
- Hazard statement(s).
- Pictograms (the pictograms or hazard symbols may be presented as graphical reproductions of the symbols in black and white or be a description of the name of the symbol (e.g., skull and crossbones, flame).
- Precautionary statement(s).
- Description of any hazards not otherwise classified.
- For a mixture that contains an ingredient(s) with unknown toxicity, a statement describing how much (percentage) of the mixture consists of ingredient(s) with unknown acute toxicity. Please note that this is a total percentage of the mixture and not tied to the individual ingredient(s).

Section 3:

Composition/information on ingredients includes information on chemical ingredients; trade secret claims.

This section identifies the ingredient(s) contained in the product indicated on the SDS, including impurities and stabilizing additives. This section includes information on substances, mixtures, and all chemicals where a trade secret is claimed. The required information consists of:

Substances

- Chemical name.
- Common name and synonyms.
- Chemical Abstracts Service (CAS) number and other unique identifiers.
- Impurities and stabilizing additives, which are themselves classified and which contribute to the classification of the chemical.

Mixtures

- Same information required for substances.
- The chemical name and concentration (i.e., exact percentage) of all ingredients which are classified as health hazards and are:

§ Present above their cut-off/concentration limits or

§ Present a health risk below the cut-off/concentration limits.

- The concentration (exact percentages) of each ingredient must be specified except concentration ranges may be used in the following situations:

§ A trade secret claim is made,

§ There is batch-to-batch variation, or

§ The SDS is used for a group of substantially similar mixture

§ Chemicals where a trade secret is claimed

- A statement that the specific chemical identity and/or exact percentage (concentration) of composition has been withheld as a trade secret is required.

Section 4:

First-aid measures include important symptoms/ effects, acute, delayed; required treatment. This section describes the initial care that should be given by untrained responders to an individual who has been exposed to the chemical. The required information consists of:

- Necessary first-aid instructions by relevant routes of exposure (inhalation, skin and eye contact, and ingestion).
- Description of the most important symptoms or effects, and any symptoms that are acute or delayed.
- Recommendations for immediate medical care and special treatment needed, when necessary.

Section 5:

Fire-fighting measures lists suitable extinguishing techniques, equipment; chemical hazards from fire. This section provides recommendations for fighting a fire caused by the chemical. The required information consists of:

- Recommendations of suitable extinguishing equipment, and information about extinguishing equipment that is not appropriate for a particular situation.
- Advice on specific hazards that develop from the chemical during the fire, such as any hazardous combustion products created when the chemical burns.
- Recommendations on special protective equipment or precautions for firefighters.

Section 6:

Accidental release measures list emergency procedures; protective equipment; proper methods of containment and cleanup. This section provides recommendations on the appropriate response to spills, leaks, or releases, including containment and cleanup practices to prevent or minimize exposure to people, properties, or the environment. It may also include recommendations distinguishing between responses for large and small spills where the spill volume has a significant impact on the hazard. The required information may consist of recommendations for:

- Use of personal precautions (such as removal of ignition sources or providing sufficient ventilation) and protective equipment to prevent the contamination of skin, eyes, and clothing.
- Emergency procedures, including instructions for evacuations, consulting experts when needed, and appropriate protective clothing.
- Methods and materials used for containment (e.g., covering the drains and capping procedures).
- Cleanup procedures (e.g., appropriate techniques for neutralization, decontamination, cleaning or vacuuming; adsorbent materials; and/or equipment required for containment/clean up).

Section 7:

Handling and storage lists precautions for safe handling and storage, including incompatibilities. This section provides guidance on the safe handling practices and conditions for safe storage of chemicals. The required information consists of:

- Precautions for safe handling, including recommendations for handling incompatible chemicals, minimizing the release of the chemical into the environment, and providing advice on general hygiene practices (e.g., eating, drinking, and smoking in work areas is prohibited).
- Recommendations on the conditions for safe storage, including any incompatibilities. Provide advice on specific storage requirements (e.g., ventilation requirements).

Section 8:

Exposure controls/personal protection lists OSHA's Permissible Exposure Limits (PELs); Threshold Limit Values (TLVs); appropriate engineering controls; personal protective equipment (PPE). This section indicates the exposure limits, engineering controls, and personal protective measures that can be used to minimize worker exposure. The required information consists of:

- OSHA Permissible Exposure Limits (PELs), American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs), and any other exposure limit used or recommended by the chemical manufacturer, importer, or employer preparing the safety data sheet, where available.
- Appropriate engineering controls (e.g., use local exhaust ventilation, or use only in an enclosed system).
- Recommendations for personal protective measures to prevent illness or injury from exposure to chemicals, such as personal protective equipment (PPE) (e.g., appropriate types of eye, face, skin or respiratory protection needed based on hazards and potential exposure).
- Any special requirements for PPE, protective clothing or respirators (e.g., type of glove material, such as PVC or nitrile rubber gloves; and breakthrough time of the glove material).

Section 9:

Physical and chemical properties list the chemical's characteristics. This section identifies physical and chemical properties associated with the substance or mixture. The minimum required information consists of:

- Appearance (physical state, color, etc.);

- Upper/lower flammability or explosive limits;
- Odor;
- Odor threshold;
- Vapor density;
- pH;
- Relative density;
- Melting point/freezing point;
- Initial boiling point and boiling range;
- Flash point;
- Evaporation rate;
- Flammability (solid, gas);
- Vapor pressure;
- Solubility(ies);
- Partition coefficient: n-octanol/water;
- Auto-ignition temperature;
- Decomposition.

The SDS may not contain every item on the above list because information may not be relevant or is not available. When this occurs, a notation to that effect must be made for that chemical property. Manufacturers may also add other relevant properties, such as the dust deflagration index (Kst) for combustible dust, used to evaluate a dust's explosive potential.

Section 10:

Stability and reactivity lists chemical stability and possibility of hazardous reactions. This section describes the reactivity hazards of the chemical and the chemical stability information. This section is broken into three parts: reactivity, chemical stability, and other. The required information consists of:

Reactivity

- Description of the specific test data for the chemical(s). This data can be for a class or family of the chemical if such data adequately represent the anticipated hazard of the chemical(s), where available.

Chemical stability

- Indication of whether the chemical is stable or unstable under normal ambient temperature and conditions while in storage and being handled.
- Description of any stabilizers that may be needed to maintain chemical stability.
- Indication of any safety issues that may arise should the product change in physical appearance.

Other

- Indication of the possibility of hazardous reactions, including a statement whether the chemical will react or polymerize, which could release excess pressure or heat, or create other hazardous conditions. Also, a description of the conditions under which

hazardous reactions may occur.

- List of all conditions that should be avoided (e.g., static discharge, shock, vibrations, or environmental conditions that may lead to hazardous conditions).
- List of all classes of incompatible materials (e.g., classes of chemicals or specific substances) with which the chemical could react to produce a hazardous situation.
- List of any known or anticipated hazardous decomposition products that could be produced because of use, storage, or heating. (Hazardous combustion products should also be included in Section 5 (Fire-Fighting Measures) of the SDS.)

Section 11:

Toxicological information includes routes of exposure; related symptoms, acute and chronic effects; numerical measures of toxicity. This section identifies toxicological and health effects information or indicates that such data are not available. The required information consists of:

- Information on the likely routes of exposure (inhalation, ingestion, skin and eye contact). The SDS should indicate if the information is unknown.
- Description of the delayed, immediate, or chronic effects from short- and long-term exposure.
- The numerical measures of toxicity (e.g., acute toxicity estimates such as the LD50 (median lethal dose)) - the estimated amount [of a substance] expected to kill 50% of test animals in a single dose.
- Description of the symptoms. This description includes the symptoms associated with exposure to the chemical including symptoms from the lowest to the most severe exposure.
- Indication of whether the chemical is listed in the National Toxicology Program (NTP) Report on Carcinogens (latest edition) or has been found to be a potential carcinogen in the International Agency for Research on Cancer (IARC) Monographs (latest editions) or found to be a potential carcinogen by OSHA

Section 12:

Ecological information. This section provides information to evaluate the environmental impact of the chemical(s) if it were released to the environment.

Section 13:

Disposal considerations. This section provides guidance on proper disposal practices, recycling or reclamation of the chemical(s) or its container, and safe handling practices. To minimize exposure, this section should also refer the reader to Section 8 (Exposure Controls/Personal Protection) of the SDS.

Section 14:

Transport information. This section provides guidance on classification information for shipping and transporting of hazardous chemical(s) by road, air, rail, or sea.

Section 15:

Regulatory information. This section identifies the safety, health, and environmental regulations specific for the product that is not indicated anywhere else on the SDS.

The information may include:

- Any national and/or regional regulatory information of the chemical or mixtures (including any OSHA, Department of Transportation, Environmental Protection Agency, or Consumer Product Safety Commission regulations).

Section 16:

Other information, includes the date of preparation or last revision.

This section indicates when the SDS was prepared or when the last known revision was made. The SDS may also state where the changes have been made to the previous version. You may wish to contact the supplier for an explanation of the changes. Other useful information also may be included here.

8.3: Steps to an Effective Hazard Communication Program

Employers that have hazardous chemicals in their workplaces are required by OSHA's Hazard Communication Standard (HCS) to implement a hazard communication program. The program must include labels on containers of hazardous chemicals, safety data sheets (SDSs) for hazardous chemicals, and training for workers. Each employer must also describe in a written program how it will meet the requirements of the HCS in each of these areas. Employers can implement an effective hazard communication program by following these six steps:

Step 1. Learn the Standard/Identify Responsible Staff

Obtain a copy of OSHA's Hazard Communication Standard. Become familiar with its provisions. Make sure that someone has primary responsibility for coordinating implementation. Identify staff for particular activities (e.g., training). You may obtain a copy of the Hazard Communication Standard on OSHA's hazard communication webpage at www.osha.gov/hazcom. The provisions of the standard that apply to employers using chemicals in their workplaces are found primarily in paragraphs (e) written hazard communication program; (f) labels and other forms of warning; (g) safety data sheets; and (h) employee information and training. It is important that you become familiar with these provisions to determine what is needed for compliance in your workplace. In order to ensure that you have an effective hazard communication program, and address all of the necessary components, responsibility for implementation of hazard communication should be assigned to someone to coordinate. The person designated for overall program coordination should then identify staff to be responsible for particular activities, such as training.

Step 2. Prepare and Implement a Written Hazard Communication Program

Prepare a written plan to indicate how hazard communication will be addressed in your facility. Prepare a list or inventory of all hazardous chemicals in the workplace. Paragraph (e) of the standard requires employers to prepare and implement a written hazard communication program. This requirement is to help ensure that compliance with the standard is done in a systematic way, and that all elements are coordinated. The written program must indicate how you will address the requirements of paragraphs (f) labels and other forms of warning; (g) safety data sheets; and (h) employee information and training, in your workplace. The written program also requires employers to maintain a list of the hazardous chemicals known to be present in the workplace. Using the product identifier (e.g., product name, common name, or chemical name) to prepare the list will make it easier for you to track the status of SDSs and labels of a particular hazardous chemical. Remember, the product identifier must be the same name that appears on the label and SDS of the hazardous chemical.

Step 3. Ensure Containers are Labeled

Keep labels on shipped containers. Label workplace containers where required. Chemical manufacturers and importers are required to provide labels on shipped containers with the following information: product identifier, signal word, pictograms, hazard statements, precautionary statements, and the name, address and phone number of the responsible party. Therefore, when an employer receives a hazardous chemical from a supplier, all of this information will be located together on the label; however, additional information may also appear. As the employer, you are required to ensure that containers in the workplace are labeled. You may use the same label from the supplier or you may label workplace containers with alternatives, such as third party systems (e.g., National Fire Protection Association (NFPA) or Hazardous Materials Identification System (HMIS)) in addition to the other required information. Any container of hazardous chemicals in the workplace must at a minimum include the product identifier and general information concerning the hazards of the chemical. Whatever method you choose, your workers need to have access to the complete hazard information.

Step 4. Maintain Safety Data Sheets (SDSs)

Maintain safety data sheets for each hazardous chemical in the workplace. Ensure that safety data sheets are readily accessible to employees. Safety data sheets are the source of detailed information on a particular hazardous chemical. Employers must maintain copies of SDSs for all hazardous chemicals present in their workplaces. If you do not receive an SDS from your supplier automatically, you must request one. You also must ensure that SDSs are readily accessible to workers when they are in their work areas during their work shifts. This accessibility may be accomplished in many different ways. You must decide what is appropriate

for your particular workplace. Some employers keep the SDSs in a binder in a central location (e.g., outside of the safety office, in the pick-up truck on a construction site). Others, particularly in workplaces with large numbers of chemicals, provide access electronically. However, if SDSs are supplied electronically, there must be an adequate back-up system in place in the event of a power outage, equipment failure, or other emergency involving the primary electronic system. In addition, the employer must ensure that workers are trained on how to use the system to access SDSs and are able to obtain hard copies of the SDSs. In the event of a medical emergency, hard copy SDSs must be immediately available to medical personnel.

Step 5. Inform and Train Employees

Train employees on the hazardous chemicals in their work area before initial assignment, and when new hazards are introduced. Include the requirements of the standard, hazards of chemicals, appropriate protective measures, and where and how to obtain additional information. Paragraph (h) of the HCS requires that employers train employees on the hazardous chemicals in their work area before their initial assignment and when new hazards are introduced into the work area, and this training must be conducted in a manner and language that employees can understand. Workers must understand they are exposed to hazardous chemicals. They must know that labels and safety data sheets can provide them with information on the hazards of a chemical, and these items should be consulted when needed. In addition, workers must have a general understanding of what information is provided on labels and SDSs, and how to access them. They must also be aware of the protective measures available in their workplace, how to use or implement these measures, and whom they should contact if an issue arises.

Step 6. Evaluate and Reassess Your Program

Review your hazard communication program periodically to make sure that it is still working and meeting its objectives. Revise your program as appropriate to address changed conditions in the workplace (e.g., new chemicals, new hazards, etc.). Although the HCS does not require you to evaluate and reassess your hazard communication program, it must remain current and relevant for you and your employees. The best way to achieve that is to review your hazard communication program periodically to make sure that it is still working and meeting its objectives and to revise it as appropriate to address changed conditions in the workplace (e.g., new chemicals, new hazards, etc.).

8.4: Summary

Failure to recognize the hazards associated with chemicals can cause chemical burns, respiratory problems, fires and explosions. Maintain a Material Safety Data Sheet (MSDS) for each chemical in the facility. Make this information accessible to employees at all times in a language or formats

that are clearly understood by all affected personnel. Train employees on how to read and use the MSDS. Follow manufacturer's MSDS instructions for handling hazardous chemicals. Train employees about the risks of each hazardous chemical being used. Provide spill clean-up kits in areas where chemicals are stored. Have a written spill control plan. Train employees to clean up spills, protect themselves and properly dispose of used materials. Provide proper personal protective equipment and enforce its use. Store chemicals safely and securely.

8.5: Review Questions

Multiple Choice Questions

1. What equation best represents the relationships between hazard and risk?
(a) Hazard / Exposure = Risk
(b) Hazard + Exposure = Risk
(c) Hazard $\times$ Exposure = Risk
(d) Hazard = Exposure - Risk
2. Which of the following is an example of a biological hazard?
(a) Noise exposure
(b) Carbon monoxide
(c) Mold and animal waste
(d) Slippery flooring
3. Slips, trips, and falls are classified under which type of hazard?
(a) Biological hazard
(b) Ergonomic hazard
(c) Physical hazard
(d) Chemical hazard
4. Which of the following is not considered a chemical route of entry into the body?
(a) Absorption through skin
(b) Inhalation through lungs
(c) Injection by sharp instruments
(d) Reflection from surfaces
5. Why cannot workers rely on their sense of smell to detect hazardous chemicals?
(a) Because masks always block the smell
(b) Because some chemicals are odorless, or harmful levels may be undetectable
(c) Because all chemicals have the same odor
(d) Because OSHA regulations forbid it
6. What is an asphyxiant?
(a) A chemical that irritates the skin
(b) A vapor or gas that reduces oxygen levels, causing suffocation
(c) A compound that reacts with metals
(d) A biological toxin from plants
7. Which section of the Safety Data Sheet (SDS) includes first-aid measures?
(a) Section 2
(b) Section 4
(c) Section 6
(d) Section 9
8. When are employers required to provide personal protective equipment (PPE)?
(a) When engineering and work practice controls are not feasible or sufficient
(b) Only during annual inspections
(c) Only if employees request it
(d) When hazards can be controlled by administrative measures alone
9. Which of the following is an example of a physical hazard?
(a) Noise
(b) Viruses

- (c) Disinfectant chemicals
- (d) Ergonomic strain

10. What is the main focus of ergonomics?

- (a) Increasing the speed of work regardless of safety
- (b) Designing jobs to fit workers for safety, comfort, and efficiency
- (c) Encouraging workers to adapt to difficult tasks
- (d) Reducing company expenses

11. Symptoms of musculoskeletal disorders (MSDs) include all of the following EXCEPT:

- (a) Tingling
- (b) Drowsiness
- (c) Burning sensation
- (d) Improved grip strength

12. Which of the following is NOT listed as an ergonomic risk factor?

- (a) Vibration
- (b) Extreme temperature
- (c) Noise
- (d) Proper posture

13. An example of an engineering improvement to reduce ergonomic hazards is:

- (a) Providing variety in job tasks
- (b) Using gloves and protective footwear
- (c) Installing adjustable seats or footstools
- (d) Encouraging workers to exercise after work

14. Which of the following is NOT one of the required elements of OSHA's Hazard Communication Standard (HCS)?

- (a) Labels on containers of hazardous chemicals
- (b) Safety Data Sheets (SDSs)
- (c) Written hazard communication program
- (d) Annual OSHA certification exams for workers

15. What should employers do if they do not automatically receive a Safety Data Sheet (SDS) from a supplier?

- (a) Ignore it if the chemical seems safe
- (b) Create their own SDS
- (c) Request one from the supplier
- (d) Use labels instead of SDSs

16. What is the purpose of a written hazard communication program?

- (a) To eliminate all hazardous chemicals from the workplace
- (b) To systematically address labeling, SDSs, and training requirements
- (c) To replace labels and SDSs with verbal instructions
- (d) To act as an optional guideline for employers

True/False Questions

- 17. True/False: Hazard and risk are the same concept and can be used interchangeably.
- 18. True/False: Biological hazards include bacteria, viruses, and fungi that can cause disease.
- 19. True/False: Some dangerous chemicals, such as carbon monoxide, are odorless and cannot be detected by smell.
- 20. True/False: Employees are responsible for properly wearing PPE and reporting when it needs repair or replacement.
- 21. True/False: Confined spaces in construction sites may present physical hazards such as slippery surfaces and obstructions.
- 22. True/False: Enviromechanical hazards include poor workstation design and unsafe flooring.
- 23. True/False: Ergonomics is about forcing workers to adapt to the job rather than fitting the job to the worker.
- 24. True/False: Fatigue, discomfort, and pain can be early warning signs of musculoskeletal disorders.
- 25. True/False: Administrative improvements include modifying tools and redesigning equipment.
- 26. True/False: Employers are required to have a written hazard communication program under OSHA's HCS.
- 27. True/False: Workers must be trained in a manner and language they can understand.

28. True/False: The hazard communication program should be reviewed and updated periodically, even though the HCS does not require formal reassessment.

29. True/False: Labels on hazardous chemical containers are optional as long as SDSs are available.

30. True/False: Safety Data Sheets (SDSs) must only be kept in electronic format, and no backup is required.

Answer Key: 1(c), 2(c), 3(c), 4(d), 5(b), 6(b), 7(b), 8(a), 9(a), 10(b), 11(d), 12(d), 13(c), 14(d), 15(c), 16(b), 17(False), 18(True), 19(True), 20(True), 21(True), 22(True), 23(False), 24(True), 25(False), 26(True), 27(True), 28(True), 29(False), 30(False).

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9: STAIRS AND LADDERS

- 9.1: Introduction
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9.1: Introduction

Background

Falls from heights and on the same level (a working surface) are among the leading causes of serious work-related injuries and deaths. OSHA estimates that, on average, approximately 202,066 serious (lost-workday) injuries and 345 fatalities occur annually among workers directly affected. OSHA's final rule on Walking-Working Surfaces and Personal Fall Protection Systems better protects workers in general industry from these hazards by updating and clarifying standards and adding training and inspection requirements. The rule affects a wide range of workers, from window washers to chimney sweeps. It does not change construction or agricultural standards.

The rule incorporates advances in technology, industry best practices, and national consensus standards to provide effective and cost-efficient worker protection. Specifically, the rule updates general industry standards addressing slip, trip, and fall hazards (subpart D), and adds requirements for personal fall protection systems (subpart I).

OSHA estimates this rule will prevent 29 fatalities and 5,842 lost-workday injuries every year.

The rule benefits employers by providing greater flexibility in choosing a fall protection system. For example, it eliminates the existing mandate to use guardrails as a primary fall protection method and allows employers to choose from accepted fall protection systems they believe will work best in a particular situation — an approach that has been successful in the construction industry since 1994. In addition, employers will be able to use non-conventional fall protection in certain situations, such as designated areas on low-slope roofs.

As much as possible, OSHA aligned fall protection requirements for general industry with those for construction, easing compliance for employers who perform both types of activities.

For example, the final rule replaces the outdated general industry scaffold standards with a requirement that employers comply with OSHA's construction scaffold standards.

The rule phases out a 1993 exception for the outdoor advertising industry that allows “qualified climbers” to forego fall protection. At least three workers have fallen from fixed ladders under this exception. One of them died. The final rule phases in the fixed ladder fall protection requirements for employers in outdoor advertising.

Introduction

Working on and around stairways and ladders is hazardous. Stairways and ladders are major sources of injuries and fatalities among construction workers for example, and many of the injuries are serious enough to require time off the job. OSHA rules apply to all stairways and ladders used in construction, alteration, repair, painting, decorating and demolition of worksites covered by OSHA's construction safety and health standards.

When should you use a ladder?

When you want to reach a higher work area, think about the best equipment to use. While a ladder or stepladder is commonly used, it may not always be the best option. Ask yourself these questions before deciding on a ladder: Will I have to hold heavy items while on the ladder? Is the elevated area high enough that it would require a long ladder that can be unstable? Will I be working from this height for a long time? Do I have to stand on the ladder sideways in order to do this work?

If your answer is yes to one of the above questions, consider using something other than a ladder. If possible, bring in other equipment like a scissor lift. If you have to use a ladder, use one that has a working platform with handrail barricades on the sides (e.g., a platform stepladder).

Whenever you use a ladder or a stepladder, take note of the safety advice in this guide.

9.2: Ladder Safety Requirements

Falls from ladders account for 20 percent of all fatal and lost work-day injuries in general industry. The new rule includes requirements to protect workers from falling off fixed and portable ladders as well as mobile ladder stands and platforms. (The ladder requirements do not apply to ladders used in emergency operations or ladders that are an integral part of or designed into a machine or piece of equipment).

In general, ladders must be capable of supporting their maximum intended load, while mobile ladder stands and platforms must be capable of supporting four times their maximum intended load. Each ladder must be inspected before initial use in a work shift to identify defects that could cause injury.

All Ladders

The following rules apply to all ladders:

- Maintain ladders free of oil, grease and other slipping hazards.
- Do not load ladders beyond their maximum intended load nor beyond their manufacturer's rated capacity.
- Use ladders only for their designed purpose.
- Use ladders only on stable and level surfaces unless secured to prevent accidental movement.
- Do not use ladders on slippery surfaces unless secured or provided with slip-resistant feet to prevent accidental movement. Do not use slip resistant feet as a substitute for exercising care when placing, lashing or holding a ladder upon slippery surfaces.
- Secure ladders placed in areas such as passageways, doorways or driveways, or where they can be displaced by workplace activities or traffic to prevent accidental movement. Or use a barricade to keep traffic or activity away from the ladder.
- Keep areas clear around the top and bottom of ladders.
- Do not move, shift or extend ladders while in use.
- Use ladders equipped with nonconductive side rails if the worker or the ladder could contact exposed energized electrical equipment.
- Face the ladder when moving up or down.
- Use at least one hand to grasp the ladder when climbing.
- Do not carry objects or loads that could cause loss of balance and falling.

In addition, the following general requirements apply to all ladders, including ladders built at the jobsite:

- Double-cleated ladders or two or more ladders must be provided when ladders are the only way to enter or exit a work area where 25 or more employees work or when a ladder serves simultaneous two-way traffic.
- Ladder rungs, cleats and steps must be parallel, level and uniformly spaced when the ladder is in position for use.
- Rungs, cleats and steps of portable and fixed ladders (except as provided below) must not be spaced less than 10 inches (25 cm) apart, nor more than 14 inches (36 cm) apart, along the ladder's side rails.
- Rungs, cleats and steps of step stools must not be less than 8 inches (20 cm) apart, nor more than 12 inches (31 cm) apart, between center lines of the rungs, cleats and steps.
- Rungs, cleats and steps at the base section of extension trestle ladders must not be less than 8 inches (20 cm) nor more than

18 inches (46 cm) apart, between center lines of the rungs, cleats and steps. The rung spacing on the extension section must not be less than 6 inches (15 cm) nor more than 12 inches (31 cm).

- Ladders must not be tied or fastened together to create longer sections unless they are specifically designed for such use.
- When splicing side rails, the resulting side rail must be equivalent in strength to a one-piece side rail made of the same material.
- Two or more separate ladders used to reach an elevated work area must be offset with a platform or landing between the ladders, except when portable ladders are used to gain access to fixed ladders.
- Ladder components must be surfaced to prevent snagging of clothing and injury from punctures or lacerations.
- Wood ladders must not be coated with any opaque covering except for identification or warning labels, which may be placed only on one face of a side rail.

Stepladders

A stepladder is a portable, self-supporting, A-frame ladder. It has two front side rails and two rear side rails. Generally, there are steps mounted between the front side rails and bracing between the rear side rails. Do not use the top or top step of a stepladder as a step. Do not use cross bracing on the rear section of stepladders for climbing unless the ladders are designed and provided with steps for climbing on both front and rear sections. Metal spreader or locking devices must be provided on stepladders to hold the front and back sections in an open position when ladders are being used.

Fixed Ladders

Fixed ladders are permanently attached to a structure, building, or equipment. These include individual-rung ladders, but not ship stairs, step bolts, or manhole steps. Fixed ladders must meet the following requirements: Fixed ladders must be able to support at least two loads of 250 pounds (114 kg) each, concentrated between any two consecutive attachments. Fixed ladders also must support added anticipated loads caused by ice buildup, winds, rigging and impact loads resulting from using ladder safety devices. Individual rung/step ladders must extend at least 42 inches (1.1 m) above an access level or landing platform either by the continuation of the rung spacings as horizontal grab bars or by providing vertical grab bars that must have the same lateral spacing as the vertical legs of the ladder rails. Each step or rung of a fixed ladder must be able to support a load of at least 250 pounds (114 kg) applied in the middle of the step or rung. Minimum clear distance between the sides of individual rung/step ladders and between the side rails of other fixed ladders must be 16 inches (41 cm). Rungs of individual rung/step ladders must be shaped to prevent slipping off the end of the rungs. Rungs and steps of fixed metal ladders manufactured after March 15, 1991, must be corrugated, knurled, dimpled, coated with skid-resistant material or treated to minimize slipping. Minimum perpendicular clearance between fixed ladder rungs, cleats, and steps and any obstruction behind the ladder must be 7 inches (18 cm), except that the clearance for an elevator pit ladder must be 4.5 inches (11 cm). Minimum perpendicular clearance between the centerline of fixed ladder rungs, cleats and steps, and any obstruction on the climbing side of the ladder must be 30 inches (76 cm). If obstructions are unavoidable, clearance may be reduced to 24 inches (61 cm), provided a deflection device is installed to guide workers around the obstruction. Step-across distance between the center of the steps or rungs of fixed ladders and the nearest edge of a landing area must be no less than 7 inches (18 cm) and no more than 12 inches (30 cm). A landing platform must be provided if the step-across distance exceeds 12 inches (30 cm).

Fixed ladders without cages or wells must have at least a 15-inch (38 cm) clearance width to the nearest permanent object on each side of the centerline of the ladder. Fixed ladders must be provided with cages, wells, ladder safety devices or self-retracting lifelines where the length of climb is less than 24 feet (7.3 m) but the top of the ladder is at a distance greater than 24 feet (7.3 m) above lower levels. Side rails of through or side-step fixed ladders must extend 42 inches (1.1 m) above the top level or landing platform served by the ladder. Parapet ladders must have an access level at the roof if the parapet is cut to permit passage through it. If the parapet is continuous, the access level is the top of the parapet. Steps or rungs for through-fixed-ladder extensions must be omitted from the extension; and the extension of side rails must be flared to provide between 24 inches (61 cm) and 30 inches (76 cm) clearance between side rails. When safety devices are provided, the maximum clearance distance between side rail extensions must not exceed 36 inches (91 cm). Fixed ladders must be used at a pitch no greater than 90 degrees from the horizontal, measured from the back side of the ladder.

Portable ladders usually consist of side rails joined at intervals by steps, rungs, or cleats. They can be self-supporting or lean against a supporting structure. The final rule will be easier for employers and workers to understand and follow because it uses

flexible performance-based language instead of detailed specification and design requirements. Under the revisions, employers must ensure that: rungs and steps are slip resistant; portable ladders used on slippery surfaces are secured and stabilized; portable ladders are not moved, shifted, or extended while a worker is on them; top steps and caps of stepladders are not used as steps; ladders are not fastened together to provide added length unless designed for such use; and ladders are not placed on boxes, barrels, or other unstable bases to obtain added height.

The minimum clear distance between side rails for all portable ladders must be 11.5 inches (29 cm). In addition, the rungs and steps of portable metal ladders must be corrugated, knurled, dimpled, coated with skid-resistant material or treated to minimize slipping. Non-self-supporting and self-supporting portable ladders must support at least four times the maximum intended load; extra heavy-duty type 1A metal or plastic ladders must sustain 3.3 times the maximum intended load. To determine whether a self-supporting ladder can sustain a certain load, apply the load to the ladder in a downward vertical direction with the ladder placed at a horizontal angle of 75.5 degrees. When portable ladders are used for access to an upper landing surface, the side rails must extend at least 3 feet (.9 m) above the upper landing surface. When such an extension is not possible, the ladder must be secured and a grasping device such as a grab rail must be provided to assist workers in mounting and dismounting the ladder. A ladder extension must not deflect under a load that would cause the ladder to slip off its supports.

Extension Ladders

Also known as “portable ladders,” extension ladders usually have two sections that operate in brackets or guides allowing for adjustable lengths. Because extension ladders are not self-supporting they require a stable structure that can withstand the intended load. Workers who use extension ladders risk permanent injury or death from falls and electrocutions. These hazards can be eliminated or substantially reduced by following good safety practices.

Portable Ladder Safety

The OSHA Standard for portable ladders contains specific requirements designed to ensure worker safety:

Loads: Self-supporting (foldout) and non-self-supporting (leaning) portable ladders must be able to support at least four times the maximum intended load, except extra-heavy-duty metal or plastic ladders, which must be able to sustain 3.3 times the maximum intended load.

Angle: Non-self-supporting ladders, which must lean against a wall or other support, are to be positioned at such an angle that the horizontal distance from the top support to the foot of the ladder is about $\frac{1}{4}$ the working length of the ladder. In the case of job-made wooden ladders, that angle should equal about $\frac{1}{8}$ the working length. This minimizes the strain of the load on ladder joints that may not be as strong as on commercially manufactured ladders.

Rungs: Ladder rungs, cleats, or steps must be parallel, level, and uniformly spaced when the ladder is in position for use. Rungs must be spaced between 10"-14" inches apart. For extension trestle ladders, the spacing must be 8"-18" inches for the base, and 6"-12" inches on the extension section. Rungs must be so shaped that an employee's foot cannot slide off and must be skid-resistant.

Slipping: Ladders are to be kept free of oil, grease, wet paint, and other slipping hazards. Wood ladders must not be coated with any opaque covering, except identification or warning labels on one face only of a side rail.

Other Requirements: Foldout or stepladders must have a metal spreader or locking device to hold the front and back sections in an open position when in use. When two or more ladders are used to reach a work area, they must be offset with a landing or platform between the ladders. The area around the top and bottom of ladder must be kept clear. Ladders must not be tied or fastened together to provide longer sections, unless they are specifically designed for such use. Never use a ladder for any purpose other than the one for which it was designed.

Misuse of Portable Ladders

You risk falling if portable ladders are not safely positioned each time they are used. While you are on a ladder, it may move and slip from its supports. You can also lose your balance while getting on or off an unsteady ladder. Falls from ladders can cause injuries ranging from sprains to death.

How Do I Avoid Hazards? Position portable ladders so the side rails extend at least 3 feet above the landing. Secure side rails at the top to a rigid support and use a grab device when 3-foot extension is not possible. Make sure that the weight on the ladder will not cause it to slip off its support. Before each use inspect ladders for cracked or broken parts such as rungs, steps, side rails, feet and locking components. Do not apply more weight on the ladder than it is designed to support. Use only ladders that comply with OSHA design standards.

9.3: Other Ladder Considerations

Defective Ladders

Ladders needing repairs are subject to the following rules:

- Portable ladders with structural defects—such as broken or missing rungs, cleats or steps, broken or split rails, corroded components or other faulty or defective components—must immediately be marked defective or tagged with "Do Not Use" or similar language and withdrawn from service until repaired.
- Fixed ladders with structural defects—such as broken or missing rungs, cleats or steps, broken or split rails or corroded components— must be withdrawn from service until repaired.
- Defective fixed ladders are considered withdrawn from use when they are immediately tagged with "Do Not Use" or similar language, *or* marked in a manner that identifies them as defective, *or* blocked—such as with a plywood attachment that spans several rungs.
- Ladder repairs must restore the ladder to a condition meeting its original design criteria before the ladder is returned to use.

Stairways Used During Construction

The following requirements apply to all stairways used during construction:

- Stairways that will not be a permanent part of the building under construction must have landings at least 30 inches deep and 22 inches wide (76 x 56 cm) at every 12 feet (3.7 m) or less of vertical rise.
- Stairways must be installed at least 30 degrees —and no more than 50 degrees—from the horizontal.
- Variations in riser height or stair tread depth must not exceed 1/4 inch in any stairway system, including any foundation structure used as one or more treads of the stairs.
- Doors and gates opening directly onto a stairway must have a platform that extends at least 20 inches (51 cm) beyond the swing of the door or gate.
- Metal pan landings and metal pan treads must be secured in place before filling.
- Stairway parts must be free of dangerous projections such as protruding nails.
- Slippery conditions on stairways must be corrected.
- Workers must not use spiral stairways that will not be a permanent part of the structure.

Temporary Stairs

The following requirements apply to stairways used temporarily during construction. Except during construction of the stairway,

- Do not use stairways with metal pan landings and treads if the treads and/or landings have not been filled in with concrete or other materials unless the pans of the stairs and/or landings are temporarily filled in with wood or other materials. All treads and landings must be replaced when worn below the top edge of the pan.
- Do not use skeleton metal frame structures and steps (where treads and/or landings will be installed later) unless the stairs are fitted with secured temporary treads and landings. *Note:* Temporary treads must be made of wood or other solid material and installed the full width and depth of the stair.

Stair Rails

The following general requirements apply to all stair rails:

- Stairways with four or more risers or rising more than 30 inches (76 cm) in height—whichever is less—must be installed along each unprotected side or edge. When the top edge of a stair rail system also serves as a handrail, the height of the top edge must be no more than 37 inches (94 cm) nor less than 36 inches (91.5 cm) from the upper surface of the stair rail to the surface of the tread.
- Stair rails installed after March 15, 1991, must be not less than 36 inches (91.5 cm) in height.
- Top edges of stair rail systems used as handrails must not be more than 37 inches (94 cm) high nor less than 36 inches (91.5 cm) from the upper surface of the stair rail system to the surface of the tread. (If installed before March 15, 1991, not less than 30 inches [76 cm]).
- Stair rail systems and handrails must be surfaced to prevent injuries such as punctures or lacerations and to keep clothing from snagging.
- Ends of stair rail systems and handrails must be built to prevent dangerous projections, such as rails protruding beyond the end posts of the system.

In addition:

- Unprotected sides and edges of stairway landings must have standard 42-inch (1.1 m) guardrail systems.
- Intermediate vertical members, such as balusters used as guardrails, must not be more than 19 inches (48 cm) apart.
- Other intermediate structural members, when used, must be installed so that no openings are more than 19 inches (48 cm) wide.
- Screens or mesh, when used, must extend from the top rail to the stairway step and along the opening between top rail supports.

Handrails

Requirements for handrails are as follows:

- Handrails and top rails of the stair rail systems must be able to withstand, without failure, at least 200 pounds (890 n) of weight applied within 2 inches (5 cm) of the top edge in any downward or outward direction, at any point along the top edge.
- Handrails must not be more than 37 inches (94 cm) high nor less than 30 inches (76 cm) from the upper surface of the handrail to the surface of the tread.
- Handrails must provide an adequate handhold for employees to grasp to prevent falls.
- Temporary handrails must have a minimum clearance of 3 inches (8 cm) between the handrail and walls, stair rail systems and other objects.
- Stairways with four or more risers, or that rise more than 30 inches (76 cm) in height— whichever is less—must have at least one handrail.
- Winding or spiral stairways must have a handrail to prevent use of areas where the tread width is less than 6 inches (15 cm).

Midrails

Midrails, screens, mesh, intermediate vertical members or equivalent intermediate structural members must be provided between the top rail and stairway steps to the stair rail system. When midrails are used, they must be located midway between the top of the stair rail system and the stairway steps.

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9.4: Training Requirements

Employers must train all employees to recognize hazards related to ladders and stairways, and instruct them to minimize these hazards. For example, employers must ensure that each employee is trained by a competent person in the following areas, as applicable:

- Nature of fall hazards in the work area;
- Correct procedures for erecting, maintaining and disassembling the fall protection systems to be used;
- Proper construction, use, placement and care in handling of all stairways and ladders; and
- Maximum intended load-carrying capacities of ladders used.

9.5: Ladder Safety Examples

- Use the right ladder for the job. For example, ensure the ladder is high enough for you to reach your work area without having to stand on the top rung.
- When using ladders to access another level, secure and extend the ladder at least 3 feet above the landing point to provide a safe handhold.
- The base of the ladder should be secured.
- Wear proper footwear (e.g., non-slip flat shoes).
- Place the ladder on stable and level ground. DO NOT place it on an uneven surface.
- Ensure that the ladder is fully extended before starting work.
- Prevent passersby from walking under or near ladders in use by using barriers (e.g., cones) or getting your coworker to act as a lookout.
- Do not work on the top rung of the ladder.
- Maintain three points of contact with the ladder at all times.
- Do not carry any tools or materials in your hands when climbing a ladder.
- Do not lean away from the ladder to carry out your task. Always keep your weight centered between the side rails.
- Do not use ladders near doorways. If you need to use a ladder near a doorway, make sure that the door is locked.
- Before using a ladder, check it carefully to ensure there are no visible defects and that it is in good working condition. Check the ladder according to the manufacturer's instructions.
- Maintain and store the ladder according to the manufacturer's instructions.
- Do not use faulty ladders. Do not use the ladder if it is bent. Do not use the ladder if it is missing a step. Do not use the ladder if the spreader bars do not have a locking device or mechanism.
- Extend the top of the ladder three feet above the landing.
- When using a ladder in a high-activity area, secure it to prevent movement and use a barrier to redirect workers and equipment. If the ladder is placed in front of a door, always block off the door.

9.6: Summary

Ladders and stairways are another source of injuries and fatalities among construction workers. OSHA estimates that there are 24,882 injuries and as many as 36 fatalities per year due to falls on stairways and ladders used in construction. Nearly half of these injuries were serious enough to require time off the job. Slips, trips and falls on stairways are a major source of injuries and fatalities among construction workers.

Use the correct ladder for the task. Have a competent person visually inspect a ladder before use for any defects such as: structural damage, split/bent side rails, broken or missing rungs/steps/cleats and missing or damaged safety devices; grease, dirt or other contaminants that could cause slips or falls; paint or stickers (except warning labels) that could hide possible defects. Make sure that ladders are long enough to safely reach the work area. Mark or tag (“Do Not Use”) damaged or defective ladders for repair or replacement or destroy them immediately. Never load ladders beyond the maximum intended load or beyond the manufacturer’s rated capacity. Be sure the load rating can support the weight of the user, including materials and tools. Avoid using ladders with metallic components near electrical work and overhead power lines. Stairway treads and walkways must be free of dangerous objects, debris and materials. Slippery conditions on stairways and walkways must be corrected immediately. Make sure that treads cover the entire step and landing. Stairways having four or more risers or rising more than 30 inches must have at least one handrail.

9.7: Review Questions

Multiple Choice Questions

1. Before using a ladder, workers should:
 - (a) Test it with heavy weights
 - (b) Inspect it for visible defects
 - (c) Paint it for indentation
 - (d) Tie it to other ladders for extra height
2. How often must ladders be inspected:
 - (a) Once a month
 - (b) Before the initial use in each work shift
 - (c) Weekly
 - (d) After every job is completed
3. Fixed ladders extending more than 24 feet must have what type of protection?
 - (a) Safety cages only
 - (b) Ladder safety or personal fall arrest systems
 - (c) Guardrails
 - (d) Harness only
4. When using a ladder to access another level, how far should the ladder extend above landing?
 - (a) 1 foot
 - (b) 2 feet
 - (c) 3 feet
 - (d) 4 feet
5. Stairways used in construction must be installed at an angle of:
 - (a) 15-30
 - (b) 25-40
 - (c) 30-50
 - (d) 45-70
6. Handrails and top rails of stair rail systems must be able to withstand at least:
 - (a) 100 pounds
 - (b) 150 pounds
 - (c) 200 pounds
 - (d) 250 pounds
7. What should be done with defective ladders?
 - (a) Used only for light work
 - (b) Painted to mark damage
 - (c) Tagged "Do not use" and withdrawn from service
 - (d) Stored until repair materials are available
8. Which of the following is not a requirement for all ladders?
 - (a) Ladders must be inspected before initial use each shift
 - (b) Ladders may be used on uneven surfaces if balanced by weight
 - (c) Ladders must not be loaded beyond rated capacity
 - (d) Ladders must be placed on stable, level surfaces
9. Portable ladders must be able to support at least:
 - (a) Twice the maximum intended load
 - (b) Three times the maximum intended load

- (c) Four times the maximum intended load
- (d) Five times the maximum intended load

10. What should you do if a ladder is placed in front of a door?

- (a) Leave the door open
- (b) Make sure someone holds the door
- (c) Lock or block off the door
- (d) Place a warning cone only

11. Which of the following situations requires the use of a fall protection or ladder safety system?

- (a) Any portable ladder used outdoors
- (b) Fixed ladders extending more than 24 feet
- (c) All ladders used in wet areas
- (d) Stepladders taller than 6 feet

12. Before using a fixed ladder in an area with electrical hazards, workers should:

- (a) Ground the ladder using metal chains
- (b) Use ladders with nonconductive side rails
- (c) Apply a coat of paint to insulate the ladder
- (d) Stand on rubber mats for protection

13. Which of the following actions is acceptable under OSHA's ladder use rules?

- (a) Climbing while carrying tools in your hands
- (b) Standing sideways on the ladder to reach a wider area
- (c) Using a ladder only for its intended design purpose
- (d) Using boxes to gain extra height if the ladder is short

True/False Questions

14. True/False: Do not move or shift a ladder while a person or equipment is on the ladder.

15. True/False: All ladders must be kept free of oil, grease, and other slipping hazards.

16. True/False: Ladders may be tied together to create a longer ladder if secured with ropes.

17. True/False: Workers can carry tools in their hands while climbing a ladder.

18. True/False: You may use ladders near exposed electrical equipment if you wear gloves.

19. True/False: Ladders with missing rungs can still be used if properly marked.

20. True/False: Stepladders can be used with the top step as a working platform

21. True/False: Wooden ladders should not be coated with opaque paint because it can hide structural defects

22. True/False: Workers should always face the ladder when climbing up or down.

23. True/False: Stepladders can be safely used with the top step as a working platform.

Answer Key: 1(b), 2(b), 3(b), 4(c), 5(c), 6(c), 7(c), 8(b), 9(c), 10(c), 11(b), 12(b), 13(c), 14(True), 15(True), 16(False), 17(False), 18(False), 19(False), 20(False), 21(True), 22(True), 23(False).

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10: NOISE PROTECTION

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10.1: Background

Noise, or unwanted sound, is one of the most pervasive occupational health problems. It is a by-product of many industrial processes. Sound consists of pressure changes in a medium (usually air), caused by vibration or turbulence. These pressure changes produce waves emanating away from the turbulent or vibrating source. Exposure to high levels of noise causes hearing loss and may cause other harmful health effects as well. The extent of damage depends primarily on the intensity of the noise and the duration of the exposure. Noise-induced hearing loss can be temporary or permanent. Temporary hearing loss results from short-term exposures to noise, with normal hearing returning after period of rest. Generally, prolonged exposure to high noise levels over a period of time gradually causes permanent damage.

Construction sites have many noisy operations and can be a significant source of noise exposure. Loud noise can also reduce work productivity and contribute to workplace accidents by making it difficult to hear warning signals. Hearing loss from loud noise limits your ability to hear high frequencies, understand speech, and reduces your ability to communicate, which can lead to social isolation. Hearing loss can affect your quality of life by interfering with your ability to enjoy socializing with friends, playing with your children or grandchildren, or participating in other activities. Damage to your hearing can be prevented, but once permanent noise-induced hearing loss occurs, it cannot be cured or reversed. Hearing loss usually occurs gradually, so you may not realize it is happening until it is too late. Noise can also affect your body in other ways. A recent study found that workers persistently exposed to excessive occupational noise may be two-to-three times more likely to suffer from serious heart disease than workers who were not exposed.

How does hearing damage happen?

A one-time exposure to a sudden powerful noise, such as an explosion, may damage your hearing instantly. Prolonged exposures to loud noise can lead to a gradual, but permanent, loss of hearing. Damage can occur within the ear at noise levels similar to that of running a lawn mower for eight hours. At first, this may cause a temporary loss of hearing that may last as long as 14-16 hours. With repeated exposure to high noise levels and periodic exposures to very high noise levels (e.g., with the use of nail guns), as is common at most construction job sites, your hearing may not fully recover. More often, the loss of hearing occurs slowly over time from exposure to moderate levels of noise. When that happens, the hearing loss becomes permanent. This is why workplace noise is sometimes referred to as a stealth long-term hazard – because it is a painless, gradual process.

Hearing loss occurs when cilia, tiny hair cells that line the inner ear, are damaged. At first, the damage happens to the cilia that receive the higher frequencies. Gradually, noise damages more of the ear and affects how speech is heard. If you hear muffled or distorted speech sounds, that may be an indication that a substantial hearing loss has already occurred.

In addition to hearing loss, you also may experience ringing in the ears. This is called tinnitus, and can occur even without other apparent hearing loss.



Image 10:1 Healthy and Damaged Inner Ears. (Source: www.osha.gov, Public Domain).

Exposure to high levels of noise can cause permanent hearing loss. Neither surgery nor a hearing aid can correct this type of

hearing loss. Short term exposure to loud noise can cause a temporary change in hearing (your ears may feel plugged) or a ringing in your ears (tinnitus). These short-term problems may go away within a few minutes or hours after leaving the noise. However, repeated exposure can lead to permanent tinnitus and/or hearing loss. Loud noise can create physical and psychological stress, reduce productivity, interfere with communication and concentration, and contribute to workplace accidents and injuries by making it difficult to hear warning signals. The effects of noise induced hearing loss can be profound, permanently limiting your ability to hear high frequency sounds, understand speech, and seriously impairing your ability to communicate.

What is noise?

Noise and vibration are both fluctuations in the pressure of air (or other media) which affect the human body. Vibrations that are detected by the human ear are classified as sound. We use the term 'noise' to indicate unwanted sound. Noise and vibration can harm workers when they occur at high levels, or continue for a long time.

Noise is measured in units of sound pressure levels called decibels, named after Alexander Graham Bell, using A-weighted sound levels (dBA). The A-weighted sound levels closely match the perception of loudness by the human ear. Decibels are measured on a logarithmic scale which means that a small change in the number of decibels results in a huge change in the amount of noise and the potential damage to a person's hearing. OSHA sets legal limits on noise exposure in the workplace. These limits are based on a worker's time weighted average over an 8-hour day. With noise, OSHA's permissible exposure limit (PEL) is 90 dBA for all workers for an 8-hour day. The OSHA standard uses a 5 dBA exchange rate. This means that when the noise level is increased by 5 dBA, the amount of time a person can be exposed to a certain noise level to receive the same dose is cut in half. The National Institute for Occupational Safety and Health (NIOSH) has recommended that all worker exposures to noise should be controlled below a level equivalent to 85 dBA for eight hours to minimize occupational noise induced hearing loss. NIOSH has found that significant noise-induced hearing loss occurs at the exposure levels equivalent to the OSHA PEL based on updated information obtained from literature reviews. NIOSH also recommends a 3 dBA exchange rate so that every increase by 3 dBA doubles the amount of noise and halves the recommended amount of exposure time.

How does the ear work?

When sound waves enter the outer ear, the vibrations impact the ear drum and are transmitted to the middle and inner ear. In the middle ear three small bones called the malleus (or hammer), the incus (or anvil), and the stapes (or stirrup) amplify and transmit the vibrations generated by the sound to the inner ear. The inner ear contains a snail-like structure called cochlea which is filled with fluid and lined with cells with very fine hairs. These microscopic hairs move with the vibrations and convert the sound waves into nerve impulses—the result is the sound we hear. Exposure to loud noise can destroy these hair cells and cause hearing loss!

How do I know if my tools or job site are too noisy?

Sound intensity is measured in decibels. When decibels are adjusted for how the ear senses sound, the sound level intensity is measured as dBA. So, if the level increases by 3 dBA this doubles the amount of noise and reduces the recommended amount of exposure time by half. Safety and health inspectors measure sound or noise levels using a device called a sound level meter. The microphone is positioned at the user's ear level. Equipment that is determined to be loud can be labeled with a hazardous noise sticker. OSHA uses noise dosimeters to document the average noise exposure over your working day or of a particular task for part of your workday. OSHA recommends that workplace noise levels be kept below 85 dBA as an 8-hour time-weighted average. As the noise level increases, it damages your hearing more quickly.

Research indicates that your hearing can be damaged by regular 8-hour exposures to 85 dBA. When noise is as loud as 100 dBA (like a jackhammer or stud welder), it can take repeated exposures of as little as 1 hour per day to damage your hearing.

Noise is likely a problem in your workplace if you:

- Hear ringing or humming in your ears when you leave work.
- Have to shout to be heard by a coworker an arm's length away.
- Experience temporary hearing loss when leaving work.

10.2: The 2-3 Foot Rule and Noise Indicator

When a sound level meter is not available, you should use the 2-to-3 foot rule: stand about an arm's length away from your coworker. If you have to raise your voice to be heard 2-3 feet away, you should assume that the sound level is at or above 85 dBA. A personal noise indicator is a warning device. It indicates if your immediate exposure is less than or greater than 85 dBA. It flashes green if the sound level is under 85 dBA and red when above 85 dBA.

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10.3: Sound Level Chart

Equipment and daily activities at construction job sites can expose workers to high levels of noise. Sound levels on the chart below are listed in decibels (dBA) – the larger the number, the higher the volume or decibel level. How loud the noise is (volume), how long the noise lasts, and how close you are to the noise are all important in determining the hazard.

What can be done about job site noise levels?

One of the best ways to reduce exposure to hazardous noise on a work site is by planning for potential exposure before activities start. When jobs produce high noise levels, there are ways to reduce your exposure other than or in addition to hearing protectors. For instance, your employer or supervisor can buy materials to build sound barriers or schedule noisy activities during hours when fewer people are working. Your employer can also rent or buy quieter equipment. Your employer should hold daily or weekly safety meetings to discuss ways to limit high noise levels and other hazards. During safety meetings, the general contractor can ask subcontractors to describe the planned tasks for the day or week where hazardous noise might be generated, as well as what equipment will be used; you can use these opportunities to talk about ways to limit exposure. Even changes in the noise level that seem small (e.g., 3 dBA) are actually significant reductions in the noise.

Here are some specific ways to limit exposure:

- Plan to make or use prefabricated noise barriers.
- Ask your employer to buy or rent quieter equipment/tools.
- Limit the hours you work in hazardous noise areas.
- Identify equipment and work areas where signs can be posted to make other workers aware of high noise areas.
- Use hearing protection to supplement noise reduction.

Noise Control at the Job Site

The work site is where workers can have the most impact by working with employers to identify hazardous equipment, conduct hazard assessments, and apply the control process explained below. Employer support for providing supplies (acoustical insulation, extension cords, pre-fabricated noise barriers), hand tools, and sufficient set-up time are essential.

10.4: Noise Hazard Control Process

Noise controls are the first line of defense against excessive noise exposure. The use of these controls should aim to reduce the hazardous exposure to the point where the risk of hearing is eliminated or minimized. With the reduction of even a few decibels, the hazard to hearing is reduced, communication is improved, and noise-related annoyance is reduced. There are several ways to control and reduce worker exposure to noise in a workplace.

Engineering controls that reduce sound exposure levels are available and technologically feasible for most noise sources. Engineering controls involve modifying or replacing equipment, or making related physical changes at the noise source or along the transmission path to reduce the noise level at the worker's ear. In some instances, the application of a relatively simple engineering noise control solution reduces the noise hazard to the extent that further requirements of the OSHA Noise standard (e.g., audiometric testing (hearing tests), hearing conservation program, provision of hearing protectors, etc.) are not necessary. Examples of inexpensive, effective engineering controls include some of the following:

- Choose low-noise tools and machinery (e.g., Buy Quiet Roadmap (NASA)).
- Maintain and lubricate machinery and equipment (e.g., oil bearings).
- Place a barrier between the noise source and employee (e.g., sound walls or curtains).
- Enclose or isolate the noise source.

Administrative controls are changes in the workplace that reduce or eliminate the worker's exposure to noise. Examples include:

- Operating noisy machines during shifts when fewer people are exposed.
- Limiting the amount of time a person spends at a noise source.
- Providing quiet areas where workers can gain relief from hazardous noise sources (e.g., construct a soundproof room where workers' hearing can recover – depending upon their individual noise level and duration of exposure, and time spent in the quiet area).
- Restricting worker presence to a suitable distance away from noisy equipment.

Controlling noise exposure through distance is often an effective, yet simple and inexpensive administrative control. This control may be applicable when workers are present but are not actually working with a noise source or equipment. Increasing the distance between the noise source and the worker reduces their exposure. In open space, for every doubling of the distance between the source of noise and the worker, the noise is decreased by 6 dBA.

Hearing protection devices (HPDs), such as earmuffs and plugs, are considered an acceptable but less desirable option to control exposures to noise and are generally used during the time necessary to implement engineering or administrative controls, when such controls are not feasible, or when worker's hearing tests indicate significant hearing damage.

An effective hearing conservation program must be implemented by employers in general industry whenever worker noise exposure is equal to or greater than 85 dBA for an 8 hour exposure or in the construction industry when exposures exceed 90 dBA for an 8 hour exposure. This program strives to prevent initial occupational hearing loss, preserve and protect remaining hearing, and equip workers with the knowledge and hearing protection devices necessary to protect them. Key elements of an effective hearing conservation program include:

Workplace noise sampling includes personal noise monitoring which identifies which employees are at risk from hazardous levels of noise.

- Informing workers at risk from hazardous levels of noise exposure of the results of their noise monitoring.
- Providing affected workers or their authorized representatives with an opportunity to observe any noise measurements conducted.
- Maintaining a worker audiometric testing program (hearing tests) which is a professional evaluation of the health effects of noise upon individual worker's hearing.
- Implementing comprehensive hearing protection follow-up procedures for workers who show a loss of hearing (standard threshold shift) after completing baseline (first) and yearly audiometric testing.
- Proper selection of hearing protection based upon individual fit and manufacturer's quality testing indicating the likely protection that they will provide to a properly trained wearer.
- Evaluate the hearing protector's attenuation and effectiveness for the specific workplace noise.
- Training and information that ensures the workers are aware of the hazard from excessive noise exposures and how to properly use the protective equipment that has been provided.

- Data management of and worker access to records regarding monitoring and noise sampling.

The easiest way to help lower noise levels at your work site is to remember a three-step noise hazard control process:

Reduce It: Reduce the noise by using the quietest equipment available. For example, choose a smaller, quieter generator.

Move It: Move the equipment farther away with the use of extension cords, additional welding leads, and air hoses (following current OSHA standards). Noise levels go down as we increase our distance from a noisy object. Move the generator farther away or face it in a direction that is away from where most people are working. If you are not required to be in a high noise area, move to a quieter area.

Block It: Block the noise by building temporary barriers of plywood or other on-site materials to keep the noise from reaching workers. Place a five-sided, oversized wooden box over the generator. Add fire-resistant acoustical absorbing material (foam) inside the box. If the generator sits on soil or sand, that will help absorb some of the noise.

10.5: Maintain and Retrofit Equipment

Proper maintenance of equipment and tools can result in lower noise levels. Changing seals, lubricating parts, using sharp blades and bits, installing mufflers, and replacing faulty or worn equipment or parts can reduce the noise levels significantly on the job site. Do you know of equipment on your job site that could benefit from regular maintenance to reduce noise levels? Your employer should ensure that there is a regular maintenance program and that everyone follows the maintenance schedule. With some ingenuity, even older, noisier equipment can be modified by adding mufflers, new seals, or insulated panels. Employees can use noise reduction equipment accessories when made available by the employer. Employers can look for ways to reduce the sound intensity of tools in their current inventory. Employers can reduce job site noise levels by following OSHA recommendations:

- Identify major noise sources and possible control solutions.
- Plan ahead and limit worker exposure as much as possible.
- Perform regular maintenance.

OSHA currently allows your employer to rely on any combination of (1) hearing protective devices with a hearing conservation program, (2) engineering controls, and (3) administrative controls to effectively reduce worker exposures below 90 dBA. OSHA also recommends that your employer provide – and that you use – hearing protective devices any time site exposures meet or exceed 85 dBA.

What can be done if engineering and administrative controls are not enough?

Proper Selection and Use of Hearing Protection: If other control strategies to reduce noise levels can't be used or fail to reduce noise levels below OSHA's permissible exposure limits (PELs), wear a hearing protective device (29 CFR 1926.52). There are many different types of hearing protection. Each type is designed for certain noise conditions. They include the types listed in the following table. But remember – unless you wear them properly and wear them all the time in high noise areas, the devices will not be effective. Convenience and comfort are important for frequent use of hearing protective devices. Earmuffs and foam earplugs in most cases offer the most noise reduction. However, performed plugs or canal caps may be more convenient where construction work generates moderate daily average noise levels. There is no one device that is the best type for all situations.

Your employer is responsible for selecting, fitting, and maintaining hearing protective devices and must provide them to you at no cost and train you in their use (29 CFR 1926.101). If you are not provided with hearing protection for high noise work tasks, ask for it. If the employer refuses to provide hearing protectors, you can request an OSHA inspection.

Contractors and workers should consider the following when selecting and wearing protective gear: the noise level of the task, communication needs, convenience, comfort, hygiene, noise reduction of the hearing protective devices, and hearing ability.

Each type of hearing protection has manufacturer's directions for use and maintenance. Follow these directions and replace or fix the devices when they appear worn, dirty, or broken. Always wear hearing protection to protect yourself from high noise exposures, both on the work site and at home. Neither portable music player headphones nor hearing aids are substitutes for hearing protective devices.

10.6: Regular Hearing Screenings

If you are routinely exposed to hazardous levels of noise, your employer should provide yearly hearing tests to monitor your hearing loss over time. If your employer does not provide these tests, you should have your hearing tested by an audiologist. The initial test (baseline) will be used as the reference test. Future tests should be compared to the baseline to see if you need to do more to protect your hearing. These hearing tests can detect small shifts in hearing ability that have taken place since previous tests. When changes in hearing ability are detected, a retest is common to determine whether the change is permanent or temporary. Tests are relatively inexpensive and take about 20-30 minutes to conduct and get results.

When looking at your hearing test, levels greater than 25 dBA indicate impairment. Furthermore, losses in the higher frequencies (3000, 4000, 6000 hertz) are more significant and you should discuss them with your audiologist. You also can do daily monitoring of your hearing with a simple self-test. This works best if you drive yourself to work. When you reach your job site and are turning off the car engine, turn the radio on so it is just barely loud enough to hear (talk radio stations work well for this exercise) and go on with your day. When you return at the end of the work shift, check to see if you can still hear the radio with the power on, but the engine off. If you can't hear the radio, think about what may have damaged your hearing and how you could better protect your hearing.

What training is required?

Employee training is very important. Workers who understand the reasons for the hearing conservation programs and the need to protect their hearing will be more motivated to wear their protectors and take audiometric tests.

Employers must train employees exposed to TWAs of 85 dB and above at least annually in the effects of noise; the purpose, advantages, and disadvantages of various types of hearing protectors; the selection, fit, and care of protectors; and the purpose and procedures of audiometric testing. The training program may be structured in any format, with different portions conducted by different individuals and at different times, as long as the required topics are covered.

Ear protective devices inserted in the ear shall be fitted or determined individually by competent persons. Plain cotton is not an acceptable protective device.

10.7: Review Questions

Multiple Choice Questions

1. Which of the following statements about noise-induced hearing loss is correct?
 - (a) It can always be corrected with surgery
 - (b) Hearing aids restore normal hearing after noise exposure
 - (c) It can be prevented but cannot be cured once it occurs
 - (d) It is always caused by one-time exposure to explosions
2. OSHA's permissible exposure limit (PEL) for workplace noise is:
 - (a) 70 dBA for 8 hours
 - (b) 85 dBA for 8 hours
 - (c) 90 dBA for 8 hours
 - (d) 100 dBA for 8 hours
3. Which part of the ear contains the cochlea with tiny hair cells that convert sound waves into nerve impulse?
 - (a) Outer ear
 - (b) Middle ear
 - (c) Inner ear
 - (d) Eardrum
4. Which of the following is an engineering control for reducing workplace noise?
 - (a) Scheduling noisy tasks during shifts with fewer workers
 - (b) Using quieter tools and machinery
 - (c) Limiting worker time near noise sources
 - (d) Providing quiet rooms for workers
5. Which of the following indicates your workplace might be too noisy?
 - (a) You hear muffled or distorted speech sounds
 - (b) You hear ringing in your ears after leaving work
 - (c) You have to shout to be heard at arm's length
 - (d) All of the above
6. The "2-to-3 Foot Rule" for workplace noise means:
 - (a) If you can hear a coworker whisper 2-3 feet away, noise levels are safe.
 - (b) If you must raise your voice to be heard 2-3 feet away, noise is at or above 85 dBA.
 - (c) You should always stand 2-3 feet away from noisy machinery
 - (d) Earplugs should be worn if workers are 2-3 feet from a noise source
7. Which type of hearing protection usually offers the most noise reduction?
 - (a) Plain cotton
 - (b) Earmuffs and foam earplugs
 - (c) Portable music player headphones
 - (d) Hearing aids
8. Which of the following is not a required element of an effective hearing conservation program?
 - (a) Annual worker training on noise hazards
 - (b) Worker audiometric testing (hearing tests)
 - (c) Provision of hearing protection devices at no cost
 - (d) Guaranteeing that workers never work in noisy environments
9. What is the primary factor determining the extent of hearing damage from noise exposure?
 - (a) The worker's age and gender
 - (b) The pitch of the noise only

- (c) The intensity and duration of exposure
- (d) The type of hearing protection worn

10. Which of the following is an example of administrative control to limit noise exposure?

- (a) Installing mufflers on loud machines
- (b) Scheduling noisy tasks when fewer workers are present
- (c) Building soundproof barriers around generators
- (d) Lubricating equipment parts

11. Which of the following best describes tinnitus?

- (a) Sudden loss of hearing due to infection
- (b) A constant ringing or buzzing in the ears
- (c) The ability to hear high-pitched sounds only
- (d) Pain in the middle ear due to pressure changes

12. Which of the following is part of the “Reduce It – Move It – Block It” noise control process?

- (a) Ignoring low-level background noise
- (b) Moving noisy equipment farther from workers
- (c) Reducing the number of workers on site
- (d) Wearing hearing aids to block background noise

True/False Questions

- 13. True/False: Noise-induced hearing loss is gradual, painless, and often unnoticed until it is too late.
- 14. True/False: A 3 dBA increase in noise doubles the amount of noise and halves safe exposure time.
- 15. True/False: Hearing aids are effective substitutes for hearing protection devices.
- 16. True/False: Proper maintenance of equipment (e.g., lubrication, sharp blades, mufflers) can help reduce workplace noise levels.
- 17. True/False: Noise-induced hearing loss can always be reversed with proper medical treatment.
- 18. True/False: Exposure to a single sudden loud noise, like an explosion, can cause instant permanent hearing damage.
- 19. True/False: Plain cotton is considered an acceptable form of hearing protection.
- 20. True/False: Noise is considered any unwanted sound that may cause harm or interfere with normal activity.
- 21. True/False: Temporary hearing loss from loud noise will always lead to permanent hearing damage.

Answer Key: 1) c, 2) c, 3) c, 4) b, 5) d, 6) b, 7) b, 8) d, 9) c, 10) b, 11) b, 12) b, 13) True, 14) True, 15) False, 16) True, 17) False, 18) True, 19) False, 20) True, 21) False.

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11: TRENCHING AND EXCAVATION SAFETY

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11.1: Introduction

Excavation and trenching are among the most hazardous construction operations. The Occupational Safety and Health Administration's (OSHA) Excavation standards, 29 Code of Federal Regulations (CFR) Part 1926, Subpart P, contain requirements for excavation and trenching operations. This chapter highlights key elements of the standards and describes safe work practices that can protect workers from cave-ins and other hazards.

11.2: Excavation vs. Trench

OSHA defines an excavation as any man-made cut, cavity, trench, or depression in the Earth's surface formed by earth removal. A trench is defined as a narrow excavation (in relation to its length) made below the surface of the ground. In general, the depth of a trench is greater than its width, but the width of a trench (measured at the bottom) is not greater than 15 feet (4.6 m).

Trenching and excavation work presents serious hazards to all workers involved. Cave-ins pose the greatest risk and are more likely than some other excavation-related incidents to result in worker fatalities. One cubic yard of soil can weigh as much as a car. An unprotected trench can be an early grave. Employers must ensure that workers enter trenches only after adequate protections are in place to address cave-in hazards. Other potential hazards associated with trenching work include falling loads, hazardous atmospheres, and hazards from mobile equipment.

OSHA standards apply to all open excavations made in the Earth's surface, including trenches. Following the requirements of the standards will prevent or greatly reduce the risk of cave-ins and other excavation-related incidents.

11.3: Soil Classification

Some of the compliance methods permitted under the Excavation standards require a competent person to classify soil and rock deposits as: (1) Stable rock; (2) Type A soil; (3) Type B soil; and (4) Type C soil.

Stable Rock – Natural solid mineral matter that can be excavated with vertical sides and remain intact while exposed. *Type A* – Cohesive soils with an unconfined compressive strength of 1.5 tons per square foot (tsf) (144 kPa) or greater. Examples include clay, silty clay, sandy clay, and clay loam. Certain conditions preclude soil from being classified as Type A. For example, no soil is Type A if it is fissured or has been previously disturbed. *Type B* – Includes cohesive soil with an unconfined compressive strength greater than 0.5 tsf (48 kPa) but less than 1.5 tsf (144 kPa) and granular cohesionless soils (such as angular gravel, similar to crushed rock, silt, silt loam, sandy loam, and, in some cases, silty clay loam and sandy clay loam). *Type C* – Cohesive soil with an unconfined compressive strength of 0.5 tsf (48 kPa) or less, granular soils (including gravel, sand, and loamy sand), submerged soil or soil from which water is freely seeping, submerged rock that is not stable, or material in a sloped, layered system where the layers dip into the excavation or with a slope of four horizontal to one vertical (4H:1V) or steeper.

11.4: Competent Person

A competent person is an individual, designated by the employer, who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous or dangerous to workers, and who is authorized to take prompt corrective measures to eliminate them. Under the Excavation standards, tasks performed by the competent person include: Classifying soil; Inspecting protective systems; Designing structural ramps; Monitoring water removal equipment; and Conducting site inspections.

Why is preplanning important for excavation work?

No matter how many trenching, shoring, and backfilling jobs an employer has done in the past, it is important to approach each new job with care and preparation. Many on-the-job incidents result from inadequate initial planning. Waiting until after the work starts to correct mistakes in shoring or sloping slows down the operation, adds to the cost of the project, and makes a cave-in or other excavation failure more likely.

How can employers prevent cave-ins?

OSHA generally requires that employers protect workers from cave-ins by: sloping and benching the sides of the excavation; supporting the sides of the excavation; or placing a shield between the side of the excavation and the work area.

In many cases the type of protective system needed is well known and simple to use. At other times employers will undertake the more complex process of designing a protective system. Designing a protective system requires consideration of many factors, including: soil classification, depth of cut, water content of soil, weather and climate, and other operations in the vicinity. Employers are free to choose the most practical design that will provide the necessary protections. Any system used must meet the required performance criteria.

The Excavation standards describe various methods and approaches that can be used to design protective systems. Examples of protective systems that can be used to comply with the Excavation standards include:

- Sloping the sides of the excavation to an angle not steeper than 1½:1 (for every foot of depth, the trench must be excavated back 1½ feet). A slope of this gradation is safe for any type of soil.
- Designing a sloping and benching system in accord with tabulated data, such as tables and charts, approved by a registered professional engineer. This data must be in writing and must include enough explanatory information (including the criteria for selecting a system and the limits on the use of the data) for the user to be able to select an appropriate protective system. At least one copy of the data, which identifies the registered professional engineer who approved it, must be kept at the worksite during construction of the protective system. After the system is completed, the data may be stored away from the jobsite, but a copy must be provided upon request to an OSHA compliance officer.
- Using a trench box or shield approved by a registered professional engineer or designed in accord with tabulated data approved by a registered professional engineer.

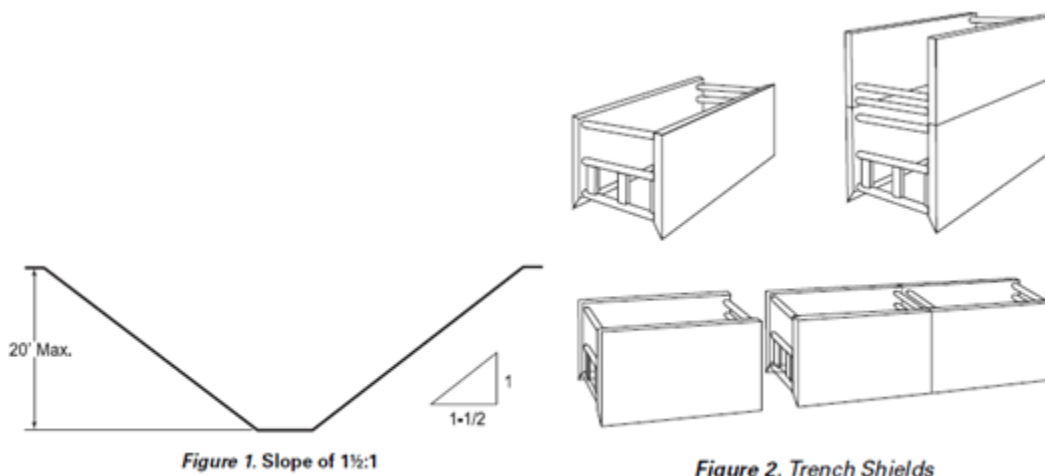


Image 11:1 Trench Slope and Shields. (Source: www.osha.gov, Public Domain).

The Excavation standards require employers to provide support systems, such as shoring, bracing, or underpinning, when necessary to ensure that adjacent structures (including adjoining buildings, walls, sidewalks and pavements) remain stable for the protection of workers. The standards also prohibit excavation below the base or footing of any foundation or retaining wall that could be reasonably expected to pose a hazard to workers unless:

- The employer provides a support system, such as underpinning;
- The excavation is in stable rock; or
- A registered professional engineer determines that the structure is far enough away from the excavation that it would not be affected by the excavation activity or that the excavation work will not pose a hazard to workers. Excavations that would undermine sidewalks, pavement, and appurtenant structures are prohibited unless the employer provides an appropriately designed support system or another effective method of protecting workers from the possible collapse of those structures.

The Excavation standards require employers to take certain steps to protect workers when installing and removing support systems. For example:

- Members of support systems must be securely connected to prevent sliding, falling, kickouts or predictable failure.
- Support systems must be installed and removed in a manner that protects workers from cave-ins and structural collapses and from being struck by members of the support system.
- Members of support systems must not be overloaded.
- Before temporary removal of individual members, additional precautions are required, such as installing other structural members to carry loads imposed on the support system.
- Removal must begin at, and progress from, the bottom of the excavation.
- Backfilling must progress together with the removal of support systems from excavations.

In addition, the standards permit excavation of 2 feet (0.61 meters) or less below the bottom of the members of a support system, but only if the system is designed to resist the forces calculated for the full depth of the trench and there are no indications, while the trench is open, of a possible loss of soil from behind or below the bottom of the support system. Employers must coordinate the installation of support systems with the excavation work.

Employers are responsible for maintaining materials and equipment used for protective systems. Defective and damaged materials and equipment can cause protective systems to fail and lead to other excavation hazards.

Employers must ensure that:

- Materials and equipment are free from damage or defects that might impair their proper function;
- Manufactured materials and equipment are used and maintained consistent with the manufacturer's recommendations and are used so as to prevent worker exposure to hazards;
- A competent person examines any damaged materials or equipment to evaluate its suitability for continued use; and
- If a competent person cannot assure that damaged material or equipment can support the intended loads or is otherwise suitable for use, the materials and equipment are removed from service until evaluated and approved by a registered professional engineer.

In addition to cave-ins and related hazards, workers involved in excavation work are exposed to hazards involving falling loads and mobile equipment. To protect workers from these hazards, OSHA requires employers to take certain precautions. For example, employers must:

- Protect workers from excavated or other materials or equipment that could pose a hazard by falling or rolling inside the excavation by placing and keeping such materials or equipment at least 2 feet (0.61 meters) from the edge and/or by using a retaining device to keep the materials or equipment from falling or rolling into the excavation.
- Provide a warning system (such as barricades, hand or mechanical signals, or stop logs) when mobile equipment is operated adjacent to an excavation, or when such equipment must approach the edge of an excavation, and the operator does not have a clear and direct view of the edge.
- Protect workers from loose rock or soil that could fall or roll from an excavation face by scaling to remove loose material, installing protective barricades at appropriate intervals, or using other equivalent forms of protection.
- Institute and enforce work rules prohibiting workers from working on faces of sloped or benched excavations at levels above other workers unless the workers at the lower levels are adequately protected from the hazards of falling, rolling, or sliding material or equipment.

- Institute and enforce work rules prohibiting workers from standing or working under loads being handled by lifting or digging equipment.
- Require workers to stand away from vehicles being loaded or unloaded to protect them from being struck by any spillage or falling materials. (Operators may remain inside the cab of a vehicle being loaded or unloaded if the vehicle is equipped, in accord with 29 CFR 1926.601(b)(6), to provide adequate protection for the operator.)

Water in an excavation can undermine the sides of the excavation and make it more difficult for workers to get out of the excavation. The OSHA standards prohibit employers from allowing workers to enter an excavation where water has accumulated or is accumulating unless adequate precautions are taken to protect workers. Such precautions can include special Trenching and Excavation Safety support or shield systems to prevent cave-ins, water removal to control the water level, or the use of a safety harness and lifeline.

If an employer uses water removal equipment to control or prevent water accumulation, the equipment and operations must be monitored by a competent person to ensure proper use. If excavation work interrupts the natural drainage of surface water, the OSHA standards also require the use of diversion ditches, dikes, or other suitable means to prevent surface water from entering the excavation and to provide adequate drainage of the adjacent area. In addition, a competent person must inspect excavations subject to runoffs from heavy rains, and excavations subject to such runoffs are subject to the requirements described previously in this paragraph.

Atmospheric testing is required before workers enter an excavation greater than 4 feet (1.22 meters) in depth where an oxygen deficiency or a hazardous atmosphere is present or could reasonably be expected, such as in excavations in landfill areas or excavations in areas where hazardous substances are stored nearby. If there are any hazardous conditions present, the employer must ensure that adequate precautions are taken to prevent employee exposure to those conditions. Such precautions include providing workers with proper respiratory protection or ventilation. In addition, when controls are used to reduce the level of atmospheric contaminants to acceptable levels, testing must be conducted as often as necessary to ensure that the atmosphere remains safe.

If hazardous atmospheric conditions exist or may reasonably be expected to develop in an excavation, the employer must ensure the ready availability of emergency rescue equipment, such as breathing apparatus, a safety harness and line, or a basket stretcher. This equipment must be attended when in use.

OSHA requires employers to provide ladders, steps, ramps, or other safe means of egress for workers working in trench excavations 4 feet (1.22 meters) or deeper. The means of egress must be located so as not to require workers to travel more than 25 feet (7.62 meters) laterally within the trench. Any structural ramps used solely for worker access or egress must be designed by a competent person. Structural ramps used for access or egress of equipment must be designed by a competent person qualified in structural design. Also, structural members used for ramps or runways must be uniform in thickness and joined in a manner to prevent tripping or displacement.

Employers must ensure that any worker who enters a bellbottom pier hole or similar deep and confined footing excavation wears a harness with a lifeline. The lifeline must be attached securely to the harness and must be separate from any line used to handle materials. Also, the lifeline must be individually attended by an observer at all times when the worker wearing the lifeline is in the excavation.

Employers must ensure that a competent person inspects all excavations, adjacent areas, and protective systems daily for possible cave-ins, indications of failures in protective systems and equipment, hazardous atmospheres, and other hazardous Trenching and Excavation Safety conditions. Inspections must be done prior to the start of work and as needed throughout the shift. Inspections are also required after natural events, such as rainstorms, or other hazard-increasing occurrences, such as blasting work. If an inspector finds any unsafe conditions during an inspection, the employer must clear workers from the hazardous area until the necessary safety precautions have been taken.

When employers share the details of their safety and health programs with workers, they should emphasize the critical role workers play in keeping the jobsite safe. Employers also need to emphasize specific practices that will help reduce the risk of on-the-job injuries at excavation sites. Such practices can include the following:

- Know where underground utilities are located before digging.
- Keep excavated soil (spoils) and other materials at least 2 feet (0.61 meters) from trench edges.
- Keep heavy equipment away from trench edges.
- Identify any equipment or activities that could affect trench stability.
- Test for atmospheric hazards such as low oxygen, hazardous fumes, and toxic gases when workers are more than 4 feet deep.

- Inspect trenches at the start of each shift.
- Inspect trenches following a rainstorm or other water intrusion.
- Inspect trenches after any occurrence that could have changed conditions in the trench.
- Do not work under suspended or raised loads and materials.
- Ensure that personnel wear high-visibility or other suitable clothing when exposed to vehicular traffic.

Employers should consider establishing and maintaining safety and health management systems that provide systematic policies, procedures, and practices for protecting workers from job-related safety and health hazards.

The primary hazard of trenching and excavation work is employee injury from a cave-in. Before workers enter a trench, a soil analysis should generally be conducted to determine the appropriate employee protection methods such as sloping, benching, shoring or shielding. Employers should also consider potential struck-by hazards associated with heavy equipment, falling loads, and public vehicular traffic in close proximity to the excavation operations. Also consider potential hazards from undermining sidewalks and buildings. Other unsafe conditions that may be encountered include hazardous atmospheres and electrical hazards from overhead and underground power lines. These five key trench safety tips will help keep workers safe:

- Ensure that there is a safe way to enter and exit: To prevent injuries during normal entry and exit of a trench or excavation at a job site, employers must provide ladders, stairways, ramps, or other safe means of egress. In some circumstances, when conditions in a trench or excavation become hazardous, survival may depend on how quickly workers can climb out.
 - Provide stairways, ladders, ramps, or other safe means of egress in all trenches that are 4 feet deep or more.
 - Position the means of egress within 25 lateral feet of workers.
 - Ensure means of entering and exiting the trench is within the protective system.
 - Structural ramps that are used for access or egress from excavations must be designed by a competent person.
 - When two or more components form a ramp or runway, they must be connected to prevent displacement, and be of uniform thickness.
 - Cleats or other means of connecting runway components must be attached in a way that would not cause tripping (e.g., attached to the bottom of the structure).
 - Structural ramps used in place of steps must have a non-slip surface.
 - Use earthen ramps as a means of egress only if a worker can walk them in an upright position, and only if they have been evaluated by a competent person.
- Ensure trenches have cave-in protection: All excavations are hazardous because soil can be unstable. If workers are not using protective systems or equipment while working in trenches or excavations that are five feet or greater in depth, they are in danger of being crushed by a cave-in. Pre-job planning is vital to incident-free excavation work; safety cannot be compromised as work progresses. The following concerns must be addressed by a competent person:
 - Evaluate soil conditions and select appropriate protective systems.
 - Construct protective systems in accordance with the standard requirements.
 - Plan ahead; contact utilities (gas, electric, water and sewage) to locate underground lines, plan for traffic control if necessary, be prepared to support utilities (pipes/ducts) passing through excavations when necessary, and determine proximity to structures that could affect choice of protective system.
 - Test for hazardous atmospheres such as low oxygen, hazardous fumes, and toxic gases, especially when gasoline engine-driven equipment is running, or when the soil has been contaminated by leaking lines or storage tanks. When necessary, ensure that there is adequate ventilation or respiratory protection.
 - Provide appropriate protections if water accumulation is a problem (i.e., remove water, divert water flow).
 - Maintain safe access into and out of the excavation.
 - Inspect the excavation, adjacent areas, and protective systems daily at the start of the shift, after a rainstorm or after any other hazard increasing event. The inspection shall be conducted by a competent person, who looks for evidence of a situation that could result in a possible cave-in, indication of failure of the protective system, hazardous atmospheres or other hazardous conditions.
 - Keep excavations open only for the minimum amount of time needed to complete operations.
- Look for standing water and test for atmospheric hazards: Excavations may present risks of hazardous atmosphere and water accumulation. If any of these conditions exist, workers could be exposed to the possibility of suffocating, inhaling toxic materials, being burned or engulfed by fire, or drowning.

Employers can ensure that excavations are safe to work in by directing the competent persons to inspect excavations:

- Before construction begins.
- Daily before each shift.

- As needed throughout the shift.
 - Following rainstorms or other hazard-increasing events (such as a vehicle or other equipment approaching the edge of an excavation). Plan ahead; contact utilities (gas, electric, water and sewage) to identify the location of underground lines and determine proximity to structures that could enter the excavation. Test for hazardous atmospheres where hazardous atmospheric conditions are likely to occur, such as when equipment is running or work is being conducted that could generate a hazardous atmosphere. Examples: low oxygen, hazardous vapors and toxic gases, especially when gasoline engine-driven equipment is running (e.g. when pumping water accumulation from the bottom of the trench), or the soil has been contaminated by leaking fuel lines or storage tanks. When necessary, ensure that there is adequate ventilation or respiratory protection. Provide appropriate protections if water accumulation is a problem (i.e., remove water, use PPE, divert water flow).
- Keep materials away from the edge of the trench: Excavated material (spoils) at your site are hazardous if they are set too close to the edge of a trench/excavation. The weight of the spoils can cause a cave-in, or spoils and equipment can roll back on top of workers, causing serious injuries or death. Provide protection by one or more of the following:
- Set spoils and equipment at least two feet back from an adequately protected excavation.
 - Use retaining devices, such as a trench box that will extend above the top of the trench to prevent equipment and spoils from falling back into the excavation.
 - Where the site does not permit a two-foot setback, spoils may need to be temporarily hauled to another location.
- Never enter a trench unless it has been properly inspected by a competent person: The conditions of an excavation can change during the course of work. Even a properly protected excavation or trench can become compromised. Inspections must be conducted by a competent person. OSHA defines a “competent person” as “one who is capable of identifying existing and predictable hazards in the surroundings, or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.”

A "competent person" has training in the use of protective systems, is knowledgeable about OSHA requirements, and has authority to immediately evacuate workers from the excavation and ensure that hazardous conditions are addressed.

11.5: Summary

Trench collapses cause dozens of fatalities and hundreds of injuries each year. Trenching deaths rose in 2003. Never enter an unprotected trench. Always use a protective system for trenches 5 feet deep or greater. Employ a registered professional engineer to design a protective system for trenches 20 feet deep or greater. Protective Systems: Sloping to protect workers by cutting back the trench wall at an angle inclined away from the excavation not steeper than a height/depth ratio of 1.5:1, according to the sloping requirements for the type of soil. Shoring to protect workers by installing supports to prevent soil movement for trenches that do not exceed 20 feet in depth. Shielding to protect workers by using trench boxes or other types of supports to prevent soil cave-ins. Always provide a way to exit a trench—such as a ladder, stairway or ramp—no more than 25 feet of lateral travel for employees in the trench. Keep spoils at least two feet back from the edge of a trench. Make sure that trenches are inspected by a competent person prior to entry and after any hazard-increasing event such as a rainstorm, vibrations or excessive surcharge loads.

11.6: Review Questions

Multiple Choice Questions

1. Which of the following best describes the difference between an exaction and a trench?
 - (a) Excavations are deeper than trenches
 - (b) A trench is always less than 10 feet deep
 - (c) Excavations are any man-made cut in the earth, while a trench is a narrow exaction where depth is greater than width and the width is less than 15 feet
 - (d) Trenches are man-made while excavations occur naturally

2. Which of the following is not a potential hazard associated with trenching and excavation work?
 - (a) Cave-ins
 - (b) Hazardous atmospheres
 - (c) Falling loads
 - (d) High noise levels

3. OSHA requires protection against cave-ins for excavations that are:
 - (a) 2 feet or deeper
 - (b) 4 feet or deeper
 - (c) 5 feet or deeper unless in stable rock
 - (d) 10 feet or deeper

4. Which soil type has the lowest compressive strength and is considered the least stable?
 - (a) Stable rock
 - (b) Type A
 - (c) Type B
 - (d) Type C

5. A competent person at an excavation site is responsible for all of the following except:
 - (a) Classifying soil
 - (b) Designing structural ramps
 - (c) Monitoring water removal equipment

(d) Operating excavation machinery

6. Which of the following protective systems involves using a shield placed between workers and trench walls?

(a) Sloping

(b) Benching

(c) Shoring

(d) Shielding

7. Materials (spoils) from an excavation must be kept at least how far from the edge?

(a) 6 inches

(b) 1 foot

(c) 2 feet

(d) 5 feet

8. Which of the following best describes the role of a “competent person” at a trenching site?

(a) Supervises workers’ daily schedules

(b) Identifies hazards and has authority to correct them

(c) Operates excavation equipment

(d) Approves construction blueprints

9. What is one of the main purposes of classifying soil before beginning an excavation?

(a) To determine the type of protective system required

(b) To estimate how long the project will take

(c) To calculate equipment rental costs

(d) To decide which workers to assign to the site

10. Which action could create a hazard when working near an excavation?

(a) Keeping heavy equipment away from trench edges

(b) Testing for hazardous atmospheres

(c) Placing spoils directly next to the trench edge

(d) Inspecting trenches after rainfall

11. Why should excavations be inspected after a rainstorm or water intrusion?

(a) Rain can cause soil conditions to change and increase cave-in risk

- (b) Rain improves soil cohesion and stability
- (c) OSHA requires inspections only after water is fully drained
- (d) Inspections after rain are optional

12. Which type of protective system involves cutting back trench walls to a safe angle?

- (a) Shielding
- (b) Shoring
- (c) Sloping
- (d) Benching

13. When should atmospheric testing be performed in an excavation?

- (a) Only when workers report feeling ill
- (b) Before each shift and whenever hazardous atmospheres might exist
- (c) Only in excavations deeper than 10 feet
- (d) After work is completed

14. Why is it dangerous to work under suspended loads in an excavation area?

- (a) It can reduce air circulation
- (b) Loads may fall and strike workers
- (c) It shows the excavation process
- (d) It increases noise levels

True/False Questions

- 15. True/False: One cubic yard of soil can weigh as much as a car.
- 16. True/False: Employers are not required to provide cave-in protection for trenches made entirely in stable rock.
- 17. True/False: Atmospheric testing is only required for trenches deeper than 10 feet.
- 18. True/False: A competent person must inspect trenches daily, before each shift, and after hazard-increasing events.
- 19. True/False: Excavated materials can be placed directly at the edge of the trench if the soil is stable.
- 20. True/False: Workers must never work under suspended or raised loads on an excavation site.
- 21. True/False: Water accumulation in an excavation does not pose a significant hazard if workers are using protective equipment.
- 22. True/False: Employers should share safety and health program details with workers to emphasize their role in excavation site safety.

23. True/False: A trench less than 5 feet deep never requires protective systems.

24. True/False: It is acceptable to enter a trench containing standing water if the worker is wearing waterproof boots.

25. True/False: Atmospheric testing is required only when there is visible gas or vapor present.

Answer Key: 1) c, 2) d, 3) c, 4) d, 5) d, 6) d, 7) c, 8) b, 9) a, 10) c, 11) a, 12) c, 13) b, 14) b, 15) True, 16) True, 17) False, 18) True, 19) False, 20) True, 21) False, 22) True, 23) False, 24) False, 25) False.

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12: CONFINED SPACE

12.1: What are confined spaces?

12.2: Fatal Incidents

12.3: Written Programs

12.4: Safe Entry

12.5: Entry Permits

12.6: Employer Responsibilities

12.7: Review Questions

12.8: Sources

12.1: What are confined spaces?

Many workplaces contain areas that are considered “confined spaces” because while they are not necessarily designed for people, they are large enough for workers to enter and perform certain jobs. A confined space also has limited or restricted means for entry or exit and is not designed for continuous occupancy. Confined spaces include, but are not limited to, tanks, vessels, silos, storage bins, hoppers, vaults, pits, manholes, tunnels, equipment housings, ductwork, pipelines, etc. In many instances, employees who work in confined spaces also face increased risk of exposure to serious physical injury from hazards such as entrapment, engulfment and hazardous atmospheric conditions. Confinement itself may pose entrapment hazards and work in confined spaces may keep employees closer to hazards such as machinery components than they would be otherwise.

OSHA uses the term “permit-required confined space” (permit space) to describe a confined space that has one or more of the following characteristics: contains or has the potential to contain a hazardous atmosphere; contains material that has the potential to engulf an entrant; has walls that converge inward or floors that slope downward and taper into a smaller area which could trap or asphyxiate an entrant; or contains any other recognized safety or health hazard, such as unguarded machinery, exposed live wires, or heat stress.

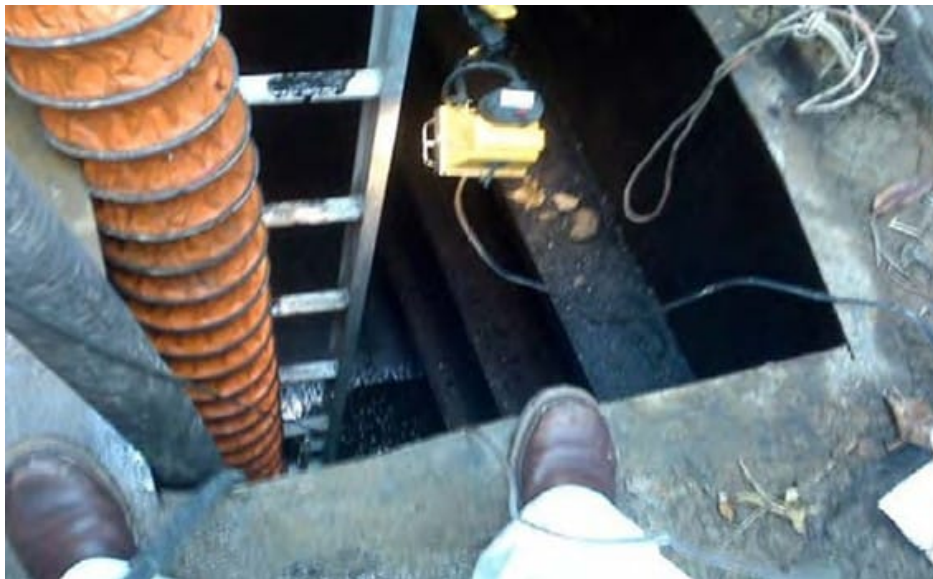


Image 12:1 An Example of Confined Spaces. (Source: www.osha.gov, Public Domain).

Confined spaces - such as manholes, crawl spaces, and tanks - are not designed for continuous occupancy and are difficult to exit in the event of an emergency. People working in confined spaces face life-threatening hazards including toxic substances, electrocutions, explosions, and asphyxiation.

A confined space is a space whose configuration and/or contents may present special dangers not found in normal work areas. Confined spaces may be poorly ventilated and, as a result, contain insufficient oxygen or hazardous levels of toxic gases. Working in a tight space can prevent a worker from keeping a safe distance from mechanical and electrical hazards in space. Fumes from a flammable liquid that is used in a poorly ventilated area can reach explosive levels. Such hazards endanger both the workers in the confined space and others who become exposed to the hazards when they attempt to rescue injured workers. In a number of cases, rescue workers have themselves died or been injured because they did not have the training and equipment necessary to conduct the rescue safely. Because confined spaces are potentially dangerous, employers must evaluate all confined spaces in which their employees work to determine whether hazards exist or whether the work to be done in the space can create hazards. Employers must take certain precautions whenever workers enter a permit space. These include (1) specifying the precautions to be taken to protect the workers in space; (2) training the workers who are covered by the standard to give them the knowledge to protect themselves and others; and (3) planning how to rescue injured workers promptly and safely.

Definitions

By definition, a **confined space**: (1) is large enough for an employee to enter fully and perform assigned work, (2) is not designed for continuous occupancy by the employee; and (3) has a limited or restricted means of entry or exit. These spaces may include underground vaults, tanks, storage bins, pits and diked areas, vessels, silos, and other similar areas. These spaces can present physical and atmospheric hazards that can be prevented if addressed prior to entering the space to perform work.

By definition, a **permit-required confined space** has one or more of these characteristics: (1) Contains or has the potential to contain a hazardous atmosphere; (2) Contains a material with the potential to engulf someone who enters the space; and (3) Has an internal configuration that might cause an entrant to be trapped or asphyxiated by inwardly converging walls or by a floor that slopes downward and tapers to a smaller cross section; and/or (4) Contains any other recognized serious safety or health hazards.

If employees are not to enter and work in permit spaces, employers must take effective measures to prevent them from entering these spaces. If employees are expected to enter permit spaces, the employer must develop a written permit space program and make it available to employees or their representatives.

12.2: Fatal Incidents

Confined space hazards in pits have led to worker deaths. Several tragic incidents included:

- Two workers suffocated while attempting to close gate valves in a valve pit.
- A worker lost consciousness, fell, and was killed while climbing down a ladder into an unventilated underground valve vault to turn on water valves.
- While replacing a steam-operated vertical pump, an equipment repair technician died from burns and suffocation after falling into an industrial waste pit.

12.3: Written Programs

Any employer who allows employee entry into a permit space must develop and implement a written program for the space. Among other things, the OSHA standard requires the employer's written program to:

- Implement necessary measures to prevent unauthorized entry;
- Identify and evaluate permit space hazards before allowing employee entry;
- Test atmospheric conditions in the permit space before entry operations and monitor the space during entry;
- Perform appropriate testing for the following atmospheric hazards in this sequence: oxygen, combustible gases or vapors, and toxic gases or vapors;
- Establish and implement the means, procedures and practices to eliminate or control hazards necessary for safe permit space entry operations;
- Identify employee job duties;
- Provide and maintain, at no cost to the employee, personal protective equipment and any other equipment necessary for safe entry and require employees to use it;
- Ensure that at least one attendant is stationed outside the permit space for the duration of entry operations;
- Coordinate entry operations when employees of more than one employer are working in the permit space;
- Implement appropriate procedures for summoning rescue and emergency services, and preventing unauthorized personnel from attempting rescue;
- Establish, in writing, and implement a system for the preparation, issue, use and cancellation of entry permits;
- Review established entry operations annually and revise the permit space entry program as necessary; and
- Implement the procedures that any attendant who is required to monitor multiple spaces will follow during an emergency in one or more of those spaces.

Controlling Hazards

The employer's written program should establish the means, procedures and practices to eliminate or control hazards necessary for safe permit space entry operations. These may include:

- Specifying acceptable entry conditions;
- Isolating the permit space;
- Providing barriers;
- Verifying acceptable entry conditions; and
- Purging, making inert, flushing or ventilating the permit space.

12.4: Safe Entry

Equipment for safe entry

In addition to personal protective equipment, other equipment that employees may require for safe entry into a permit space includes:

- Testing, monitoring, ventilating, communications and lighting equipment;
- Barriers and shields;
- Ladders; and
- Retrieval devices.

Detection of hazardous conditions

If hazardous conditions are detected during entry, employees must immediately leave the space. The employer must evaluate the space to determine the cause of the hazardous atmosphere and modify the program as necessary.

When entry to permit spaces is prohibited, the employer must take effective measures to prevent unauthorized entry. Non-permit confined spaces must be evaluated when changes occur in their use or configuration and, where appropriate, must be reclassified as permit spaces.

A space with no potential to have atmospheric hazards may be classified as a non-permit confined space only when all hazards are eliminated in accordance with the standard. If entry is required to eliminate hazards and obtain data, the employer must follow specific procedures in the standard.

Informing Contract Employees

Employers must inform any contractors whom they hire to enter permit spaces about:

- The permit spaces and permit space entry requirements;
- Any identified hazards;
- The employer's experience with the space, such as knowledge of hazardous conditions; and
- Precautions or procedures to be followed when in or near permit spaces.

When employees of more than one employer are conducting entry operations, the affected employers must coordinate entry operations to ensure that affected employees are appropriately protected from permit space hazards. The employer also must give contractors any other pertinent information regarding hazards and operations in permit spaces and be debriefed at the conclusion of entry operations.

12.5: Entry Permits

A permit, signed by the entry supervisor, must be posted at all entrances or otherwise made available to entrants before they enter a permit space. The permit must verify that pre-entry preparations outlined in the standard have been completed. The duration of entry permits must not exceed the time required to complete an assignment.

Entry permits must include:

- Name of permit space to be entered, authorized entrant(s), eligible attendants and individuals authorized to be entry supervisors;
- Test results;
- Tester's initials or signature;
- Name and signature of supervisor who authorizes entry;
- Purpose of entry and known space hazards;
- Measures to be taken to isolate permit spaces and to eliminate or control space hazards;
- Name and telephone numbers of rescue and emergency services and means to be used to contact them;
- Date and authorized duration of entry;
- Acceptable entry conditions;
- Communication procedures and equipment to maintain contact during entry;
- Additional permits, such as for hot work, that have been issued authorizing work in the permit space;
- Special equipment and procedures, including personal protective equipment and alarm systems;
- Any other information needed to ensure employee safety.

Cancelled entry permits

The entry supervisor must cancel entry permits when an assignment is completed or when new conditions exist. New conditions must be noted on the canceled permit and used in revising the permit space program. The standard requires that the employer keep all canceled entry permits for at least one year.

12.6: Employer Responsibilities

All employers engaged in construction work must (1) identify any confined spaces in which their workers will be working, and (2) determine whether any such spaces are permit spaces. When workers work in permit spaces, they must be protected against the hazards in those spaces. To ensure such protection, the Confined Spaces standard imposes duties on “entry employers,” “host employers,” and “controlling contractors.” If an employer knows that a permit space is present at its worksite, it must inform its workers of the location and danger posed by each space. It may do this by making sure that warning signs are posted. In addition, where an employer’s workers have no work to do in the space, that employer must ensure that its workers stay out. One way to do this is for employers to make sure that workers recognize permit space warning signs and understand their significance.

Most deaths and injuries in confined spaces result from atmospheric hazards. Such hazards include insufficient oxygen and toxic or flammable chemicals. The competent person must evaluate, including testing as necessary, whether the following hazards are or may be present, before workers enter the space:

- Oxygen deficiency (concentration less than 19.5 percent) or excess (concentration above 23.5 percent).
- Concentration of any flammable gas, vapor, or mist in excess of 10 percent of its lower explosive limit:
- Airborne combustible dust at a concentration equal to or greater than its lower explosive limit.
- Atmospheric concentration of any substance that can cause death, incapacitation, impairment of ability to self-rescue, injury or acute illness.

Asphyxiation due to insufficient oxygen is one of the leading causes of death during construction work in confined spaces. An oxygen-deficient atmosphere endangers both the workers assigned to enter space and others who may attempt a rescue without proper equipment and training. Therefore, in evaluating a confined space to determine whether it is a permit space, particular consideration should be given to whether it contains or has the potential to contain an oxygen concentration of less than 19.5 percent.

Any space that is to be entered after being isolated from the atmosphere for a period of time could be oxygen-deficient, and the oxygen concentration should be measured to determine whether the space must be classified as a permit space. Direct reading instruments that measure the concentration of oxygen in the air are available for this purpose. Such instruments must be properly calibrated and used to give reliable results.

Engulfment means the surrounding and effective capture of a person by a liquid or finely divided (flowable) solid substance that can be aspirated to cause death by filling or plugging the respiratory system or that can exert enough force on the body to cause death by strangulation, constriction, or crushing, or the substance suffocates the individual. The competent person must consider whether any liquid or flowable solid (such as sand) could enter space. Any pipe or manhole in an operating water or sewer system in which a worker works is a confined space that could potentially engulf an entrant and must be treated as a permit space.

Hazards that the competent person should consider include fire and explosion hazards, the presence of mechanical, electrical, hydraulic and pneumatic energy, temperature extremes, radiation, noise, corrosive chemicals, and biological hazards (such as venomous animals or insects).

If a workplace contains a permit space or spaces, the employer must inform workers in the vicinity of the location of the danger posed by each space. This can be done by posting warning signs like that to the right at each possible point of entry, or by other equally effective means.

In addition to posting warning signs, an employer who learns about a permit space must also notify its employees’ authorized representative and the controlling contractor of the location and danger of the space. The controlling contractor must then notify other employers on the site, whose activities could create a hazard in the permit space, of the presence and location of such spaces and the hazards associated with them before workers enter the space.

Worker Training

Before the initial work assignment begins, the employer must provide proper training for all workers who are required to work in

permit spaces. After the training, employers must ensure that the employees have acquired the understanding, knowledge and skills necessary to safely perform their duties. Additional training is required when:

- The job duties change;
- A change occurs in the permit space program or the permit space operation presents any new hazard; and
- An employee's job performance shows deficiencies.

In addition to this training, rescue team members also require training in CPR and first aid. Employers must certify that this training has been provided.

After completion of training, the employer must keep a record of employee training and make it available for inspection by employees and their authorized representatives. The record must include the employee's name, the trainer's signature or initials and dates of the training.

Safety Entry Requirements

Preparation: Before workers can enter a confined space, employers must provide pre-entry planning. This includes:

- Having a competent person evaluate the work site for the presence of confined spaces, including permit-required confined spaces.
- Once the space is classified as a permit-required confined space, identifying the means of entry and exit, proper ventilation methods, and elimination or control of all potential hazards in the space.
- Ensuring that the air in a confined space is tested, before workers enter, for oxygen levels, flammable and toxic substances, and stratified atmospheres.
- If a permit is required for the space, removing or controlling hazards in the space and determining rescue procedures and necessary equipment.
- If the air in a space is not safe for workers, ventilating or using whatever controls or protections are necessary so that employees can safely work in the space.

Authorized entrant

Authorized entrants are required to:

- Know space hazards, including information on the means of exposure such as inhalation or dermal absorption, signs of symptoms and consequences of the exposure;
- Use appropriate personal protective equipment properly;
- Maintain communication with attendants as necessary to enable them to monitor the entrant's status and alert the entrant to evacuate when necessary;
- Exit from the permit space as soon as possible when: Ordered by the authorized person; He or she recognizes the warning signs or symptoms of exposure; A prohibited condition exists; or An automatic alarm is activated.
- Alert the attendant when a prohibited condition exists or when warning signs or symptoms of exposure exist.

Attendant

The attendant is required to:

- Remain outside the permit space during entry operations unless relieved by another authorized attendant;

- Perform non-entry rescues when specified by the employer's rescue procedure;
- Know existing and potential hazards, including information on the mode of exposure, signs or symptoms, consequences and physiological effects;
- Maintain communication with and keep an accurate account of those workers entering the permit space;
- Order evacuation of the permit space when: A prohibited condition exists; A worker shows signs of physiological effects of hazard exposure; An emergency outside the confined space exists; and The attendant cannot effectively and safely perform required duties.
- Summon rescue and other services during an emergency;
- Ensure that unauthorized people stay away from permit spaces or exit immediately if they have entered the permit space;
- Inform authorized entrants and the entry supervisor if any unauthorized person enters the permit space; and
- Perform no other duties that interfere with the attendant's primary duties.

Entry supervisor

Entry supervisors are required to:

- Know space hazards including information on the mode of exposure, signs or symptoms and consequences;
- Verify emergency plans and specified entry conditions such as permits, tests, procedures and equipment before allowing entry;
- Terminate entry and cancel permits when entry operations are completed or if a new condition exists;
- Verify that rescue services are available and that the means for summoning them are operable;
- Take appropriate measures to remove unauthorized entrants; and
- Ensure that entry operations remain consistent with the entry permit and that acceptable entry conditions are maintained.

The permit space program must establish a system for preparing, using, and canceling entry permits, which are written or printed documents that allow and control entry into permit spaces. A permit space program must:

- Implement measures to prevent unauthorized entry;
- Identify and evaluate permit space hazards before allowing employee entry;
- Provide for the atmospheric conditions in the permit space to be tested before entry operations and for the space to be monitored during entry;
- Require appropriate testing for the following atmospheric hazards in this sequence: oxygen, combustible gases or vapors, and toxic gases or vapors;
- Establish and implement the means, procedures and practices to eliminate or control hazards necessary for safe permit space entry operations;
- Identify employee job duties;
- Provide and maintain, at no cost to the employee, personal protective equipment and any other equipment necessary for safe entry, and require employees to use the equipment properly;
- Ensure that at least one attendant is stationed outside the permit space during entry operations;
- Implement the procedures that any attendant who is required to monitor multiple spaces will follow during an emergency in one or more of those spaces;

- Coordinate entry operations (in consultation with the controlling contractor) when employees of more than one employer are working in the permit space; and Protecting Construction Workers in Confined Spaces
- Establish procedures for summoning rescue and emergency services and preventing unauthorized personnel from attempting rescue.

Rescue service personnel

The standard requires employers to ensure that responders are capable of responding to an emergency in a timely manner. Employers must provide rescue service personnel with personal protective and rescue equipment, including respirators, and training in how to use it. Rescue service personnel also must receive the authorized entrants training and be trained to perform assigned rescue duties.

The standard also requires that all rescuers be trained in first aid and CPR. At a minimum, one rescue team member must be currently certified in first aid and CPR. Employers must ensure that practice rescue exercises are performed yearly and that rescue services are provided access to permit spaces so they can practice rescue operations. Rescuers also must be informed of the hazards of the permit space.

Confined Spaces in Pits

Even though a pit is typically open on top and over 4 feet deep, it can still be a confined space or permit-required confined space. Additionally, pits can be completely underground or below grade, such as a utility vault within a sewer system or a pit within a pit in a wastewater treatment plant.



Image 12:2 An Example of Confined Spaces. (Source: www.osha.gov, Public Domain).

Pits are found in many environments. Examples include sump pits, valve pits or vaults (e.g., wastewater treatment plants, municipal water systems), electrical pits/vaults, steam pits/vaults, vehicle service/garage pits, elevator pits, dock leveler pits, industrial chemical waste pits, and many more. Many of these spaces qualify as permit-required confined spaces.

Employers must take all necessary steps to keep workers safe in confined spaces, including following the OSHA Construction Confined Spaces standard. This standard applies to both new construction in a pit and alterations and/or upgrades. Among the pit-related tasks covered by the standard are:

- Opening or closing valves during renovation work.
- Installing or upgrading pump equipment, cables, or junction boxes.

Construction work can create confined spaces, even if there are none at the start of a project. Changes to the entry/exit, the ease of exit, and air flow could produce a confined space or cause one to become permit-required.

Personal protective equipment: Employers should assess the worksite to determine what personal protective equipment (PPE) is needed to protect workers. Employers should provide workers with the required PPE and proper training on its use and about any related hazards before the work starts.

12.7: Review Questions

Multiple Choice Questions

1. Which of the following best defines a confined space?
 - (a) A small space that workers must crawl through
 - (b) Any space designed for continuous occupancy
 - (c) A space large enough for a worker to enter, has limited entry to exit, and is not designed for continuous occupancy
 - (d) A space that always contains hazardous materials
2. Which of the following characteristics makes a confined space “permit-required”?
 - (a) The space is outdoors
 - (b) It contains or has potential to contain a hazardous atmosphere
 - (c) It is only used for electrical work
 - (d) It is well ventilated
3. What should be tested first before entering a confined space?
 - (a) Toxic gases
 - (b) Combustible gases
 - (c) Oxygen level
 - (d) Temperature
4. What is the primary duty of the attendant during a confined space entry?
 - (a) Perform maintenance inside the space
 - (b) Remain outside and monitor entrants
 - (c) Issue permits for entry
 - (d) Approve emergency procedures
5. What is the main cause of death in confined spaces according to OSHA?
 - (a) Falls
 - (b) Atmospheric hazards
 - (c) Electrical shock
 - (d) Noise exposure
6. Which of the following is not required in a written confined space program?
 - (a) Testing atmospheric conditions
 - (b) Providing protective equipment
 - (c) Posting warning signs
 - (d) Allowing unauthorized entry for observation
7. What is the oxygen concentration below which an atmosphere is considered deficient?
 - (a) 20.9%
 - (b) 21.0%
 - (c) 19.5%
 - (d) 18.0%
8. What of the following is not duty of an authorized entrant?
 - (a) know space hazards
 - (b) maintain communication with attendants
 - (c) Perform atmospheric testing
 - (d) exit when ordered to evacuate
9. What is “engulfment” in the context of confined spaces?
 - (a) Exposure to electrical energy
 - (b) The surrounding and capture of a person by liquid or flowable solid

- (c) Collapse of a structure
- (d) Exposure to noise hazards

10. What must be done if atmospheric testing reveals unsafe oxygen levels inside a confined space?

- (a) Continue work but limit time inside
- (b) Increase worker rotation
- (c) Evacuate immediately and correct the condition before re-entry
- (d) Post a warning sign but continue operations

11. Which situation represents an “engulfment hazard”?

- (a) Exposure to extreme noise levels
- (b) A worker trapped in a pit filling with sand or liquid
- (c) Lack of communication with attendants
- (d) Poor lighting in the work area

12. Before assigning workers to a confined space, the employer must ensure that employees:

- (a) Have at least 10 years of experience
- (b) Are trained to recognize and control confined space hazards
- (c) Have performed rescue duties previously
- (d) Are certified electricians

True/False Questions

13. True/False: Confined spaces can present conditions that are immediately dangerous to workers if not properly identified, evaluated, tested, and controlled.

14. True/False: A space may also be a permit-required confined space if it has a hazardous atmosphere, the potential for engulfment or suffocation, a layout that might trap a worker through converging walls or a sloped floor, or any other serious safety or health hazard.

15. True/False: All confined spaces are permit-required confined spaces.

16. True/False: Only authorized entrants need training for confined space work.

17. True/False: Oxygen concentrations above 23.5% are safe for workers.

18. True/False: Confined spaces are designed for continuous human occupancy.

19. True/False: Rescue service personnel must be trained in CPR and first aid.

20. True/False: A permit-required confined space may contain hazards such as toxic gases, insufficient oxygen, or converging walls that can trap workers

21. True/False: Posting a warning sign near a confined space eliminates the need for a written permit program.

22. True/False: If atmospheric hazards are detected during entry, workers must exit immediately and the space must be reevaluated before re-entry.

23. True/False: Even when a space is open at the top, it can still be classified as a confined space if it has limited entry or exit.

24. True/False: Personal protective equipment (PPE) is optional if workers have completed confined space training.

Answer Key: 1) c, 2) b, 3) c, 4) b, 5) b, 6) d, 7) c, 8) c, 9) b, 10) c, 11) b, 12) b, 13) True, 14) True, 15) False, 16) False, 17) False, 18) False, 19) True, 20) True, 21) False, 22) True, 23) True, 24) False.

12.8: Sources

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13: SCAFFOLDS

13.1: Introduction

13.2: Who Works with Scaffolds?

13.3: Scaffold Components

13.4: Scaffold Access

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13.1: Introduction

You can set up a scaffold to work on just about anything – silos, tanks, chimneys, bridges, stairways, roofs, ramps, and ceilings, are just a few examples. In its most basic form, a supported scaffold is just a platform and a couple of uprights. Anyone can set one up. And that's the main reason why too many workers are injured or killed when they're using a scaffold – components fail, planks break, handrails give way, or the entire structure collapses in a heap. Most scaffold accidents happen because scaffold users are untrained or improperly trained. Because supported scaffolds used for construction work are complex structures, you need to know how to erect, dismantle, and work from them safely.

The Bureau of Labor Statistics' Census of Fatal Occupational Injuries (CFOI) reported 52 fatal falls to lower levels from scaffolding in 2020. All of these can be controlled by compliance with OSHA standards. Millions of workers in the construction industry work on scaffolds. Protecting these workers from scaffold-related incidents can prevent injuries and deaths attributed to falls from scaffolding each year. Scaffold incidents causing injury or death to workers is often the result of either the planking or support giving way, by the worker slipping, the absence of fall protection, or being struck by a falling object. These incidents can be avoided by compliance with OSHA standards.

A scaffold is an elevated, temporary work platform. There are two basic types of scaffolds:

- Supported scaffolds, which consist of one or more platforms supported by rigid, load-bearing members, such as poles, legs, frames, outriggers, etc.
- Suspended scaffolds, which are one or more platforms suspended by ropes or other non-rigid, overhead support.
- Other types of equipment, principally scissor lifts and aerial lifts, can be regarded as other types of supported scaffolds.

13.2: Who Works with Scaffolds?

Erectors or Dismantlers, who are workers whose principal activity involves assembling and disassembling scaffolding before other work can begin, and after that work, or a portion of it, has been completed. OSHA requires employers to provide training by a competent person to each employee who is involved in erecting and/or disassembling a scaffold. Scaffolds must be designed by a qualified person and be constructed and loaded in accordance with that design.

Scaffold Users are workers whose work requires them to be supported by scaffolding to access the area of a structure where that work is performed. Employers are required by OSHA standards to have a qualified person provide training to each employee who performs work while on a scaffold. The training must enable employees to recognize the hazards associated with the type of scaffold being used and to understand the procedures to control or minimize those hazards.

Scaffold designers are workers who are qualified to design scaffolds. Designers for certain scaffolds also must be registered professional engineers.

Common Hazards Associated with All Scaffolds

- Falls from elevation, due to lack of fall protection.
- Collapse of the scaffold, caused by instability or overloading.
- Being struck by falling tools, work materials, or debris.
- Electrocution, due to the proximity of the scaffold to overhead power lines.

Competent person required for scaffolding

OSHA's scaffolding standard defines a competent person as "one who is capable of identifying existing and predictable hazards in the surroundings or working conditions, which are unsanitary, hazardous to employees, and who has authorization to take prompt corrective measures to eliminate them." The standard requires a competent person to perform the following duties under these circumstances:

- In General: To select and direct employees who erect, dismantle, move, or alter scaffolds. To determine if it is safe for employees to work on or from a scaffold during storms or high winds and to ensure that a personal fall arrest system or wind screens protect these employees.
- For Training: To train employees involved in erecting, disassembling, moving, operating, repairing, maintaining, or inspecting scaffolds to recognize associated work hazards.
- For Inspections: To inspect scaffolds and scaffold components for visible defects before each work shift and after any occurrence which could affect the structural integrity and to authorize prompt corrective actions. To inspect ropes on suspended scaffolds prior to each workshift and after every occurrence which could affect the structural integrity and to authorize prompt corrective actions. To inspect manila or plastic (or other synthetic) rope being used for top rails or midrails. Scaffolds and components must be inspected by a competent person before each workday and after any incident that could weaken them. Any part of a damaged scaffold or a scaffold component must be removed from service until it is repaired or replaced.
- For Suspension Scaffolds: To evaluate direct connections to support the load. To evaluate the need to secure two-point and multi-point scaffolds to prevent swaying.
- For Erectors and Dismantlers: To determine the feasibility and safety of providing fall protection and access. To train erectors and dismantlers (effective September 2, 1997) to recognize associated work hazards.

- For Scaffold Components: To determine if a scaffold will be structurally sound when intermixing components from different manufacturers. To determine if galvanic action has affected the capacity when using components of dissimilar metals.

Qualified person required for scaffolding

The standard defines a qualified person as “one who—by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training, and experience—has successfully demonstrated his/her ability to solve or resolve problems related to the subject matter, the work, or the project.” The qualified person must perform the following duties in these circumstances:

- In General: To design and load scaffolds in accordance with that design.
- For Training: To train employees working on the scaffolds to recognize the associated hazards and understand procedures to control or minimize those hazards.
- For Suspension Scaffolds: To design the rigging for single-point adjustable suspension scaffolds. To design platforms on two-point adjustable suspension types that are less than 36 inches (0.9 m) wide to prevent instability. To make swaged attachments or spliced eyes on wire suspension ropes.
- For Components and Design: To design scaffold components construction in accordance with the design.

13.3: Scaffold Components

Capacity requirements for all scaffolds

Each scaffold and scaffold component must support without failure its own weight and at least four times the maximum intended load applied or transmitted to it. A qualified person must design the scaffolds, which are loaded in accordance with that design. Scaffolds and scaffold components must not be loaded in excess of their maximum intended loads or rated capacities, whichever is less. Load carrying timber members should be a minimum of 1,500 lb-f/in² construction grade lumber.

Scaffold platform construction

Each scaffold platform must be planked and decked as fully as possible with the space between the platform and uprights not more than 1 inch (2.5 centimeters) wide. The space must not exceed 9 inches (24.1 centimeters) when side brackets or odd-shaped structures result in a wider opening between the platform and the uprights. Scaffold planking must be able to support, without failure, its own weight and at least four times the intended load. Solid sawn wood, fabricated planks, and fabricated platforms may be used as scaffold planks following the recommendations by the manufacturer or a lumber grading association or inspection agency. The platform must not deflect more than 1/60 of the span when loaded. Each scaffold platform and walkway must be at least 18 inches (46 centimeters) wide. When the work area is less than 18 inches (46 centimeters) wide, guardrails and/or personal fall arrest systems must be used.

The standard requires employers to protect each employee on a scaffold more than 10 feet (3.1 m) above a lower level from falling to that lower level. To ensure adequate protection, install guardrails along all open sides and ends before releasing the scaffold for use by employees, other than the erection and dismantling crews. Guardrails are not required, however, when the front end of all platforms are less than 14 inches (36 centimeters) from the face of the work; when outrigger scaffolds are 3 inches (8 centimeters) or less from the front edge. Place platforms so that the spaces between them do not exceed one inch unless more space is necessary (for fitting around uprights with side brackets to extend platform width, for example).

Supported Scaffolds

Supported scaffolds are platforms supported by legs, outrigger beams, brackets, poles, uprights, posts, frames, or similar rigid support. The structural members, poles, legs, posts, frames, and uprights, must be plumb and braced to prevent swaying and displacement. When employees are plastering and lathing 18 inches (46 centimeters) or less from the front edge. All employees must be trained by a qualified person to recognize the hazards associated with the type of scaffold being used and how to control or minimize those hazards. The training must include fall hazards, falling object hazards, electrical hazards, proper use of the scaffold, and handling of materials.

Supported scaffolds with a height to base width ratio of more than 4:1 must be restrained by guying, tying, bracing, or an equivalent means. Either the manufacturers' recommendation or the following placements must be used for guys, ties, and braces: Install guys, ties, or braces at the closest horizontal member to the 4:1 height and repeat vertically with the top restraint no further than the 4:1 height from the top. Vertically—every 20 feet (6.1 meters) or less for scaffolds less than three feet (0.91 meters) wide; every 26 feet (7.9 meters) or less for scaffolds more than three feet (0.91 meters) wide. Horizontally—at each end; at intervals not to exceed 30 feet (9.1 meters) from one end. Supported scaffolds' poles, legs, posts, frames, and uprights must bear on base plates and mud sills, or other adequate firm foundation. Forklifts can support platforms only when the entire platform is attached to the fork and the forklift does not move horizontally when workers are on the platform. Front-end loaders and similar equipment can support scaffold platforms only when they have been specifically designed by the manufacturer for such use. Stilts may be used on a large area scaffold. When a guardrail system is used, the guardrail height must be increased in height equal to the height of the stilts. The manufacturer must approve any alterations to the stilts. Note: A large area scaffold consists of a pole, tube and coupler systems, or a fabricated frame scaffold erected over substantially the entire work area.

Suspended Scaffolds

A suspension scaffold contains one or more platforms suspended by ropes or other non-rigid means from an overhead structure,

such as the following scaffolds: single-point, multi-point, multi-level, two-point, adjustable, boatswains' chair, catenary, chimney hoist, continuous run, elevator false car, go-devils, interior hung, masons', and stone setters'.

Some of the requirements for all types of suspension scaffolds include: Employers must ensure that all employees are trained to recognize the hazards associated with the type of scaffold being used. All support devices must rest on surfaces capable of supporting at least four times the load imposed on them by the scaffold when operating at the rated load of the hoist, or at least one-and-a-half times the load imposed on them by the scaffold at the stall capacity of the hoist, whichever is greater. A competent person must evaluate all direct connections prior to use to confirm that the supporting surfaces are able to support the imposed load. All suspension scaffolds must be tied or otherwise secured to prevent them from swaying, as determined by a competent person. Guardrails, a personal fall arrest system, or both must protect each employee more than 10 feet (3.1 meters) above a lower level from falling. A competent person must inspect ropes for defects prior to each workshift and after every occurrence that could affect a rope's integrity. When scaffold platforms are more than 24 inches (61 centimeters) above or below a point of access, ladders, ramps, walkways, or similar surfaces must be used. When using direct access, the surface must not be more than 24 inches (61 centimeters) above or 14 inches (36 cm) horizontally from the surface. When lanyards are connected to horizontal lifelines or structural members on single-point or two-point adjustable scaffolds, the scaffold must have additional independent support lines equal in number and strength to the suspension lines and have automatic locking devices. Emergency escape and rescue devices must not be used as working platforms, unless designed to function as suspension scaffolds and emergency systems.

Counterweights used to balance adjustable suspension scaffolds must be able to resist at least four times the tipping moment imposed by the scaffold operating at either the rated load of the hoist, or one-and-a-half (minimum) times the tipping moment imposed by the scaffold operating at the stall load of the hoist, whichever is greater. Only those items specifically designed as counterweights must be used. Counterweights used for suspended scaffolds must be made of materials that can not be easily dislocated. Flowable material, such as sand or water, cannot be used. Counterweights must be secured by mechanical means to the outrigger beams. Vertical lifelines must not be fastened to counterweights. No materials or devices may be used to increase the working height on a suspension scaffold. This includes ladders, boxes, and barrels.

Narrow Frame Scaffolds

Narrow frame scaffolds, also known as Baker/Perry style scaffolds, are among the most popular pieces of construction equipment. Due to their versatility many contractors use them instead of ladders because they allow workers to maintain their balance and work more easily from the platform. A narrow frame scaffold has wheels and is often used as a mobile scaffold with the end frame measuring 3 feet or less in width. Designed to be easily moved, they are used for operations such as painting, drywall installation, plastering, and other jobs where workers must frequently change position. Scaffolds can be adapted to stairs, ramps, and other uneven surfaces.

Some of the hazards associated with narrow frame scaffolds, **can** lead to personal injury or death; they include: Falls from an elevated level, Tip-overs, Electric shocks, and Structural failures (collapse).

Improper Scaffold Construction

Working with heavy equipment and building materials on the limited space of a scaffold is difficult. Without fall protection or safe access, it becomes hazardous. Falls from such improperly constructed scaffolds can result in injuries ranging from sprains to death.

How Do I Avoid Hazards?

- Construct all scaffolds according to the manufacturer's instructions.
- Install guardrail systems along all open sides and ends of platforms.
- Use at least one of the following for scaffolds more than 10 feet above a lower level:
 - • Guardrail Systems
 - • Personal Fall Arrest Systems
- Provide safe access to scaffold platforms.
- Do not climb cross-bracing as a means of access.

The majority of the workers injured in scaffold accidents attribute the accident to factors like the planking or support giving way, or to lack of guardrails or other fall protection. OSHA's most frequently cited serious scaffold violations include lack of fall protection; scaffold access; use of aerial lifts without body belts and lanyards, platform construction and no worker training.

Scaffold work requires guardrails or a personal fall arrest system on any platform 10 feet or higher. Also, do not climb cross-bracing as a means of access; safe access must be provided by your employer. Ensure that your fall protection equipment is right for the work you are doing, in good condition, and that you use it properly. Remember that your employer needs to provide you with protection to prevent falls at your worksite.

13.4: Scaffold Access

Employers must provide access when the scaffold platforms are more than 2 feet (0.6 meters) above or below a point of access. Direct access is acceptable when the scaffold is not more than 14 inches (36 centimeters) horizontally and not more than 24 inches (61 centimeters) vertically from the other surfaces. The standard prohibits the use of crossbraces as a means of access. Climbing the structural cross-braces of a scaffold is unsafe, and specifically forbidden by federal standards. However, OSHA permits direct access from another scaffold, structure, or personnel hoist. If such access is not possible, portable ladders, hook-on ladders, attachable ladders, stair towers, stairway-type ladders, ramps, walkways, or built-in ladders must be used, under the following regulations:

Portable, Hook-on, and Attachable Ladders

- Must be positioned so as not to tip the scaffold.

Hook-on and Attachable Ladders

- Must be specifically designed for the type of scaffold with which they are used.
- Must have their lowest rung no more than 24 inches above the level on which the scaffold is supported.
- When used on a supported scaffold more than 35 feet high, must have rest platforms at 35-foot maximum intervals.
- Must have a minimum rung length of 11½ inches, and a maximum space between rungs of 16¾ inches.

Stairway-type Ladders

- Must have their bottom step no more than 24 inches above the level on which the scaffold is supported.
- Must have rest platforms at 12-foot maximum intervals.
- Must have a minimum step width of 16 inches, except that mobile stairway-type ladders shall have a minimum step width of 11½ inches.
- Must have slip-resistant treads on all steps and landings.

Stair Towers

- Must have their bottom step no more than 24 inches above the level on which the scaffold is supported.
- Must have a stair-rail, consisting of a top-rail and a mid-rail, on each side.
 - The top-rail of each stair-rail must also be capable of serving as a handrail, unless a separate handrail is provided.
 - Stair-rails and handrails must be designed and constructed to prevent punctures, lacerations, snagged clothing, and projection.
 - Handrails, and top-rails used as handrails must be at least 3 inches from other objects.
 - Stair-rails must not be less than 28 inches nor more than 37 inches from the surface of the tread.
- Must be at least 18 inches wide between stair-rails, and have a landing platform at least 18 inches wide by at least 18 inches long at each level.
- Must have slip-resistant surfaces on all treads and landings.
- Must be installed between 40 degrees and 60 degrees from the horizontal.
- Must have uniform riser height, within ¼ inch, for each flight of stairs, except for the top and bottom steps of the *entire* system.
- Must have uniform tread depth, within ¼ inch, for each flight of stairs.

Built-in Scaffold Ladders

- Must be specifically designed and constructed for use as ladder rungs.
- Must have a rung length of at least 8 inches.
- Must not be used as work platforms when rungs are less than 11½ inches, unless each employee uses fall protection or a positioning device.

- Must be uniformly spaced within each frame section.
- Must have rest platforms at 35-foot maximum intervals on all supported scaffolds more than 35 feet high.
- Must have a maximum space between rungs of 16¾ inches.

Steps and rungs of ladders and stairways must line up vertically with each other between rest platforms.

Ramps and Walkways

- Must have guardrails which comply with 29 CFR 1926.502(b) and 29 CFR 1926 Subpart M if more than 6 feet above lower levels.
- Must have a slope of no more than 1 vertical to 3 horizontal degrees (20 degrees above the horizontal).
- Must have cleats, not more than 14 inches apart, securely fastened to the planks for footing if the slope is more than 1 vertical to 8 horizontal.

Direct Access

- Direct access to or from another surface shall only be used when the scaffold is not more than 14 inches horizontally and 24 inches vertically from the other surface.

13.5: Scaffold Safety

Fall protection for Scaffolds

Fall protection includes guardrail systems and personal fall arrest systems. Guardrail systems are explained below in another question. Personal fall arrest systems include harnesses, components of the harness/belt such as Dee-rings, and snap hooks, lifelines, and anchorage point. Vertical or horizontal lifelines may be used. Lifelines must be independent of support lines and suspension ropes and not attached to the same anchorage point as the support or suspension ropes. When working from an aerial lift, attach the fall arrest system to the boom or basket.

Employers must provide fall protection for each employee on a scaffold more than 10 feet (3.1 meters) above a lower level. A competent person must determine the feasibility and safety of providing fall protection for employees erecting or dismantling supported scaffolds. Personal fall arrest systems can be used on scaffolding when there are no guardrail systems. Each employee on a self-contained adjustable scaffold shall be protected by a guardrail system (with minimum 200 pound top rail capacity) when the platform is supported by the frame structure, and by both a personal fall arrest system and a guardrail system (with minimum 200 pound top rail capacity) when the platform is supported by ropes. Vehicle-mounted aerial devices used to elevate employees—such as extensible boom platforms, aerial lifts, articulating boom platforms, and vertical towers—are considered “aerial lifts.”

Falling objects for Scaffolds

If you're exposed to falling objects (such as tools, materials, or equipment), you must wear a hard hat and ensure that you're protected from above by toe boards, screens, guardrail systems, debris nets, catch platforms, or canopies. Your hard hat can't be the only means of protecting you from falling objects.

If people below you are exposed to falling objects, you must barricade the area below your scaffold or place a toe board along the edge of the scaffold platform. Use panels or screens to protect people below when tools, materials, or equipment are piled higher than the top edge of the toe board.

Scaffold Safety

Employers must ensure the following:

- Follow the manufacturer's allowable load for the casters, scaffold components and platforms, along with recommended bracing to ensure a rigid and structurally sound scaffold.
- Assess the work area, site conditions, and work to be performed.
- Conduct a pre-operation inspection to verify that all scaffold components are functioning properly and/or are correctly assembled.
- Keep the platform free from tripping hazards such as hand tools, equipment, or materials.
- Lock scaffold wheels with positive wheel and/or wheel and swivel locks to prevent movement while in use.
- Use guardrails which include top rails, mid- rails, and toe boards, or fall protection at working platform heights of 10 feet or higher.
- Stay at least 10 feet away from energized power lines.
- If outriggers are installed, deploy installed outriggers on both sides of the scaffold. All locking pins must be engaged before using the scaffold.

Employers must ensure that workers have been effectively trained in the following:

- Not to stand on the guardrail or use any components of the scaffold or other items (e.g., stepladders, buckets, boxes, barrels, etc.) inside the scaffold to gain additional standing height.
- Not to try to pull yourself from one location to another while standing on the platform.
- Not to use a scaffold if it is incomplete, broken or has missing or ill-fitting parts which need replacement. Contact your employer immediately.
- Not to move the scaffold with worker(s) on the scaffold when:

--The worker(s) on the scaffold is unaware of the move and/or the surface under the scaffold is not within 3 degrees of level and free of pits, holes or obstructions.

--The worker is on any part of the scaffold which extends outward beyond the wheels, casters, or other supports.

--Manual force is not being applied as close to the base as practicable. Manual force must be applied not more than 5 feet above the supporting surface (1926.452(w)(3)).

--The height to base width ratio of the scaffold during movement is greater than 2 to 1, unless the scaffold is designed and constructed to meet or exceed nationally recognized stability test requirements (such as ANSI/SIA A92.5 and A92.6) (1926.452(w)(6)(ii)).

Employers must retrain employees when inadequacies are observed, changes in worksite conditions occur or when it is believed that an employee lacks the skill or understanding needed for safe work involving the erection, use or dismantling of the scaffold.

13.6: Summary

Scaffold must be sound, rigid and sufficient to carry its own weight plus four times the maximum intended load without settling or displacement. It must be erected on solid footing.

Unstable objects, such as barrels, boxes, loose bricks or concrete blocks must not be used to support scaffolds or planks.

Scaffold must not be erected, moved, dismantled or altered except under the supervision of a competent person.

Scaffold must be equipped with guardrails, midrails and toeboards.

Scaffold accessories such as braces, brackets, trusses, screw legs or ladders that are damaged or weakened from any cause must be immediately repaired or replaced.

Scaffold platforms must be tightly planked with scaffold plank grade material or equivalent.

A “competent person” must inspect the scaffolding and, at designated intervals, reinspect it.

Rigging on suspension scaffolds must be inspected by a competent person before each shift and after any occurrence that could affect structural integrity to ensure that all connections are tight and that no damage to the rigging has occurred since its last use.

Synthetic and natural rope used in suspension scaffolding must be protected from heat-producing sources.

Employees must be instructed about the hazards of using diagonal braces as fall protection.

Scaffold can be accessed by using ladders and stairwells.

Scaffolds must be at least 10 feet from electric power lines at all times.

13.7: Review Questions

Multiple Choice Questions

1. Which of the following is a supported scaffold?
 - (a) a platform suspended by ropes from above
 - (b) a platform supported by poles or frames
 - (c) a movable ladder
 - (d) a rope hoist system
2. The main reason for scaffold-related injuries is:
 - (a) improper weather conditions
 - (b) lack of proper training and unsafe setup
 - (c) faulty building materials
 - (d) use of metal planks
3. According to OSHA, scaffolds must be designed by:
 - (a) a competent person
 - (b) a qualified person
 - (c) a site supervisor
 - (d) the construction foreman
4. A scaffold is best defined as:
 - (a) a permanent structure used in building
 - (b) an elevated, temporary work platform
 - (c) a steel frame used for welding
 - (d) a fixed stair system for buildings
5. A competent person is defined by OSHA as someone who:
 - (a) has a college degree in construction
 - (b) can identify existing and predictable hazards and has authority to correct them
 - (c) works under the direction of a foreman
 - (d) supervises scaffold users only
6. A qualified person is defined as someone who:
 - (a) has recognized credentials or extensive experience to solve scaffold-related problems
 - (b) has attended at least one scaffold safety class
 - (c) is assigned by the employer as team leader
 - (d) holds an OSHA card
7. Who is responsible for inspecting scaffolds before each work shift?
 - (a) competent person
 - (b) qualified person
 - (c) site manager
 - (d) any work on site
8. Each scaffold must support at least:
 - (a) Twice the maximum intended load
 - (b) Four times the maximum intended load
 - (c) Five times the total work weight
 - (d) Only its own weight
9. Which of the following cannot be used as a means of access to a scaffold?
 - (a) Cross-bracing
 - (b) Hook-on ladder

- (c) Stair tower
- (d) Built-in ladder

10. Which of the following provides acceptable fall protection?

- (a) Hard hat
- (b) Guardrail system or personal fall arrest system
- (c) Safety net only
- (d) Toe boards

11. Narrow frame scaffolds are also known as:

- (a) Baker/Perry style scaffolds
- (b) Swing stage scaffolds
- (c) Tower scaffolds
- (d) Mason scaffolds

12. Which of the following is not a common scaffold hazard?

- (a) Falls from elevation
- (b) Collapse due to instability
- (c) Electrocution
- (d) Exposure to sunlight

13. Which of the following is not safe practice when working on scaffolds?

- (a) Locking scaffold wheels during use
- (b) Using guardrails and toe boards
- (c) Moving a scaffold while a worker is on it
- (d) Keeping the platform clear of tripping hazards

14. If a scaffold shifts because it was built on unstable ground, the employer failed to:

- (a) Provide proper signage
- (b) Conduct an engineering survey
- (c) Ensure a competent person supervised its erection
- (d) Train workers in electrical safety

15. Which of the following statements about scaffold load capacity is correct?

- (a) Scaffolds must support only the worker's weight
- (b) Scaffolds must support at least twice the intended load
- (c) Scaffolds must support their own weight plus four times the intended load
- (d) Scaffolds must support their own weight plus ten times the intended load

16. What should be done if a scaffold or its component is found damaged?

- (a) Continue using it until the shift ends
- (b) Report it but continue working
- (c) Removing it from service until repaired or replaced
- (d) Strengthen it using spare boards

17. When must employers retrain scaffold workers?

- (a) Every 5 years
- (b) Whenever unsafe practices or new hazards are identified
- (c) Only after an accident occurs
- (d) Once per project completion

True/False Questions

- 18. True/False: A scaffold is a permanent structure used for accessing elevated areas.
- 19. True/False: Scaffold accidents usually occur due to untrained workers or improper training.
- 20. True/False: Scaffold safety training is optional if the worksite supervisor is present.
- 21. True/False: A competent person has the authority to correct hazards immediately.

- 22. True/False: Scaffold platforms can have any amount of space between the planks and uprights.
- 23. True/False: A hard hat alone provides sufficient protection against falling objects.
- 24. True/False: Employers must retrain workers whenever unsafe practices or condition changes are observed.
- 25. True/False: Scaffolds can safely be moved with workers on the platform, as long as the surface is level.

Answer Key: 1) b, 2) b, 3) b, 4) b, 5) b, 6) a, 7) a, 8) b, 9) a, 10) b, 11) a, 12) d, 13) c, 14) c, 15) c, 16) c, 17) b, 18) False, 19) True, 20) False, 21) True, 22) False, 23) False, 24) True, 25) False.

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14: FIRE PROTECTION AND PREVENTION

14.1: Introduction

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14.1: Introduction

The Occupational Safety and Health Administration (OSHA) requires employers to implement fire protection and prevention programs in the workplace. Fire is a chemical reaction that requires three elements to be present for the reaction to take place and continue. The three elements are: heat, or an ignition source, fuel and oxygen.

These three elements typically are referred to as the “fire triangle.” Fire is the result of the reaction between the fuel and oxygen in the air. Scientists developed the concept of a fire triangle to aid in understanding of the cause of fires and how they can be prevented and extinguished. Heat, fuel and oxygen must combine in a precise way for a fire to start and continue to burn. If one element of the fire triangle is not present or removed, fire will not start or, if already burning, will extinguish.

Ignition sources can include any material, equipment or operation that emits a spark or flame—including obvious items, such as torches, as well as less obvious items, such as static electricity and grinding operations. Equipment or components that radiate heat, such as kettles, catalytic converters and mufflers, also can be ignition sources.

Fuel sources include combustible materials, such as wood, paper, trash and clothing; flammable liquids, such as gasoline or solvents; and flammable gases, such as propane or natural gas.

Oxygen in the fire triangle comes from the air in the atmosphere. Air contains approximately 79 percent nitrogen and 21 percent oxygen. OSHA describes a hazardous atmosphere as one which is oxygen-deficient because it has less than 19.5 percent oxygen, or oxygen enriched because it has greater than 23.5 percent oxygen. Either instance is regarded by OSHA as an atmosphere immediately dangerous to life and health (IDLH) for reasons unrelated to the presence of fire. Depending on the type of fuel involved, fires can occur with much lower volume of oxygen present than needed to support human respiration.

Every roofing project has all three of the fire triangle elements present in abundance. The key to preventing fires is to keep heat and ignition sources away from materials, equipment and structures that could act as fuel to complete the fire triangle.

14.2: Definitions

Fire Classifications

Fires are classified as A, B, C, D or K based on the type of substance that is the fuel for the fire, as follows: Class A—fires involving ordinary combustibles, such as paper, trash, some plastics, wood and cloth. A rule of thumb is if it leaves an ash behind, it is a Class A fire. Class B—fires involving flammable gases or liquids, such as propane, oil and gasoline. Class C—fires involving energized electrical components. Class D—fires involving metal. A rule of thumb is if the name of the metal ends with the letters “um,” it is a Class D fire. Examples of this are aluminum, magnesium, beryllium and sodium. Class D fires rarely occur in the roofing industry. Class K—fires involving vegetable or animal cooking oils or fats; common in commercial cooking operations using deep fat fryers

Fire Extinguishers

There are different types of fire extinguishers designed to put out the different classes of fire. Selecting the appropriate fire extinguisher is an important consideration for a roofing contractor. The wrong extinguisher actually may make a fire emergency worse. For example, failing to use a C-rated extinguisher on energized electrical components may endanger workers by causing the extinguishing material to be electrified by the energized components that are on fire. C-rated fire extinguishers put out the fire by using a chemical that does not conduct electricity.

Fire Prevention

Fire prevention requires segregating the three elements of the fire triangle. In practice, a method to achieve that goal is to post—and enforce—no-smoking signs around flammable liquids and gases and have fire watches on all work involving torch-applied materials of a minimum of two hours after the last torch is turned off.

Flammable and Combustible Liquids

Proper storage and handling of flammable and combustible liquids will help prevent fires from occurring; only approved, closed containers for storage of flammable or combustible liquids may be used under OSHA rules. Such containers include safety cans or containers approved by the U.S. Department of Transportation. A safety can is a container that has a self-closing lid, internal-pressure relief and flame arrestor with a capacity of not more than 5 gallons. Inexpensive, plastic cans without those features previously mentioned, such as those typically bought at hardware stores or gas stations, are not approved for use in roofing operations. However, manufacturers do sell plastic containers that meet the OSHA requirements for safety cans.

Flammable liquids that are extremely viscous, or difficult to pour, like single-ply adhesive, can be left in their original shipping containers. Similarly, OSHA allows the use of original containers of flammable liquids that are in quantities of one gallon or less.

Static electricity may be generated when transferring liquids, gases or solids through pipes or hoses. It is important to dissipate this electric charge when handling flammable and combustible materials. When transferring flammable or combustible liquids from one container to another, the two containers must be “bonded” together. The bonding process involves attaching a wire with alligator clips on each end to both containers. The clips must penetrate the container coating and touch metal. You may need to score the paint with the alligator clips. To dissipate static, the container receiving the liquid must be in contact with the ground and not insulated from contact with the ground. For example, plastic or composite pickup truck bed liners prevent the flow of static electricity to ground because the liner does not conduct electricity. The receptacle container must have a clear path to ground, by direct contact or use of a grounding strap or wire, to effectively eliminate static.

Fire Alarm Devices

OSHA requires an alarm system established by an employer to alert workers on the job site and local fire departments of fire emergencies. Job-site telephones and employee entrances must have alarm codes and reporting instructions at employee

entrances.

A roofing contractor's emergency action plan for the job site must include:

- Emergency escape procedures
- Equipment operation procedures prior to evacuation
- Procedures to account for all employees
- Rescue and medical duties for those employees responsible for such duties
- Preferred means of reporting emergencies
- Names and titles of employees with duties under the plan

14.3: Fire Protection

Employee Training

OSHA requires that all employees be trained to use fire extinguishers. Training is required upon employment and at least annually thereafter. It is recommended the training session cover how to determine when a fire is too big to handle; what type of extinguisher to use; and the PASS system of early-stage firefighting. It also is recommended that live fire training be conducted periodically (this level of training is not needed each year). Live training exposes employees to the pressure released from a fire extinguisher when the handle is squeezed and provides hands-on practice extinguishing a fire. Some local fire departments and most fire extinguisher suppliers offer this type of training.

Reporting and Extinguishing a Fire

- The fire department and area supervisor will be notified when a fire is spotted.
- All workers will be alerted and evacuated as needed.
- The PASS method will be used to extinguish the fire by those employees who have been properly trained.
- The area will be evacuated immediately if the fire is large.

Fire Protection

- Before each project begins, the project manager or designee will contact the local fire department and determine whether any variations from the company's standard fire-prevention procedures are required.
- No-smoking signs will be posted in all regulated areas.
- Only approved containers will be used to store flammable or combustible materials.
- All containers will be bonded together and grounded when transferring flammable or combustible liquids.
- All work areas will be kept free of debris and other combustible materials.

Inside company-owned or leased buildings, fire extinguishers will be spaced no more than 100 feet apart and will have no less than a 2A rating for every 3,000 feet of protected building.

- All employees will be trained on the use of fire extinguishers initially upon hire and annually thereafter.
- No employee will be permitted to use an extinguisher without having been fully trained.
- Fire extinguishers will be stored at a distance no greater than 10 feet from torch users.
- A fire extinguisher, rated not less than 10B, will be provided within 50 feet of the location where more than 5 gallons of flammable or combustible liquids or 5 pounds of a flammable gas are used on a job site.
- Mops will be "spun out" and placed on a noncombustible surface at the end of each day on projects involving hot bitumen.
- A fire watch will be posted for two hours after work has concluded for torch-applied roof systems.

Flammable and Combustible Liquid Storage

- No more than 25 gallons of flammable and combustible liquids will be stored outside approved safety cabinets in indoor

locations.

- No more than 60 gallons of flammable liquids will be stored inside an approved safety cabinet in indoor locations.
- Combustible liquids will not exceed 120-gallon capacity inside approved safety cabinets.
- The number of approved safety cabinets in one room will not exceed three.
- Gasoline will not be used as a solvent for cleaning.
- All containers will be labeled in accordance with OSHA's Hazard Communication Standard.
- Buildings or structures containing flammable liquids or gases must be constructed of fire-resistant material.
- Flammable liquids or gases will be kept away from heat and ignition sources including welding work or any other operation involving flames or sparks.

Handling Flammable Gases

- LPG cylinders will be placed on a firm foundation and secured in an upright position.
- All LPG cylinders will be equipped with valve-protection devices.
- LPG cylinders will not be stored closer than 10 feet to the kettle.
- LPG cylinders will be placed away from vehicular traffic.
- LPG cylinders will not be stored inside buildings.
- Acetylene bottles will be stored in the upright position and secured.
- When in transport or not in use, acetylene bottles will have caps in place.
- Oxygen cylinders must be stored at least 20 feet from acetylene cylinders.

Handling Flammable and Combustible Liquids

- During refueling operations, all engines and motors will be turned off and allowed to cool.
- Open flames or other ignition sources must be kept at least 50 feet away from flammable or combustible liquids.
- No smoking will be permitted during the fueling process.
- Containers being filled will be placed directly on the ground or a grounding strap attached to form a connection to ground.
- No flammable liquid or gas will be used unless it has been positively identified beforehand.
- Health and physical hazards will be communicated to employees in accordance with OSHA's Hazard Communication Standard before the product is used.
- When flammable liquids and gases are being transported, all Department of Transportation rules will be followed.

Fire Extinguishers

- In buildings, all fire extinguishers will be mounted on a wall and properly marked.
- All vehicles will carry at least one ABC-rated extinguisher.

- When at a job site, all employees will know the location of each fire extinguisher.
- Before using an extinguisher, all employees will be trained and familiar with the PASS method of firefighting.
- Each fire extinguisher will be inspected monthly to make sure it is in its designated location and has not been tampered with or actuated.
- Each fire extinguisher will be clearly visible with nothing obstructing or obscuring it from view.

All fire extinguishers will be examined at least yearly and/or recharged or repaired to ensure operability and safety. A tag must be attached to show the maintenance or recharge date and the signature or initials of the person performing the service.

Employers should train workers about fire hazards in the workplace and about what to do in a fire emergency. When required, employers must develop an emergency action plan that: Describes the routes for workers to use and procedures to follow. Accounts for all evacuated employees. Remains available for employee review. Includes procedures for evacuating disabled employees. Addresses evacuation of employees who stay behind to shut down critical plant equipment. Includes preferred means of alerting employees to a fire emergency. Provides for an employee alarm system throughout the workplace. Requires an alarm system that includes voice communication or sound signals such as bells, whistles, or horns. Makes the evacuation signal known to employees. Ensures the provision of emergency training. Requires employer review of the plan with new employees and with all employees whenever the plan is changed.

14.4: Fire Prevention Plan

The purpose of the fire prevention plan is to prevent a fire from occurring in a workplace. It describes the fuel sources (hazardous or other materials) on site that could initiate or contribute both to the spread of a fire, as well as the building systems, such as fixed fire extinguishing systems and alarm systems, in place to control the ignition or spread of a fire.

A fire prevention plan must be in writing, be kept in the workplace, and be made available to employees for review. However, an employer with 10 or fewer employees may communicate the plan orally to employees.

At a minimum, your fire prevention plan must include:

- A list of all major fire hazards, proper handling and storage procedures for hazardous materials, potential ignition sources and their control, and the type of fire protection equipment necessary to control each major hazard.
- Procedures to control accumulations of flammable and combustible waste materials.
- Procedures for regular maintenance of safeguards installed on heat-producing equipment to prevent the accidental ignition of combustible materials.
- The name or job title of employees responsible for maintaining equipment to prevent or control sources of ignition or fires.
- The name or job title of employees responsible for the control of fuel source hazards.

An employer must inform employees upon initial assignment to a job of the fire hazards to which they are exposed. An employer must also review with each employee those parts of the fire prevention plan necessary for self-protection.

14.5: Review Questions

Multiple Choice Questions

1. Which of the following elements are part of the fire triangle?
 - (a) Fuel, Water, Oxygen
 - (b) Heat, Fuel, Oxygen
 - (c) Heat, Smoke, Air
 - (d) Carbon, Fuel, Light
2. What happens if one element of the fire triangle is removed?
 - (a) The fire burns slower
 - (b) The fire becomes stronger
 - (c) The fire will not start or will be extinguished
 - (d) Fire produces more smoke
3. Which of the following is not an example of an ignition source?
 - (a) Torches
 - (b) Static electricity
 - (c) Grinding operations
 - (d) Concrete slabs
4. How often must employees be trained to use fire extinguishers according to OSHA?
 - (a) Upon hire only
 - (b) Annually
 - (c) Every two years
 - (d) Monthly
5. A Fire Prevention Plan (FPP) must include all of the following except:
 - (a) Major fire hazards and controls
 - (b) Evacuation routes for employees
 - (c) Maintenance procedures for heat-producing equipment
 - (d) Names of responsible employees for fire safety duties
6. According to OSHA, an atmosphere with less than 19.5% oxygen is considered:
 - (a) Safe for short-term exposure
 - (b) Oxygen-enriched
 - (c) Immediately dangerous to life and health
 - (d) Fire-prone but not hazardous
7. What is the primary purpose of a Fire Prevention Plan (FPP)?
 - (a) To describe evacuation routes during an emergency
 - (b) To identify and control sources of ignition and fuel before a fire occurs
 - (c) To list the number of extinguishers required on a site
 - (d) To assign rescue duties during fire incidents
8. In the event of a fire, employees should only attempt to extinguish it if:
 - (a) They are the first person to see the fire
 - (b) They have been properly trained and the fire is small and contained
 - (c) They are within 50 feet of a fire extinguisher
 - (d) They are wearing protective gloves
9. Fire extinguishers must be:
 - (a) Recharged monthly
 - (b) Inspected monthly and serviced yearly

- (c) Inspected yearly only
- (d) Maintained only after use

True/False Questions

- 10. True/False: Fire requires three elements—heat, fuel, and oxygen—to start and continue burning.
- 11. True/False: Removing one part of the fire triangle will have little effect on an existing fire.
- 12. True/False: Static electricity cannot act as an ignition source
- 13. True/False: OSHA allows the use of open, non-approved containers for flammable liquids.
- 14. True/False: Employers must inform employees of fire hazards they are exposed to upon initial job assignment.
- 15. True/False: All fire extinguishers must be clearly visible and unobstructed.
- 16. True/False: All fire extinguishers are safe to use on any type of fire.
- 17. True/False: Only approved safety cans may be used for storing flammable or combustible liquids.
- 18. True/False: Fire extinguisher training is only required when a fire occurs on-site.

Answer Key: 1) b, 2) c, 3) d, 4) b, 5) b, 6) c, 7) b, 8) b, 9) b, 10) True, 11) False, 12) False, 13) False, 14) True, 15) True, 16) False, 17) True, 18) False.

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15: HAND AND POWER TOOLS

15.1: Introduction

15.2: Definitions

15.3: Identifying and Preventing Hazards

15.4: Review Questions

15.5: Sources

15.1: Introduction

Tools are such a common part of our lives that it is difficult to remember that they may pose hazards. Tragically, a serious incident can occur before steps are taken to identify and avoid or eliminate tool-related hazards.

Hand tools are tools that are powered manually. Hand tools include anything from axes to wrenches. The greatest hazards posed by hand tools result from misuse and improper maintenance.

Some examples include the following: If a chisel is used as a screwdriver, the tip of the chisel may break and fly off, hitting the user or other employees. If a wooden handle on a tool, such as a hammer or an axe, is loose, splintered, or cracked, the head of the tool may fly off and strike the user or other employees. If the jaws of a wrench are sprung, the wrench might slip. If impact tools such as chisels, wedges, or drift pins have mushroomed heads, the heads might shatter on impact, sending sharp fragments flying toward the user or other employees.

The employer is responsible for the safe condition of tools and equipment used by employees. Employers shall not issue or permit the use of unsafe hand tools. Employees should be trained in the proper use and handling of tools and equipment.

Employees, when using saw blades, knives, or other tools, should direct the tools away from aisle areas and away from other employees working in close proximity. Knives and scissors must be sharp; dull tools can cause more hazards than sharp ones. Cracked saw blades must be removed from service.

Wrenches must not be used when jaws are sprung to the point that slippage occurs. Impact tools such as drift pins, wedges, and chisels must be kept free of mushroomed heads. The wooden handles of tools must not be splintered.

Iron or steel hand tools may produce sparks that can be an ignition source around flammable substances. Where this hazard exists, spark-resistant tools made of non-ferrous materials should be used where flammable gases, highly volatile liquids, and other explosive substances are stored or used.

Appropriate personal protective equipment such as safety goggles and gloves must be worn to protect against hazards that may be encountered while using hand tools.

Workplace floors shall be kept as clean and dry as possible to prevent accidental slips with or around dangerous hand tools.

Power tools must be fitted with guards and safety switches; they are extremely hazardous when used improperly. The types of power tools are determined by their power source: electric, pneumatic, liquid fuel, hydraulic, and powder-actuated.

To prevent hazards associated with the use of power tools, workers should observe the following general precautions:

- Never carry a tool by the cord or hose.
- Never yank the cord or the hose to disconnect it from the receptacle.
- Keep cords and hoses away from heat, oil, and sharp edges.
- Disconnect tools when not using them, before servicing and cleaning them, and when changing accessories such as blades, bits, and cutters.
- Keep all people not involved with the work at a safe distance from the work area.
- Secure work with clamps or a vise, freeing both hands to operate the tool.
- Avoid accidental starting. Do not hold fingers on the switch button while carrying a plugged-in tool.
- Maintain tools with care; keep them sharp and clean for best performance.
- Follow instructions in the user's manual for lubricating and changing accessories.

- Be sure to keep good footing and maintain good balance when operating power tools.
- Wear proper apparel for the task. Loose clothing, ties, or jewelry can become caught in moving parts.
- Remove all damaged portable electric tools from use and tag them: "Do Not Use."

15.2: Definitions

Guards

The exposed moving parts of power tools need to be safe guarded. Belts, gears, shafts, pulleys, sprockets, spindles, drums, flywheels, chains, or other reciprocating, rotating, or moving parts of equipment must be guarded. Machine guards, as appropriate, must be provided to protect the operator and others from the following:

- Point of operation.
- In-running nip points.
- Rotating parts.
- Flying chips and sparks.

Safety guards must never be removed when a tool is being used. Portable circular saws having a blade greater than 2 inches (5.08centimeters) in diameter must be equipped at all times with guards. An upper guard must cover the entire blade of the saw. A retractable lower guard must cover the teeth of the saw, except where it makes contact with the work material. The lower guard must automatically return to the covering position when the tool is withdrawn from the work material.

Electric Tools

Employees using electric tools must be aware of several dangers. Among the most serious hazards are electrical burns and shocks. Electrical shocks, which can lead to injuries such as heart failure and burns, are among the major hazards associated with electric-powered tools. Under certain conditions, even a small amount of electric current can result in fibrillation of the heart and death. An electric shock also can cause the user to fall off a ladder or other elevated work surface and be injured due to the fall.

To protect the user from shock and burns, electric tools must have a three-wire cord with a ground and be plugged into a grounded receptacle, be double insulated, or be powered by a low-voltage isolation transformer. Three-wire cords contain two current-carrying conductors and a grounding conductor. Any time an adapter is used to accommodate a two-hole receptacle, the adapter wire must be attached to a known ground. The third prong must never be removed from the plug.

Double-insulated tools are available that provide protection against electrical shock without third-wire grounding. On double-insulated tools, an internal layer of protective insulation completely isolates the external housing of the tool.

The following general practices should be followed when using electric tools:

- Operate electric tools within their design limitations.
- Use gloves and appropriate safety footwear when using electric tools.
- Store electric tools in a dry place when not in use.
- Do not use electric tools in damp or wet locations unless they are approved for that purpose.
- Keep work areas well lighted when operating electric tools.
- Ensure that cords from electric tools do not present a tripping hazard.

In the construction industry, employees who use electric tools must be protected by ground-fault circuit interrupters or an assured equipment-grounding conductor program.

Portable Abrasive Wheel Tools

Portable abrasive grinding, cutting, polishing, and wire buffing wheels create special safety problems because they may throw off flying fragments. Abrasive wheel tools must be equipped with guards that: (1) cover the spindle end, nut, and flange projections; (2) maintain proper alignment with the wheel; and (3) do not exceed the strength of the fastenings.

Before an abrasive wheel is mounted, it must be inspected closely for damage and should be sound- or ring-tested to ensure that it is free from cracks or defects. To test, wheels should be tapped gently with a light, non-metallic instrument. If the wheels sound cracked or dead, they must not be used because they could fly apart in operation. A stable and undamaged wheel, when tapped, will give a clear metallic tone or “ring.”

To prevent an abrasive wheel from cracking, it must fit freely on the spindle. The spindle nut must be tightened enough to hold the wheel in place without distorting the flange. Always follow the manufacturer’s recommendations. Take care to ensure that the spindle speed of the machine will not exceed the maximum operating speed marked on the wheel.

An abrasive wheel may disintegrate or explode during start-up. Allow the tool to come up to operating speed prior to grinding or cutting. The employee should never stand in the plane of rotation of the wheel as it accelerates to full operating speed. Portable grinding tools need to be equipped with safety guards to protect workers not only from the moving wheel surface, but also from flying fragments in case of wheel breakage.

When using a powered grinder:

- Always use eye or face protection.
- Turn off the power when not in use.
- Never clamp a hand-held grinder in a vise.

Pneumatic Tools

Pneumatic tools are powered by compressed air and include chippers, drills, hammers, and sanders.

There are several dangers associated with the use of pneumatic tools. First and foremost is the danger of getting hit by one of the tool's attachments or by some kind of fastener the worker is using with the tool.

Pneumatic tools must be checked to see that the tools are fastened securely to the air hose to prevent them from becoming disconnected. A short wire or positive locking device attaching the air hose to the tool must also be used and will serve as an added safeguard.

If an air hose is more than ½-inch (12.7 millimeters) in diameter, a safety excess flow valve must be installed at the source of the air supply to reduce pressure in case of hose failure.

In general, the same precautions should be taken with an air hose that are recommended for electric cords, because the hose is subject to the same kind of damage or accidental striking, and because it also presents tripping hazards.

When using pneumatic tools, a safety clip or retainer must be installed to prevent attachments such as chisels on a chipping hammer from being ejected during tool operation.

Pneumatic tools that shoot nails, rivets, staples, or similar fasteners and operate at pressures more than 100 pounds per square inch must be equipped with a special device to keep fasteners from being ejected, unless the muzzle is pressed against the work surface.

Airless spray guns that atomize paints and fluids at pressures of 1,000 pounds or more per square inch (6,890 kPa) must be equipped with automatic or visible manual safety devices that will prevent pulling the trigger until the safety device is manually released.

Eye protection is required, and head and face protection is recommended for employees working with pneumatic tools.

Screens must also be set up to protect nearby workers from being struck by flying fragments around chippers, riveting guns, staplers, or air drills.

Compressed air guns should never be pointed toward anyone. Workers should never “dead-end” them against themselves or anyone else. A chip guard must be used when compressed air is used for cleaning.

Use of heavy jackhammers can cause fatigue and strains. Heavy rubber grips reduce these effects by providing a secure handhold. Workers operating a jackhammer must wear safety glasses and safety shoes that protect them against injury if the jackhammer slips or falls. A face shield also should be used.

Noise is another hazard associated with pneumatic tools. Working with noisy tools such as jackhammers requires proper, effective use of appropriate hearing protection.

Liquid Fuel Tools

Fuel-powered tools are usually operated with gasoline. The most serious hazard associated with the use of fuel-powered tools comes from fuel vapors that can burn or explode and also give off dangerous exhaust fumes. The worker must be careful to handle, transport, and store gas or fuel only in approved flammable liquid containers, according to proper procedures for flammable liquids.

Before refilling a fuel-powered tool tank, the user must shut down the engine and allow it to cool to prevent accidental ignition of hazardous vapors. When a fuel-powered tool is used inside a closed area, effective ventilation and/or proper respirators such as atmosphere-supplying respirators must be utilized to avoid breathing carbon monoxide. Fire extinguishers must also be available in the area.

Powder-Actuated Tools

Powder-actuated tools operate like a loaded gun and must be treated with extreme caution. In fact, they are so dangerous that they must be operated only by specially trained employees.

When using powder-actuated tools, an employee must wear suitable ear, eye, and face protection. The user must select a powder level—high or low velocity—that is appropriate for the powder-actuated tool and necessary to do the work without excessive force.

The muzzle end of the tool must have a protective shield or guard centered perpendicular to and concentric with the barrel to confine any fragments or particles that are projected when the tool is fired. A tool containing a high-velocity load must be designed not to fire unless it has this kind of safety device.

To prevent the tool from firing accidentally, two separate motions are required for firing. The first motion is to bring the tool into the firing position, and the second motion is to pull the trigger. The tool must not be able to operate until it is pressed against the work surface with a force of at least 5 pounds (2.2 kg) greater than the total weight of the tool.

If a powder-actuated tool misfires, the user must hold the tool in the operating position for at least 30 seconds before trying to fire it again. If it still will not fire, the user must hold the tool in the operating position for another 30 seconds and then carefully remove the load in accordance with the manufacturer's instructions. This procedure will make the faulty cartridge less likely to explode. The bad cartridge should then be put in water immediately after removal. If the tool develops a defect during use, it should be *tagged* and must be *taken out of service immediately* until it is properly repaired.

Safety precautions that must be followed when using powder-actuated tools include the following:

- Do not use a tool in an explosive or flammable atmosphere.
- Inspect the tool before using it to determine that it is clean, that all moving parts operate freely, and that the barrel is free from obstructions and has the proper shield, guard, and attachments recommended by the manufacturer.
- Do not load the tool unless it is to be used immediately.
- Do not leave a loaded tool unattended, especially where it would be available to unauthorized persons.

- Keep hands clear of the barrel end.
- Never point the tool at anyone.

When using powder-actuated tools to apply fasteners, several additional procedures must be followed:

- Do not fire fasteners into material that would allow the fasteners to pass through to the other side.
- Do not drive fasteners into very hard or brittle material that might chip or splatter or make the fasteners ricochet.
- Always use an alignment guide when shooting fasteners into existing holes.
- When using a high-velocity tool, do not drive fasteners more than 3 inches (7.62 centimeters) from an unsupported edge or corner of material such as brick or concrete.
- When using a high velocity tool, do not place fasteners in steel any closer than $\frac{1}{2}$ -inch (1.27 centimeters) from an unsupported corner edge unless a special guard, fixture, or jig is used.

Hydraulic Power Tools

The fluid used in hydraulic power tools must be an approved fire-resistant fluid and must retain its operating characteristics at the most extreme temperatures to which it will be exposed. The exception to fire-resistant fluid involves all hydraulic fluids used for the insulated sections of derrick trucks, aerial lifts, and hydraulic tools that are used on or around energized lines. This hydraulic fluid shall be of the insulating type.

The manufacturer's recommended safe operating pressure for hoses, valves, pipes, filters, and other fittings must not be exceeded.

All jacks—including lever and ratchet jacks, screw jacks, and hydraulic jacks—must have a stop indicator, and the stop limit must not be exceeded. Also, the manufacturer's load limit must be permanently marked in a prominent place on the jack, and the load limit must not be exceeded.

A jack should never be used to support a lifted load. Once the load has been lifted, it must immediately be blocked up. Put a block under the base of the jack when the foundation is not firm, and place a block between the jack cap and load if the cap might slip.

To set up a jack, make certain of the following:

- The base of the jack rests on a firm, level surface;
- The jack is correctly centered;
- The jack head bears against a level surface; and
- The lift force is applied evenly.

Proper maintenance of jacks is essential for safety. All jacks must be lubricated regularly. In addition, each jack must be inspected according to the following schedule: (1) for jacks used continuously or intermittently at one site—inspected at least once every 6 months, (2) for jacks sent out of the shop for special work—inspected when sent out and inspected when returned, and (3) for jacks subjected to abnormal loads or shock—inspected before use and immediately thereafter.

15.3: Identifying and Preventing Hazards

Employers must assess work activities to determine hazards or potential hazards, and implement measures to protect workers. The assessment must include evaluation of the equipment necessary (e.g., portable and hand-held power tools) for the task and any hazards that they might produce. Noise, respirable dust, flying projectiles, contact with sharp objects, as well as fire from heat generation and sparks, are some of the hazards associated with the use of portable and hand-held power tools. To prevent injuries with the use of portable and hand-held power tools, employers should train workers to:

Keep all tools in good condition with regular maintenance;

Use the right tool for the job;

Examine each tool for damage before use and do not use damaged tools;

Operate tools according to the manufacturers' instructions, including proper tool orientation and use of accessories or attachments; and

Use the right PPE provided for the task (e.g., gloves, respiratory protection, safety glasses, goggles, or face shield)

Employers and workers should work together to establish and maintain safe working conditions. If a hazardous situation arises, it should be brought immediately to the attention of the appropriate individual(s) for hazard abatement.

When using power grinders:

Always use eye or face protection.

Disconnect tools when not in use, before servicing or cleaning, and when changing accessories.

Never disable the pressure switch or control, such as by clamping the hand-held grinder in a vise.

Ensure that angular exposure of the grinding wheel periphery and sides do not exceed 180 degrees of safety guards in place.

Only replace accessories with those recommended by the manufacturer.

15.4: Review Questions

Multiple Choice Questions

1. The greatest hazards posed by hand tools result from:
 - (a) Overuse and fatigue
 - (b) Misuse and improper maintenance
 - (c) Manufacturing defects
 - (d) Incorrect labeling
2. If a wooden handle on a hammer or axe is loose, splintered, or cracked, the:
 - (a) Handle might slip
 - (b) Head of the tool may fly off
 - (c) Tool becomes heavier
 - (d) User gains better control
3. Spark-resistant tools should be used when working around:
 - (a) Wet environments
 - (b) Flammable gases and liquids
 - (c) Electrical hazards
 - (d) Dusty areas
4. Employers are responsible for:
 - (a) Employee personal habits
 - (b) The safe condition of tools used by employees
 - (c) Replacing all broken tools at their expense
 - (d) The design of tools used in other companies
5. Power tools are classified based on their:
 - (a) Weight and size
 - (b) Speed and torque
 - (c) Power source
 - (d) Handle design
6. Never carry a power tool by:
 - (a) the handle
 - (b) the cord or hose
 - (c) the safety guard
 - (d) the casing
7. Loose clothing and jewelry should be avoided when using power tools because:
 - (a) they can cause overheating
 - (b) they can become caught in moving parts
 - (c) they reduce grip
 - (d) they block airflow
8. One of the most serious hazards associated with electric tools is:
 - (a) vibration
 - (b) electrical burns and shocks
 - (c) dust inhalation
 - (d) noise
9. Double-insulated tools:
 - (a) require a three-wire grounding cord
 - (b) do not provide protection against electrical shock

- (c) are protected by an internal layer of insulation
- (d) must be used only outdoors

10. Electric tools should not be used in:

- (a) dry areas
- (b) damp or wet locations unless approved for that purpose
- (c) well-lighted areas
- (d) workshops with fans

11. Pneumatic tools are powered by:

- (a) gasoline
- (b) compressed air
- (c) water pressure
- (d) electricity

12. When using pneumatic tools, eye protection is:

- (a) optional
- (b) recommended only for new workers
- (c) required
- (d) not necessary if wearing gloves

13. Employers must assess work activities to determine:

- (a) production time
- (b) worker satisfaction
- (c) hazards or potential hazards
- (d) job completion rates

14. PPE for power tool use may include:

- (a) gloves, respirators, safety glasses
- (b) hair nets and sandals
- (c) earphones and scarves
- (d) none of the above

True/False Questions

- 15. True/False: Employers are responsible for ensuring that all tools used by employees are in safe condition.
- 16. True/False: Power tools must be equipped with guards and safety switches.
- 17. True/False: It is acceptable to remove safety guards from a tool to complete a job faster.
- 18. True/False: You should always carry power tools by their cords or hoses to prevent dropping them.
- 19. True/False: Keeping cords and hoses away from sharp edges and heat sources is part of safe tool maintenance.
- 20. True/False: Electric shocks from power tools can cause falls or even death.

Answer Key: 1) b, 2) b, 3) b, 4) b, 5) c, 6) b, 7) b, 8) b, 9) c, 10) b, 11) b, 12) c, 13) c, 14) a, 15) True, 16) True, 17) False, 18) False, 19) True, 20) True.

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GLOSSARY

Administrative Controls

Changes in work procedures, schedules, policies, or training that reduce worker exposure to hazards without physically removing the hazard.

Amputation

The loss of a body part due to a workplace injury.

Asbestos

A hazardous mineral fiber once commonly used in construction materials. Exposure may cause serious lung diseases.

Biological Hazard

A workplace hazard involving exposure to infectious diseases, mold, toxic plants, or animal materials that may cause illness or allergic reactions.

Caught-In or Between Hazard

A construction hazard where workers can be crushed, squeezed, pinched, or compressed between objects or machinery.

Confined Space

An enclosed or partially enclosed space with limited entry or exit that may contain hazardous atmospheres or other dangers.

Construction Safety

Practices, standards, and procedures intended to prevent injuries, illnesses, and fatalities on construction sites.

Controlled Access Zone

An area designated to limit worker access where certain construction activities occur.

Electrical Hazard

A workplace danger involving exposure to electric shock, burns, arc flash, or electrocution.

Elimination

The most effective hazard control method, which completely removes a hazard from the workplace.

Engineering Controls

Physical changes to equipment or processes that isolate workers from hazards, such as machine guards or ventilation systems.

Ergonomic Hazard

A workplace condition involves repetitive motion, awkward posture, vibration, or heavy lifting that may cause musculoskeletal disorders.

Fall Protection

Systems and methods used to prevent workers from falling from elevated surfaces or into openings.

Fatal Four

The four leading causes of construction worker deaths: falls, struck-by incidents, caught-in/between incidents, and electrocutions.

Fire Protection

Measures and equipment used to prevent or control workplace fires.

Guardrail System

A barrier system installed to prevent workers from falling to lower levels.

Hazard

Any condition, material, activity, or situation that can cause injury, illness, or death.

Hazard Assessment

The process of identifying workplace hazards and evaluating the likelihood and severity of harm.

Hazard Communication

Procedures for informing workers about chemical hazards through labels, SDSs, and training.

Hierarchy of Controls

A system for selecting hazard controls in order of effectiveness: elimination, substitution, engineering controls, administrative controls, and PPE.

Job Hazard Analysis

A method of examining job tasks to identify hazards and determine safe work procedures.

Leading Edge

The advancing edge of a floor, roof, or formwork where fall hazards exist during construction.

Lockout/Tagout

Procedures used to ensure machines and equipment are properly shut off and cannot restart during maintenance or servicing.

NIOSH

The National Institute for Occupational Safety and Health, a federal agency that conducts research and provides recommendations for workplace safety and health.

Occupational Safety and Health Administration (OSHA)

A federal agency within the U.S. Department of Labor responsible for enforcing workplace safety and health regulations.

OSH Act

The Occupational Safety and Health Act of 1970, the federal law establishing OSHA and workplace safety protections.

Personal Fall Arrest System

Equipment such as harnesses, lanyards, and anchors designed to protect a worker during a fall.

Personal Protective Equipment (PPE)

Protective clothing or devices worn by workers to reduce exposure to hazards, including hard hats, gloves, respirators, and safety glasses.

Respirator

A type of PPE designed to protect workers from inhaling harmful dusts, fumes, vapors, or gases.

Root Cause

The fundamental underlying reason an incident or hazard occurred.

Safety Data Sheet (SDS)

A document providing information about chemical hazards, safe handling, storage, and emergency measures.

Scaffold

A temporary elevated platform used to support workers and materials during construction.

Safety Net System

A fall protection system designed to catch workers after a fall.

Silica Dust

Fine particles generated during cutting, grinding, or drilling materials such as concrete or stone.

Struck-By Hazard

A construction hazard where workers are injured by moving vehicles, falling objects, or flying materials.

Substitution

Replacing a hazardous material, process, or activity with a safer alternative.

Trenching

An excavation deeper than it is wide, often used for underground utility installation.

Ventilation System

Engineering controls to remove airborne contaminants from the workplace.

Whistleblower

A worker who reports unsafe working conditions, violations, or illegal activities and is protected from retaliation under OSHA law.

Workplace Violence

Violent acts, threats, intimidation, or disruptive behavior occurring in the workplace.

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Overview

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