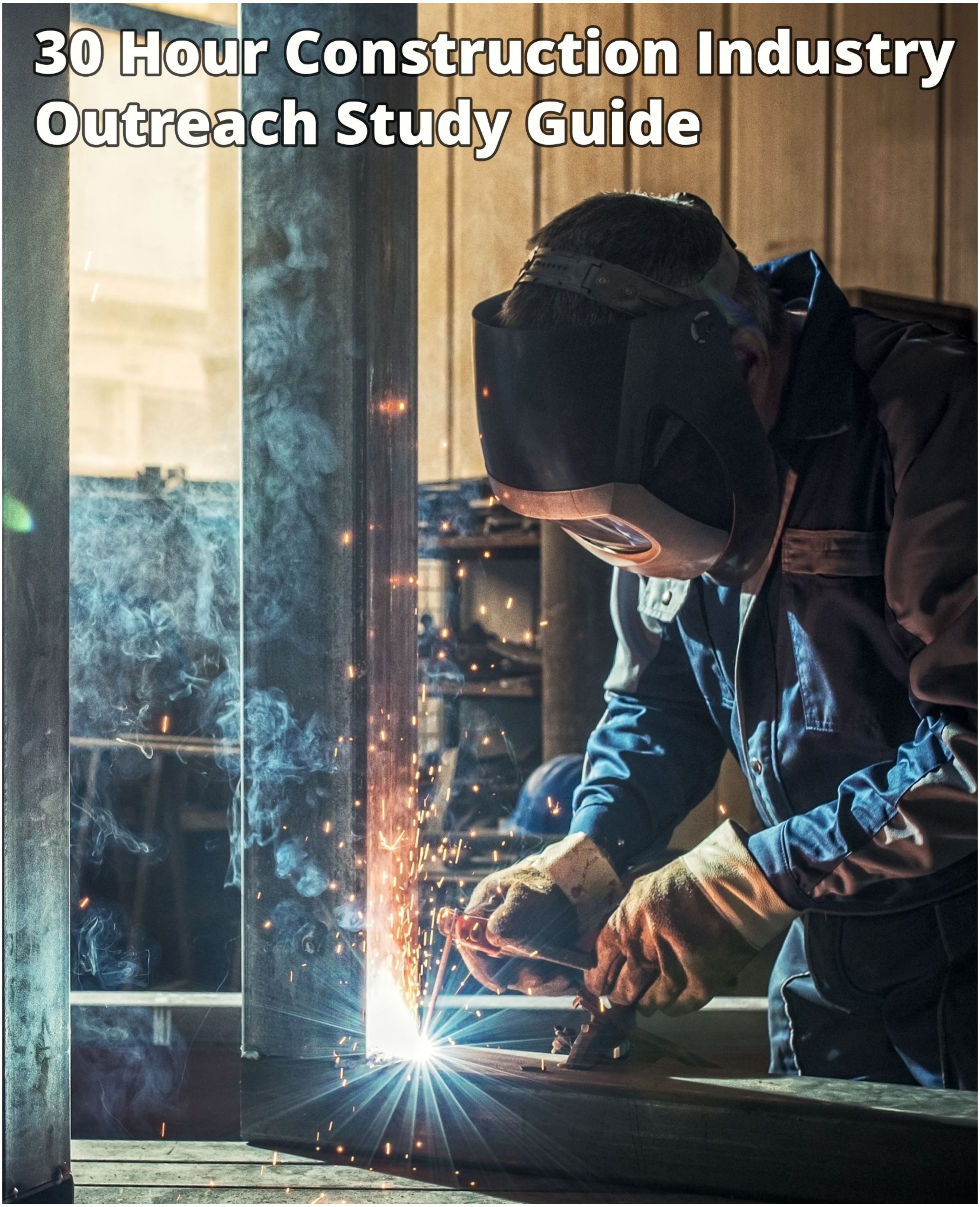
30 Hour Construction Industry Outreach Study Guide



UNIVERSAL 18
U18
SAFETY SOLUTIONS

Table of Contents

Course Description

The OSHA 30 Hour Construction Industry Outreach Training course is a comprehensive safety program designed for anyone involved in the construction industry. Specifically devised for safety directors, foremen, and field supervisors; the program provides information on OSHA compliance issues. OSHA recommends Outreach Training Programs as an orientation to occupational safety and health for workers, covered by OSHA 29 CFR 1926. Construction workers must receive additional training, when required by OSHA standards, on specific hazards of the job.

Learning Objectives

At the conclusion of this course, the student will be able to:

- Explain the importance of OSHA in providing a safe and healthful workplace to workers
- Locate OSHA Standards references applicable to specific hazardous conditions and practices (Introduction to OSHA Standards)
- Recognize the aspects of 1926 Subpart C (General Safety and Health Provisions)
- Implement preventative measures for accidents in their workplace (Subpart D - Occupational health and Environmental Controls)
- Describe types of personal protective equipment (PPE), and the requirements for its use in OSHA standards (Subpart E - Personal Protective Equipment)
- Understand the requirements for fire protection in the workplace (Subpart F - Fire Protection and Prevention)
- Identify the various types of rigging equipment used to protect employees (Subpart H - Rigging; Subpart N - Cranes and Rigging)
- Identify the critical health and safety hazards of welding and cutting in the construction industry (Subpart J - Welding and Cutting)
- Identify common electrical hazards and related OSHA standards (Subpart K - Electrical Standards)
- Understand the importance of scaffolding for workers in elevated workplaces (Subpart L - Scaffolding)
- Implement measures for protecting workers and equipment from dangerous falls (Subpart M - Fall Protection)
- Recognize the hazards associated with working in or around excavation sites (Subpart P - Excavations)
- Understand the safety requirements necessary to protect workers around concrete and masonry jobs (Subpart Q - Concrete and Masonry)

- Protect workers who perform jobs on or around stairways or ladders at worksites (Subpart X - Stairways and Ladders)
- List and describe the hazards and prevention required for confined spaces

Key Terms

Acceptable Entry Conditions: Conditions that must exist in a permit space to allow entry and to ensure that employees involved with a permit-required, confined space entry can safely enter into, and work within, the space.

Accident: Harmful event that is unexpected or without apparent cause.

Acetylene: Acetylene forms explosive mixtures with oxygen or air. When dissolved in acetone, it is non-explosive and so is stored as such; however, the acetone is under pressure in steel cylinders for commercial use.

Act: As a statute, decree, or enactment resulting from a decision by a legislative body.

Action Level: The level of lead particulates present in the air that signifies close monitoring is required so that the PEL is not approached. The action level for lead is 30 micrograms per cubic meter (ug/m3) for eight hours.

Administer: Manage or have jurisdiction over, as in federal jurisdiction in Federal Plan States, or state jurisdiction in State Plan States.

Amperes or Amps: The volume of the current flow.

Anchorage: A secure point of attachment for lifelines, lanyards, or deceleration devices.

ANSI: American National Standards Institute

Approved: For the purpose of this course, the word "approved" means equipment that has been listed or approved by a nationally recognized testing laboratory or by federal agencies.

Article: A manufactured item other than a fluid or particle:

- Which is formed to a specific shape or design during manufacture,

- Which has end use function(s) dependent in whole or in part upon its shape or design during end use, and
- Which under normal conditions of use does not release more than very small quantities, e.g., minute or trace amounts of a hazardous chemical and does not pose a physical hazard or health risk to employees.

Asbestosis: An incurable restrictive lung disease often linked to occupational exposure.

Atmospheric Tank: A storage tank which has been designed to operate at pressures from atmospheric through 0.5 psig (pounds per square inch gauge).

Attendant: An individual, stationed outside one or more permit spaces, who monitors the authorized entrants and performs all attendant's duties assigned in the employer's permit space program.

Audible Backup Alarms: These devices must be installed on heavy construction vehicles and maintained in proper working order. They sound an alarm to nearby workers that a dangerous vehicle is backing up.

Authorized Entrant: An employee who is authorized by the employer to enter a permit space.

Authorized Person: A person assigned by the employer to perform a duty or to be at a particular job site.

AWG: American wire gauge (AWG), which is one measurement standard used to size wire.

Barricade: An obstruction to deter the passage of persons or vehicles.

Bearer (Putlog): A horizontal transverse scaffold member (which may be supported by ledgers or runners) upon which the scaffold platform rests and which joins scaffold uprights, posts, poles, and similar members.

Beryllium: A steel-gray, light, strong, brittle, toxic, bivalent metallic element used chiefly as a hardening agent in alloys.

Blast Area: The area where explosives are loaded and blasting operations are carried out.

Blasting Agent: Any material or mixture that consists of a fuel and oxidizer used for blasting, but is not considered an explosive. The ingredients in the blasting agent are also not classified as explosives.

Blasting Cap: A metallic tube that is closed at one end and contains a charge of detonating compounds that can be detonated from the flame of a safety fuse placed into the open end of the tube.

Block: Sheaves or grooved pulleys in a frame with a hook, eye, and strap.

Bloodborne Pathogens: Infectious microorganisms found in human blood can cause diseases such as Hepatitis B and C and the Human Immunodeficiency Virus (HIV).

BLS: Bureau of Labor Statistics

Boatswains' Chair: A single-point adjustable suspension scaffold consisting of a seat or sling designed to support one employee in a sitting position.

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

Boom: An inclined spar, strut, or other long member supporting the hoisting tackle.

Boom Angle Indicator: An accessory device that measures the angle of the boom base section centerline to horizontal load and the weight of the object being lifted which includes load blocks and hooks, wire ropes, rigging, boom attachments, and ancillary attachments.

Boom Stops: A device used to limit the angle of the boom at its highest position.

Brace: A rigid connection that holds one scaffold member in a fixed position with respect to another member or to a building or structure.

Brake: To slow or stop motion by friction or power.

Cadmium: A bluish-white malleable ductile toxic bivalent metallic element used especially in protective plating and in bearing metals.

Catastrophic Release: A major uncontrolled emission, fire, or explosion, involving one or more highly hazardous chemicals, that presents serious danger to employees in the workplace.

Chemical: Any element, compound, or mixture of elements and/or compounds.
Chimney Hoist: A multi-point adjustable suspension scaffold used to provide access to work inside chimneys.

Chock: A wedge or block used to keep a vehicle parked on an incline from rolling.

Chromium: A blue-white metallic element found naturally only in combination and used especially in alloys and electroplating.

Circuit: Completion of the path of the current; including a voltage source, conductors, and the load (such as a lamp, tool, or heater).

Closed Container: A container so sealed by means of a lid or other device that neither liquid nor vapor will escape from it at ordinary temperatures.

Combustible: A material having a flashpoint of 100 degrees Fahrenheit, or above.

Combustible Liquids: Any liquid having a flash point between 140°F and 200°F.

Combustion: Burning of a material, i.e., a chemical change accompanied by the production of heat and light.

Competent Person: A person who has authorization to take corrective action and is able to recognize existing and predictable hazards.

Concrete: A mixture of cement, sand, aggregate, and water in specific proportions that hardens to a strong stony consistency over varying lengths of time.

Conductors: Materials that contain free electrons that allow current to flow through the material.

Confined Space: A space that, by design and/or configuration, has limited openings for entry and exit, unfavorable natural ventilation, may contain or produce hazardous substances, and is not intended for continuous employee occupancy.

Connector: A device that is used to couple (connect) parts of a personal fall arrest system or positioning device system together.

Container: Any bag, barrel, bottle, box, can, cylinder, drum, reaction vessel, storage tank, or the like that contains a hazardous chemical.

Contaminant: Any material which by reason of its action upon, within, or to a person is likely to cause physical harm.

Controlled Access Zone: A work area designated and clearly marked in which certain types of work (such as overhand bricklaying) may take place without the use of conventional fall protection systems--guardrail, personal arrest or safety net--to protect the employees working in the zone.

Conveyor: A mechanical apparatus for moving articles or bulk material from place to place, like an endless moving belt or a chain of receptacles.

Counterweight: Weights used for balancing loads and the weight of the crane in providing stability.

Coupler: A device for locking together the tubes of a tube and coupler scaffold.

Crane: A large, sometimes mobile machine that is used to transport workers and/or material from one point to another, usually in a vertical direction. These are commonly used in the construction of buildings and ships.

Crawling Board (Chicken Ladder): A supported scaffold consisting of a plank with cleats spaced and secured to provide footing for use on sloped surfaces such as roofs.

Current: Electron flow (measured in amperes).

dBA: Adjusted decibels

Deceleration Device: Any mechanism, such as rope, grab, rip-stitch lanyard, specially-woven lanyard, tearing or deforming lanyards, automatic self-retracting/lanyards, which serve to dissipate a substantial amount of energy during a fall arrest, or otherwise limits the energy imposed on an employee during fall arrest.

Deck: The revolving superstructure or turntable bed.

Department of Labor: The U.S. Federal Agency of which OSHA is a division.

Derrick: A derrick is an apparatus consisting of a mast or equivalent member held at the head by guys or braces, with or without a boom, for use with a hoisting mechanism and operating ropes.

Detonating Cord: A flexible cord that is filled with high explosives. When detonated, these explosives have enough strength to detonate other explosives they contact.

Detonator: Blasting caps, electric blasting caps, delay electric blasting caps, and non-electric delay blasting caps.

Double-Cleat Ladder: A ladder with a center rail to allow simultaneous two-way traffic for employees ascending or descending.

Drum: The spool or cylindrical member around which cables are wound for raising and lowering loads.
Electric Blasting Cap: A blasting cap designed for and capable of detonation by means of an electric current.

Electric Shock: The physical effect nerve stimulation and/or muscle contraction caused by the flow of current through the body.

Electrocution: Death caused by electrical shock.

Emergency: Any occurrence (including any failure of hazard control or monitoring equipment), or event, internal or external to the permit space that could endanger entrants.

Employer: A contractor or subcontractor.

Entry Permit: A written or printed document that is provided by the employer to allow and control entry into a permit space and that contains the information specified in section (f) of the standard.

Excavation: A man-made cut, cavity, trench, or depression formed by earth removal.

Excavation Work: Excavation-related work is a major cause of caught in between hazards. In 2005, the vast majority of caught in between hazard citations were related to excavation operations.

Explosive: A chemical that causes a sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature.

Facility: The buildings, containers, or equipment that contain a process.

Failure: Load refusal, breakage, or separation of components.

Federal: Being part of, or pertaining to, the United States government.

Fixed Ladder: A ladder that cannot be readily moved or carried because it is an integral part of a building or structure.

Flammable: A material having a flashpoint below 100 degrees Fahrenheit. Also, is capable of being easily ignited and of burning intensely, or having a rapid rate of flame spread.

Flammable Liquids: Means any liquid having a flash point below 140°F and having a vapor pressure not exceeding 40 pounds per square inch (absolute) at 100°F.

Flash Point: The lowest temperature at which the vapors of a liquid can catch fire.

Forklift: A type of powered industrial truck that is used to transport material, clearly identified by the large forks that are capable of vertical motion and are installed at the front.

GFCI: Ground-Fault Circuit Interrupter. A device that detects current imbalance between the circuit conductors and reference to the grounding conductor. If an imbalance or "leak" occurs as small as 5 milliamps (.005 amps) for as little as 1/40th of a second this device will interrupt the circuit, preventing a shock which most people would not feel.

Grounding: An intentional conductive connection to the earth that provides a path back to the source from any conductive portion of the load device or equipment for any fault current that may occur in a circuit.

Guardrail: A protective railing enclosing an elevated platform.

Guardrail System: A barrier erected to prevent employees from falling to lower levels.
Handrail: A rail used to provide employees with a handhold for support.

Hazardous Atmosphere: An atmosphere that may cause death, illness or injury to persons exposed to it because it may be explosive, flammable, poisonous, corrosive, oxidizing, irritating, oxygen-deficient, toxic, or otherwise harmful.

Hazardous Chemical: Any chemical that poses a physical or health hazard.

Hazards: Sources of danger and risks to health.
HazCom: Hazard Communication Standard.

HCP: Health Care Professional.

Highly Hazardous Chemical: A substance possessing toxic, reactive, flammable, or explosive materials/chemicals.

Hoist: Used to lift and lower load.

Hole: A void or gap 2 inches (5.1 cm) or more in the least dimension in a floor, roof, or other walking/working surface.

Hot Work: Work involving electric or gas welding, cutting, brazing, or similar flame or spark-producing operations.

Hot Work Permit: The employer's written authorization to perform operations--for example: riveting, welding, cutting, burning, and heating--capable of providing a source of ignition.

Inerting: The displacement of the atmosphere in a permit space by a noncombustible gas (such as nitrogen) to such an extent that the resulting atmosphere is.

Inhalation: Breathing in an airborne substance that may be in the form of gases, fumes, mists, vapors, dusts, or aerosols.

Insulators: Materials with few free electrons. Current does not easily flow through insulators, if at all.

Jack: A portable device that uses a mechanical or hydraulic lifting system to raise heavy objects, especially cars, a short distance.

Jib: Extension attached to the boom point to provide added boom length for lifting specified loads.

Job-Made Ladder: A ladder that is fabricated by employees, typically at the construction site and not commercially manufactured.

Lanyard: A flexible line of rope, wire rope, or strap that 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/working surface (such as the deck) which changes location as additional floor, roof, decking, or formwork sections are placed, formed, or constructed.

Lifeline: A component consisting of a flexible line that connects to an anchorage at one end to hang vertically (vertical lifeline) or that connects 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.

Limited Access Zone: The area adjacent to masonry wall construction that clearly limits access by all but essential employees.

Liquefied Petroleum Gases (LPG): A material which is composed primarily of any of the following hydrocarbons or their mixtures, such as propane, propylene, butane, and butylenes.

Low-Slope Roof: A roof having a slope less than or equal to 4 in 12 (vertical to horizontal).

Magazine: Any building or structure, other than an explosives manufacturing building, used for the storage of explosives.

Masonry: Stonework—the stone or brick parts of a building or other structure.

Maximum Intended Load: The total load of all persons, equipment, tools, materials, transmitted loads, and other loads reasonably anticipated to be applied to a scaffold or scaffold component at any one time.

Non-Permit Confined Space: A confined space that does not contain or, with respect to atmospheric hazards, have the potential to contain any hazard capable of causing death or serious physical harm.

Normally Unoccupied Remote Facility: A facility which is operated, maintained, or serviced by employees who visit the facility only periodically to check its operation and to perform necessary operating or maintenance tasks.

Opening: A gap or void 30 inches (76 cm) or more high and 18 inches (46 cm) or more wide, in a wall or partition, through which employees can fall to a lower level.

OSHA: Occupational Safety and Health Administration
Outrigger: The structural member of a supported scaffold used to increase the base width of a scaffold in order to provide support for and increased stability to the scaffold.

Outrigger Beam (Thrustout): The structural member of a suspension scaffold or outrigger scaffold which provides support for the scaffold by extending the scaffold point of attachment to a point out and away from the structure or building.

Outriggers: Support members attached to the crane's carrier frame that are used to level and stabilize the crane.

Oxygen Deficient Atmosphere: An atmosphere containing less than 19.5 percent oxygen by volume.

Oxygen Enriched Atmosphere: An atmosphere containing more than 23.5 percent oxygen by volume.

PCSA: Power Crane and Shovel Association.

Pendants: Stationary wire ropes used to support the boom.

Permissible Exposure Limit (PEL): The maximum level of lead particles in air that can be considered acceptable for normal workplace exposure. The PEL for lead is 50 micrograms per cubic meter (ug/m3).

Permit-Required Confined Space Program (Permit Space Program): The employer's overall program for controlling, and, where appropriate, for protecting employees from, permit space hazards and for regulating employee entry into permit spaces.

Personal Fall Arrest System: A system including, but not limited to, an anchorage, connectors, and a body harness used to arrest an employee in a fall from a working level. As of January 1, 1998, the use of a body belt for fall arrest is prohibited.

Personal Protective Equipment (PPE): All types of protective equipment such as hard hats, gloves, boots, and eye protection, along with respiratory aids.

Physical Hazard: A chemical for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive), or water-reactive.

PLHCP: Physician or other Licensed Health Care Professional.
Point of Access: All areas used by employees for work-related passage from one area or level to another.

Portable Ladder: A ladder that can be readily moved or carried.

Portable Tank: Means a closed container having a liquid capacity of more than 60 U.S. gallons and not intended for fixed installation.

Positioning Device System: A body belt or body harness system rigged to allow an employee to be supported on an elevated vertical surface, such as a wall, and work with both hands free while leaning backwards.

Powered Industrial Trucks: Trucks that are used for the transport of material. They may be modified to operate in hazardous conditions.

Primary Blasting: The blasting operation by which an original rock formation is dislodged from its natural location.

PSI/P.S.I.: Pounds per square inch is the common unit of measurement for pressure. (Example: compressed air.)

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

Radiant Energy: A kind of energy that travels outward in all directions from its sources.

Radius: The horizontal distance from the axis of the rotation of the crane's superstructure to the center of the suspended load.

Reinforcing: Strengthen something; to make something stronger by providing additional external support or internal stiffening for it.

Resistance: Opposition to current flow.
Retrieval System: The equipment (including a retrieval line, chest or full-body harness, wristlets, if appropriate, and a lifting device or anchor) used for non-entry rescue of persons from permit spaces.

Rope Grab: A deceleration device that travels on a lifeline and automatically, by friction, engages the lifeline and locks to arrest a fall.

ROPS: Rollover Protective Structures.

Safety Can: Means an approved closed container of not more than five gallons capacity, having a flash-arresting screen, spring-closing lid and spout cover, and so designed that it will safely relieve internal pressure when subjected to fire exposure.

Safety Fuse: A flexible cord that contains combustible matter that is used to convey fire to blasting caps.

Safety-Monitoring System: A safety system in which a competent person is responsible for recognizing and warning employees of fall hazards.

Scaffolds: Framework to support workers; a temporary framework of poles and planks that is used to support workers and materials during the erection, repair, or decoration of a building.

Screw Conveyor: Screw conveyors usually consist of a trough or tube containing either a spiral coiled around a shaft, driven at one end and held at the other, or a Shaftless Spiral, driven at one end and free at the other.

SDS: Safety Data Sheet, a document containing the chemical hazard and safe handling information pertaining to a specific chemical or compound and which is prepared in accordance with the OSHA Hazard Communication Standard.

Self-Retracting Lifeline/Lanyard: A deceleration device containing a drum-wound line which can be slowly extracted from, or retracted onto, the drum under minimal tension during normal employee movement and which, after onset of a fall, automatically locks the drum and arrests the fall.

Shield: Structure able to withstand a cave-in and protect employees.

Shoring: A structure like a metal hydraulic, mechanical, or timber shoring system that supports the sides of an excavation and is used to prevent cave-ins.

Signals: Moving signs, provided by workers, such as flagmen, or by devices, such as flashing lights, to warn of possible or existing hazards.

Signs: Visual warnings of hazard, temporarily or permanently affixed to, or placed at locations, where hazards exist.

Silicosis: An occupational lung disease, this is a respiratory disease caused by the inhalation of silica.

Sills—Building Bottom of Frame: The horizontal part at the bottom of a window or door frame.

Sills—Building Window Ledge: A ledge below a window, especially one on the inside of a building.

Single-Cleat Ladder: A ladder consisting of a pair of side rails connected together by cleats, rungs, or steps.

Slab: Architecture stone base for something; a flat rectangular base or foundation of concrete or stone.

Sloping: A technique that employs a specific angle of incline on the sides of the excavation.

Snap-Hook: A connector consisting 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.

Stair Rail System: A vertical barrier erected along the unprotected sides and edges of a stairway to prevent employees from falling to lower levels.

Standards: Measure of comparison for quantitative or qualitative value; a criterion.

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

Superstructure: The rotating frame, gantry, and boom or other operating equipment.

Tags: Temporary signs, usually attached to pieces of equipment or structures, to warn of existing or immediate hazards.
TB: Tuberculosis.

Testing: The process by which the hazards that may confront entrants of a permit space are identified and evaluated. Testing includes specifying the tests that are to be performed in the permit space.

Title 29 of the Code of Federal Regulations: This is the section of the CFR that contains all OSHA standards and guidelines (29 CFR).

Toeboard: A type of guard installed along the lower edge of scaffold platforms and overhead walkways that is designed to keep tools and other objects from falling and injuring workers below. Installing toeboards is considered an engineering control.

Toxic Substance: A substance that can affect the proper functioning of an organism, resulting in a change in physiology through a chemical process.

Trade Secret: Any confidential formula, pattern, process, device, information, or compilation of information that is used in an employer's business, and gives the employer an opportunity to obtain an advantage over competitors who do not know or use it.

Training: A course of study in which employees are trained to identify and work safely.

Tread Depth: The horizontal distance from front to back of a tread, excluding nosing, if any.

Trench: A narrow excavation made below the surface of the ground in which the depth is greater than the width and the width does not exceed 15 feet.
Ultraviolet Rays: Situated beyond the visible spectrum at its violet end; used to describe radiation having a wavelength shorter than those of visible light and longer than those of x-rays.

Unprotected Sides and Edges: Any side or edge (except at entrances to points of access) of a walking/working surface (e.g., floor, roof, ramp, or runway) where there is no wall or guardrail system at least 39 inches (1 meter) high.

Valve: Device for controlling the flow of fluids (liquids and gases).

Volts: The electrical pressure (measure of electrical force).

Walking/Working Surface: Any surface, whether horizontal or vertical, on which an employee walks or works, including, but not limited to, floors, roofs, ramps, bridges, runways, formwork, and concrete reinforcing steel. Does not include ladders, vehicles, or trailers on which employees must be located to perform their work duties.

Warning Line System: A barrier erected on a roof to warn employees 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 belt, or safety net systems to protect employees in the area.

Watts: Measurement work produced by the electrical circuit.

Wire Gauge: System used to measure the physical size of wire.

Workplace: An establishment, job site, or project at one geographical location containing one or more work areas.

Module 1: Introduction to OSHA

Module Description

The Occupational Safety and Health Administration (OSHA) was established to protect the health of the American workers. In 1971, the Occupational Safety and Health Act was created to give structure to the worker protection activities. OSHA holds the employer responsible for providing a workplace that is free from recognized hazards. This module will give an understanding of OSHA, employer responsibilities, and employee rights in the workplace.

Module Learning Objectives

At the conclusion of this module, you should be able to:

- Explain why OSHA is important to workers.
- Explain worker rights under OSHA.
- Discuss employer responsibilities under OSHA.
- Discuss the use of OSHA standards.
- Explain how OSHA inspections are conducted.
- Utilize helpful worker safety and health resources.

Lesson 1: Introduction to OSHA

Lesson Focus

This lesson focuses on the following topics:

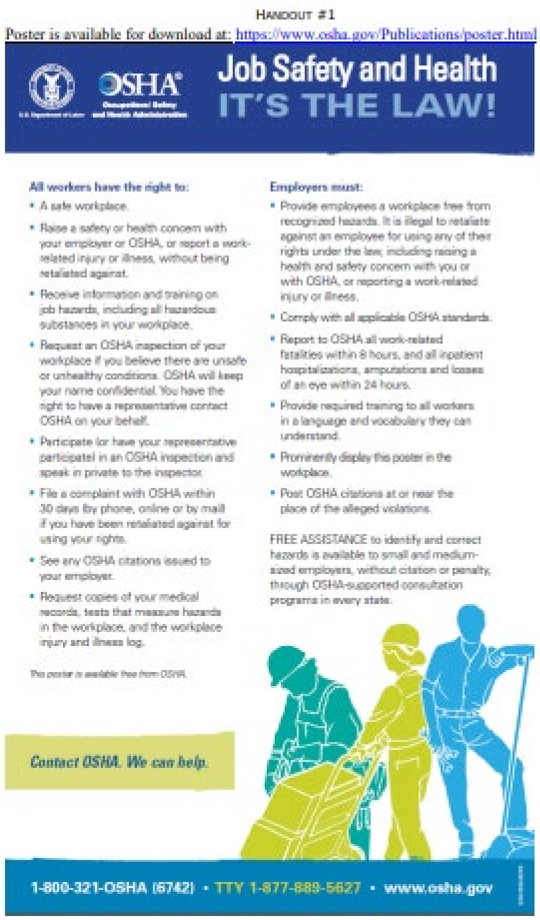
- OSHA's Mission
- State Plans
- OSHA Standards
- Employer Responsibilities
- Workers' Rights& Responsibilities
- Enforcing Standards
- Reporting Safety Hazards
- Whistleblower Protections
- Worker Resources

OSHA's Mission

History of OSHA

OSHA stands for the Occupational Safety and Health Administration, an agency of the U.S. Department of Labor. OSHA's responsibility is worker safety and health protection. The U.S. Congress created OSHA under the Occupational Safety and Health Act of 1970 (the OSH Act). Congress passed the law and established OSHA "to assure so far as possible every working man and woman in the nation safe and healthful working conditions and to preserve our human resources."

The current mission of OSHA is "to save live, prevent injuries, and protect the health of America's workers". It is the employer's responsibility to keep the workplace free from any known or recognized hazard that is likely to cause injury or illness to their worker.



https://www.osha.gov/Publications/poster.html

The OSH Act is also known as Public Law 91-596. It covers all private sector employers and their workers in the 50 states and all territories and jurisdictions under federal authority. Employers and workers in many fields, including but not limited to manufacturing, construction, long shoring, agriculture, law, medicine, charity and disaster relief are covered by OSHA. Religious groups are covered if they employ workers for secular purposes, such as maintenance or gardening.

Who is Covered by the OSH Act?

• OSHA covers all employees and their employers in the 50 states and certain territories and jurisdictions under federal government authority. 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.

- Coverage is provided either directly by federal OSHA or through an OSHA-approved state program.

- Section 19 of the OSH Act makes federal agency heads responsible for providing safe and healthful working conditions for their employees. OSHA conducts federal workplace inspections in response to employee reports of hazards.

- The OSH Act also requires federal agencies to comply with standards consistent with those for private sector employers. Under a 1998 amendment to the Act, it covers the U.S. Postal Service the same as any private sector employer.

Which Groups Do Not Come Under OSHA's Coverage?

Those groups that are not covered by OSHA include:

- The self-employed
- Immediate members of farming families not employing outside workers
- Mine workers, certain truckers and transportation workers, and atomic energy workers who are covered by other federal agencies
- Public employees in state and local governments, although some states have their own plans that cover these workers

More Information:

OSHA provisions cover the private sector only. However, some federal agencies have created their own health and safety programs, which are at least as stringent as U.S. OSHA. These state programs cover state and local government employees.

OSHA does not cover the self-employed or immediate members of farm families that do not employ outside workers; worker conditions that are regulated under worker safety or health requirements of other federal agencies; or employees of state and local governments, although some states have their own occupational safety and health plans that cover these workers.

To achieve this, federal and state governments work together with more than 100 million working men and women and eight million employers. Some of the things OSHA does to carry out its mission are:

- Developing job safety and health standards and enforcing them through worksite inspections

- Maintaining a reporting and recordkeeping system to keep track of job-related injuries and illnesses
- Providing training programs to increase knowledge about occupational safety and health

OSHA also assists the States in their efforts to assure safe and healthful working conditions, through OSHA-approved job safety and health programs operated by individual states. State plans are OSHA-approved job safety and health programs created by individual states instead of federal OSHA.

States with approved plans cover most private sector employees as well as state and local government workers in the state. State plan programs respond to accidents and employee complaints and conduct unannounced inspections, just like federal OSHA. And, some states have OSHA-approved plans that cover only state and local government workers.

State Plans

Safety and Health Programs

State plans are OSHA-approved job safety and health programs operated by individual states instead of federal OSHA. The OSH Act encourages states to develop and operate their own job safety and health plans and precludes state enforcement of OSHA standards, unless the state has an approved plan. OSHA approves and monitors all state plans. The state plans must be at least as effective as federal OSHA requirements.

State plans covering the private sector also must cover state and local government employees. OSHA rules also permit states and territories to develop plans that cover only public sector (state and local government) employees. In these cases, private sector employment remains under federal OSHA jurisdiction. Twenty-two states and territories operate complete plans and six cover only the public sector.

Click for more information.

OSHA's Impact

Since OSHA's creation in 1970, the nation has made substantial progress in occupational safety and health. OSHA and its many partners in the public and private sectors have, for example:

- Cut the work-related fatality rate to historic lows for 2002 to 2004.
- From 2003 to 2004, reduced the number of workplace injuries and illnesses by 4 percent and lost workday case rates dropped by 5.8 percent in that same period.
- In 2005, OSHA conducted close to 39,000 inspections and issued just over 85,000 citations for violations.
- In 2004, the Consultation Program made over 31,000 visits to employers.

OSHA Standards

OSHA standards are rules that describe the methods that employers must use to protect their employees from hazards. There are OSHA standards for Construction work, Agriculture, Maritime operations, and General Industry, which are the standards that apply to most worksites. These standards limit the amount of hazardous chemicals workers can be exposed to, require the use of certain safe practices and equipment, and require employers to monitor hazards and keep records of workplace injuries and illnesses.

Examples of OSHA standards include, but are not limited to 29 CFR 1910, 1926, and 1928 (OSHA standards are online). General Duty Clause, Section 5(a) (1) explain that this is used when there is not a specific OSHA standard that applies to the situation.

Establishing a safe and healthful workplace requires every employer to make safety and health a priority. In general, OSHA requires employers to:

- Maintain conditions and adopt practices reasonably necessary to protect workers on the job. The first and best strategy is to control the hazard at its source. Engineering controls do this, unlike other controls that generally focus on the worker who is exposed to the hazard. The basic concept behind engineering controls is that, to the extent feasible, the work environment and the job itself should be designed to eliminate hazards or reduce exposure to hazards.
- Be familiar with the standards that apply to their workplaces, and comply with these standards.
- Ensure that workers are provided with, and use, personal protective equipment, when needed. When exposure to hazards cannot be engineered completely out of normal operations or maintenance work, and when safe work practices and

other forms of administrative controls cannot provide sufficient additional protection, an additional method of control may be the use of protective clothing or equipment. This is collectively called personal protective equipment, or PPE. PPE may also be appropriate for controlling hazards while engineering and work practice controls are being installed.

- Comply with the OSH Act's "General Duty Clause" where no specific standards apply. The general duty clause, or Section 5(a)(1) of the Act requires each employer to "furnish a place of employment which is free from recognized hazards that are causing or are likely to cause death or serious physical harm to employees."

An example of the OSHA standard is 29 CFR 1910. 95 Occupational Noise Exposure. Noise in the workplace can cause adverse effects to the worker's hearing when the noise reaches over 85db for an 8 hour Time Weighted Average (TWA). The damage from continuous loud noise exposure is permanent. OSHA requires that hearing conservations programs are used for workplaces that exceed the 85 dB TWA and for employers to provide Personal Protective Equipment at no cost to the workers. Earplugs/Earmuffs must be used to reduce noise hazards in the workplace.

Though PPE is provided for workers at no cost to them, the employer should look for engineering controls such as sound proofing or using sound barriers to reduce the noise. Additionally, the standard requires that the worker will have annual Audiometric Testing and training regarding occupational noise. Other standards address issues such as:

- Chemicals
- Protective equipment
- Fall protection
- Guarding of open sided platform
- Scaffolding
- Right to know

Employer Responsibilities

OSHA standards mandate that employers must:

- Provide a workplace free from recognized hazards and comply with OSHA standards
- Provide training required by OSHA standards
- Keep records of injuries and illnesses
- Set up a reporting system;

- Provide copies of logs (i.e., OSHA 300), upon request;
  - Post the annual summary;
  - Report within 8 hours any work-related fatalities and within 24 hours, all work-related: inpatient hospitalizations, amputations, and losses of an eye.
- Provide medical exams when required by OSHA standards and provide workers access to their exposure and medical records
- Not discriminate against workers who exercise their rights under the Act
- Post OSHA citations and abatement verification notices
- Provide and pay for most Personal Protective Equipment (PPE)

HANDOUT #2

Employers Must Provide and Pay for PPE

Personal Protective Equipment (PPE)

The Occupational Safety and Health Administration (OSHA) requires that employers protect you from workplace hazards that can cause injury or illness. Controlling a hazard at its source is the best way to protect workers. However, when engineering, work practice and administrative controls are not feasible or do not provide sufficient protection, employers must provide personal protective equipment (PPE) to you and ensure its use.

PPE is equipment worn to minimize exposure to a variety of hazards. Examples include items such as gloves, foot and eye protection, protective hearing protection (earplugs, muffs), hard hats and respirators.

Employer Obligations	Workers should:
✓ Performing a "hazard assessment" of the workplace to identify and control physical and health hazards. ✓ Identifying and providing appropriate 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.	✓ 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.

Employers Must Pay for Personal Protective Equipment (PPE)

On May 15, 2008, a new OSHA rule about employer payment for PPE went into effect. With few exceptions, OSHA now requires employers to pay for personal protective equipment used to comply with OSHA standards. The final rule does not create new requirements regarding what PPE employers must provide.

The standard makes clear that employers cannot require workers to provide their own PPE and the worker's use of PPE they already own must be completely voluntary. Even when a worker provides his or her own PPE, the employer must ensure that the equipment is adequate to protect the worker from hazards at the workplace.

Examples of PPE that Employers Must Pay for Include:

- Metatarsal foot protection
- Rubber boots with steel toes
- Non-prescription eye protection
- Prescription eyewear inserts/lenses for full face respirators
- Goggles and face shields
- Fire fighting PPE (helmet, gloves, boots, proximity suits, full gear)
- Hard hats
- Hearing protection
- Welding PPE

Handout #2
Employers Must Provide and Pay for PPE

Payment Exceptions under the OSHA Rule

Employers are not required to pay for some PPE in certain circumstances:

- Non-specialty safety-toe protective footwear (including steel-toe shoes or boots) and non-specialty prescription safety eyewear provided that the employer permits such items to be worn off the job site. (OSHA based this decision on the fact that this type of equipment is very personal, is often used outside the workplace, and that it is taken by workers from jobsite to jobsite and employer to employer.)
- Everyday clothing, such as long-sleeve shirts, long pants, street shoes, and normal work boots.
- Ordinary clothing, skin creams, or other items, used solely for protection from weather, such as winter coats, jackets, gloves, parkas, rubber boots, hats, raincoats, ordinary sunglasses, and sunscreen
- Items such as hair nets and gloves worn by food workers for consumer safety.
- Lifting belts because their value in protecting the back is questionable.
- When the employee has lost or intentionally damaged the PPE and it must be replaced.

OSHA Standards that Apply

OSHA General Industry PPE Standards

- 1910.132: General requirements and payment
- 1910.133: Eye and face protection
- 1910.134: Respiratory protection
- 1910.135: Head protection
- 1910.136: Foot protection
- 1910.137: Electrical protective devices
- 1910.138: Hand protection

OSHA Construction PPE Standards

- 1926.28: Personal protective equipment
- 1926.95: Criteria for personal protective equipment
- 1926.96: Occupational foot protection
- 1926.100: Head protection
- 1926.101: Hearing protection
- 1926.102: Eye and face protection
- 1926.103: Respiratory protection

There are also PPE requirements in shipyards and marine terminals and many standards on specific hazards, such as 1910.1030: Bloodborne pathogens and 1910.146: Permit-required confined spaces.

OSHA standards are online at www.osha.gov.

Workers' Rights & Responsibilities

Workers' Rights

Most importantly, the creation of OSHA provided workers the right to a safe and healthful workplace. Section 5(a)(1) of the OSH Act states: "Each employer shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees."

A safe and healthful workplace means that hazards are removed and workers are trained. If a hazard cannot be removed completely, protection (for example, respirators or earplugs) must be provided.

OSHA Provides Workers the Right to:	
WORKERS RIGHTS	A safe and healthful workplace
	Know about hazardous conditions
	Information about injuries and illnesses in your workplace
	Complain or request hazard correction from employer
	Training as provided in the OSHA standards
	Hazard exposure and medical records
	File a complaint with OSHA
	Participate in an OSHA inspection
	Be free from retaliation for exercising safety and health rights

Workers' Rights: Right to Know About Hazardous Chemicals

Another important right is the Right to Know about hazardous substances in your workplace. Employers must have a written, complete hazard communication program that includes information on:

- Container labeling
- Safety Data Sheets (SDSs)

Worker training must include the physical and health hazards of the chemicals and how workers can protect themselves; including specific procedures the employer has implemented to protect workers, such as work practices, emergency procedures, and personal protective equipment

The program must also include a list of the hazardous chemicals in each work area and the means the employer uses to inform workers of the hazards of non-routine tasks. In addition, the program must explain how the employer will inform other employers of hazards to which their workers may be exposed (for example, contract workers).

Safety Data Sheets

Safety data sheets provide invaluable information about hazardous substances. SDSs contain the following sections:

- Section 1—Identification of the Substance or Mixture and of the Supplier
- Section 2—Hazard(s) Identification
- Section 3—Composition and Information on Ingredients

- Section 4—First Aid Measures
- Section 5—Fire-Fighting Measures
- Section 6—Accidental Release Measures
- Section 7—Handling and Storage
- Section 8—Exposure Controls and Personal Protection
- Section 9—Physical and Chemical Properties
- Section 10—Stability and Reactivity
- Section 11—Toxicological Information
- Section 12—Ecological Information (Non-Mandatory
- Section 13—Disposal Considerations (Non-Mandatory)
- Section 14—Transport Information (Non-Mandatory)
- Section 15—Regulatory Information
- Section 16—Other Information

Workers' Rights: Right to Information about Injuries and Illnesses in your Workplace

OSHA's Recordkeeping rule requires most employers with more than 10 workers to keep a log of injuries and illnesses. The log, which is also called the OSHA 300, must contain all work-related injuries and illnesses resulting in lost workdays, restricted work or transfer to another job, as well as any incident requiring more than first aid treatment.

You have the right to review the current log, as well as the logs stored for the past 5 years. The employer must provide this by the end of the next workday. The names and other information on the log may not be removed, unless the case is a "privacy concern case."

You also have the right to view the annually posted summary of the injuries and illnesses (OSHA 300A).

More Information: "Privacy concern cases" are those involving an intimate body part, mental illness, HIV, etc. For more detail, see 1904.29(b)(7).

The right to review the log includes former employees, their personal representatives, and authorized employee representatives.

Workers' Rights: Anti-Discrimination Provisions

The OSH Act prohibits employment retaliation against an employee who complains to an employer regarding a workplace safety issue or condition, files a complaint related to workplace safety or health conditions, initiates a proceeding, contests an abatement date, requests information from OSHA, or testifies under the Act. In certain circumstances, an employee may refuse to work under seriously threatening health or safety conditions.

Workers' Rights: Right to Training

You have a right to get training from your employer on a variety of health and safety hazards and standards that your employer must follow. We've already discussed the training required under OSHA's Hazard Communication (Right to Know) standard. Other required training may include lockout-tagout, bloodborne pathogens, noise, confined spaces, fall hazards in construction, personal protective equipment, and a variety of other subjects.

Some examples of a safe and healthful workplace when training is in place include:

- Trenches are inspected and have appropriate protective systems in place when necessary.
- Proper confined space entry procedures, testing, equipment is present and used appropriately.
- Noise levels are controlled. When levels remain at unsafe levels, workers are given hearing tests and are provided training and hearing protection.
- Protection from chemical hazards is provided, including an evaluation of chemicals used, a written program, Safety Data Sheets, worker protection (for example, respirators or gloves), and information and training.

Workers' Rights: Right to Hazardous Exposure Records and Medical Records

Under OSHA's standard 1910.1020, you have the right to examine and copy exposure and medical records, including records of workplace monitoring or measuring a toxic substance. This is important if you have been exposed to toxic substances or harmful physical agents in the workplace, as this regulation may help you detect, prevent, and treat occupational disease.

Examples of toxic substances and harmful physical agents are:

- Some metals and dusts, such as, lead, cadmium, and silica
- Biological agents, such as bacteria, viruses, and fungi
- Physical stress, such as noise, heat, cold, vibration, repetitive motion, and ionizing and non-ionizing radiation

OSHA standards require employers to measure exposure to potentially harmful substances, and workers or their representatives have the right to observe the testing and examine the results. If the exposure levels are above the limit set by the standard, the employer must tell workers what will be done to reduce their exposure.

Workers' Rights: Right to File a Complaint with OSHA

You may file a complaint with OSHA if you believe a violation of a safety or health standard or an imminent danger situation exists in your workplace. You may request that your name not be revealed to your employer. You can file a complaint on OSHA's web site, in writing or by telephone, to the nearest OSHA area office. You may also call the office and speak with an OSHA compliance officer about a hazard, violation, or the process for filing a complaint. You can contact OSHA by calling 1-800-321-OSHA.

If you file a complaint, you have the right to find out OSHA's action on the complaint and request a review if an inspection is not made.

Workers' Rights: Right to Participate in an OSHA Inspection

If an OSHA inspection is conducted in your workplace, you have the right to have your representative accompany the inspector on the inspection.

You also have the right to talk to the inspector privately. You may point out hazards, describe injuries, illnesses or near misses that resulted from those hazards, and describe any concerns you have about a safety or health issue.

You also have the right to find out about inspection results and abatement measures, and get involved in any meetings or hearings related to the inspection. You may also object to the date set for the violation to be corrected and be notified if the employer files a contest.

Contest: If an employer disagrees with the results of the OSHA inspection, he or she may submit a written objection to OSHA, called a Notice of Contest.

Reporting Safety Hazards

Workers have a right to seek safety and health on the job without fear of punishment. That right is spelled out in Section 11(c) of the OSH Act. The law says the employer shall not punish or discriminate against employees for exercising such rights as complaining to the employer, union, OSHA, or any other government agency about safety and health hazards. Workers are also protected for participation in OSHA inspections, conferences, hearings, and other OSHA-related activities.

Workers also have the right to refuse to do a job if they believe in good faith that they are exposed to an imminent danger. "Good faith" means that even if an imminent danger is not found to exist, the worker had reasonable grounds to believe that it did exist. Since the conditions necessary to justify a work refusal are very stringent, refusing work should be an action taken as a last resort.

If time permits, the condition should be reported to OSHA or the appropriate government agency. If you believe you have been punished for exercising your safety and health rights, you must contact OSHA within 30 days in order to preserve the protections provided under the OSH Act. The *How OSHA Responds to a Complaint* table provides information on how OSHA responds to the way a complaint is reported.

Ways to Report Workplace Hazards	
Contact	Contact your team leader, supervisor, manager, safety committee, etc.
Phone	Call the Regional or local office or 1-800-321-OSHA. [Provide your local office number.]
Fax or Mail	Obtain the complaint form online at www.osha.gov or from the local OSHA office.
In Person	Visit the local OSHA Office. [A current list is of OSHA offices is at www.osha.gov]
Online	File complaints online at the OSHA website at www.osha.gov

How OSHA Responds to a Complaint	
If the Complaint is…	***Then OSHA will…***
Filed over the phone, is not signed, or is not a serious hazard	Contact the employer by phone, fax, or email
About a serious hazard	Conduct an inspection at the worksite
Written, signed and submitted to the OSHA area or State Plan office	Most likely, conduct an onsite inspection
Submitted online	Handle most complaints using the OSHA phone/fax system, which means they may even be resolved by phone

Enforcing Standards

OSHA enforces standards through inspections. The current budget is small —all together nationwide (with our State partners) there are only about 2,400 inspectors for over 7 million workplaces. At this rate, it would take about 100 years for us to inspect every workplace once.

Therefore, OSHA targets the most dangerous workplaces; industries with fatalities and serious injuries (e.g. grain handling in Colorado) and construction (i.e., falls).

The OSHA inspection process consists of an opening conference, a walkthrough and a closing conference with the employer. Results can take up to 6 months, after which OSHA may issue citations. These may include fines and will include dates by which hazard must be abated.

When an OSHA inspection is conducted in the workplace, workers have the right to have a worker representative accompany the inspector on the inspection. Workers can talk to the inspector privately. They may point out hazards, describe injuries, illnesses or near misses that resulted from those hazards and describe any concern you have about a safety or health issue. Workers also can find out about inspection results and abatement measures, and get involved in any meetings or hearings related to the inspection. Workers may also object to the date set for the violation to be corrected and be notified if the employer files a contest.

Whistleblower Protections

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. Workers cannot be transferred, denied a raise, have their hours reduced, be fired, or punished in any other way because they exercised any right given to them under the OSH Act. Help is available from OSHA for whistleblowers.

OSHA recommend that the following message be posted for OSHA outreach students:

> *If you have been punished or discriminated against for using your rights, you must file a complaint with OSHA within 30 days of the alleged reprisal for most complaints. No form is required, but you must send a letter or call the OSHA Area Office nearest you to report the discrimination within 30 days of the alleged discrimination.*

Handout [3]
https://www.osha.gov/OshDoc/data_General_Facts/whistleblower_rights.pdf

Worker Resources

There are many resources available to workers who want to find out more information about safety or health issues both inside and outside of their workplace.

Because of the rights provided to workers, they can utilize some sources inside the workplace, such as:

- Employer or supervisor, co-workers and union representatives;
- Safety Data Sheet (SDS);
- Labels and warning signs; and/or
- Employee orientation manuals or other training manuals.

Handout [4] https://www.osha.gov/Publications/3334we-can-help-sm.pdf

Samples of outside of the workplace worker safety and health resources are:

- Many at OSHA online such as, OSHA Compliance Assistance Specialists in the area offices.
- NIOSH is OSHA's sister agency. Workers can request NIOSH conduct Health Hazard Evaluations (HHEs) of workplaces in cases where workers are getting sick from an unknown cause or are exposed to an agent or working condition that is not regulated by OSHA.
- Health care providers can be a resource on the health effects of toxic substances, proper medical and first aid treatment, and other health-related issues.

Lesson Summary

In 1971, the Occupational Safety and Health Act was created to give structure to the worker protection activities. OSHA holds the employer responsible for providing a workplace that is free from recognized hazards.

The current mission of OSHA is "to save live, prevent injuries, and protect the health of America's workers". It is the employer's responsibility to keep the workplace free from any known or recognized hazard that is likely to cause injury or illness to their workers.

Workers have the right to know what hazardous materials they are required to work around. Workers must have a way to report hazardous conditions, injuries and illnesses.

Employers must provide training for the workers to inform them on hazard recognition and hazard control. Additional to training, the employers must have medical screening and monitoring when employees are exposed to certain hazards.

Module 2: Managing Safety and Health

Module Description

This module begins with an overview of accident costs, direct and indirect. Then we explore the elements and processes of safety programs and worksite analysis. The job hazard analysis is commonly used for training workers as to how to perform a job in the safest manner possible. Hazard recognition and the hierarchy of hazard control are also discussed.

Next, the module explains how to understand accident causation and the various accident theories. If you learn the cause and effect relationship of accident causation and the human element, then you can reduce injuries and illnesses. The final lesson concludes with an overview of incident investigation techniques.

Module Learning Objectives

At the conclusion of this module, you will be able to:

- Examine the direct cost of an accident
- Evaluate the indirect cost of an accident
- Describe the true cost of an accident related to human error factors
- Summarize the components of a safety program
- Explain how hazards are identified, prevented, and controlled
- Discuss safety training and program improvement
- Analyze worksites and tasks and identify hazards
- Identify the hierarchy of hazard control
- Introduce accident causation theories
- Explain how unsafe behaviors contribute to accidents
- Examine the role of a safety management system in preventing accidents and incidents
- Identify incident investigation techniques to find a root cause of an event

Lesson 1: Accident Costs and Prevention

Lesson Focus

This lesson focuses on the following topics:

- Accident Costs
- Safety Programs
- Worksite Analysis
- Hazard Recognition
- Hierarchy of Hazard Control

Accident Costs

Many accidents are expensive when considering lost time events. However, there are many more cost factors related to accidents that can be direct or indirect. To evaluate the total cost of the accident, you must combine both of these costs.

In order for the cost to be paid, the organization must use the profits of the company. All profits are derived after the operational costs of the company have been calculated. Accidents affect the organization's profitability because the costs of the accidents must be paid from increased revenue. A company's profit margin is calculated by **Profit Margin=Total Profits/Total Sales**. The revenue required for funds to offset an injury are: **Revenue Required=Total Cost of Incident/Profit Margin**.

Additionally, the Business Roundtable publication, Improving Construction Safety Performance, published a study conducted by Stanford University Department of Civil Engineering that provides an indirect cost estimator for accidents as it relates to direct costs of an accident.

Direct Cost of an Accident

The direct costs of an accident are directly associated with the event and are easily quantifiable. Most direct costs are paid by the insurance company of the employer. Examples of some of these costs are:

- Physical therapy
- Medical expenses
- Repair fees for damaged equipment
- Increase in workers' compensation premium

- Continuation of pay
- Compensatory damages

Indirect Cost of an Accident

The indirect costs of an accident are not paid through the insurance and therefore are unrecoverable. While the direct costs are easy to quantify, the indirect costs are often unseen or impossible to quantify. The relationship between direct cost and indirect cost is the indirect cost is greater than the direct cost for the company. Examples of indirect cost are:

- Wages paid to injured workers for absences not covered by Worker's Compensation;
- Lost wages and work stoppage associated with the worker injury;
- Over time due to the accident;
- Administrative costs and time spent by safety personnel, clerical workers, and other employees after the injury;
- Training for replacement workers;
- Lost productivity due to the work unit separation from the injury;
- New employee learning curve;
- Accommodation of the injured employee within the organization:
- Clean up, preparation and replacement cost of damaged material, machinery, and property.

The National Council Compensation Insurance, Inc. (NCCI) collected statistics and data from insurance claims between policy periods 2011 through 2013. This data was incorporated by OSHA in the Safety Pays cost estimator for accidents. The NCCI manages the nation's largest database of workers compensation insurance information.

Indirect costs have a measurable relationship to the direct cost of accidents, which was discovered by the business Roundtable publication, improving construction safety performance, and the Stanford University Department of civil engineering. The magnitude of indirect costs is inversely related to the severity of an accident. Using these numbers, OSHA created the **Safety Pays Cost Calculator**.

Cost Estimate Calculator

The following chart will give the relationship between direct costs and indirect costs in a ratio that is used to calculate the total accident cost.

Direct Costs	Indirect Cost Ratio
$0-$2,999	4.5
$3000-$4,999	1.6
$5,000-$9,999	1.2
$10,000 or more	1.1

To use the cost estimate calculator, you need to know either the injury type or the workers compensation direct cost of an accident and the company's profit margin. However, if the profit margin is not known to the officer using the cost estimator then OSHA will give a default 3% profit margin for calculation of the direct and indirect costs in relation to the additional sales needed to pay total cost of the accident.

As an example of this calculator, if you select an amputation from the entry type menu and give the company a profit margin of 10%, the calculator will give you the following information:

- Amputation: (1) Instance
- Direct Cost: $77,995
- Indirect Cost: $85,794
- Total Cost: $163,789
- Additional Sales needed to recuperate cost (Indirect Cost): $857,945
- Additional Sales needed to recuperate cost (Total Cost); $1,637,890

Therefore, this example illustrates that just one instance of an amputation through most likely an at-risk behavior has historically cost $77,995 of direct costs and $85,794 of indirect costs yielding a total injury cost of $163,789.

Organizations will have to use funds from the profits to cover both direct and indirect cost of the accident. However, up to $77,995 can be recoupable through workers' compensation; then sales must increase $2,859,816 to cover the indirect costs of the injury that they cannot get reimbursed at a 3% profit margin.

Safety Programs

The components for an injury and illness program include:

- Management Leadership
- Worker Participation
- Hazard Identification & Assessment
- Hazard Prevention & Control
- Education & Training

- Program Evaluation & Improvement
- Communication & Coordination for Host Employers, Contractors, and Staffing Agencies

Management Leadership

Leaders are all considered managers in some form or fashion. A committed management unit provides clearly defined objectives and goals for organizational safety behavior. They finance the safety activities through purchases and resource allocations. Every level of management value safety practices and accomplishments as much as regulatory compliance and water quality.

Steps to implement leadership commitment to safety are:

- Writing or personally signing a clearly defined safety policy that acknowledges safety and health as important as productivity, water quality, regulatory compliance, and customer service.
- Communicating the policy and values to all levels of the organization
- Visually set examples of safety behavior and demonstrate actions consistent with a safety culture.
- Allocate resources for safety and health
- Hold all levels of the organization accountable for safety performance

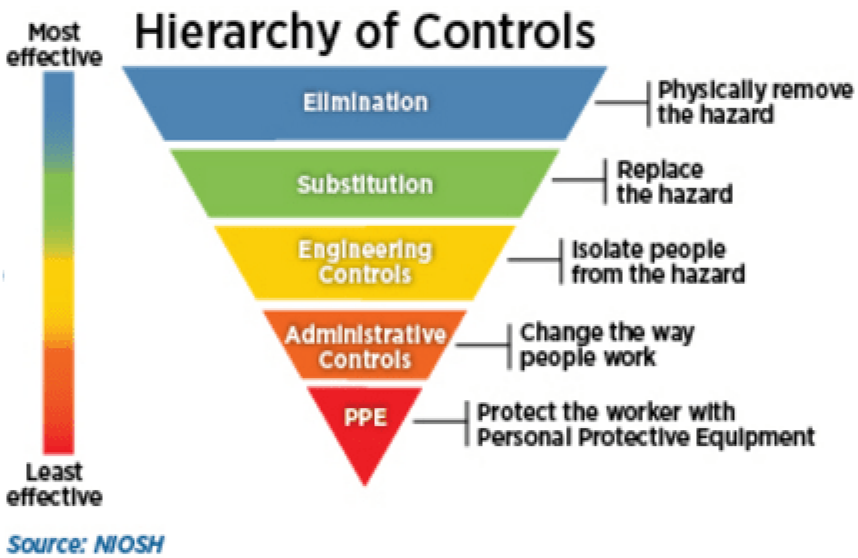
Hazard Identification & Assessment

A hazard is any condition or action that can cause an organizational loss. An organizational loss can come in the form of an injury, illness, damaged equipment, or even worker turnover. When a loss occurs, the organization must determine the root cause of the loss and not just the symptoms leading to the loss event. The assessment process must be structured, detailed, and deliver actionable measures to address the root cause. Hazard identification and assessment can be accomplished by:

- Worksite analysis of past, present, and predictive data from reports, instrumentation and maintenance logs, even worker injury and illness records
- Worksite inspections for safety hazards
- Investigate each accident until the root cause is completely disclosed
- Identify hazards that may arise outside of normal operating conditions including emergencies, start-up, or shut-down operations.

- Characterize the true composition of a hazard, give a priority value to them, and identify appropriate hazard controls

Hazard Prevention & Control



The prevention and control of hazards protect the worker from injury and illness, but also give employees a clear sign that the company cares about their wellbeing.

Elimination of hazards is the best way to avoid an organizational lose. However, that may not be possible in all situations. Therefore, hazard control is appropriate for some hazards that are still present when workers are performing their daily tasks. Although some worksites are practicing substitution of highly hazardous chemicals such as gas chlorine to liquid chlorine, it is mostly because they are trying to avoid the Risk Management Program, regulated by the EPA, and not primarily worker safety.

The hierarchy of hazard controls after elimination and substitution are:

1. Engineering (Physical barrier or device such as a machine guard)
2. Administrative (Work rule such as work rotation)
3. PPE (Protection worn by workers as a barrier to hazards such as a hardhat)

Tips for implementing hazard prevention and controls are as follows:

- Identifying what controls are available for each type of hazard

- Selecting the proper controls by doing a detailed hazard assessment
- Develop, maintain, and update a hazard control plan
- Select controls that are applicable for all aspects of the organization and conditions
- Implement the selected hazard controls with a priority on elimination and substitution of hazards
- Follow up on all hazard controls for each task to make sure they are protective enough

Education & Training

Education and training can be thought of as a tool that binds each step together to keep the efforts cohesive. Some companies have relied on safety training from organizations or even video tapes with outdated material. The role of education and training must be a factor in developing both management and workers to meet the overall safety culture. General workers should have safety awareness training with regular operations or maintenance training. However, if they work in a specialized area that exposes them to unique hazards, then training must be applicable to that hazard. Effective training can be done peer-to-peer, formal classrooms, online, or at the worksite. Some **actions items OSHA suggests** are:

- Provide program awareness training
- Train employers, managers, supervisors on their individual safety roles
- Train workers on their specific role in the safety program
- Train workers on hazard identification and controls

Program Evaluation & Improvement

Every program in an organization must be vetted and improved in order to stay viable and productive; safety programs are no different. Program evaluation must be done at given intervals by a competent group. If there are deficiencies found in a program, then the corrections must be made in a systematic way by high risk issues being fixed first then lower risk areas lastly.

Probability

Risk can be calculated as Probability x Severity=Risk. The probability of a loss event occurring can be broken down into 5 categories:

1. Improbable
2. Unlikely
3. Probable
4. Likely
5. Frequent

Severity

Severity speaks of the consequence of a loss event when it does occur:

1. Minor
2. Marginal
3. Serious
4. Catastrophic

If your risk assessment tells you that a task is a P4 x S3=R12, then it should get your attention over a R3 item.

Program evaluation and improvement must include the following areas:

- Monitoring performance and progress
- Verifying the program is implemented and is operating
- Correct program shortcomings and identify opportunities to improve (**OSHA, 2016**)

Many safety and health program have a significant deficiency in the written programs that are both OSHA regulations and procedures for safe work. The written safety program is used to keep workers from having to guess what is required for the task at hand. These programs must be periodically evaluated to determine if they are creating a hazardous condition by being vague, old information, or just not applicable to current working operations.
There are many OSHA required written programs, which are based on what the employees are exposed to in the work environment. Some common programs are:

- Emergency Action Plan (EAP)
    - The emergency action plan (EAP) is a created to help the workers understand what is the procedures to follow during an emergency situation at the facility.
    - Workers must know who is responsible for making sure that everyone is out of the facility. There must be a mechanism to check for employees that are left to perform critical activities and have to be evacuated after the shutdown process.
    - This plan will detail what emergency service will be called and who is making the call. The numbers must be kept up to date at all times.
    - Workers must be trained as to their roles in an emergency and all aspects of the EAP
- Fire Prevention Plan (FPP)
    - The FPP is regulated in the same vein of the EAP, because these two concepts are complementary in nature. The workers must be able to know what to do to prevent a fire at the facility.
    - In the FPP, the workplace has a person that is in charge of maintaining the combustible material separate from flammable materials.
    - Flammable materials must not be accumulated in such a way that is can cause a fire.
    - This plan also requires workers to be trained as to its contents and what to do to prevent fires, including understanding the use of a fire extinguisher.
- Control of Hazardous Energy Program
    - The control of hazardous program is commonly known as Lockout/Tagout or LOTO because that is the mechanism that is used to be an engineering control for the energy source.
    - This program will detail the interaction of a worker that must perform a task on heavy machinery that can cause amputations, crushing injuries, or even fatalities.
    - LOTO includes a detailed procedure to identify all energy sources of an equipment, release of latent energy, placing a locking device on the energy source, and placing a tag on the locking device or equipment detailing that the equipment is being serviced and not to energize the equipment.
    - The heart of the program is to have individualized lockout procedures for each unique piece of equipment and annual audits to make sure the procedures are still applicable.

- Fall Protection Program
  - Both General Industry and Construction have detailed information that are required for workers that are exposed to a fall hazard. Falls in construction are the #1 killer of workers in that industry.
  - A fall protection plan will uniquely identify the source of the fall hazard then match the most protective and practical fall prevention or fall arrest system for that job.
  - In some cases, it is not feasible to have traditional fall protection, which is, Personal Fall Arrest System, safety net, or guardrails, so an alternate procedure plan is put in place to protect the workers.
  - Training on the components of the fall protection system, fall hazards, and other fall related material is mandatory for employers that have workers that are exposed to fall hazards.
  - The standard does have different fall protection criteria for each industry such as:
    - 4 ft for General Industry
    - 6 ft for Construction
    - 10 ft for Scaffolds
    - 15 ft for Steel Erection work
- Hazard Communication (HazCom)
  - Hazard communication is the top cited standard for General Industry each year. Because to the lack of understanding of the regulation.
  - A worker has the right to know of any hazardous chemical that they are exposed to in the work environment.
  - Often the workers are exposing themselves to hazardous chemicals by putting substances in the wrong secondary container and not putting a proper label on the new bottle. Then the worker will forget or place the chemical in the mislabeled or unlabeled bottle in the general working environment. This can prove to be fatal if a worker consumes chemicals, thinking it is a beverage.
  - The Hazard Communication standard give details on what to place on the label for proper communication of the liquid and its hazard potential. In recent years, OSHA has adapted the Globally Harmonized System for the Classification and Labeling of chemical (GHS). The GHS is a UN initiative that has recommendation for all countries that ship and use chemical for their product.

There are many more written programs that are used to give detailed guidance to the worker for protecting them from unique hazards. To evaluate the written program, the

safety committee must think of the Maturity of the program and how Critical the program is to the overall operations of the facility.
A Maturity/Criticality assessment will give a quantifiable number as to where the current state of the written program is for the company. This will also help the program evaluation team to see where the needed changes must be and how to prioritize what written program gets changed first.

The determining of the maturity and criticality of a written program will align to the overall corporate vision and objectives. Once the program is aligned in such a fashion then it becomes easier to get the budgetary funding for the programs and all activities related to the written program including training and equipment for the workers.
First, the program must be analyzed for the current phase of maturity or immaturity using the following scale (Steinbacher & Smith):

Maturity Score	Maturity Level	Description
4	Introduction	The program may not have elements that are necessary or only covers the basic information with significant gaps in the vision or current state of the program
3	Informal	Program is just getting off the ground with moderate gaps in the vision and current state of the existence
2	Functional	The program is established with almost no gaps or very little gaps between the vision of the program and how it is currently administered
1	Model	The program is a benchmark for other entities. There are no gaps in the execution of the program or functions.

After the Maturity number is assigned then the Criticality is assessed through the following method and numbering system:

Criticality Score	Criticality Level	Description
3	Business Critical	This program is required for the business operations. There will be noncompliance of regulatory requirements, major injury and illness potential, This activity may have an impact on the community and public relations.
2	Core	Key element for the complete Safety Management System of the organization
1	Improvement Oriented	Elements of ongoing process to get a better overall Safety Management System

The Maturity/Criticality Ranking is determined by M x C=MC Rank

Element	M	C	MC	Opportunities
Ergonomics	3	2	6	BBS observation for Ergonomics should be scheduled
LOTO	2	3	6	Get some more training and tools for program success
Driver Safety	3	3	9	Have all drivers go through a safety training program semi-annually through our insurance company

The information that is gathered can be utilized for many components of the over Safety Management System or even the organization as a whole. The message of the score can be used in a color-coded chart to give a visual as to what is priority for the company and what can wait.

MC Decision Matrix			
Model (1)	3	2	1
Functional (2)	6	4	2
Informal (3)	9	6	3
Introduction (4)	12	8	4
	Critical (3)	Essential (2)	Improvement (1)
	High Priority	Medium Priority	Low Priority

Using the M/C scoring system is a great way to visualize and prioritize the activities of the evaluation team as they review the written programs of the organization. Having a written program is only the first stage of keeping the works safe. The plan must be enforced, monitored for completeness, and adjusted as needed to hit its target.

Communication & Coordination for Host Employers, Contractors, and Staffing Agencies

The host company must take responsibility for all workers including contract and staffing agency workers. Many public sector businesses are not under the jurisdiction of federal OSHA or even a state OSHA, but the contract companies are under an occupational safety agency that will regulate and cite them for violations. However, local government officials have a moral obligation to make sure that workers of all types who do business with them are protected from hazards. To keep the workers safe, the company should:

- Communicate with all outside contractors the importance of worker safety
- Coordinate with supervisors, owners, and workers throughout the project to make sure the worksite is safe
- Hold all workers and agencies accountable for operating a safe worksite
- Verify that the bids and contracts specify that safe work practices are a must for working with the company

A safety culture will protect the workers from injury and illness because the company places a value on the lives of the workers. This is a deposit into the "good will" bank of the worker and will be rewarded with loyalty. A deep commitment to a safety culture will lead to worker retention and organizational benefits far beyond regulatory compliance.

Worksite Analysis

Hazard prevention and control comes from all levels of the organization including the chief executive officer all the way down to individual working at the tasks themselves. A safety management system is built on the foundation that not only is everyone responsible for their own safety, but a system can be incorporated in all task that will protect workers from contacting the hazard.

One of the most common ways for workers to visualize hazards in a job prior to doing the job is through a Job Hazard Analysis (JHA).

What is a JHA?

A job hazard analysis is a tool that is used throughout organizations to help the workers visualize a job that needs to be done and break it into steps. It is different than the standard operating procedure because each step will have an identified hazard and an identified control.

The job hazard analysis is commonly used for training workers as to how to perform a job in the safest manner possible. A standard operating procedure will only show the person how to do the job by breaking down its components. The components of any job are usually communicated through instructions by people who have done it in the past. These can be frontline supervisors or the manufacturers of the equipment.

Using the manufacturer’s recommendation, you will see how the equipment is supposed to work, but it may not detail the safety requirements of the job. In a standard operating procedure (SOP), the task is detailed from the beginning to the end of the activity.

Many JHA can be started by using the SOP to get the steps outlined in chronological order as to the way it should be done. Then the safety committee with a good selection of the working crew will dissect the steps to see if and where a hazard may present itself.

Once the hazard or hazards for a step are identified, then the workers will look to the hierarchy of hazard control to see if they can either eliminate the hazard, substitute it, engineer out a control, use existing or new work rules as an administrative control, or finally wear personal protective equipment during that step.

The workers can go back and forth reviewing the JHA to determine completeness of tasks and total identification of hazards. The JHA is also formalized by writing on a JHA worksheet and kept for the review of the employees prior to doing the task.

Some JHA’s can be done in advance for jobs that are routine, while others are done onsite prior to the beginning of the task. However, even JHA’s that are done prior should be revisited by the work team before any work begins. If there is any doubt as to the steps, hazards, or hazard control, then the work should not progress until all questions have been answered.

Job Hazard Analysis Form

JOB TITLE: DATE OF ANALYSIS:

JOB LOCATION:

STEP	HAZARD	NEW PROCEDURE OR PROTECTION

Hazard Recognition

To understand the behavior-based safety program, it is necessary to understand what a hazard is first. A hazard is anything that can injure or hurt an individual. While you know a workplace can have various hazards that does not mean that there will be an injury. Hazards must have exposure in order for there to be an injury or an incident. Hazard identification is primary to understanding how an accident can happen. Later in this program, we will review accident causation from a few different models.

The hazard itself may be the issue for workers when it comes to safety or it may be the exposure to that hazard that is the issue for the employer. For instance, if there is a cave-in hazard for trenching and excavation the cave-in is possible even without the workers being present. The hazard becomes an accident or incident when workers are present, meaning exposure.

Hazard recognition should be first and foremost taught to the front-line supervisors. If the front-line supervisors, who control their work conditions, are aware of hazards then they will protect themselves and the people they supervise. Hazard recognition secondarily must be taught at the level of each worker as they become employed at the facility.

There are obvious hazards such as working at heights, but there are also hazards that may not be as obvious. Workers may be exposed to an odorless toxic fume, so they are not aware that they are being poisoned. This may be the case in many permit-required confined spaces because they often have hazardous atmospheres.

Hazard Types

Hazard types are ways to classify what specifically the hazard is to the worker. Examples of hazard types are:

- ergonomics
- caught in
- contact with
- chemical exposure
- flammable liquids
- laceration
- Falls to below
- Falls to the same level
- mechanical hazards
- engulfment

There are many more hazard types that are job specific, so the worker must be trained to recognize these hazards from the first day of work. Once the hazards are identified, the next stage is to learn how to control the hazard and prevent it from injuring a worker.

Hierarchy of Hazard Control

There is a hierarchy of hazard control beginning with:

1. **Elimination** is the primary way to protect the worker from any hazard. If workers do not have any exposure to that hazard because it is not present, then they will not be injured or harmed.
2. **Substitution** is a secondary way to protect the worker from injury or illness. If there is work with the gas Chlorine and the workplace decides to go to liquid bleach, that substitution would protect the workers from exposure to a hazardous gas.
3. **Risk Transfer:** Another type of hazard control would be to transfer exposure using a contractor. When the contractor is used to perform jobs that your workers would have been doing, then the exposure will go to the contractor and not to your employees. Many companies decide to use this method when the hire specialist such as mold remediation companies, asbestos removal companies, or private fire rescue companies.
4. **Engineering controls:** An engineering control is one that creates a physical barrier between the worker and the hazard point. This physical barrier is not something that can easily be removed or bypassed without worker intervention. There are several types of engineering controls; they should be used primarily for keeping the worker protected.
    a. An example of engineering control is a machine guard on a table saw. If the workers want to use the table saw without the machine guard, they would have to physically take off that guard and then operate the machinery. The behavior would be an at-risk behavior creating exposure to a low hazard that can cause a laceration or amputation.
5. **Administrative controls**: An administrative control is a work rule set by the employer to protect workers from injuries or illnesses. A work rule, policies, procedures, and employer's safety culture are company norms that will translate into absolutes. An example of an administrative control is to have workers read the procedure on how to safely do a task. This procedure would be detailed, identify the hazards, and help the worker select the appropriate control to that hazard.
6. **Personal Protective Equipment (PPE)**: PPE is the very last line of defense for worker safety and health because they are still exposed to that hazard. If an engineering control is being manufactured and the worker must still be exposed to the hazard, then the PPE should be selected for protection.

a. In general industry, personal protective equipment must be accompanied with a PPE hazard assessment. The PPE hazard assessment is the workplace choosing the right protective equipment to match the hazard that the workers are exposed to. For instance, disposable gloves can be worn to protect against biological hazards. If a worker is cleaning up a blood-borne pathogen spill from human fluids, then he or she would use gloves. The PPE hazard assessment would tell him or her what types of gloves to use. It could be latex gloves, nitrile gloves, or even thicker gloves depending on if there is also a needlestick hazard.

Lesson Summary

There are many cost factors related to accidents that can be direct or indirect. The direct costs of an accident are directly associated with the event and are easily quantifiable. Most direct costs are paid by the insurance company of the employer. The indirect costs of an accident are not paid through the insurance and therefore are unrecoverable.
The components for an injury and illness program include:

- Management Leadership
- Worker Participation
- Hazard Identification & Assessment
- Hazard Prevention & Control
- Education & Training
- Program Evaluation & Improvement
- Communication & Coordination for Host Employers, Contractors, and Staffing Agencies

One of the most common ways for workers to visualize hazards in a job prior to doing the job is through a Job Hazard Analysis (JHA). The job hazard analysis is commonly used for training workers as to how to perform a job in the safest manner possible.

A hazard is anything that can injure or hurt an individual. Hazard identification is primary to understanding how an accident can happen. Hazard types are ways to classify what specifically the hazard is to the worker.

Once the hazards are identified, the next stage is to learn how to control the hazard and prevent it from injuring a worker.
There is a hierarchy of hazard control:

- Elimination
- Substitution

- Risk transfer
- Engineering controls
- Administrative controls
- Personal Protective Equipment (PPE)

Lesson 2: Accident Causation and Investigation

Lesson Focus

This lesson focuses on the following topics:
- Understanding Accident Causation
- Accident Theories
- Incident Investigation Techniques

Understanding Accident Causation

To understand accident causation, investigation relies on the idea that most accidents are caused by human error. Therefore, if you learn the cause and effect relationship of accident causation and the human element, then you can reduce injuries and illnesses. Although, there are additional factors that cause accidents, the human aspect is a leading cause of incidents.

The difference between and accident and an incident are slight but worth noting. Accidents denote a loss-producing, unintended event, and an incident denotes an unintended event that possibly doesn't result in a loss (Friend & Kohn, London). In this session, we will refer to incidents and accidents as interchangeable because, the outcome, in this context, is not as relevant as the causes.

In order for an accident to happen, there must be two factors present: the hazard and exposure to the hazard. The hazard is anything that will hurt harm you through contact. Exposure is how susceptible you are to an injury or illness due to being near to the hazardous substance or material. Accident causation models deal with controlling/eliminating exposure or eliminating, substituting, or controlling the hazard itself.

Types of Hazards

There are several different types of hazards, including but not limited to:
- Chemical
- Caught in between
- Contact by
- Electrical
- Ergonomics
- Excavation

- Slips, trips, and falls
- Mechanical
- Overexertion
- Struck by
- Struck against

Hazardous Control Techniques

If safety professionals do not have the option to eliminate or substitute hazard, then they must control the hazard to which their employees are exposed. There are three types of hazardous control techniques:

1. Engineering controls are the most preferred way to control hazards from affecting a worker. The engineering control is a physical device or barrier that prevents the worker from coming into contact with a point of operation or uncontrolled energy. An example of engineering controls are machine guards, locking devices, and the fume exhaust systems.
2. Administrative controls (or work rules) are controls that create a policy and procedure to protect worker from the hazard. Examples include the safety management system, lockout tag out policies, and job hazard analysis.
3. Personal protective equipment is the last line of defense because the worker is still exposed to the hazard. Some examples of personal protective equipment are hardhats, close, and primary eye protectors.

These hazard controls are set up in the hierarchy scenario, therefore hazardous material must be controlled through engineering controls first, then administrative controls, and finally personal protective equipment. However, in most scenarios one or more of these controls are used to protect the worker from the hazardous condition or material.

Hazard Analysis

Hazard analysis is a way to understand the nature and complexity of a hazardous condition. A proper analysis is done through assessing the risk involved for the workers when confronted with this hazard. Usually hazard analysis includes the probability of the hazard creating an accident and the likelihood that the incident will result in an injury or illness to a certain degree. Therefore, a calculation of probability times severity equals risk.

Probability categories are often delineated into five cases improbable, remote, occasional, probable, and frequent. In most risk analyses, each probability category can be assigned a number beginning with the lowest category improbable being assigned one and the highest category frequent being assigned to five.

The severity factors also are delineated by the characteristics negligible, marginal, critical, and catastrophic. Similar to the probability factor, numbers are assigned to the severity factors beginning with negligible as a one and catastrophic events as a four.
With this understanding of risk, an assessment can be performed using the number system of probability times severity and give a class of hazard. The higher the hazard the more probable that there will be an accident. Combined with the human error factor, the probability and severity may both increase any hazard that is a high risk.

An example of conducting a risk analysis is as follows:
Risk = Probability x Severity

Frequency of Occurrence-Probability	Catastrophic (Fatality) (4)	Critical (OSHA Recordable) (3)	Marginal (First-Aid) (2)	Negligible (Near Miss) (1)
Frequent (5)				
Probable (4)				
Occasional (3)				
Remote (2)				
Improbable (1)				

Example:
A worker working in a laboratory is using acid without any hand protection.

The probability of a chemical burn is high enough to warrant the top level of likelihood of an event occurring, which is a 5. The consequence of a chemical burn will yield a severity of 3. In calculating this risk, the use of acid in a laboratory without hand protection is a risk factor 15. Using the maximum scale of 20, the highest probability 5 and the highest severity as 4, then this action by the worker is a high-risk activity.

In this example, the use of chemicals without proper personal protective equipment has an element of behavioral deficiency. This at-risk behavior can be identified through a behavioral-based safety inspection and coached. Although, the worker did not have gloves on when handling the chemical, it is unlikely that an accident will be the cause of the single factor.

Accident Theories

Single Factor Theory

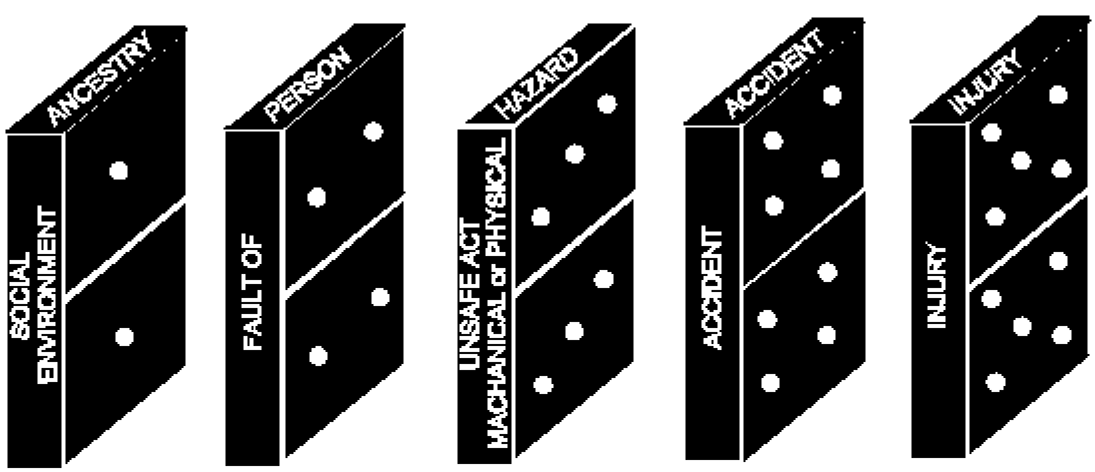
The Single Factor Theory for accident investigation is the most basic of the accident causation models. In the single factor theory, it is thought that there is one event solely responsible for an accident or incident. It is akin to the “pilot error syndrome” that states that the cause of the accident was solely due to an error caused by the pilot. In modern accident causation models, the single factor theory has little to no value.

H.W. Heinrich’s Domino Theory

In 1931, HW Heinrich presented a theory called the axiom of industrial safety. The first axiom dealt with accident causation, which states “the occurrence of the injury invariably results from the complicated sequences of factor, the last one of which being the accident itself” (Heinrich et al, 1980). The model that was used to illustrate this point was a lineup of dominoes, which became known as the domino theory. In all the domino theories, there are 3 phases that are influencers of an accident. These phases are:

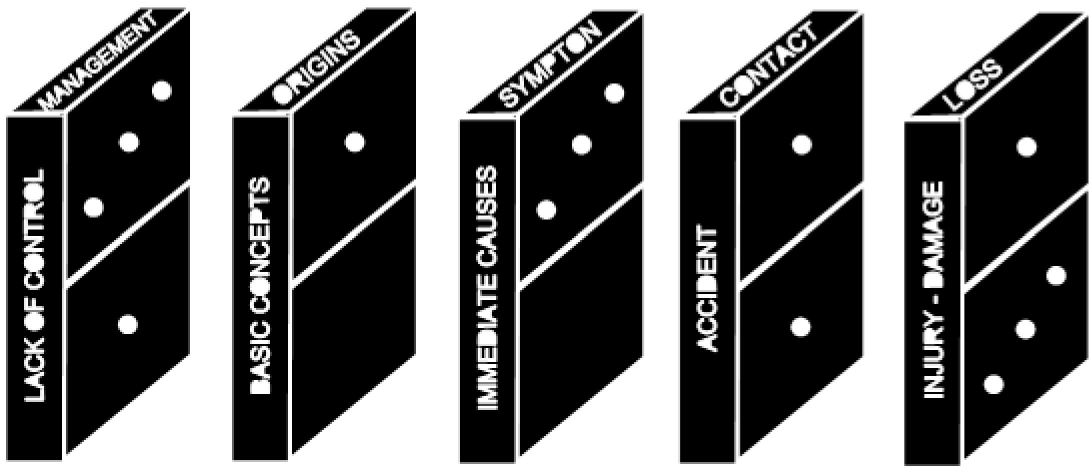
1. Pre-Contact phase prior to the event happening
2. Contact phase, which refers to the event as it’s happening.
3. Post contact phase, which refers to after the release of unplanned energy, the product downtime, or the injury or illness

The domino theory is summarized as an injury is caused by an accident due to an unsaved act and/or mechanical or physical hazards due to the fault of the person, caused by their ancestry and social environment. (Heinrich et al, 1980)



(Heinrich, D, & Roos, 1980)

In this model, Heinrich states that by removing one of the dominoes, preferably the middle unsaved act domino, then the accident would have never occurred. The later model of the Domino, Bird and Loftus added managerial influence and managerial error dominoes. In the later model, loss was organizational loss as opposed to just an accident. An example of organizational loss could be property damage, loss of public trust, as well as an illness or injury.



(Heinrich, D, & Roos, 1980)

A point of contention of the Domino theories was that they don't glean your nature of the incidents. As the accident theories developed, more dimensional approaches became common, indicating that the cause of an incident may be multi-factual with events happening in a nonlinear format.

Multiple Factor Theory

The multiple factor theory looks at not just the 3 phases in the domino theory of pre-contact -- contact -- post contact, it analyzes other factors that influence an accident. Multiple factor theories analyze other things such as management, the machines, the media, and the man. The role of management would be to create the organizational structures, the policy, and procedures. The machinery includes the design, shape, size, and the type of energy sources of the equipment. The role of media can be described as environmental factors. The factor of the man includes gender, age, mentality, fatigue factors, height, weight, etc.

In analyzing all these factors, it becomes apparent that your model does not include just the influencers. Unlike previous theories, management's role is more concrete in the multiple factor theories. Strong management that respects the role of occupational safety will support and lead the safety effort of the organization.

Human Factor Theory

The human factor theory states that the accident is caused by human error. This theory analyzes the factors that lead to the human error. Such factors are overload, inappropriate activities, and inappropriate responses.

Overload doesn't always mean that the worker is overburdened, but the job itself may have excess stressors such as noise, heat, or unclear instructions. Workers can often feel overloaded when given too many tasks at a time or work instructions do not clearly define the goals. Front-line supervisors are charged with making sure that the workers understand the steps of each task.

There are two types of failures that cause human errors: active failures and latent failures (Reason J. , 1990). An active failure is usually caused by the worker or person engaged in an activity. The actions give an immediate consequence, which is the direct cause of the accident. Latent failures lay the foundation of an active failure due to such issues as:

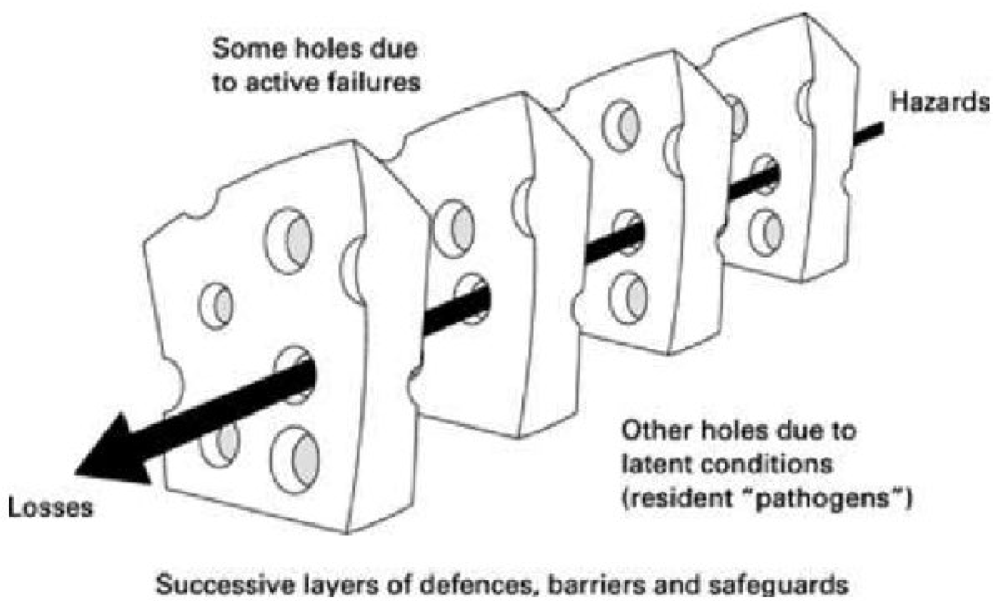
- Ineffective training
- Poor engineering of the equipment or location
- Poor or inadequate supervision
- Ineffective communication
- Unclear roles for the worker

The observation of the human factor theory through a behavioral-based safety analysis can help improve the safety system. The BBS is designed to highlight the behavior of the worker that is causing the accident and to address them systematically. The key to systematic intervention is having a well-planned and thought out BBS program.

James Reason's Swiss Cheese Theory

In recent years, a professor from Manchester University in the United Kingdom, James Reason, developed an accident causation model based on the analogy of holes in Swiss cheese. In his analysis of an accident, he uses a visualization of a complete system with no holes. In a complete system, management is involved, employees are motivated, there is a safety management system in place, and a safety culture exists in the organization.

Fig. (1): The Swiss Cheese Model by James Reason published in 2000. Adopted from Perneger BMC Health ServicesResearch 2005 5:71.



https://www.researchgate.net/figure/Fig-1-The-Swiss-Cheese-Model-by-James-Reason-published-in-2000-Adopted-from-Perneger_fig1_324280519

A breakdown of any one of these components, the blanks, will create a whole similar to the hole in a slice of Swiss cheese. As mortals developed, the system becomes less than ideal and dysfunctional. Eventually each one of the systems will have their holes line up and allow a release of unplanned energy to create an accident condition. In this model, it does have a linear component, but it also includes multiple factors that influence the accident.

An example of how each one of the blanks can develop holes can be found in the following scenario:

Upper management has a change in leadership with the new ownership group. The ownership group values production more than safety. Therefore, the workers are not given adequate time for safety briefings in the morning. Production becomes the main factor for the organization. Quality and safety may suffer due to the production quotas. Eventually workers will become fatigued, equipment fails, or safety training is omitted entirely.

During a busy shift when the worker is trying to meet production quota, he decides not to report a broken guard on a piece of equipment and comes in contact with the unguarded point of operation. The worker sustains a laceration that could have easily been an amputation.

Incident Investigation Techniques

Root Cause Analysis

A root cause analysis is a detailed procedure used by safety professionals to look beyond the initial knee-jerk reaction to assign blame for an incident. First, the investigator will notice direct causes to any accident, but he or she cannot see indirect causes or latent causes that became activated to create the accident.

A root cause analysis must be conducted to determine all factors and variables responsible for an incident. Most of these types of analysis will require a team of trained professionals alert to accident causation models, as well as good investigators and critical thinkers. There are many types of root cause analysis, but they all seek to do the same thing: address the source cause of any accident.

The 5 Whys

The 5 Whys is an accident investigation technique used by safety professionals in developing the root cause analysis. This technique will help the data entry investigator pass simple questions to date beyond the superficial yes or no answer. They are quantifiable questions that build one upon the next. As each question gets answered, the investigator will uncover more reasons for an accident. Although this technique is called the 5 Whys, it often takes more questionings to get to the root cause.

An example of the 5Y technique for incident investigation is as follows:

A worker receives a laceration from touching unguarded blade on a handfed ripsaw. Using the 5 Whys technique for questioning, the investigator can begin with these questions:

1. Why did the worker receive a laceration? -- Because, he touched unguarded blade.
2. Why did the worker touch the unguarded blade? --Because the guard was not placed on the saw.
3. Why was the guard not on the saw? --Because the worker believed he can work faster without the guard.
4. Why did the worker believe it is better to work faster and not safer? --Because the worker gets paid on a quota basis.
5. Why is management placing a greater importance on production quotas over safety? --Because management receives a bonus for achieving production quotas.

In this brief example, the use of production quotas indirectly led to the worker valuing speed over safety. There may be many other factors related to why the worker received a laceration in the scenario. Such factors can include but are not limited to:

- Poor organizational safety culture
- Untrained worker
- Management and supervision has unfair expectation of production quotas
- Worker fears retribution for slowing down production to address safety concerns
- Upper management has condoned and/or rewarded production goals over safety concerns.

When conducting a 5 Whys accident analysis, the investigator will dig deeper to uncover an accident causation. This new revelation may lead the organization to address gaps in their safety management system. The value of operating safely to reduce or eliminate injury and illness must be made apparent to management in order for them to value safety equal with production.

Lesson Summary

Managing safety and health is a key part of keeping workers free from injury and illness. The company will save money by investing in the safety needs of the employees. An organization that values low risk will have a safety culture that will promote safe behaviors in all level of the organization. Additionally, through accident investigations, the company will get a good understanding of what hazards created the incident and how to stop it from hurting future workers.

To understand accident causation, investigation relies on the idea that most accidents are caused by human error. Therefore, if you learn the cause and effect relationship of accident causation and the human element, then you can reduce injuries and illnesses. In order for an accident to happen, there must be two factors present: the hazard and exposure to the hazard.

Accident theories include:

- Single Factor Theory
- H.W. Heinrich's Domino Theory
- Multiple Factor Theory
- Human Factor Theory
- James Reason's Swiss Cheese Theory

A root cause analysis is a detailed procedure used by safety professionals to look beyond the initial knee-jerk reaction to assign blame for an incident. It is conducted to determine all factors and variables responsible for an incident.

The 5 Whys is an accident investigation technique used by safety professionals in developing the root cause analysis by asking questions. As each question gets answered, the investigator will uncover more reasons for an accident.

Module 3: OSHA Focus Four Hazards

Module Description

This module gives you a basic understanding of OSHA's role in prevention and elimination of work-related illnesses and injuries. The OSHA standards identify various construction worksite areas and activities that can lead to hazards. You will learn about the various illnesses, injuries, and/or fatalities in relation to the focus four hazards [fall, caught-in or between, struck-by and electrocution] in construction and become capable of recognizing them.

You will learn about the duties of the employers, the importance of identifying and evaluating hazards and necessity of providing training to employees. Under the OSHA standard, employers are required to select proper protection measures compatible with the type of hazard and the work being performed.

Module Learning Objectives

At the conclusion of this module, you will be able to:

- Identify the focus four hazards
- Describe the various types of hazards
- Explain how workers can protect themselves from the focus four hazards
- Recognize employer requirements to protect workers from these hazards

Lesson 1: Fall Protection

Lesson Focus

This lesson focuses on the following topics:

- Case Study
- Falls
- Protection from Falling Objects
- Types of Fall Protection—Passive Systems
- Types of Fall Protection—Active Systems

Case Study

Worker Falls from Scaffolding

This accident occurred during the construction of a new two-story wood frame house. The work procedures on the day of the accident involved working on the ground to insert pillars into the floor joists, which were then lifted by a mobile crane. Three workers were engaged in this assembly work on the ground, including the victim and two coworkers who carried out the elevated assembly work. The framing for the second-floor roof was completed in the morning after which the workers took a lunch break.

After the break, work resumed on the site and workers carried on with the same assignment. The incident happened when the victim went to stand on a scaffolding board that was stretched over the second-floor ceiling beam. As the worker stood on the board it suddenly fell onto the first-floor concrete foundation, killing the worker.

What do you think were some of the causes of the accident?

- The scaffolding board was not fixed.
- No guardrail system or personal fall protection system was used by employees while working at heights greater than six feet.
- No competent person for fall protection was onsite during the construction of this project.
- While the victim had been newly employed the day of the accident, he was not given new hire safety orientation prior to starting work.

Falls

Falls are the leading cause of fatalities in the construction industry. with 349 total deaths related to falls in the construction industry reported in 2014.

The Physics of a Fall

A body in motion can cover vast distances in a short period of time. Consider this:

- A body in free fall can travel 4 feet in 0.5 seconds.
- A body in free fall can travel 16 feet in 1 second.
- A body in free fall can travel 64 feet in 2 seconds.
- A body in free fall can travel 144 feet in just 3 seconds.

Fall Prevention Measures

In order to prevent workers from falling, employers must:

- Select fall protection systems appropriate for given situations.
- Use proper construction and installation of safety systems.
- Supervise employees properly.
- Use safe work procedures.
- Train workers in the proper selection, use, and maintenance of fall protection systems.

Areas Required to Have Fall Protection

Depending on the circumstances, the following areas are required to have fall protection:

- Unprotected sides and edges
- Leading edges
- Hoist areas
- Holes
- Formwork and reinforcing steel
- Ramps, runways, and other walkways
- Excavations
- Dangerous equipment
- Overhand bricklaying and related work
- Roofing work on low-slope roofs
- Roofs
- Pre-cast concrete erection
- Residential construction
- Wall openings
- Walking/working surfaces not otherwise addressed

Duty to Have Fall Protection

- Fall protection is generally required when one or more employees have exposure to falls of six feet or greater to the lower level.
- Surfaces must be inspected before the work begins.
- Employees are only permitted to be on surfaces that are strong enough to support them.

Employers are required to assess the workplace to determine if the walking/working surfaces on which employees are to work have the strength and structural integrity to safely support workers. Employees are not permitted to work on those surfaces until it has been determined that the surfaces have the requisite strength and structural integrity to support workers. Once employers have determined that the surface is safe for employees to work on, the employer must select one of the available options for the work operation if a fall hazard is present.

> **Example:** For example, if an employee is exposed to falling 6 feet (1.8 meters) or more from an unprotected side or edge, the employer must provide a guardrail system, safety net system, or personal fall arrest system to protect the worker. Similar requirements are prescribed for other fall hazards as follows.

Leading Edge Work

Each employee who is constructing a leading edge six feet (1.8 meters) or more above lower levels shall be properly protected. Suitable protection may be provided by guardrail systems, safety net systems, or personal fall arrest systems.

Hoist Areas

Each employee in a hoist area shall be protected from falling 6 feet (1.8 meters) or more by guardrail systems, personal fall arrest systems, or other appropriate means. If guardrail systems (or chain gate or guardrail) or portions thereof must be removed to facilitate hoisting operations, as during the landing of materials, and a worker must lean through the access opening or out over the edge of the access opening (to receive or guide equipment and materials, for example), that employee must be protected by one of the appropriate means.

Formwork and Re-Bar

During formwork or re-bar assembly, employees shall be protected from falls of six feet or more by personal fall arrest systems, safety net systems, or positioning device systems.

Ramps, Runways, and Walkways

Each employee using ramps, runways, and other walkways shall be protected from falling 6 feet (1.8 meters) or more.

Excavations

Each employee at the edge of an excavation 6 feet (1.8 meters) or deeper shall be protected from falling by guardrail systems, fences, barricades, or covers, when the excavations are not readily seen because of plant growth or other visual barriers.

Where walkways are provided to permit employees to cross over excavations, guardrails are required on the walkway if it is 6 feet (1.8 meters) or more above the excavation.

Dangerous Equipment

Each employee working above dangerous equipment must be protected from falling into or onto the dangerous equipment by guardrails systems or by equipment guards even in those cases where the fall distance is less than 6 feet (1.8m).

Overhand Bricklaying

Except as otherwise provided in the OSHA Fall Protection Standards, each employee performing overhand bricklaying and related work 6 feet (1.8 m) or more above lower levels, shall be protected from falling by guardrail systems, safety net systems, personal fall arrest systems, or shall work in a controlled access zone.

> **Note:** Bricklaying operations performed on scaffolds are regulated by subpart L of OSHA 1926 – Scaffolds.

Low-Sloped Roof Work

Each employee engaged in roofing activities on low-slope roofs, with unprotected sides and edges six feet or more above lower levels, shall be protected from falling by guardrail systems, safety net systems, and personal fall arrest systems, or a combination of a warning line system and guardrail system, warning line system and safety net system, warning line system and personal fall arrest system, or warning line system and safety monitoring system.

- **Safety Monitoring System:** a safety system in which a competent person is responsible for recognizing and warning employees of fall hazards.
- **Warning Line System:** a barrier erected on a roof to warn employees 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 guardrails, body belts, or safety net systems to protect employees in the area.

Steep Roofs

Each employee on a steep roof with unprotected sides and edges 6 feet (1.8 meters) or more above lower levels shall be protected by guardrail systems with toe-boards, safety net systems, personal fall arrest systems, or by other appropriate means.

Pre-Cast Concrete

Each employee who is 6 feet (1.8 meters) or more above lower levels while erecting pre-cast concrete members and related operations such as grouting of pre-cast concrete members, shall be protected by guardrail systems, safety net systems, or personal fall arrest systems.

Wall Openings

Each employee 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 (1.8 meters) or more above lower levels and the inside bottom edge of the wall opening is less than 39 inches (1.0 meter) above the walking/working surface must be protected from falling by the use of a guardrail system, a safety net system, or a personal fall arrest system.

Protection from Falling Objects

When employees are exposed to falling objects, the employer must have employees wear hardhats and implement one of the following measures:

- Erect toe-boards, screens, or guardrail systems to prevent objects from falling from higher levels.

OR

- Erect a canopy structure and keep potential fall objects far enough from the edge so that those objects will not go over the edge if they are accidentally displaced.

OR

- Barricade the area to which objects could fall, prohibit employees from entering the barricaded area, and keep objects that may fall far enough away from the edge of a higher level so that those objects would not go over the edge if they were accidentally displaced.

Types of Fall Protection—Passive Systems

Passive systems are protective systems that do not involve the actions of employees. An example of a passive system is a catch platform extending around the perimeter of the work area.

Guardrails

Guardrails are one the most common forms of fall protection. They can be constructed of wood, pipe, structural steel, or wire rope. Flags must be provided on wire rope to increase visibility. Guardrails must have a top rail, a midrail and posts, and when necessary, a toe board.

- Guardrail systems shall be capable of withstanding, without failure, a force of at least 200 pounds (890 N) applied within 2 inches (5.1 cm) of the top edge, in any outward or downward direction, at any point along the top edge.
- Steel or plastic bands must not be used as top rails or midrails.
- Manila, plastic or synthetic rope being used for top rails or midrails shall be inspected as frequently as necessary to ensure that it continues to meet the mandated strength requirements.

Note: When the 200-pound test is applied in a downward direction, the top edge of the guardrail shall not deflect to a height less than 39 inches (1.0 m) above the walking/working level. Guardrail system components selected and constructed in accordance with the Appendix B to subpart M of OSHA 1926 will be deemed to meet this requirement.

Guardrails: Design Criteria

- Top edge height of top rails, or equivalent guardrail system members, shall be 42 inches (1.1 m) plus or minus 3 inches (8 cm) above the walking/working level. When conditions warrant, the height of the top edge may exceed the 45-inch height, provided the guardrail system meets all other criteria of this paragraph.
- Midrails, screens, mesh, intermediate vertical members, or equivalent intermediate structural members shall be installed between the top edge of the guardrail system and the walking/working surface when there is no wall or parapet wall at least 21 inches (53 cm) high.
- Midrails, when used, shall be installed at a height midway between the top edge of the guardrail system and the walking/working level.
- Top rails and midrails shall be at least one-quarter inch (0.6 cm) nominal diameter or thickness to prevent cuts and lacerations. If wire rope is used for top rails, it shall be flagged at not more than 6-foot intervals with high-visibility material.

- For pipe railings: posts, top rails, and intermediate railings shall be at least one and one-half inches nominal diameter (schedule 40 pipe) with posts spaced not more than 8 feet (2.4 m) apart on centers.
- For structural steel railings: posts, top rails, and intermediate rails shall be at least 2-inch by 2-inch (5 cm x 10 cm) by 3/8-inch (1.1 cm) angles, with posts spaced not more than 8 feet (2.4 m) apart on centers.
- Screens and mesh, when used, shall extend from the top rail to the walking/working level and along the entire opening between top rail supports.
- Intermediate members (such as balusters), when used between posts, shall not be more than 19 inches (48 cm) apart.
- Other structural members (such as additional midrails and architectural panels) shall be installed such that there are no openings in the guardrail system that are more than 19 inches (.5m) wide.

Safety Net Systems

Safety net systems must comply with the following provisions:

- They must be installed as close as practicable under the walking or working surface on which employees are working, but in no case more than 30 feet below the surface.
- If the net is not vertically more than 5 feet from the working level, the safety net must extend outward from the outermost projection of the work by 8 feet.
- If the net is not vertically more than between 5 feet and 10 feet from the working level, the safety net must extend outward from the outermost projection of the work by 10 feet.
- If the net is vertically more than 10 feet from the working level, the safety net must extend outward from the outermost projection of the work by 13 feet.
- Safety nets must be drop-tested at the jobsite after they are installed and before use, whenever relocated, after major repair, and at 6-month intervals after installation, if left in one place.
- Drop-tests must consist of a 400-pound bag of sand 28-32 inches in diameter being dropped into the net from the highest working or walking surface, but not from less than 42 inches above that level.
- Safety nets must have enough clearance beneath them to prevent contact with the surface or structures below when a load equal to the drop-test weight is dropped on them.
- Safety nets must be capable of absorbing an impact force that is equal to the drop test weight.
- Defective nets cannot be used.

- All materials, scraps, equipment, and tools that have fallen in the net must be removed as soon as possible and at least before the next work shift.
- The maximum size of each safety net mesh opening shall not exceed 36 square inches (230 cm2) nor be longer than 6 inches (15 cm) on any side, and the opening, measured center-to-center of mesh ropes or webbing, shall not be longer than 6 inches (15 cm).
- The safety net must have a border rope with a minimum breaking strength of at least 5,000 pounds.
- If safety nets are connected together, the connection must be as strong as the individual nets and not more than 6 inches apart.

Types of Fall Protection—Active Systems

Active fall protection systems require workers to be engaged in ensuring that proper protection is in use. This may include activities such as donning a full-body harness with an attached lanyard and attaching the lanyard to appropriate anchorage point.

Active systems are designed to operate in free fall situations. Active systems must be connected to other systems/components or activated to provide protection. Active systems are designed to protect employees from the following:

- Falls
- Forces that can cause injury

An example of an active system is a personal fall arrest system (PFAS).

Personal Fall Arrest Systems (PFAS)

Personal Fall Arrest Systems (PFAS) are inexpensive and easy to use. When used according to the manufacturer's instructions, a PFAS can save a life should a fall occur. Generally, a PFAS consists of three major components:

1. A full-body harness
2. A shock-absorbing lanyard or retractable lifeline
3. Secure anchors

PFAS – Usage

Personal Fall Arrest Systems (PFAS) shall not be attached to a guardrail system or hoists.

All components of a fall arrest system must be inspected before each use and after impact. Defective components must be removed from service. Personal fall arrest systems and components subjected to impact loading shall be immediately removed from service and shall not be used again for employee protection until inspected by a competent person, and determined to be undamaged and suitable for reuse.

Action must be taken to promptly rescue fallen employees or be assured they can rescue themselves. When stopping a fall, a PFAS must:

- Limit maximum arresting force on an employee to 1,800 pounds (8 kN) when used with a body harness.
- Be rigged such that an employee can neither free fall more than 6 feet (1.8 m), nor contact any lower level.
- Be attached to an anchor point capable of withstanding 5000 pounds of force or shall be designed, installed, and used as part of a complete personal fall arrest system, which maintains a safety factor of at least two and is used under the supervision of a qualified person.
- Bring an employee to a complete stop and limit maximum deceleration distance an employee travels to 3.5 feet (1.07 m).
- Have sufficient strength to withstand twice the potential impact energy of an employee free falling a distance of 6 feet (1.8 m), or the free fall distance permitted by the system, whichever is less.

Lesson Summary

Steel or plastic bands must not be used as top rails or midrails. Midrails, when used, shall be installed at a height midway between the top edge of the guardrail system and the walking/working level.

When employees might be exposed to falling objects, the employer must have employees wear hardhats and erect toe-boards, screens, or guardrail systems to prevent objects from falling from higher levels. This means that employers must either erect a canopy structure or ensure that potential fall objects are far enough from the edge so that those objects will not go over the edge, if they are accidentally displaced, or barricade the area to which objects could fall, thereby prohibiting employees from entering the barricaded area and keeping objects that may fall far enough away from the edge of a higher level so that those objects will not go over the edge if they were accidentally displaced.

Each employee engaged in roofing activities on low-slope roofs, with unprotected sides and edges six feet or more above lower levels, shall be protected from falling by guardrail systems, safety net systems, and personal fall arrest systems, or a combination of a warning line system and guardrail system, warning line system and safety net system, warning line system and personal fall arrest system, or warning line system and safety monitoring system.

During formwork or re-bar assembly, employees shall be protected from falls of six feet or more by personal fall arrest systems, safety net systems, or positioning device systems. Passive systems are protective systems that do not involve the actions of employees.

Lesson 2: Inspection and Safety Monitoring Systems

Lesson Focus

This lesson focuses on the following topics:
- Inspecting Fall Protection Equipment
- Positioning Device Systems
- Safety Monitoring System
- Fall Protection Plan
- Training
- Case Study

Inspecting Fall Protection Equipment

The fall protection equipment must be inspected before each use for:
- Tears, cuts, burns and abrasions
- Distorted hooks, damaged springs, and non-functioning parts
- Manufacturer labels
- Deformed eyelets, D-rings and other metal parts
- Dirt, grease, oil, corrosives, and acids

PFAS—Harnesses

Harness systems are constructed of synthetic fibers.
- When used as PFAS, only systems which encompass the entire body (full body harness) are permitted.
- Body belts cannot be used for fall arrest.
- A full body harness will distribute weight across the waist, pelvis, and thighs.

PFAS—Lanyards

Lanyards are flexible lines synthetic fiber or wire rope which have a connector at each end for connecting the body belt or body harness to a deceleration device, lifeline, or anchorage.
- Lanyards and vertical lifelines must have a minimum breaking strength of 5000 pounds.
- Lanyards should be attached to a D ring between the shoulder blades above the employee.
- There are several types of lanyards including: synthetic webbing, synthetic rope, and shock absorbing.

Types of Lanyards

- **Self-retracting:** Eliminates excess slack in the lanyard (cable, rope, or web)
- **Shock absorbing:** Device slows and eventually stops descent and absorbs the forces (i.e., rip stitch controlled tearing)
- **Synthetic rope:** Absorbs some of the force by stretching
- **Synthetic webbing:** Strong but not flexible (absorbs little force)

PFAS—Life Lines

Life lines consist of flexible material connected at one or both ends to an anchorage point. There are two types of life lines:

- o **Vertical:** hangs vertically (5000 pound minimum breaking strength).
- o **Horizontal:** connects at both points to stretch horizontally (serves as connection point for other components of PFAS- total system must have safety factor of two and be capable of locking in both directions on the lifeline).

Lifelines, Safety Belts, and Lanyard (PPE)

Lifelines, safety belts, and lanyards shall be used only for employee safeguarding. Any lifeline, safety belt, or lanyard actually subjected to in-service loading, as distinguished from static-load testing, shall be immediately removed from service and shall not be used again for employee protection until inspected and determined by a competent person to be undamaged and suitable for reuse.

Vertical lifelines shall have a minimum breaking strength of 5,000 pounds (22.2 kN). Self-retracting lifelines and lanyards which automatically limit free fall distance to 2 feet (0.61 m) or less shall be capable of sustaining a minimum tensile load of 3,000 pounds (13.3 kN) applied to the device with the lifeline or lanyard in the fully extended position.

More Information: All safety belt and lanyard connectors shall be made of drop forged, pressed or formed steel, or equivalent materials. Each connector shall have a corrosion-resistant finish and its surface shall be smooth and free of sharp edges.

PFAS—Snap Hooks

Snap hooks are used to connect lanyards to D-rings on a body harness.

- D rings must be compatible. Must be connected to harness or anchorage point only.
- Snap hooks and D rings must have tensile strength of 5000 pounds and be proof tested to a minimal tensile load of 3600 pounds.

- When using snap hooks:
    - All snap hooks must have a locking mechanism.

Locking Snap Hooks

Locking snap hooks have a self-closing, self-locking keeper, which remains closed and locked until unlocked and pressed open for connection or disconnection.

PFAS—Anchorage Points

The anchorage point is most effective when it is above the employee's head; located as to not allow an employee to fall more than 6 feet.

Anchorages used for the attachment of personal fall arrest equipment shall be independent of any anchorage being used to support or suspend platforms and capable of supporting at least 5,000 pounds per employee attached, or shall be designed, installed, and used as follows:

- As part of a complete personal fall arrest system which maintains a safety factor of at least two, and
- Under the supervision of a qualified person.

Positioning Device Systems

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

- Positioning device systems must be inspected before each use for defects, and defective components must be removed from service.
- Positioning devices shall be rigged such that an employee cannot free fall more than 2 feet (0.9 m).
- Positioning devices shall be secured to an anchorage capable of supporting at least twice the potential impact load of an employee's fall or 3,000 pounds, whichever is greater.
- A positioning device system is not a fall arrest system!

Warning Line System

A warning line system is an awareness device erected on a roof to warn employees 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 belt, or safety net systems to protect employees in the area.

Warning line systems and their use shall comply with the following provisions:

- The warning line shall be erected around all sides of the roof work area.
- Warning lines shall consist of rope, wire, chains, or supporting stanchions, which are used to warn employees of an unprotected edge, and must be erected as follows:
    - It must be flagged at not more than 6 foot intervals with high-visibility materials.
    - The rope, wire, or chain must be rigged and supported such that:
        - Its lowest point (including sag) is no less than 34 inches from walking/working surface.
        - Its highest point no more than 39 inches from surface.
- Stanchions, with rope, chain, or wire attached, must be able to withstand, without tipping over, a force of 16 pounds applied horizontally against the stanchion, 30 inches (.8 m) above the walking/working surface, perpendicular to the warning line, and in the direction of the floor, roof, or platform edge.
- The rope, wire, or chain used must have a minimum tensile strength of 500 pounds.
- No employee is permitted between roof's edge and a warning line unless the employee is performing roof work in that area.

Note: A warning line system is used mainly on roofs, where the use of PFAS is impractical.

Controlled Access Zone (CAZ)

- When used to control access to areas where overhand bricklaying or related work are taking place only qualified personnel involved in overhand bricklaying or related work are permitted in the controlled access zone.
- Ropes, wires, tapes, or chains with supporting stanchions are used to designate the area.
- Must be erected between 6 and 25 feet away from unprotected edge.
- The control line shall be connected on each side to a guardrail system or a wall.
- CAZ must be defined by a control line erected 10-15 feet from the edge.
- Lines must be flagged at 6 foot intervals and have a minimum breaking strength of 200 pounds.

Safety Monitoring System

The employer must designate a competent person to monitor the safety of other employees, and the employer has the duty to ensure that the safety monitor complies with the following requirements:

- He/she must be competent to recognize fall hazards.
- He/she must warn the employee when it appears that the employee is unaware of a fall hazard or is acting in an unsafe manner.
- He/she must be on the same walking/working surface and within visual sighting distance of employee being monitored.
- He/she must be close enough to communicate orally with the employee.
- He/she must not have other responsibilities which could take attention from monitoring function.

Note: Each employee working in a controlled access zone must be directed to comply with all instructions from the monitor.

It is recommended that you have a written plan for using the safety monitoring system to address:

- Identification of the monitor
- Roles of employees in monitoring system
- Training for using the monitoring system

Covers

Covers are used to protect personnel from falling through holes in walking surfaces. Covers for holes in floors, roofs, and other walking/working surfaces shall meet the following requirements:

- All covers shall be secured when installed so as to prevent accidental displacement by the wind, equipment, or employees.
- All covers shall be color coded or they shall be marked with the word "HOLE" or "COVER" to provide warning of the hazard.
- Covers located in roadways and vehicular aisles shall be capable of supporting, without failure, at least twice the maximum axle load of the largest vehicle expected to cross over the cover.
- All other covers shall be capable of supporting, without failure, at least twice the weight of employees, equipment, and materials that may be imposed on the cover at any one time.

Note: This provision does not apply to cast iron manhole covers or steel grates used on streets or roadways.

Falling Objects

Employers are required to protect their employees from falling objects. Some methods that might have to be used (when necessary) consist of:

- Installation of toe boards (at least 3.5 inches wide) erected along the edges of the overhead walking/working surfaces for a distance sufficient to protect persons working below.
    - Toe boards shall 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 toe board.
    - Where tools, equipment, or materials are piled higher than the top edge of a toe board, paneling or screening shall be erected from the walking/working surface or toe board to the top of a guardrail system's top rail or midrail, for a distance sufficient to protect employees below.
- Building barricades and restricting entrance.

Fall Protection Plan

The fall protection plan option is available only to employees engaged in leading edge work, precast concrete erection work, or residential construction work who can demonstrate that it is unfeasible or it creates a greater hazard to use conventional fall protection equipment.

If used, the plan should be strictly enforced.

- A Fall Protection Plan must be prepared by a qualified person and developed specifically for each site.
- The Fall Protection Plan must be maintained up to date.
- Any changes to the plan must be approved by a qualified person.
- A copy of the plan with all approved changes must be maintained at the site.
- The fall protection plan shall document the reasons why the use of conventional fall protection systems (guardrail systems, personal fall arrest systems, or safety nets systems) is infeasible or why their use would create a greater hazard.

Elements of a Fall Protection Plan

A fall protection plan must consist of the following elements:

- Statement of Policy
- Fall Protection Systems to be Used
- Implementation of Plan
- Enforcement
- Accident Investigation

- Changes to the Plan

Training

All employees exposed to fall hazards must receive training by a competent person who addresses:

- The nature of fall hazards in the work area.
- Procedures for erecting, maintaining, disassembling and inspecting fall protection systems to be used.
- The use and operation of fall arrest equipment.

Training Elements

An employee training program must include the:

- Role of an employee in a safety monitoring system (when used)
- Limitations on the use of mechanical equipment for low-slope roofs
- Role of employees in the fall protection plans
- Standards contained in 29 CFR 1926.500-503
- Procedure for handling and storage of equipment

Case Study

Fall during the Assembly of a Suspended Scaffold for Bridge Painting

The following is a case study of an accident involving falls and fall protection.

This accident occurred while suspended scaffold was being installed for painting bridge girders. The suspended scaffold was comprised of the main pipes supported by chains hung from the bridge girders and single tubes that extended perpendicular to the main pipes. The plan called for installing two layers of scaffold.

Measures to prevent a fall when this scaffold was completed included safety netting that was stretched below the bottom of the lower scaffold platform, and scaffolding boards beneath, to the right and left of bridge girders to make personnel movement easy.

Two lift trucks, each with a maximum work height of 15 meters, were being used for this work. Each truck was moved after each scaffold section was complete.

On the day of the accident, three workers exited onto the ground from one of the lift trucks in order to move the vehicle. However, the truck could not be moved forward because the truck tires were stuck in river sand. Five other workers, who had their safety belts on and attached to the hanging chains, were on scaffold boards watching and waiting for the truck to be moved.

After several minutes, some of these workers who were tied off on the scaffold heard a loud sound and turned in time to see a fellow worker attempting to catch one of the chains as he fell beneath the single tubes. The worker had been attempting to adjust the chains by himself. He fell while attempting to adjust the hanging chain or during his movement from the scaffold board to a flange below.

What do you think were some of the causes of the accident?

1. Although the victim had been wearing a safety harness while waiting on the scaffold, when he moved to adjust the hanging chains he was no longer wearing it and it wasn't tied off.
2. Workers should have waited on the ground while the truck was being moved, and not at an elevated site that posed a danger of falling.
3. The operations chief for scaffolding erection did not provide proper supervision regarding the proper use of personal fall arrest systems.

Lesson Summary

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

A warning line system is an awareness device erected on a roof to warn employees 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 belt, or safety net systems to protect employees in the area.

A Fall Protection Plan must be prepared by a qualified person and developed specifically for each site. The Fall Protection Plan must be maintained up to date. Any changes to the plan must be approved by a qualified person. A copy of the plan with all approved changes must be maintained at the site. The fall protection plan shall document the reasons why the use of conventional fall protection systems (guardrail systems, personal fall arrest systems, or safety nets systems) is infeasible or why their use would create a greater hazard.

Lesson 3: Electrocution

Lesson Focus

This lesson focuses on the following topics:

- Introduction
- Electricity—The Dangers
- Electricity—How it Works
- Electrical Injuries
- Electrical Hazards and How to Control Them

Introduction

OSHA's electrical standards address electrical workplace hazards, equipment, work practices, safety practices, and more. Employees working on, near, or around electricity may be exposed to dangers such as, electric shock, electrocution, burns, fires, and explosions. The objective of the standards is to minimize the potential hazard by specifying design characteristics of safety when installing and using electrical equipment and systems.

Electricity—The Dangers

The following are some of the dangers associated with electricity:

- More than five workers are electrocuted every week.
- Electricity causes 12 percent of young worker deaths in the workplace.
- It takes very little current flow to cause harm to a person who comes in direct contact with an electrical circuit.
- There is a significant risk of fires due to electrical malfunctions.

Safety Tips

When working with or near electricity:

- 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 (3 meters) away from overhead wires during cleanup and other activities. Many lines require a much more significant safe working

distance. 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.

More Information:

- Never operate electrical equipment while you are standing in water.
- Never perform repairs to 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.

Electricity—How It Works

Electrical current is the flow of electrons from a voltage source back to its source. It requires a source of voltage, a circuit path through a conductor, and a load that uses the current flow as work.

Electrical Injuries

The following are the main types of electrical injuries:

Direct:

The following are considered to be direct electrical injuries:

- Electrocution (death due to electrical shock)
- Electrical shock and related symptoms resulting from the shock (e.g. tissue damage, neurological disorders, muscle contractions which can cause falls and injuries, etc.)
- Burns
- Arc flash/blast (usually resulting in burns, concussion injuries, etc.)

Indirect:

The following are considered to be indirect electrical injuries:

- Falls
- Back Injuries
- Cuts to the hands

Electrical Shock

An electrical shock is received when electrical current passes through the body. You will get an electrical shock if parts of your body complete an electrical circuit by:

- Touching an exposed energized circuit with one part of your body and a grounded point with another part of your body.
- Contacting two different energized conductors at the same time.

Shock Severity

The severity of the shock depends on:

- The path of current through the body.
- The amount of current flowing through the body (amps).
- The duration of the shocking current through the body.

More Information: LOW VOLTAGE DOES NOT MEAN LOW HAZARD!

Levels of Electric Shock

mA	Affect
0.5–3	Tingling sensation
3–20	Muscle contractions and pain
10–40	"Let go" threshold may be exceeded. Worker may be unable to release a live circuit
20–150	Painful shock with severe muscle contraction, breathing may become difficult
30–75	Possible respiratory paralysis
100–200	Possible ventricular fibrillation affecting the heart
200–4,000	Likely heart damage or stoppage

The overcurrent at which a typical fuse or circuit breaker opens is 15,000 milliamps (15 amps). These devices are designed to protect the electrical system, not people! By the time these devices open, death or very serious injury is likely to have occurred.

More Information: *mA = milliampere = 1/1,000 of an ampere

Burns and Arc Flash

Burns are among the most common shock-related injuries. Burns can occur when you touch exposed energized electrical wiring or equipment. Many burns occur as a result of arc flash. Burns often occur on the hands, although other parts of the body may be affected, and may be very serious injuries that require immediate attention. In the case of arc flash, additional internal injuries may occur with the burns as a result of the concussion force produced by the explosion from the arc flash. The heat produced by an arc flash is four times hotter than the surface of the sun.

Falls

Electric shock can also cause indirect injuries. Workers on ladders and in elevated locations who experience a shock can fall, resulting in serious injury or death.

Electrical shocks, fires, or falls result from many conditions, including the following hazards:

- Exposed electrical parts
- Overhead power lines
- Inadequate wiring
- Defective insulation
- Improper grounding
- Overloaded circuits
- Wet conditions
- Damaged tools and equipment
- Improper personal protective equipment (PPE)

Electrical Hazards and How to Control Them

Electrical accidents are caused by many factors, including these:

1. Unsafe equipment and/or installation
2. Unsafe workplace environments
3. Unsafe work practices

Exposed Electrical Parts

Live parts of electric equipment operating at 50 volts or more must be guarded against accidental contact by cabinets or other forms of enclosures or by any of the following means:

- By location in a room, vault, or similar enclosure that is accessible only to qualified persons.
- By partitions or screens so arranged that only qualified persons will have access to the space within reach of the live parts. Any openings in such partitions or screens shall be so sized and located that persons are not likely to come into accidental contact with the live parts or to bring conducting objects into contact with them.
- By location on a balcony, gallery, or platform so elevated and arranged as to exclude unqualified persons.
- By elevation of at least eight feet or more above the floor or other working surface and so installed as to exclude unqualified persons.

Conductors Entering Boxes, Cabinets, or Fittings

Conductors entering boxes, cabinets, or fittings must be protected from abrasion. Openings through which conductors enter must be effectively closed. Unused openings in cabinets, boxes, and fittings also must be effectively closed.

Covers and Canopies

All pull boxes, junction boxes, and fittings shall be provided with covers. If metal covers are used, they 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.

Hazard—Overhead Power Lines

Overhead power lines usually are not insulated; some examples of equipment that can contact power lines are:

- Cranes
- Ladders
- Scaffolds
- Backhoes
- Scissors lifts
- Raised dump truck beds
- Paint rollers

Overhead and buried power lines are especially hazardous because they may carry extremely high voltage. Fatal electrocution is the main risk, but burns and falls from elevation are also hazards. Using tools and equipment that can come into contact with power lines increases the risk.

Control—Overhead Power Lines

Power lines hazards can be avoided if the following precautions are taken:

- A distance at least ten feet away from the power lines is maintained. A much greater distance may be required, depending on the voltage capacity of the lines.
- Warning signs are posted.
- Power lines are assumed to be energized.
- Wood or fiberglass ladders, not metal ladders, are used.
- Special training and personal protective equipment is provided to power line workers.
- Power lines are de-energized and/or shielded when necessary.

Hazard—Inadequate Wiring

A wire that is too small for the current is a hazard. If a portable tool with an extension cord has a wire too small for the tool:

- The tool will draw more current than the cord is designed to handle, with the potential of causing overheating and a possible fire without tripping the circuit breaker.
- The circuit breaker could be the right size for the circuit but not for the smaller-wire extension cord.

Control—Inadequate Wiring

Use the Correct Wire

The following are the important points to consider when using wires:

- The wire use depends on the operation, building materials, electrical load, and environmental factors.
- Use fixed cords rather than flexible cords when possible.
- Use the correct extension cord.

The OSHA standards require flexible cords to be designed for hard or extra-hard usage. These ratings are to be indelibly marked at approximately every 24" (National Electric Code Article 400.6) of the cord. Because deterioration occurs more rapidly in cords, which are not rugged enough for construction conditions, the NEC and OSHA have specified the types of cords to use in a construction environment. This rule designates the types of cords that must be used for various applications, including portable tools, appliances, and temporary and portable lights. The cords are designated HARD and EXTRA HARD SERVICE.

Hazard—Defective Cords and Wires

Extension cords may have damaged insulation. Sometimes, the insulation inside of an electrical tool or appliance is damaged. When 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. If you touch damaged power tools or other equipment, you may receive a shock. You are more likely to receive a shock if the tool is not grounded or double-insulated.

Hazard—Damaged Cords

Cords can be damaged as a result of:

- Aging
- Door or window edges
- Staples or fastenings
- Abrasion from adjacent materials
- Activity in the area
- Improper use
- Lifting tools/equipment with the cords
- Pulling on cords to unplug

Improper use of cords can also cause shocks, burns, or fire.

The normal wear and tear on extension and flexible cords at your site can loosen or expose wires, creating hazardous conditions. Cords that are not of the three-wire type, not designed for hard-usage, or that have been modified, increase your risk of contacting electrical current.

Control—Cords and Wires

The following requirements apply to the use of cords and wires:

- Live wires should be insulated where required.
- Cords should be checked before use.
- Only cords that are three-wire type should be used.
- Only cords marked for hard or extra-hard usage should be used (Designated by "S" at the beginning of the cord type. SJ indicates junior hard usage.)

- Only cords, connection devices, and fittings equipped with strain relief should be used.
- Cords should be removed by pulling on the plugs, not on the cords.
- Cords not marked for hard or extra-hard use, or which have been modified, must be taken out of service immediately.

Permissible Use of Flexible Cords

Flexible cords and cables must be protected from damage! DO NOT use flexible wiring where frequent inspection would be difficult or where damage would be likely.

Flexible cords must not be:
- Run through holes in walls, ceilings, or floors.
- Run through doorways, windows, or similar openings (unless physically protected).
- Hidden in walls, ceilings, floors, conduit, or other raceways.

Arc Flash Hazard

An arc flash is a MUCH more significant event than a typical short circuit.
An arc flash occurs when a flashover of electric current leaves the intended path and travels through the air from one conductor to another, or to ground. The results of an arc flash are often very violent, with a large amount of concentrated radiant energy explodes outward from electrical equipment, creating pressure waves that can damage a person's hearing, a high intensity flash that can damage eyesight and a superheated ball of gas that can severely burn a worker's body and melt metal.

Origination of Arc Flash Energy

An arc flash, and its resulting release of energy, can only occur if an arc between two differences of potential occurs.

A difference of potential (voltage reading) exists between any two phase conductors, or any phase conductor and a grounded part (grounded systems only).

An arc flash can be caused by many different conditions, including: accidental contact with electrical components, accumulation of dust, corrosion, dropped tools, improper installation of equipment, and improper work procedures.

Characteristics of an Arc Flash

When an arc occurs, current that is available from the source of electrical energy passes from one conductor to the other conductor at the point of the arc fault.

Incident Energy

Because the travel of current in an arc flash is not contained within a conductor, but travels through free air, the effects of the energy are not contained.

This energy is referred to as "incident energy."

Lesson Summary

Burns often occur on the hands, although other parts of the body may be affected. In the case of arc flash, additional internal injuries may occur with the burns as a result of the concussive force produced by the explosion from the arc flash.

When an arc occurs, current that is available from the source of electrical energy passes from one conductor to another at the point of the arc fault. In an arc flash incident, a large amount of concentrated radiant energy explodes outward from electrical equipment, creating pressure waves that can damage a person's hearing, a high-intensity flash that can damage eyesight and a superheated ball of gas that can severely burn a worker's body as well as melt metal.

Lesson 4: Electrical Hazards—Other Preventive Measures

Lesson Focus

This lesson focuses on the following topics:

- Grounding
- Power Tool Requirements
- Clues that Electrical Hazards Exist
- Locking Out and Tagging Out of Circuits
- Safety-Related Work Practices
- Examples of the Infeasibility to De-Energize
- Preventing Electrical Hazards—Personal Protective Equipment (PPE)
- Training
- Batteries and Battery Charging

Grounding

Grounding creates a low-resistance path from a tool to the earth to disperse unwanted current.

When a short or lightning occurs, energy flows to the ground, helping protect you from electrical shock, injury, and death.

Hazard–Improper Grounding

Tools plugged into improperly grounded circuits may become energized. There also may be occurrences of broken wires or plugs on the extension cord.

Control–Ground Tools and Equipment

The following should be taken into consideration when working with tools and equipment:

- Properly ground power supply systems, electrical circuits, and electrical equipment.
- Frequently inspect electrical systems to ensure that the path to ground is continuous.
- Inspect electrical equipment before use.
- Don't remove ground prongs from tools or extension cords.
- Do not use tools or extension cords with missing or damaged ground plugs.

- Ground exposed metal parts of equipment.

Control–Using a Ground-Fault Circuit Interrupter (GFCI)

A GFCI performs the following functions:

- Helps to protect you from shock.
- Detects differences in current as small as 4 mA between the amounts of electricity flowing into a circuit compared to the amount flowing out of the circuit.
- Shuts off electricity in 1/40th of a second if a ground fault is detected.

Control–Assured Equipment Grounding Conductor Program (AEGCP)

An employer must use *either ground fault circuit interrupters* or an assured equipment grounding conductor to protect employees on construction sites.

The AEGCP on construction sites must cover:

- All cord sets.
- Receptacles not part of a building or structure.
- Equipment connected by plug and cord available for use by the employer.

Program requirements include:

- Specific procedures adopted by the employer (in writing and available for inspection).
- A competent person designated by the employer to implement the program.
- Daily visual inspection for damage of equipment and cords connected by cords and plugs before use.

Click "More About" for more Information:

Hazard–Overloaded Circuits

Too many devices plugged into a circuit can result in heated wires and possibly fire.

Wire insulation melting can cause arcing and fire in the area where the overload exists, even inside a wall.

Control—Electrical Protective Devices

Electrical protective devices are designed to automatically open a circuit if excess current from overload or ground-fault is detected, resulting in the shutting off of electricity.

Electrical protective devices include GFCIs, fuses, and circuit breakers.

Ground-Fault Circuit Interrupter (GFCI): A device for the protection of personnel that functions to de-energize a circuit or portion thereof within an established period of time when a current to ground exceeds some predetermined value that is less than that required to operate the overcurrent protective device of the supply circuit.

Fuses: (Over 600 volts, nominal) Overcurrent protective devices with a circuit opening fusible part that is heated and severed by the passage of overcurrent through that part. A fuse comprises all the parts that form a unit capable of performing the prescribed functions. A fuse may or may not be the complete device necessary to connect it into an electrical circuit.

Circuit Breakers:

(a) (600 volts nominal, or less) Devices designed to open and close a circuit by non-automatic means and to open the circuit automatically on a predetermined overcurrent without injury to itself when properly applied within its rating.

(b) (Over 600 volts, nominal) Switching devices capable of making, carrying, and breaking currents under normal circuit conditions, and also capable of making, carrying for a specified time, and breaking currents under specified abnormal circuit conditions, such as those of short circuit.

Power Tool Requirements

Power tools must:

- Be grounded through a 3-wire cord with one wire going to ground OR be double insulated; OR
- Be double-insulated or be powered by a low-voltage isolation transformer; OR
- Be powered by a properly designed and self-contained battery power unit.

Tool Safety Tips

The following are some safety tips to consider when using tools:

- Use gloves and appropriate footwear when using tools and when safe and appropriate to do so.
- Store tools in a dry place when not in use.
- Don't use tools in wet/damp conditions unless they are designed for this purpose.
- Keep working areas well lit.
- Ensure that tools and cords do not create a tripping hazard.
- Don't carry a tool by the cord.

- Don't yank the cord to disconnect the tool from the electrical source.
- Keep cords away from heat, oil and sharp edges.
- Disconnect tools when not in use and when changing accessories such as, blades and bits.
- Remove damaged tools from use.

More Information: Avoid accidental starting. Do not hold fingers on the power switch or button while carrying a plugged-in tool or while tagging damaged tools.

Preventing Electrical Hazards-Tools

The following measures should be taken to prevent electrical hazards associated with the use of tools:

- Inspect tools before use.
- Use the right tool correctly.
- Protect your tools from damage.
- Use double insulated tools when appropriate.

Temporary Lights

Temporary lights should be protected from contact and damage, and they should not be suspended by cords unless designed to do so.

Clues that Electrical Hazards Exist

The following are some clues that can help you in determining whether an electrical hazard exists:

- When there are tripped circuit breakers or blown fuses.
- When tools, wires, cords, connections, or junction boxes are warm to the touch.
- When a GFCI shuts off a circuit.
- When there is a worn or frayed insulation around a wire or a connection.

More Information: If a GFCI trips while you are using a power tool, there is a problem. Don't keep resetting the GFCI and continue to work. You must evaluate the "clue" and decide what action should be taken to control the hazard.

Locking Out and Tagging Out of Circuits

The following steps must be performed when locking out and tagging out circuits:

- Apply locks to the power source after de-energizing.
- Verify circuit is de-energized by testing with known functioning meters.

- Tag deactivated controls and power sources.
- Tag de-energized equipment and circuits at all points where they can be energized.
- Tags must identify equipment or circuits being worked on.

Safety-Related Work Practices

To protect workers from electrical shock:

- Use barriers and guards to prevent passage through areas of exposed energized equipment.
- Pre-plan work, post hazard warnings, and use protective measures.
- Keep working spaces and walkways clear of cords.
- Use special insulated tools when working on fuses with energized terminals.
- Don't use worn or frayed cords and cables.
- Don't fasten extension cords with staples, hang the cords from nails, or suspend the cords using wire.

More Information:

1. Employers must not allow employees to work near live parts of electrical circuits, unless the employees are protected by one of the following means:
   - De-energizing and grounding the parts.
   - Guarding the part by insulation.
   - Any other effective and approved means.
2. In work areas where the exact location of underground electrical power lines is unknown, employees using jack hammers, bars, or other hand tools that may contact the lines must be protected by insulating gloves, aprons, or other protective clothing that will provide equivalent electrical protection.
3. Flexible cords must be connected to devices and fittings so that strain relief is provided which will prevent pull from being directly transmitted to joints or terminal screws.
4. Equipment or circuits that are de-energized must be rendered inoperative and must have appropriate locks and tags attached at all points where the equipment or circuits could be energized.

As appropriate, the employer shall ensure that all wiring components and utilization equipment in specific hazardous locations are maintained in a dust-tight, dust-ignition-proof, or explosion-proof condition. There shall be no loose or missing screws, gaskets, threaded connections, seals, or other impairments to a tight condition.

Avoiding Wet Conditions

The following are important points to consider in avoiding wet conditions:

- If you touch a live wire or other electrical component while standing in even a small puddle of water you may get a shock.
- Damaged insulation, equipment, or tools can expose you to live electrical parts.
- Improperly grounded metal switch plates and ceiling lights are especially hazardous in wet conditions.
- Wet clothing, high humidity, and perspiration increase your chances of being electrocuted.

Energized Work

Working on or Near Live parts

Energized work must be put into an electrically safe work condition or the reasons for not doing so must be properly documented and justified.

To justify energized work, an employer must demonstrate that de-energizing introduces additional or increased hazards, or is infeasible due to equipment design or operational limitations.

Work on circuits with voltages less than 50 volts may be performed in an energized state if a proper assessment has been completed and there is no increased exposure to electrical burns or explosion risks due to arcs.

Examples of Increased or Additional Hazards (Justification to Work on Energized Circuits Over 50 Volts)

- Interruption of life support equipment
- Deactivation of emergency alarm systems
- Shutdown of hazardous location ventilation equipment

Examples of the Infeasibility to De-Energize

- Performing diagnostics and testing during startup or troubleshooting that can only be done in an energized state
- Work on circuits that are part or a continuous process that would otherwise require the entire process to be shut down

Energized Electrical Work Permit

If justification for energized work is demonstrated, then the work can be performed only after proper completion of a written permit.

Elements of an Energized Electrical Work Permit include the following:

- Description and location of the circuit and the equipment involved
- Justification for energized work
- List of the safe work practices to be applied
- Results of a shock risk assessment
- Determination of the shock protection boundaries as noted in NFPA 70E
- Results of an arc flash analysis
- Required PPE
- Means used to restrict entry of qualified personnel into the work area
- Completion of a job briefing, including a discussion of job specific hazards
- Authorized and signed energized work approval

Exemptions to a Work Permit

Work that is performed on or near live parts by qualified persons and related to tasks such as testing, troubleshooting, and voltage measuring may not require an energized electrical work permit as long as the appropriate safe work practices and required PPE are used.

NFPA 70E Compliments OSHA Regulations

In lieu of detailed specifications, OSHA recognizes, and in some cases refers to, industry consensus standards such as the National Fire Protection Association's (NFPA) 70E as a tool for assisting with regulatory compliance. A copy of NFPA 70E is considered by many to be a critical addition to every employer's safety library.

The National Fire Protection Association provides free access to read and review their standards, including 70E. This service allows users to view the standards after registering with the association. This access is available on the website.

Purchasing or accessing this standard is critical a full and complete understanding of the definitions, work practices, controls, documentation, and equipment necessary to provide for a safe work site and to ensure compliance with the applicable OSHA standards.

The following definitions are used by the NFPA in defining the type and nature of protective measures to be taken at varying locations. It is highly recommended that you access NFPA 70E to ensure you have all of the information necessary.

Approach Boundaries to Energized Parts

Arc Flash Boundary: In those activities or conditions where the hazard of an arc flash is present, the arc flash boundary is that distance from the source that an exposed individual could receive second degree burns. In other words, the individual is potentially in harm's way.

Limited Approach Boundary: In those activities or conditions where the hazard of an electrical shock is presented by energized electrical components, this is the distance at which exposure to a shock is possible.

Restricted Approach Boundary: This is the distance at which there is a heightened possibility of electrical shock from energized electrical components, due to a combination of existing conditions, personnel movement, and proximity.

> **Note:** Any personnel working on energized parts must have training on the requirements of NFPA 70E. Please complete the additional training program on this code prior to working on energized parts.
>
> Detailed information regarding the application of the boundaries can be found in NFPA 70E. Appendix C, Section 1.2.3 of this standard provides an excellent graphical representation of the boundaries which may be useful for training and enforcement activities.

Preventing Electrical Hazards—Personal Protective Equipment (PPE)

When it is necessary to handle or come close to wires with a potentially live electrical charge, it is essential to use proper insulating personal protective equipment (PPE) to help protect employees from coming into contact with the hazardous electrical energy.

The following measures can provide protection from electrical hazards:

- Proper foot protection
- Rubber insulating gloves, hoods, sleeves, matting, and blankets
- Hard hat (insulated—nonconductive)

Safety Shoes and Boots

Safety shoes and boots should be nonconductive and should protect your feet from completing an electrical circuit to ground. Safety shoes can help protect against open circuits of up to 600 volts in dry conditions. These shoes should be used with other insulating equipment and in connection with active precautions to reduce or eliminate the potential for providing a path for hazardous electrical energy.

Hard Hats

Specific types of hard hats are needed when performing electrical work.

A "Class E" electrical/utility type hard hat protects against falling objects and high-voltage shock and burns.

> **Note:** Wearing a hard hat provides protection for your head of up to 20,000 volts.

Basis for Determining Personal Protective Equipment for Work within a Flash Protection Boundary

When it is determined that work must be performed within an Arc Flash Boundary, a flash hazard analysis must determine, and the employer must document, the incident energy exposure of the worker in cal/cm^2.

Type of PPE for Arc Flash Protection

Flame-resistant (FR) clothing and PPE must be used by anyone crossing any part of her or his body into the Arc Flash Boundary as based on the incident energy calculation.

Training

Employees working with electric equipment must be trained in safe work practices, including:

- De-energizing electric equipment before inspecting or repairing.
- Using cords, cables, and electric tools that are in good repair.
- Lockout / tagout recognition and procedures.
- Using appropriate protective equipment.

De-Energizing Electrical Equipment

Accidental or unexpected starting of electrical equipment can cause injury or death. Before any inspections or repairs are made, the current must be turned off at the source and this location locked in the "OFF" position. Additionally, the switch or controls of the machine, or other equipment being locked out of service, must be tagged securely to show which equipment or circuits are being worked on.

Employees should be trained in, and familiar with, the safety-related work practices that pertain to their respective job assignments.

A De-Energizing or Lockout / Tag out Program requires the following:

- Application of locks to all power sources, including all potential sources of electrical energy, after each source has been de-energized.
- Application of a tag on each de-energized control identifying who has locked the control out, and instructing others to not unlock or re-energize the control.
- Proper training for all workers involved in or potentially impacted by the de-energization of the equipment. Included in this training should be the following groups of employees:
    - **Authorized employees**—those who lock out and/or tag out machines or equipment in order to perform maintenance or servicing
    - **Affected employees**—those whose job requires them to use or operate equipment or machines being maintained or serviced
    - **All other employees**—who work or operate in areas where lockout/tagout procedures are used

Batteries and Battery Charging

Batteries of the unsealed type shall be located in enclosures with outside vents or in well-ventilated rooms and shall be arranged so as to prevent the escape of fumes, gases, or electrolyte spray into other areas.

Following are the parts of Section 1926.441(a) and (b).

Click on the highlighted parts of Section 1926.441(a) and (b) to learn more.
1926.441(a)(2): Ventilation shall be provided to ensure diffusion of the gases from the battery and to prevent the accumulation of an explosive mixture.

1926.441(a)(3): Racks and trays shall be substantial and shall be treated to make them resistant to the electrolyte.

1926.441(a)(4): Floors shall be of acid resistant construction unless protected from acid accumulations.

1926.441(a)(5): Face shields, aprons, and rubber gloves shall be provided for workers handling acids or batteries.

1926.441(a)(6): Facilities for quick drenching of the eyes and body shall be provided within 25 feet (7.62 m) of battery handling areas.

1926.441(a)(7): Facilities shall be provided for flushing and neutralizing spilled electrolyte and for fire protection.

1926.441(b): Charging*

1926.441(b)(1): Battery charging installations shall be located in areas designated for that purpose.

1926.441(b)(2): Charging apparatus shall be protected from damage by trucks.

1926.441(b)(3): When batteries are being charged, the vent caps shall be kept in place to avoid electrolyte spray. Vent caps shall be maintained in functioning condition.

*Section title is not clickable.

Lesson Summary

Wearing a proper hard hat can provide protection for your head of up to 20,000 volts, and safety shoes can protect against open circuits of up to 600 volts in dry conditions. Safety shoes should be used with other insulating equipment and in connection with active precautions to reduce or eliminate the potential for providing a path for hazardous electrical energy.

Live parts to which an employee may be exposed must be de-energized before the employees work on or near them, unless the employer provides proper justification to demonstrate that de-energizing introduces additional or increased hazards or is infeasible due to equipment design or operational limitations.

Lesson 5: Struck by Hazards

Lesson Focus

This lesson focuses on the following topics:
- What is the Struck-By Hazard?
- Danger from Heavy Vehicles
- Danger from Falling or Flying Objects
- Danger from Constructing Masonry Walls

What is the Struck-By Hazard?

According to the U.S. Department of Labor Occupational Safety and Health Administration, being struck by objects is a leading cause of construction-related deaths. Only falls rank higher and is the number one cause of death in the construction industry. OSHA estimates that 75 percent of struck-by fatalities involve heavy equipment like trucks or cranes. The number of workers that die as a result of being struck by a vehicle was at a seven-year high in 1998.

Safety and health programs must include ways to limit or eliminate the many ways struck-by accidents can occur because one of the major causes of construction-related deaths is from being struck by objects.

Typically, struck-by accidents are associated with:
- Vehicles
- Falling or flying objects
- Masonry walls

The Danger from Heavy Vehicles

Danger

If vehicular safety practices are not followed at a work site, workers are at risk of being pinned (caught) in between construction vehicles and walls or stationary surfaces, struck by swinging equipment, crushed beneath overturned vehicles, or many other similar accidents. When working near a public roadway, workers are additionally exposed to being struck by trucks, cars, or other vehicles.

Improper operation of heavy vehicles poses a life-threatening danger to construction workers. Always follow safe practices to minimize injuries and save lives.

Important engineering controls include:
- Always install, use, and maintain vehicle back-up alarms.
- Station flaggers behind vehicles that have obstructed rear views.
- Keep non-essential workers away from areas of vehicle use.
- Keep workers away from temporary overhead activities.
- Place barriers and warning signs around hazardous operations and public roadways.

Seat Belts

The use of seatbelts during use of construction equipment or other motor vehicle must be made mandatory to reduce the effects of a crash. Research shows that the use of a seat belt reduces the risk of a fatal injury by 45% to front seat occupants of a car and 60% by light truck occupants.

Workers must wear seat belts in all vehicles that are equipped with seat belts. In the event of an accident, workers can be struck by the frame of the cab. Roll-over accidents can cause tools or material into the operator.

Avoiding Vehicle-Related Injuries

There are many ways to protect workers from being struck by objects and equipment.

Two important general rules to follow are:
- **Never** put yourself between moving or fixed objects.
- **Always** wear bright, highly visible clothing when working near equipment and vehicles.

Internal Traffic Control Plans for Work Zones

Using an internal traffic control plan (ITCP) for work zones is the best practice for construction site vehicle safety. The ITCP can be utilized by the project manager as a communication and coordination tool to control the movement of construction workers, vehicles, and equipment in the activity area.

ITCP's are intended to promote the safety of the roadway and to prevent caught in or struck by accidents to workers or others in the area. Some considerations for having an internal traffic control plan are:

- Internal signage denoting the activity area
- Specific protocols and procedures for construction vehicle ingress/egress

- Movement of traffic within the activity area
- Designated areas that prohibit workers that are on foot
- Communication protocol between all parties on the construction site.

Portable LED Tower Lighting

It is important for nighttime work zones to have proper lighting that will improve visibility for all the work activities within that area. High-efficiency light emitting diodes (LED) floodlights that are mounted on portable trailers or on moving equipment are very helpful and, in some cases, considered required equipment. LED Tower lights are lightweight and can be mounted between 14 and 15 feet high with a directional aim to the work area.

The use of LED lighting will provide low maintenance and durable lighting of good quality for the work area. This type of lighting will also reduce glare, helping avoid any spillover or struck by/caught in accidents. This type of portable set up can be labor-intensive therefore, it is best to use it for short-term project like lane or road closure.

Road Closure Program

Construction projects must be analyzed to determine any prior road closures before setting up of construction activities. The city or county where the road closure will occur would have to conduct a cost benefit analysis to determine its impact on the surrounding area. Some of considerations that will be made during this cost-benefit analysis will be traffic volumes, duration of the project, and the length of the detour that will be required. Another consideration will be provisions that need to be made for residents and businesses that are affected by the road closure. The possibility of closing the road prior to the construction activities will eliminate any chances of struck by vehicle hazards for the workers as well as general public.

Lane Closure Policy/Map

There are some states that have adopted lane closure policies based on traffic mapping. Traffic mapping informs traffic engineers what areas are prone to more traffic during various times of a day or on a specific day of the week as compared to other areas. Understanding the flow of traffic pattern of the community will lead to effective work lane closure policies. For instance, Colorado DOT (CDOT) has identified six distinct regions that have their own unique lane closure policies. CDOT will publish Lane closure maps and spreadsheets for works to engineers and contractors. This program has helped the

Colorado Department of transportation to plan more effective enclosures based on the specific needs of the region.

Working around Other Vehicular Traffic

When working in an area that is exposed to vehicular traffic it is important to be aware of struck-by accidents.

This section will focus on the hazard of controlling traffic and how to control the worksite to avoid any injuries to workers. There are a few areas of concern when controlling traffic due to construction activities, these include but are not limited to:

- Maintenance of Traffic Basics
- Traffic Control Devices
- Flagger Procedures

The Federal Highway Administration (FHWA) has a Federal guidance for traffic control devices known as the Manual on Uniform Traffic Control Devices (MUTCD). In the MUTCD, the instruction is to use signs and channelizing devices to warn and direct traffic to the open lanes. Communication with the traveling public starts in the advance warning area. This is where the MOT designer will set up channeling devices and warning size based on:

1. The build of the road:
    a. Two-lane/Two way Roads
    b. Multilane road
2. Where the work is located:
    a. Shoulder
    b. Travel lane
    c. Median
3. Speed limit of the travel lane

Traffic Control Devices

The use of traffic control devices is crucial to the maintenance of traffic operations. This traffic device that is placed in the road must:

- **Fulfill a need**- A channelizing is needed to guide and direct traffic and pedestrians to the safest traveling path. These devices are helpful in creating barriers and boundaries on a temporary basis. It also helps in training the drivers regarding what is expected of them on the road.

- **Command attention**- Both drivers and pedestrians must look at the channeling devices. These are generally made from a retro reflective material, have a warning light, or a ballast and will warn and alert drivers of hazards created by construction and maintenance activities in or near the roadways. Any disregard for the channeling devices or signs can increase the likelihood of a struck by accident.
- **Convey a clear and simple meaning**- The traffic control engineer must choose an appropriate traffic control device that gives a clear meaning to the drivers. No channeling device or message should cause an accident due to its design.
- **Command respect**- Both drivers and pedestrians must obey and respond to the road signs, channeling devices, or traffic personnel. Everything that the MOT operator does must be communicated through authority.

Traffic Control Signage

The use of temporary traffic control devices and signage can greatly reduce traffic related hazards. These signs come in three categories:

- **Warning:** Warning signs have a basic shape, usually diamond, to denote a hazard ahead. Sometimes the signs are orange with black legend or yellow with black legend.
- **Regulatory**: Regulatory signs are legal obligation which, if broken, can result in a traffic citation. This obligation is denoted on the sign that is usually in a rectangular design with a white background and black legend. However, there are some regulatory signs with unique shapes such as the eight sided stop sign.
- **Guidance:** Guidance signs are generally rectangular in shape in basic white on green colors. However, signs indicating construction activity ahead may be black on orange.

In addition to using signs, channeling devices must also be used to control traffic. The function of any channeling device is to help guide and direct the pedestrians, cyclist, or motorist to the safest way to proceed past the construction area. Additionally, these channeling devices will provide warnings of hazards which were created by the construction activities.

Channeling devices consist of the following:

- Traffic Cone
- Tubular marker
- Drums
- Vertical panels
- Type I barricades
- Type II barricades
- Type III barricades
- Longitudinal Channelization Devices (LCD)
- Arrow boards
- Portable Changeable Message Sign (PCMS)
- Radar Display Speed Unit
- Portable Regulatory Sign
- Truck/Trailer Mounted Attenuators (TMA’s)
- Temporary Lane Separators
- Painted or Raised Pavement Markers
- Temporary Signals

Purpose of the Traffic Control Device

Each temporary traffic control device has its own purpose and use. The person who is creating the maintenance of a traffic plan must be aware of the several other conditions prior to the choice of channeling devices.

MOT sites are set up into 4 distinct areas:

1. **Advanced Warning Areas** - Used as the first indication to the motorist that there is upcoming construction work in the roadway or shoulder. In the advanced warning area the signs will be of:
    a. Road Work
    b. Men at Work
    c. Lane Closed or Flagger Ahead
    d. Workers Ahead

2. **Transition Area** - Used to channel the motorist to the open travel lane.
3. **Activity Area** - This section will have the buffer space for motorist to get back into the travel way, if they go through the MOT towards the work space.
4. **Termination Area** - Used to channel the traffic back into the usual travel lanes.

The first part of every traffic control zone is to warn the vehicles of the change that is about to take place. The disruption of the driver's pattern is a hazardous latent condition that could result in a struck by incident. The signs that are posted leading into the construction zone all the way to the end of the construction zone must be uniform in design and expectations.

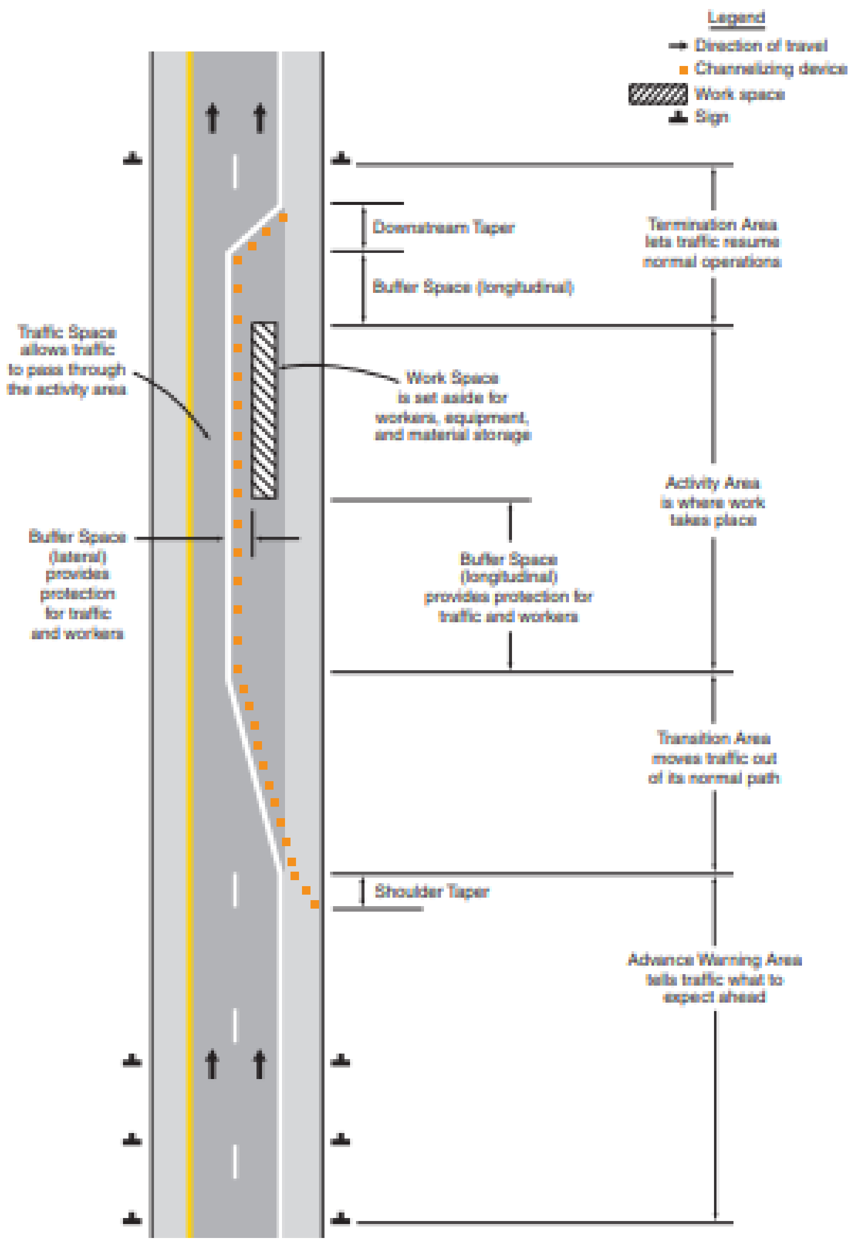
The channeling devices are placed in a pattern that begins in the advanced warning area so that when the cones are parallel to the work area they have been angled back. This angling of the channeling devices is referred to as the taper.

The taper length and the spacing between each column is subsided through a calculation of the posted speed limit. As the speed of the vehicles increase, the amount of taper length and buffer space is created prior to the activity area.

At the activity area, the channeling devices are placed adjacent to the traveled way to keep the traffic out and work as warning devices for the workers. Some construction zones will have the barricades as an engineering control to avoid the struck-by accidents. Workers are the most at risk from public vehicle activities.

It is also important to keep the buffer space area free from equipment or staging material, to give the wayward driver an opportunity to swerve back into their own lane. If there is any material in that Transition Area, then the driver can have a collision in the MOT zone.

Figure 6C-1. Component Parts of a Temporary Traffic Control Zone



Flagger Safety

All workers who are designing or maintaining the MOT for a construction zone must be trained for their responsibilities. The flaggers play a very important part in the protection of the workers. Each flagger must have the knowledge of proper techniques and requirements for controlling the traffic.

The ultimate control of public safety lies within the communications made by the flagger. The flagger must understand how to maneuver the traffic along the channeling devices; give guidance to the pedestrian, cyclist, and motorist.

The first priority of the flaggers is first to protect themselves, the personnel on the construction site, the drivers and the pedestrians. In all cases, the flagger must leave an escape route for themselves in case someone disregards a warning sign. The flagger must warn the crew of the potential danger. In some cases the flagger will be the primary person to obtain vehicle information and driver description.

The flagger must also be visible to oncoming traffic therefore proper high visibility apparel must be worn during flagging operations. It is important that the flaggers remain alert and stay off the path of any approaching vehicle.

Flagger Responsibilities

It is important for the flagger to never turn his back to traffic or perform any other activity while flagging. The basic rules of conduct which the flaggers must all adhere to are:

- Stay alert to the needs of the emergency vehicles cruise
- Report a car if they refuse to obey instructions
- To cover or remove flagger signs when no flagging operations are present
- Never mingle with the work crew, traveling public, or people
- Do not lean against any vehicle

It’s also imperative for the lead flagger to have communication with all other flaggers. This communication can be two-way radios or hand signals, whichever is more appropriate for the situation. The flaggers must also be equipped with a stop/slow paddle and an illuminated flagging station during nighttime operations.

In order to get a vehicle to stop, the flagger must present the stop side of the paddle and with a raised hand palm out. To proceed, the flagger will rotate the stop/slow paddle to the slow indication and deliberately and slowly waive the drivers through the work zone.

If there’s a driver who is going faster than the posted speed limit, then it is the responsibility of the flagger to slow him/her down. The procedure to slow down the driver involves showing the slow side of the paddle to the driver while indicating him/her to slow down by slowly raising and lowering the palm of the hand.

In case of emergency, when the flagger is not equipped with a stop/slow paddle, they can use a flag for immediate MOT usage. During nighttime operations it is also necessary for the flagger to have a flashlight, lantern or the lighted signals that display a red warning light.

The flags are 24 x 24” and are used by qualified flagger to control the traffic. To stop traffic the flagger should hold their hands straight out with the flag facing downwards and the other hand extended with the palm facing the driver. Both hand gestures should be shoulder height for maximum visibility.

When it’s time for the flagger to release traffic, they will put the flag to their side to wave the traffic through by rotating their bodies as they motion with their non-flag bearing arm.

To slow the traffic, the flagger must slowly raise and lower the flag from their side to shoulder height. This will signal the driver that they are going too fast and need to adjust their speed through the works zone.

Safety Controls

Additional safe practices are:

- Use manufacturer-approved safety restraints unless the vehicle is not designed for them.
- Never allow workers to drive equipment in reverse without an alarm or flagger.
- Enforce a limited access zone before dumping or lowering buckets.
- Properly turn off and block all equipment, including accessories.
- Set parking brakes and use chock wheels if parked on an incline.
- Install cab shields on hauling vehicles to protect against struck by and rollover injuries.
- Never exceed the vehicle’s rated lift capacity or carry unauthorized personnel.
- Use signs, barricades, and flaggers to protect workers near roadways.
- Use proper lighting and reflective clothing/vests at night.

Maintenance and Safety

Proper maintenance of vehicles and the surfaces on which they operate will eliminate many struck by injuries. Be sure to:

- Require workers to check equipment before each shift.
- Only drive vehicles/equipment on safely constructed and maintained surfaces.
- Every vehicle must have a working, properly maintained brake system.

Danger from Being Struck by Falling or Flying Objects

Danger

Workers are at risk from *falling* objects when they are required to work around cranes, scaffolds, overhead electrical line work, etc.

There is a danger from *flying* objects when using power tools, or during activities like pushing, pulling, or prying, that can cause objects to become airborne.

Flying/falling objects can also roll off rooftops, or be accidentally kicked off walkways, scaffold platforms, etc. if they are not properly constrained.

Depending on the situation, injuries from being struck by flying or falling objects range from minor ones like bruises to severe ones like concussions, blindness, and death.

Training

Loose debris left on a roof can easily be blown by a gust of wind which will carry it to the ground below where a worker could be standing. When working in this kind of an environment, accidents are inevitable. Workers must be trained to be careful and remain constantly on the lookout for such conditions, securing all materials in an appropriate manner.

Employers must educate their employees on how to prevent accidents and exposures. Employers have a responsibility under OSHA standards to educate and train their employees to recognize and avoid unsafe conditions that can lead to struck-by injuries.

Ways to Avoid Being Struck by Falling or Flying Objects

Workers can be struck by falling or flying objects or by materials that slide, collapse, or otherwise fall on them. To protect workers from these types of injuries, OSHA requires that employers:

- Require workers to use hardhats/helmets when appropriate.
- Train employees to stack materials to prevent sliding, falling, or collapsing .
- Install protective devices onsite, such as toe boards on elevated platforms and walkways.
- Install debris nets beneath overhead work.

Safety nets must be installed as close as practicable under the walking/working surface on which employees are working, but in no case more than 30 feet (9.1 m) below such levels. When nets are used on bridges, the potential fall area from the walking/working surface to the net must be unobstructed.

Properly Use and Inspect Power Tools and Equipment

Before each use, inspect equipment and tools to ensure that they work properly. Loose parts can fly into the air and cause damage. Never allow workers to use powder actuated tools until they are properly trained on how to use and maintain them. A qualified person who is properly trained should inspect all equipment before use.

PPE for Power Tools and Equipment

Ensure that workers use all required PPE when operating power tools and equipment. Examples of required PPE include:

- Safety glasses and goggles
- Face shields
- Hardhats/helmets

Head Protection Equipment

Head injuries are generally caused by falling or flying objects, or by bumping the head against a fixed object. Head protectors in the form of protective hats can resist penetration and absorb the shock of a blow. The shell of the protective hat is hard enough to resist many blows and the suspension system keeps the shell away from the wearer's skull. Some protective hats can also protect against electrical shock.

Protective hats are made in the following types and classes:

- Type 1—Helmets with a full brim.
- Type 2—Brimless helmets with a peak extending forward from the crown.
- Class G—General service, limited voltage. Intended for protection against impact hazards. Used in mining, construction, and manufacturing.
- Class E—Utility service, high voltage. Used by electrical workers.
- Class C—Special service, no voltage protection. Designed for lightweight comfort and impact protection. Used where there is a possibility of bumping the head against a fixed object.

Compressed Air and Flying Objects

Compressed air is a productive tool when used correctly. If used incorrectly, it can launch unexpected and very dangerous objects into the air that can strike and injure unsuspecting workers.

Follow these steps when using compressed air to keep objects from flying. Be sure to:

- Limit compressed air pressure to safe level when cleaning floors, equipment, etc.
- Ensure equipment parts are fastened before cleaning.
- Always use appropriate guarding.
- Never use compressed air to clean clothing.

Nail Gun Safety

One of the most used power tools in the construction field is the nail gun. It is also responsible for an estimated 37,000 emergency room visits. A study of apprentice carpenters by OSHA states that:

- 2 out of 5 were injured using a nail gun during their 4 years of training.
- 1 out of 5 were injured twice.
- 1 out of 10 were injured three or more times.

Most of the injuries obtained from a nail gun accident involves hand and finger injuries that involve structural damage to tendons, joints, nerves, and bones.

Some serious injuries related to being struck-by a nail from a nail gun (nailer) are:

- Paralysis
- Blindness
- Brain damage
- Bone Fractures and
- Death

There are various types of specialized nailers such as for framing, roofing, and flooring. The framing nail guns are powerful pieces of equipment that fire larger nails. Framers are therefore even more at risk from the mishandling and misuse of nailers.

Workers who understand the trigger mechanism can greatly reduce the potential of injury. The trigger has two basic control mechanisms:

1. Finger trigger
2. Contact safety tip

These trigger mechanisms can be single discharge or multiple discharge when the controls are activated. The safest type of nail gun trigger is the one that only fires a nail when the controls are activated in a certain order. Nails cannot be fired in a bump fire mode but only through a single shot trigger, restricted trigger, or by a trigger fire mode.

Nail gun accidents can happen in a variety of manners with different types of triggers. Contact triggers can have a double fire discharge of a second unintended release. If a person has the activation trigger depressed and knows the safety contact, then the nailer will discharge and most likely cause an accident.

Nails can also penetrate lumber material and discharge into a person on the other side of the lumber. The nail can ricochet from hitting a wood knot, metal, or other hard surface and strike a nearby worker with the nail. If a worker is in the habit of gripping the nail gun by the trigger when traveling with the unit, it may lead to an accidental discharge of the nail gun.

Workers can get injured if a part of the nailer is not working properly or missing altogether. Each worker must check their tools before each shift and prior to each use. This will ensure that all tools and equipment are in proper working order with all safety features working properly.

When workers are working in an awkward position, it may be difficult for them to control the application or angle of the nailer. In some cases, the workers might use their body as a brace and put themselves in the line of fire.

Tips to Better Nail Gun Safety

The following tips will ensure proper handling of a nail gun:

1. Use the full sequential trigger nail gun for the safest trigger mechanism. This type of trigger reduces the risk of unintentional nail discharge or double fires. New workers should be restricted to using the full sequential trigger nail guns only until they are fully oriented with other trigger types.

2. All workers that use nail guns must be trained on how to use the tool and its safety features. Hands on training is always the best form of training, so the worker can see how to use the equipment first hand. OSHA recommends the following training topics:
    a. How nail guns work and how triggers differ.
    b. Main causes of injuries – especially differences among types of triggers.
    c. Instructions provided in manufacturer tool manuals and where the manual is kept.
    d. Hands-on training with the actual nailers to be used on the job. This gives each employee an opportunity to handle the nailer and to get feedback on topics such as:
        i. How to load the nail gun
        ii. How to operate the air compressor
        iii. How to fire the nail gun
        iv. How to hold lumber during placement work
        v. How to recognize and approach ricochet-prone work surfaces
        vi. How to handle awkward position work (e.g., toe-nailing and work on ladders)
        vii. How best to handle special risks associated with contact and single actuation triggers such as nail gun recoil and double fires. For example, coach new employees on how to minimize double fires by allowing the nail gun to recoil rather than continuing to push against the gun after it fires.
        viii. What to do when a nail gun malfunctions.
    e. Training should also cover items covered in the following sections of the guidance, such as:
        - Company nail gun work procedures
        - Personal protective equipment
        - Injury reporting, and
        - First aid and medical treatment

3. Establish nail gun work procedures for workers that will include:
    a. Mandatory reviews of the tool operations and maintenance manual
    b. Have O & M manuals onsite for review
    c. Check tools and power source for proper operations and require broken or malfunctioning equipment to be taken out of service immediately
    d. Check lumber surfaces to ensure that there are not knots, nails, hangers, or anything that can impede the nail from going through the material.
    e. Keep hands at least 12 inches away from the point of impact of the nailer.
    f. Disconnect the compressed air when servicing, traveling or clearing a nail jam from the equipment
    g. Analyze the dangers of nail gun work and mitigate as many hazards as possible prior to working in the area.
4. Provide Personal Protective Equipment (PPE) such as hard hats, high impact eye protection, and hearing protection.
5. Encourage reporting and discussion of injuries and near misses to help workers learn how to identify hazards. Once the hazards have been identified, the prompt correction of the problem is needed.
6. Provide first aid and medical treatment for workers at the job location. Getting workers medical care as quickly as possible to limit the impact of the accident.

Roofing and Multi-Story Construction

Workers must always be aware that a tool, piece of building material, or equipment could accidentally fall from roofs or above-ground building levels. Ensure that workers:

- Use safety nets or other protective means when objects can fall on workers below.
- Use limited access zone guidelines to keep outsiders and non-essential workers from being struck.
- Install toe boards on scaffolds and walkways when appropriate.

PPE for Roofing and Multi-Story Construction

Always use PPE to protect the face and head when there is a chance of being struck by a falling or flying object at a construction site. During the workday, you can be struck by an unsecured falling roofer's hammer or by a piece of lumber that accidentally falls through a hole in the floor above your work area.

Examples of PPE to be used during building activities include:

- Hardhats
- Face shields
- Goggles

Working Around Cranes and Hoists

It is extremely hazardous to work underneath heavy equipment, especially when it is being operated. Heavy debris can fall from a swinging bucket. A crane can accidentally break something loose and send it flying. If hoists break during use, their loads can tumble down and strike workers. Work must not be performed beneath an elevated, unsecured load at any time.

Always follow these safe practices while working around cranes and hoists:

- Never allow employees to work underneath suspended loads.
- Barricade areas and post warning signs to keep non-essential employees and outsiders away from overhead equipment.
- Inspect cranes and hoists before each use to ensure components are in good working condition.
- Never exceed the lifting capacity of cranes and hoists.

Operating Cranes and Hoists

When operating cranes and hoists during construction work, always:

- Secure tools and building materials to keep them from falling or being pushed over.
- Barricade areas underneath operation and post warning signs.
- When using hoists for scaffold work, use toe boards, screens, or guardrails to keep materials and tools from falling.
- Use debris nets or other appropriate safeguards to intercept falling objects.

Danger from Constructing Masonry Walls

Danger

Because of the tremendous weight of a masonry wall or slab, if one collapses on a worker, it can cause permanent injury or death. Proper safeguards should be used and all jacks and equipment used to support and position such walls and slabs must be reliably maintained and kept failsafe.

Avoiding Struck-By Hazards Related to Masonry Construction

Only essential workers should be allowed near this type of operation. To enforce this, set up a limited access zone around operations. Additionally, be sure to:

- Have concrete structures checked by qualified persons before placing loads.
- Adequately shore or brace structures until they are permanently supported.
- Secure unrolled wire mesh so it cannot recoil.
- Never load a lifting device beyond its intended capacity.

Abrasive Wheels and Tools

Abrasive wheels and tools may throw off flying fragments creating a struck-by incident. Many incidents are due do the blade wheel fracturing and flying towards the worker. In a 2017 case, OSHA reported an employee of a freight trucking company was working on an abrasive grinding wheel. The wheel broke apart and struck the employee in the right eye creating a laceration.

This event lead to an OSHA inspection of the workplace where the organization was cited for a violation in the machine guarding standard for portable power tools. This citation was $11,408 to the employer on top of having an injured worker.

Most of the injuries from the angle grinders are in the head and face area. The high speed of disc when broken will cause disfiguring, permanent disabilities or even a fatality. The injuries occur for many reasons, such as, but not limited to:

- The wheel kicking back from the surface it is cutting. This usually will cause the blade to fly back on the operator.
- Blade cracks but the guard has been removed causing the blade to fly back and injure the operator.
- When the blade is not rated for the grinder, it will shatter causing a shrapnel that will create many foreign body embedment's or lacerations.
- Overhead use of the grinder is associated with fatal intracranial injuries.

Equip abrasive wheels with guards that:

- Cover the spindle end, nut, and flange projections.
- Maintain proper alignment with the wheel.
- Do not exceed the strength of the fastening.
- Guard so that a minimal amount of the wheel is exposed.

Inspecting Abrasive Wheels

Before mounting:

- Inspect closely for damage.
- Perform sound or ring test to ensure that the wheel is free from cracks and/or defects.

To test:

- Tap wheel gently with a light, non-metallic instrument.
- If the wheel sounds cracked or dead, do not use it because it could fly apart.

Keep in mind that this test is most accurate if the abrasive wheel is suspended and not held. By holding the wheel you could possibly alter the sound and giving off a false indicator of defects.

Abrasive Wheel Use

To prevent cracking:

- Fit the wheel on the spindle freely.
- Tighten the spindle nut enough to hold the wheel in place without distorting the flange.
- Let the tool come up to speed prior to grinding or cutting.
- Don’t stand in front of the wheel as it comes up to full speed.
- Use eye and/or face protection while operating wheel.

Abrasive Wheel Work Rests

The following information applies to abrasive wheel work rests:

- Keep work rests not more than 1/8th inch from wheel surface, and tongue guards at the top of the wheel not more than 1/4 inch from wheel surface.
- This minimizes the chance of jamming the work between the wheel and the rest, which may cause the wheel to break.
- Don’t adjust the wheel while it is rotating.

Additional safe operating tips for angle grinders is as follows:

- Use the correct disc size for the wheel's rpm.
- Remove cracked or chipped discs from service
- Stop using if vibration is very apparent
- Keep the guard in place
- Don't us an angle grinder above your head. Stand next to the plane of the cutting wheel.
- Always wear gloves, goggles, face-shields and hard hats when operating the equipment.

The Impact of an Accident on the Employer

Many accidents are considered to be thought of as expensive when considering lost time events. However, there are many more cost factors related to the accident that can be both direct or indirect cost of the accident. To evaluate the total cost of the accident you must combine both of these costs.

In order for the cost to be paid, the organization must use the profits of the company. All profits are derived after the operational cost of the company have been calculated. Accidents effect the organization's profitability, because the costs of the accidents must be paid from increased revenue. A company's profit margin is calculated by **Profit Margin=Total Profits/Total Sales**. The revenue required for funds to offset an injury are: **Revenue Required=Total Cost of Incident/Profit Margin**.

Additionally, the Business Roundtable publication, *Improving Construction Safety Performance*, published a study conducted by *Stanford University Department of Civil Engineering* which provides an indirect cost estimator for accidents as it relates to direct costs of an accident.

Direct Cost of an Accident

The direct costs of an accident are seen to be directly associated with the event and is easily quantifiable. Most direct costs are paid by the insurance company of the employer. An example some of these costs are:

- Physical therapy
- Medical expenses
- Repair fees for damaged equipment
- Increase in workers' compensation premium
- Continuation of pay
- Compensatory damages

Indirect Cost of an Accident

The indirect cost of an accident cost is not paid for through insurance and therefore is unrecoverable. While the direct costs are easy to be quantified, the indirect costs are often unseen or impossible to quantify. The relationship between direct cost and indirect cost is the indirect cost is greater than the direct cost for the company. Examples of indirect cost are:

- Wages paid to injured workers for absences not covered by Worker's Compensation;
- Lost high wages work stoppage associated with the worker injury;
- Over time due to the accident;
- Administrative costs and time spent by safety personnel, clerical workers, and other employees after the injury;
- Training for replacement worker;
- Lost productivity due to the work unit separation from the injury;
- New employee learning curve;
- Accommodation the injured employee within the organization:
- Clean up, prepare, replacement cost of damage material, machinery, and property.

The National Council Compensation Insurance, Inc. (NCCI) conducted statistics and data collected from insurance claims between policy periods 2011 through 2013. This data was incorporated by OSHA in the Safety Pays cost estimator for accidents. The NCCI manages the nation's largest database of workers compensation insurance information.

OSHA's program uses the *Business Roundtable* publication "**Improving Construction Safety Performance"** to calculate the indirect costs estimates and create the Safety Pays Cost Calculator, which are based on a study conducted by the Stanford University Department of Civil Engineering. According to this the indirect costs have a measurable relationship to the direct cost of accidents and the magnitude of indirect costs is inversely related to the severity of an accident.

The following chart will help understand the relationship between direct costs and indirect costs in a ratio that is used to calculate the total accident cost.

Direct Costs	**Indirect Cost Ratio**
$0-$2,999	4.5
$3000-$4,999	1.6
$5,000-$9,999	1.2
$10,000 or more	1.1

To use the cost estimate calculator, you need to know either the injury type or the workers' compensation, direct cost of an accident and the company's profit margin. However, if the profit margin is not known to the officer using the cost estimator then OSHA will give a default 3% profit margin for calculation of the direct and indirect costs relations to the additional sales needed to pay total cost of the accident.

In the example of this calculator, if you select an amputation from the entry type menu and give the company a profit margin of 10%, the calculator will give you the following information:

- Amputation: (1) Instance
- Direct Cost: $77,995
- Indirect Cost: $85,794
- Total Cost: $163,789

Additional Sales needed to recuperate cost (Indirect Cost): $857,945
Additional Sales needed to recuperate cost (Total Cost); $1,637,890

Therefore, this example illustrates that just one instance of an amputation through most likely an at-risk behavior has historically cost $77,995, with direct costs of $85,794 and indirect costs yielding a total injury cost of $163,789.

Organizations will have to use funds from the profits to cover both direct and indirect cost of the accident. However, up to $77,995 can be recoupable through workers' compensation; then sale must increase $2,859,816 to cover the indirect costs of the injury that cannot be reimbursed at a 3% profit margin.

Lesson Summary

There are many ways to protect workers from being struck by objects and equipment. Two important general rules to follow are:

- Never put anyone between moving or fixed objects.
- Always wear bright, highly visible clothing when working near equipment and vehicles.

Many struck-by accidents are associated with vehicles, falling or flying objects, and masonry walls. For example, workers are at risk from falling objects when they are required to work in the vicinity of cranes, scaffolds, and overhead electrical lines. There is also danger from flying objects when using power tools or during activities like pushing, pulling, or prying that can cause objects to become airborne.

Flying/falling objects can also roll off rooftops or be accidentally kicked off walkways or scaffold platforms if not properly constrained. Depending on the situation, injuries from being struck by flying or falling objects range from minor ones like bruises to severe ones like blindness or death. Because improper operation of heavy vehicles and equipment poses a life-threatening danger to construction workers, always follow safe practices to minimize injuries and save lives.

Lesson 6: Caught in Between Hazards

Lesson Focus

This lesson focuses on the following topics:

- What is the Caught in Between Hazard?
- Preventing Caught in Between Hazards
- Observing Behaviors to Coach workers to Safer Behaviors

What is the 'Caught in Between' Hazard?

OSHA's website states that the top four causes of construction fatalities are a result of:

1. Falls
2. Struck-by
3. Caught in between
4. Electrocution

In this lesson we will discuss situations in which workers can be caught in between equipment, moving loads, or even safety guards. This hazard exists in many situations where struck by hazards also exist. For instance, a worker can be caught in between a falling slab and a concrete foundation or a worker can be caught (or pinned) in between a vehicle and a structure. Also, workers can be caught in between a collapsed trench that is not properly braced, or warehoused construction materials that was not correctly stacked to prevent sliding. In 2016, there were 72 construction deaths that were reportedly caused by a caught-in/between event.

The recognized hazards related to caught-in-between accidents come from:

- Cranes and Heavy Equipment
- Tools and Equipment
- Material Handling
- Trenching and Excavations

General Construction Site Caught-in-Between Hazards

When workers are not paying attention to their body position in relation to a caught-in-between hazard, they place themselves between an immovable object and a moveable one. Sometimes, the worksite has limited access and travel ways between staging materials. In such a situation, the workers will find themselves squeezing between a loaded forklift and pallets of materials.

If the forklift operator loses his focus or has an event in which they lose faculties, then the workers walking between the two loads can be crushed. A clear walking path must be established with the workers being trained to keep those paths free from heavy equipment.

Cranes and Heavy Equipment

Cranes and heavy equipment can cause a variety of injuries to the workers in a dangerous location. The worker must never place their body between the tracks and the super structure of the crane. Though it is the closest area to communicate with the driver, this is an extremely dangerous practice. The crane operator and the personnel must have alternative means of communication to avoid this practice.

Workers that place themselves between a fixed object such as a wall and have heavy equipment operating behind them or next to them are also in the line of fire. If a backhoe operator is starting an excavation next to the wall where the person is standing, then the possibility of an accident becomes greater.

When a crane is actively moving a load from one area to the next it produces a swing radius for the rotating part of the equipment with the load. The individual that is within the swing radius of the crane can be struck-by the load or if the load drops, they can be caught-in between the material and the ground.

It is important for the worker to always keep a safe distance from the equipment to avoid having their feet or legs crushed by being rolled over by the equipment. Some workers are caught up in the job and forget the boundaries that must be maintained from equipment, vehicles, and themselves. It is common for individuals to get their feet in the path of a skip loader or backhoe and get their feet crushed by the equipment.

In the construction standard, 1926.1424 OSHA requires Work Area Control for a swing radius hazard where there are accessible areas in which the equipment’s rotating superstructure (whether permanently or temporarily mounted) poses a reasonable risk of striking and injuring an employee or pinching/crushing the employee against any part of the equipment.

The work area must be delineated as to the location that is off limits to anyone on the construction site that isn’t authorized or trained to recognize the hazards within that swing arm radius. Additionally, the general public must be restricted from entering the construction site especially, around cranes and derricks with an active load.

Tools and Equipment

Most tools and equipment that are not used per the manufacturer's recommendation will lead to some misuse or even a hazardous condition. Guarding of portable power tools and bench tools often have guards taken off for reasons that are behaviorally driven. The worker may feel that they are able to see the work better so they remove the guard on the equipment creating a new hazard.

When a guard is missing, it becomes easier for loose clothing, gloves, or jewelry to get caught up in the rotating parts of the equipment. Once that occurs the speed of most equipment will snag the loose item and pull it into the machinery. In the event of that happening, it becomes more difficult to pull out the part of the body that the loose item is attached to. That would lead the worker into a crushing injury. It is best practice to never place hands or the body near moving parts.

The construction manager should have a daily inspection of the integrity of the equipment that is on the construction site. Each person that uses the equipment must also keep a log of when it was checked and if there are issues such a broken parts or missing safety functions. This will ensure a regular check of the equipment and help in avoiding any future caught-in-between accidents.

Material handling

Workers must use extreme caution when handling material from one location to another. It is common to see workers "stabilizing" a load by having their hands on the material as it is traveling by crane or rough terrain forklifts. This practice can lead to being crushed by the load if there is a shift due to road conditions, driver error, or poor rigging.
Workers that have to guide a load in anyway must not use their own hands on the load, but an approved tag line or guide line.

The stacking and storing of material is important, because the worker that is walking next to the load will be more susceptible to getting trapped under the load if there is a shift in the balance of weight. A clear walking path for pedestrians is need to ensure that if any material that is being stored tips, it will not land on a worker.

Storage of materials must be in a manner that will aid in the stability of the product. They must be stacked or interlocked in a way as to not create a falling object hazard. The height of the material also matters as to the stability of the cargo. If the product is too high, then it will be easier for it to tip one side or the next. This can lead to someone getting trapped underneath the load.

Workers must be ever mindful as to not place themselves in a way that will pin them against an immovable structure. This will come from hazard recognition tools and training. A system of near miss reporting can bring to light any conditions that may be hazardous and cause a debilitating injury.

Masonry and Stone Work

The hazards associated with handling concrete slabs include being caught in between slabs if they fall or shift onto a worker.

Some caught in between hazards have been documented while transporting granite and marble slabs. During loading, transport, and unloading of these slabs, the loads have been known to shift and tip over. Workers can either be caught in between slabs or they can be struck by such shifting or falling slabs.

Jacking equipment must be capable of supporting at least two and one-half times the load being lifted during jacking operations, and the equipment must not be overloaded. Lifting inserts that are embedded or otherwise attached to tilt-up wall panels must be capable of supporting at least two times the maximum intended load applied or transmitted to them. Lifting inserts for other pre-cast members, excluding tilt-up members, must be capable of supporting four times the load. Lifting hardware members must be capable of supporting five times the maximum intended load applied to the lifting hardware.

Erected shoring equipment must be inspected immediately before, during, and after concrete placement. All base plates, shore heads, extension devices, and adjustment screws must be in firm contact, and secured when necessary, with the form and foundation. Shoring equipment that is found to be damaged or weakened after erection must be reinforced immediately.

Vehicles

We have already discussed the need to equip vehicles with backup alarms or provide flaggers when drivers do not have a clear view to the rear. It is bad enough if a worker is struck by a vehicle, but if he or she is also pinned or caught in between another stationary surface, there is a high likelihood that life or limb will be lost.
Blind spots on construction vehicles must always be checked for. When a vehicle is large and has an enclosed cap, it can make blind areas around the equipment which are hard to see. This can be hazardous for ground workers and pedestrians, specifically on roadway work zones.

Trenches

If a trench collapses on a worker, he or she may be caught in between the rubble. In addition to the collapse hazard, at times a backhoe may be used to lower material like a precast pipe section into a trench with a worker present. In this case he or she may be adequately protected by remaining in a trench box while the backhoe is operated.

If a trench worker was to stand directly between the hoisting path and the trench box wall, he or she would be vulnerable to both the struck-by and caught in between hazards. However, if a long trench box (or several adjoining ones) was provided and the worker was far enough away from the backhoe and hoisting path to eliminate a struck-by or caught in between hazard, then he or she could safely remain in the trench box.

Preventing Caught in Between Hazards

Safety Measures

Engineering controls like shoring, fall protection systems, and properly stacking building materials can help prevent caught in between hazards. Some strongly recommended safety practices are:

- Never allow workers to enter an unprotected trench (or excavation) that is 5 feet or deeper unless an adequate protective system is in place; in many cases, trenches less than 5 feet deep may also require such a system.
- Ensure the trench (or excavation) is adequately protected by sloping, shoring, benching, or trench shield systems.
- Follow fall protection guidelines per 1926.502 Subpart M.
- Always properly stack building materials so they are clear of work areas and so they do not suddenly shift or slide onto a worker.

Trenches

Trenches 5 feet or deeper must be protected using any of the following protective systems. In many cases, even trenches that are less than 5 feet deep must be secured. Protective systems are used to ensure that trenches do not collapse onto workers.

All trench protective systems must be designed or verified by a competent person and/or an engineer. These systems include:

- Sloping
- Shoring
- Benching
- Trench Shield Systems

Fall Protection

While guardrails are a critical engineering control used to protect workers from falling, they can pose a caught in between hazard under certain circumstances. Subpart M addresses this hazard.

Guardrails and Suspended Load Clearances

Guardrail requirements can actually create a hazard at the leading edge of installed floor or roof sections by creating the potential for employees to be caught in between guardrails and suspended loads.

Ensure there is an allowance for a clear work space (path) in which to guide any suspended load into position for placement and welding of members. This is necessary to eliminate, this particular type of caught in between hazard.

Operational plans must always allow for adequate work areas in which to move suspended loads.

Stacking Building Materials

Building materials must be stacked in such a way as to prevent their toppling over. Always allow enough space around stacks of materials or wide walkways to allow workers to quickly move out of the way in case materials slide or are accidentally pushed over.

Many of the accidents that are caused by struck-by and caught-in accidents are behavioral in nature. If a worker feels that they can do something to get an edge at work or even perform a task faster, they may become prone to unconsciously put themselves in a situation which might lead to an accident.

There is a safety and health tool known as behavior based safety (BBS) program that picks at risk behaviors and monitors the worker to understand why they are behaving in a way that can hurt them. This behavior is called at-risk behavior and it can be coached towards safe behaviors through the BBS program.

Common Human Performance Snares

There are several behaviors that can cause a human to perform below expectations. These performance traps or snares will show themselves to be behaviors to be coached in a BBS observation. To overcome these behaviors the coach should be aware of what they are and how to help the worker understand ways to master the behavior.
The following are common human performance snares and ways to overcome them.

Time Constraints

One of the most common human performance snares are workers feeling that they have a time constraint forcing them to cut corners. They are many actual pressures related to jobs such as due dates, daily schedules, personal pressures for performance, and frontline supervision time crunches. Sometime pressures are legitimate and cannot be adjusted or easily adjusted.

When there is a time constraint due to a pressing engagement such as an emergency situation, then the employee will have to make decisions rapidly. During times were there are rapid decisions needed, the employee must rely on what is already a habit strength. Habit strength will leave the worker to resorting to their homeostasis for behavior. In the behavior-based safety program the workers will be trained to use safe behaviors versus at-risk behaviors which would lead them to that habit strength in time of emergencies.

However, in some cases workers just use time constraints as a way of avoiding what is the opportunity to use safe behaviors. In these situations, the coaching session should include some tools that can help deal with time constraints. The coach should consider certain considerations when coaching this particular behavior:

- The coach can perform a self-check to see if there was truly a time constraint to perform this duty
- A peer check of the situation will also reveal if another person is feeling a time constraint for performing this task
- A pre-job briefing would help the worker to see the whole job and visualize how long it will take
- A careful consideration of the worker’s attitude at the time of the job will reveal if they are placing a self-pressure on time
- Create an opportunity to do a three-way communication to ensure that all considerations were taken prior to performing a task
- Was policy and procedure followed for the employee performing the task or was it bypassed?

Interruptions or Distractions

In some cases, in at-risk behavior is caused because the worker is being distracted or interrupted during the task. In order to successfully coach this individual, there must be an assessment of what was the distraction and where did it come from. In some cases, the distraction can come from the worker himself or an outside source such as a phone ringing.

In coaching distractions or interruptions, first there must be a removal of the distraction itself, or the removal of the employee from the distraction area. The employee should perform a system check prior to resuming the task to make sure all conditions are still safe for operations.

It may also be a good idea to have the worker seek assistance from a coworker before resuming work in order to assess the situation for any more distractions or interrupting forces. Then all distraction should be removed so that the worker can focus on how to perform a task with safe behaviors.

Multitasking

As the creation of technology becomes commonplace, more people are doing what is known as multitasking. The term multitasking implies that the person can do more than one task at the exact same time. It is nearly impossible for workers to multitask in the purest sense of the word. Worker can, however, try to switch rapidly from one task to the next in order to multitask.

This can become a very dangerous pattern of behavior that can lead to mistakes on both or more processes. The worker should prioritized a list of tasks he/she needs to accomplish first. Once a task is accomplished then the next task in line should be tackled. If the worker feels that they have too many tasks that are due at the same time then they might feel tempted to multitask. This activity will only slow them down and potential create substandard outcomes.

Overconfidence

When a BBS observation team finds a worker who is overconfident, they will notice certain behaviors that can lead the worker to be at-risk of hurting or injuring themselves or others. In some instances, the worker will feel that they do not need to be checked behind because they performed the work correctly the first time. However, this is not always the case and even the best worker can forget steps in the procedure.

To help workers overcome the feeling of overconfidence (that they are too good to make a mistake), the coaching team should ask them how they would feel if they did not get all the steps correct and there was an incident. This may get them to rethink the idea of never making any errors. Additionally, the coaching session may include the idea of having them question or challenge their own expectations through a self-check.

The supervisor should routinely reinforce expectations of policies and procedures with this individual. Then they should show the individual, or a work team that maybe overconfident, some benchmarks from industry leaders.

Vague Guidance

There are incidents where workers developed at-risk behaviors because they were informed of a job through vague guidance. It is a possibility that the supervisor himself/herself might not have a good understanding of the task at hand, therefore the information that was disseminated to the worker was vague. When this happens, there is no clarity of roles and responsibilities or even procedures.

The BBS steering committee must address this issue through the front-line supervisor. If there are established policies or standard operating procedures for a certain job then it must be reviewed by all parties. Standard operating procedures are there to make sure that each step of the job has been identified.

The worker should be encouraged to ask questions if they're unsure of any guidance given by the supervisor. And the supervisor should have a good understanding of the job and ensure that all workers understand each task that has been assigned to them. In some cases, the supervisor might even require retraining on how to perform any given task that they are responsible for delegating.

Overnight Shift Work

In some instances, there is a human performance letdown for workers that are working the overnight shift. The shift was typically from 11 PM at night to 7 AM in the morning or some variation of working during the early morning time period. Workers who were on the shift for a continuous amount of time learn how to adapt to the schedule. However, new workers will need a break in time to adjust to this lifestyle change.

During the time that the new late shift operator gets their body adjusted to their work schedule, there are chances of at-risk behavior due to drowsiness or other related factors. It is possible that they are unable to sleep during the day because they are used to sleeping at night and the sudden change of schedule might keep them from getting ample sleep.

Therefore, at home, the late shift worker must have systems in place to keep them from getting fatigue. Some workers are known to use blackout curtains and shut off all electronic devices during the sleep hours. When you are coaching the worker who is showing at-risk behavior during the night shift consider the simple things that lead to fatigue. It must be your common goal to have a worker assimilate to the new schedule when they are new on a job.

In some cases, to help prevent this issue the shift supervisor should monitor the new hire and coach them on how to get better sleep after the job is complete. Additionally, some coaching from coworkers will help them.

Some other behaviors related to late-night work can lead to lazy turnovers during the day shift when the workers feel fatigued in the final hours of the work shift and become labored. Therefore, final checks must be done before the day shift workers come to take over the process.

To combat this issue, it may be necessary to have a more detailed shift turnover between the lead operators. Another tool that can be used to combat this issue is to have a detailed checklist of each shift, regardless of if it's day or night. The checklist will serve as a reminder as to what is required for each shift. So, the behavior of laziness due to fatigue can be mitigated by a detailed checklist.

Peer Pressure

Social impact from peers in the workforce is very important to monitor. This impact can be both good and bad depending on the individuals involved. When there's a workforce that is very tightknit and the safety culture that values low risk, then many workers will encourage each other to have safe behaviors.

In some cases however, there may be a "bad apple" among the workers. If this bad apple has some social impact on the workers, then more workers will have at-risk behavior as a result. Is important for the front-line supervisor to be an agent of change and not be the bad influence themselves. When poor behavior is observed among multiple people in one division then it is easy to assume that this behavior that is being pressured or conditioned in that one group.

The assessment of the at-risk behavior may lead to modeling from an agent of influence in that group. It may be the front-line supervisor or someone who's been there for considerable numbers for years.

Peer pressure can result in some behavior such as:

- Taking shortcuts with safety
- Ineffective or misleading communication
- Inadequate use of procedures
- Dereliction of rules

- Inadequate job briefings
- Not using peer checks
- Inadequate self-checks

In these instances, there may be a need to have progressive disciplinary action when there are cases of workers who are being pressured to have poor behavior. The influencer must be acknowledged and put on notice until the behavior changes. The management team should consider separating the work team or unit two different locations or divisions in the company.

A positive way of also creating a new peer pressure towards good behavior is to have mentoring and coaching opportunities for all at-risk workers. Peer mentoring will also help the workers see that it is possible for someone at their level to have a positive strong influence. This will also indicate to the worker that the organization cares for them and is willing to work with them to improve behaviors.

Change

Some workers are averse to change, so when there is a change happening they become more prone to at-risk behaviors. They might become uncertain about what to do and their changed behavior might be a way to get attention. Attention seeking behaviors can lead workers to an injury or illness because their mind is not on the work but on gaining attention.

Change may be inevitable in some organizations, but workers need to feel that they are still in the system. Certainty in the system will enable the workforce to feel more comfortable in the idea of change and understand that it is in their best interest. In some cases, it is better to inform workers of the change and give them all scenarios related to the event before any actions are taken.

When dealing with operations such as the process safety management programs, the change analysis must be made prior to any major change. A change analysis is a detailed system that is utilized for the workers to see what domino effects will happen from changing a major element of their system.

This analysis is performed through the entire organization and utilizes systematic steps to analyze all repercussions of the change. For instance, if a company wants to change from using gas chorine to liquid bleach then a change analysis is in order. The release of gas chlorine into the atmosphere can create adverse effects for the whole community and not just the workplace. However, liquid chlorine bleach is not as harmful to a community if released into the atmosphere. The change analysis would incorporate all necessary parts, equipment, training, and regulatory requirements prior to the occurrence of such a major change in the system.

Physical Environment

There may be some performance issues due to the actual layout of the workspace. Things like poor lighting, ventilation problems, or even layout of machines can lead to poor workmen behaviors. Many workplaces have worksite analysis to make sure that there are no environmental factors adversely impacting any part of the job.

Workers will be the first ones to see if there are any physical environmental problems that are leading them to at-risk behaviors. They will work around them as best as possible through whatever means available to them.

A third-party audit would be a great way to analyze the work environment to ensure that there are no physical issues that would lead the workers to adapt at-risk behaviors. When the assessment is complete, a third-party auditor will have a final report with recommendations. Once recommendations have been read and understood, the organization should start making all the required changes to the physical environment promptly.

Mental Stress

Mental stress is produced by many things in the work environment. Although, workers may also bring some stresses from home. In the past, it was believed that workers could separate their home life from work life, but this is not always the case. Some workers will exhibit at-risk behaviors because of home stresses.

Mental stress can produce severe outcomes when they are coupled with at-risk behavior in the workplace. Some jobs are not forgiving when it comes to any form of deviation from safe practices. In some cases, the worker will not only hurt themselves and their coworkers but their behavior might even affect the community or the environment adversely.

Mental stress coupled with fatigue can also be a deadly factor for employees and their coworkers. There can be distractions as well as worker harassment that may be an outcome of mental stress. Some workers internalize stress in such a way that they become pressurized with emotions until there is a breaking point with a certain work situation or an interaction with a person there was a previous friction with.

At all costs the workplace should have areas where workers can release mental stresses to prevent at-risk behaviors. One such ways to combat mental stresses is by providing an employee assistance program for workers which provides them with the chance to talk about any stresses that are happening in their lives to a psychologist or a mental health professional. These mental health professionals are used often to help workers cope with home and work life.

Additionally, when there is at-risk behavior observed, and mental stress is the conclusion, then the coaching should be sympathetic. When dealing with situations when workers are under stress, understanding the source of stress is important. The best approach is to try and eliminate the source of stress in the work atmosphere. Clearly communicating all expectations of the organization to have stress free workers and environments is of the utmost importance. Workers who are observed for stress should have increased supervision and coaching. If stress cannot be eliminated, then a managing approach must be taken.

Organizations can utilize stress limiting or reducing techniques. These include, but are not limited to:

- Workplace sponsored teambuilding activities
- Calisthenics and yoga
- Wellness programs
- Sponsoring of a community event
- Collaborating with a nonprofit organization to perform activities such as feeding the homeless, reading books to children, or helping with literacy programs

Understanding these common human performance snares will enable the steering committee or assigned coaches to give the workers a better understanding of how to combat some at-risk behaviors which will help them perform their jobs in a better way.

Lesson Summary

Operational plans must always allow for adequate work areas in which to move suspended loads. While guardrails are a critical engineering control used to protect workers from falling, they can pose a caught in between hazard under certain circumstances. Guardrail requirements can actually create a hazard at the leading edge of installed floors or roof sections by creating a possibility of employees being caught in between guardrails and suspended loads. Because workers can also be caught in between a collapsed trench that is not properly braced, or warehoused construction materials which were not correctly stacked to prevent sliding, engineering and workplace controls like shoring, fall protection systems, and properly stacking building materials can help in preventing caught in between hazards.

Sometimes the workers fall into a common human performance trap that leads to at-risk behaviors which can put them in the way of hazards. It is important to recognize the behaviors and address them through coaching efforts.

Module 4: Personal Protective Equipment

Module Description

This module will provide employers and employees alike with knowledge concerning the proper selection, care, and use of Personal Protective Equipment (PPE). They also will be informed of the requirements for compliance with OSHA requirements.

Module Learning Objectives

At the conclusion of this module, you will be able to:

- Describe the role of PPE in controlling exposure to hazards in the workplace.
- Identify parts of the body most vulnerable to injury and name hazards associated with each.
- Describe the appropriate PPE to be worn for worker safety.

Lesson 1: Introduction to Personal Protective Equipment

Lesson Focus

This lesson focuses on the following topics:

- What is Personal Protective Equipment?
- Personal Protective Equipment Standards
- Employer Responsibilities
- Employee Responsibilities

Overview

What Is Personal Protective Equipment?

Personal Protective Equipment (PPE) means any type of device or clothing (i.e., head protection, eye/face protection, protective footwear, respiratory protection, etc.) worn for protection against biological, chemical, thermal, physical, or other hazards on the job.

All employees who are exposed to hazards like these, and others, may be required to wear appropriate PPE to reduce or eliminate their exposure to hazards.

Personal Protective Equipment Standard

What Is the Personal Protective Equipment Standard?

The Occupational Safety and Health Administration requires that, when necessary, employers establish and administer an effective Personal Protective Equipment (PPE) program for employees in order to reduce the effects of workplace hazard exposure and, as a result, the workplace accident rate in the U.S.

Engineering Controls

If . . .

The machine or work environment can be physically changed to prevent employee exposure to the potential hazard,

Then . . .

The hazard should be eliminated with an engineering control.

Payment for PPE

When PPE is required to protect employees, it must be provided by the employer at no cost to employees, except for specific items, such as:

- Safety-toe footwear not limited to the worksite
- Prescription safety eyewear
- Everyday clothing and weather-related gear and
- Logging boots

Employer Responsibilities

Hazard Assessment

The employer shall assess the workplace to determine if hazards are present, or likely to be present, which may necessitate the use of personal protective equipment. While an employer's first responsibility upon identification of a workplace hazard is to eliminate it through the use of engineering controls, PPE often is the final solution for remaining hazards.

Physical Hazards

Physical hazards include:

- Motion
- High and low temperatures
- Light radiation:
  - Welding
  - Brazing
  - Heat treating
  - High intensity lighting
- Falling objects
- Sharp objects
- Sources of rolling or pinching objects
- Electric hazards
- Hazardous floor conditions

Health Hazards

Health hazards include:

- Types of chemicals an employee could be exposed to
- Harmful dusts, fumes, and mists
- Nuclear radiation
- Noise

Selection of PPE

The selection of personal protective equipment depends on the hazard the worker needs to be protected against, the level of hazard present, and the availability of suitable equipment. Individual components of clothing and equipment should be assembled that both protects the worker from the specific hazard and minimizes the hazard and potential drawbacks of the PPE itself. PPE shall, wherever possible, be provided for the exclusive use of a single employee.

Periodic reevaluation of the selection is necessary in order to deal with changes in workplace conditions or wearer activities. The type of PPE selected is very important; different brands of PPE should be tried by workers to get the best possible protection. For example, using the wrong types of gloves to work with solvents can lead to ineffective protection.

Training

The employer shall provide training to each employee using PPE. Each employee shall be trained in at least the following:

- When and why PPE is necessary,
- What PPE is required for certain jobs.
- How to properly put on, take off, adjust, and wear PPE.
- The limitations of the PPE.
- The proper care, maintenance, useful life and disposal of PPE.
- How damaged, worn out, or defective PPE can be replaced.

Maintenance

All PPE should be inspected for tears, leaks, punctures, breaks, contamination, or signs of wear before use. Damaged or defective equipment should not be used.

PPE should be stored carefully and kept clean to prevent damage. Contaminated PPE that cannot be decontaminated should be disposed of properly.

Recordkeeping

The employer must maintain records of the workplace hazard assessment and employee training.

Employee Responsibilities

Employees are responsible to:

- Attend all required training sessions regarding PPE.
- Wear PPE as required and trained.
- Clean, maintain, and care for PPE as required.
- Report potential hazards they identify to their supervisors.
- Inform their supervisors or safety managers of the need to repair or replace PPE.
- Follow ALL warnings and precautions.
- Listen and follow the directions from supervisors or safety managers.

Case Study

This accident occurred in a cellophane-tape manufacturing factory during work to wash a drum that contained an adhesive.

The victim who was on the night shift was working with a group leader to monitor the machine that applies a coat of adhesive and to conduct sampling inspections. While they were taking turns working in thirty-minute shifts, the victim did not return to work after a break. When the group leader searched for the victim, he found him unconscious having fallen head first into an empty drum that previously contained adhesive.

Although the victim was immediately taken to the hospital for emergency treatment, he never regained consciousness.

Incidentally, a group leader on the day shift had washed the drum with toluene, before the task was transferred to the night shift workers at the time of the shift-change meeting.

What do you think some of the causes were?

- Ventilation was not used at a site where toluene was used.
- The victim bent forward to wash the inside of the drum that still contained toluene vapor.
- The victim did not use a respirator during the washing work.

Lesson Summary

Personal Protective Equipment (PPE) protects against biological, chemical, or physical hazards on the job. The employer will assess the workplace to determine if hazards are present, or likely to be present, which may necessitate the use of PPE. This protective equipment is often the final solution for hazards that cannot be eliminated through the use of engineering controls. Also, wherever possible, PPE will be provided for the exclusive use of a single employee.

Lesson 2: Eye, Face, and Respiratory Protection

Lesson Focus

This lesson focuses on the following topics:

- **Eye and Face Protection**
- **Respiratory Protection**

Eye and Face Protection

Every day an estimated 1,000 eye injuries occur in American workplaces.

The financial cost of these injuries is enormous—more than $300 million per year is lost in production time, medical expenses, and workers compensation. No dollar figure can adequately reflect the personal toll these accidents take on injured workers.

What contributes to eye injuries at work?

Take a moment to think about possible eye hazards at your workplace. The Labor Department's Bureau of Labor Statistics (BLS) survey of about 1,000 minor eye injuries reveals how and why many on-the-job accidents occur.

1. **Not Wearing Eye Protection.** The BLS reports that nearly three out of every five workers injured were not wearing eye protection at the time of their accidents.
2. **Wearing the Wrong Kind of Eye Protection for the Job.** About 40% of the injured workers were wearing some form of eye protection when the accident occurred, but often, it was not the correct eye protection for the job being done.

What causes eye injuries?

1. **Flying Particles:** The BLS found that almost 70% of the accidents studied resulted from flying or falling objects or sparks striking the eye. Injured workers estimated that nearly three-fifths of the objects were smaller than pin heads. Most of the particles were said to be traveling faster than hand-thrown objects when accidents occurred.
2. **Contact with Chemicals:** Chemicals caused one-fifth of the injuries.

3. **Other accidents:** Miscellaneous accidents were caused by objects swinging from a fixed or attached position—like tree limbs, ropes, chains, or tools pulled into an eye while a worker was using them.

Where do accidents occur most often?

Potential eye hazards can be found in nearly every industry, but BLS reported that more than 40% of injuries occurred among craft workers, like mechanics, repairers, carpenters, and plumbers.

Over a third of the 40% injured operated machinery, such as assemblers, sanders, and grinding machine operators. Laborers suffered about one-fifth of the eye injuries. Almost half the injured workers were employed in manufacturing; slightly more than 20% were in construction.

How can eye injuries be prevented?

1. **Always wear effective eye protection:** To be effective, eyewear must be appropriate for the hazard and also must be properly fitted. All eye-protective equipment provided by an employer must meet ANSI Z-87.1 standards. (American National Standards Institute)
2. **Better training and education:** The BLS reported that most workers were hurt while doing their regular jobs. Workers injured while not wearing protective eyewear most often said they believed it was not required by the situation. Even though the vast majority of employers furnished eye protection at no cost to employees, about 40% of the workers received no information on when and what kind of eyewear should be used.
3. **Maintenance:** Eye protection devices must be properly maintained. Scratched and dirty devices reduce vision, cause glare, and may contribute to accidents.

Eyewash Stations

Eyewash stations should be located within 10 seconds of a hazard area. If employees accidentally get something into their eyes, they must go directly to the eyewash station and flush their eyes with water for at least 15 minutes. The employee should hold the eyelids open and "look" directly into the water streams. They should NOT rub their eyes. Rubbing the eyes may scratch or embed particles. Employees should seek medical attention immediately.

Eye and Face Protectors

Face and eye protection includes:

1. **Goggles:** Goggles of soft, pliable body design provide adequate eye protection from many hazards. These goggles are available with clear or tinted lenses, perforated, port vented, or non-vented frames. Single lens goggles provide similar protection to spectacles and may be worn in combination with spectacles or corrective lenses to ensure protection along with proper vision.
2. **Face shields:** Face shields may be used in operations when the entire face needs protection and should be worn to protect eyes and face against flying particles and metal sparks. Specifically designed shields also provide protection from chemical and biological splash. Wearing a face shield does not necessarily protect from impact hazards.
3. **Welding shields:** Tinted shields will be provided to protect workers' eyes and face from infrared or radiant light burns, flying sparks, metal spatter, and slag chips encountered during welding, brazing, soldering, resistance welding, bare or shielded electric arc welding and oxyacetylene welding and cutting operations. Tinted lenses are available in varying shades or degrees of tinting, and it's the employer's responsibility to provide the appropriate lenses for the hazard to be encountered.

Safe Work Practices

As an employee works:

- He or she should read and follow all warnings and precautions that may be found on equipment and hazardous materials.
- He or she should avoid throwing tools or participating in horseplay.
- He or she should keep sharp or pointed objects away from his or her eyes.
- He or she should follow the supervisor's or safety manager's suggestions and recommendations for working safely.

Respiratory Protection

Health hazards in the workplace are a major concern for both employers and employees. Hazardous materials can enter our body in four ways:

1. Ingestion
2. Skin Absorption
3. Inhalation
4. Injection

Because many substances that are health hazards can become airborne, knowing how to protect ourselves is very important.

There are four basic methods of controlling inhalation hazards:

1. **Substitution** involves replacing the hazardous material or process with a non-hazardous or less hazardous one.
2. **Engineering controls** include enclosing the process so that contaminants do not get into the workspace, improving the ventilation, and changing the equipment or processes.
3. **Administrative controls** include restricting access to contaminated areas, limiting the total time workers are exposed, and establishing housekeeping procedures to control exposure.
4. **Personal protective equipment** includes the use of respirators. In some cases, however, respirators are the only means to protect workers.

What is a Respirator and When is it Needed?

A respirator is a protective device that covers the worker's nose and mouth or the entire face and head to keep airborne contaminants out of the worker's respiratory system and to provide a safe air supply.

There are two major categories of respirators:

1. **Air Purifying Respirators:** These types of respirators include:
   - Air Purifying Disposable Particulate Masks
   - Air Purifying Half Mask Respirators
   - Air Purifying Full Face Mask Respirators
   - Gas Masks
   - Powered Air Purifying Respirators
2. **Supplied Air Respirators:** These types of respirators include:
   - Airline Respirators
   - Emergency Escape Breathing Apparatus
   - Self-Contained Breathing Apparatus (SCBA)

Selecting the Correct Respirator

The first step in selecting the correct respirator is to determine the level of hazard that is posed by the environment in which one will be working. To do this, one must be able to answer five basic questions:

1. What type of contaminant is present?
2. What is the form of the contaminant?
3. How toxic is the contaminant?
4. What is the concentration of the contaminant?
5. What will be the length and duration of the exposure?

Employees should always work with their supervisor or safety professional to determine the correct answers to these questions. Without the technical knowledge to make correct decisions, it's best to consult with an industrial hygienist or safety professional who is trained to provide professional guidance on proper respirator selection and use.

It should be noted that before an employer provides any employee with a respirator to use in a workplace, the employer must create a formal written respiratory protection program and have every employee who will wear a respirator medically evaluated by a licensed healthcare professional.

Inspection before Use

Every time an employee uses a respirator, he or she must first inspect it. To properly inspect a respirator before using it, one should look for:

- Chips or cracks in the faceplate
- Cracks or holes in the breathing tube or airlines
- Worn or frayed straps
- Worn or damaged fittings
- Bent or corroded buckles
- Dirty or improperly seated valves

If you find anything wrong with your respirator, do not use it. Have it repaired or replaced immediately.

Donning (putting on) a Respirator

Each respirator should be donned making certain to follow the manufacturer's instructions carefully. You must be able to demonstrate proper donning of the respirator to your supervisor or safety professional.

Case Study

This accident occurred during work to lift a drain pump through a manhole in a sewerage construction worksite.

The work was to replace the pipes for rainwater. As another drain pump became necessary, it was decided to use the drain pump in another manhole for which work was almost completed. Accordingly, two workers opened the cover of the manhole and entered, using a ladder.

After a short while, a colleague who was going to the material shed spotted the two workers lying at the bottom when he looked into the manhole and raised an alarm with other workers. One of the workers who ran to the spot entered the manhole and called out to them but received no answer. Immediately after this, this worker also collapsed.

Although the three were taken to a hospital by a rescue team, the two workers died, and the would-be rescuer was hospitalized with brain damage caused by hypoxia (a lack of oxygen).

The two fatalities were attributed to anoxia (meaning, without oxygen).

What do you think were some of the causes?

- Although survey results had been provided by the client, neither the general contractor nor the subcontractor assessed the worksite as presenting the hazard of anoxia.
- The employer and supervisor failed to measure the oxygen content of the hole and to carry out ventilation measures before allowing any employee to enter.

- The project should have been declared a Permit Required, Confined Space, and all elements of OSHA's standard for PRCS should have been implemented.
- Neither special education nor rescue training concerning work at sites with the danger of anoxia was provided to workers.

Lesson Summary

To be effective, eyewear must be appropriate for the encountered hazard and also be fitted properly. All eye-protective equipment provided by an employer must meet ANSI standards.

Not wearing eye protection and wearing the wrong kind of eye protection for the job are common factors in eye injuries on the job. Causes of eye injuries include flying particles, contact with chemicals, and objects swinging from a fixed or attached position.

Eye injuries be prevented with:

- Effective eye protection
- Better training and education
- Maintenance

Face and eye protection includes:

- Goggles
- Face shields
- Welding shields

Because many substances that are health hazards can become airborne, knowing how to protect ourselves is very important. A respirator is a protective device that covers the worker's nose and mouth or the entire face and head to keep airborne contaminants out of the worker's respiratory system and to provide a safe air supply. There are two major categories of respirators air purifying respirators and supplied air respirators.

Every time an employee uses a respirator, he or she must first inspect it.

When necessary, workers must be able to demonstrate proper donning and doffing of respirators. If you find anything wrong with a respirator, do not use it; instead, have it repaired or replaced immediately.

Lesson 3: Head, Hand, Face, and Foot Protection

Lesson Focus

This lesson focuses on the following topics:

- Why Head Protection Is Important
- Potential Hazards
- Occupational Noise
- Why Hand Protection Is Important
- Foot Protection Is Important

Why Head Protection Is Important

Your head is a very delicate part of the human body.

Injuries to the head may be very serious. For this reason, head protection and safety are very important.

Potential Hazards

Impact to the head

Falling or flying objects are a common cause of head injuries. Also, falling or walking into hard objects can cause head injuries. These injuries include neck sprains, concussions, and skull fractures.

Electrical Shocks

Accidents involving electricity result in electrical shocks and burns.

How Hard Hats Protect an Employee's Head

Hard hats protect an employee's head by providing the following features:

- A rigid shell that resists and deflects blows to the head and a suspension system inside the hat that acts as a shock absorber.
- Some hats serve as insulators against electrical shocks.

- Hard hats may shield the scalp, face, neck, and shoulders against splashes, spills, and drips.
- Some hard hats are constructed so that face shields, goggles, hoods, or hearing protection can be added.

When necessary, employers must provide hard hats that meet the appropriate ANSI standards.

Note: OSHA does not specify when an employer must provide hard hats. It's up to each employer to make that determination based on the hazards of the workplace and through the required completion of a proper hazard assessment.

Occupational Noise

Noise is a common problem found in many workplaces. Research has shown that high levels of noise will damage your hearing. Losing your hearing is typically a gradual process, and is less noticeable than other types of workplace injuries. It is, however, a permanent handicap for those who are affected.

Remember the four "P"s of hearing loss: It's Painless, Permanent, Progressive and usually, Preventable.

When an employer determines the "Action Level" of 85 dBs has been reached, they must create a formal written hearing conservation program.

Types of Hearing Protection Devices

Many types of hearing protection devices are available. Popular types of hearing protection devices are the following:

- Foam Earplugs
- PVC Earplugs
- Earmuffs

Caring for Hearing Protection Devices

Foam Earplugs

When not using your foam earplugs, store them in a clean, cool, dry place. If your foam earplugs become soiled, torn or stiff, discard them and ask your supervisor or safety manager for a new pair.

PVC Earplugs

When not using your PVC earplugs, store them in a clean, cool, dry place. If your PVC earplugs become soiled, you can clean them according to the manufacturer's guidelines. If your PVC earplugs become torn or brittle, discard them and ask your supervisor or safety manager for a new pair.

Earmuffs

When not using your earmuffs, store them in a clean, cool, dry place. Always inspect your earmuffs for cracks around the foam cups. If your earmuffs are damaged, have them repaired immediately or ask your supervisor or safety manager for a new pair.

Why Hand Protection Is Important

Take a moment to hold your hands out in front of you. Look at them. They are the only two hands you will ever have.

A number of disabling accidents on the job involve the hands. Without your fingers or hands, your ability to work would be greatly reduced.

Human hands are unique. No other creature in the world has hands that can grasp, hold, move, and manipulate objects like human hands. They are one of your greatest assets and, as such, must be protected and cared for.

Potential Hazards to the Hand

Traumatic Injuries

An employee can suffer a traumatic injury to his or her hands in many ways:

- Tools and machines with sharp edges can cut hands.
- Staples, screwdrivers, nails, chisels and stiff wire can puncture hands.

- Getting your hands caught in machinery can sprain, crush or remove your hands and fingers.

Contact Injuries

Coming into contact with caustic or toxic chemicals, biological substances, electrical sources or extremely cold or hot objects can irritate or burn one's hands.

Toxic substances are poisonous substances, some of which can be absorbed through one's skin and enter the body.

Repetitive Motion Injuries

Whenever you repeat the same hand movement over a long period of time, you run the risk of repetitive motion problems. Repetitive motion problems can appear as a numb or tingling sensation, chronic or acute pain, loss of gripping power in your hands, or in many other ways.

Preventative Measures

Poorly maintained machinery, tools, sloppy work areas, and cluttered aisles all contribute to hand injuries.

Good hygiene includes hand washing. Proper washing helps remove germs and dirt from your hands. Clean hands are less susceptible to infection and other skin problems such as contact dermatitis.

Instructions for the Safe Removal of Contaminated Gloves

When removing contaminated gloves, remember to:

1. Pull one glove near your wrist towards your fingertips until the glove folds over.
2. Carefully grab the fold and pull towards your fingertips. As you pull you are turning the inside of the glove outwards.
3. Pull the fold until the glove is almost off.
4. To avoid contamination of your environment, continue to hold the removed glove. Completely remove your hand from the glove.
5. Slide your finger from your glove-free hand under the remaining glove. Continue to slide your finger towards your fingertips until almost half of your finger is under the glove.

6. Turn you finger 180 degrees and pull the glove outwards and towards your fingertips. As you do this, the first glove will be encased in the second glove. The inside of the second glove will also be turned outwards.
7. Grab the gloves firmly, by the uncontaminated surface (the side that was originally touching your hand). Release your grasp of the first glove you removed. Pull your second hand free from its glove. Dispose of the gloves properly.

Foot Protection Is Important

Scientists and engineers for centuries have marveled at the design and structure of the human foot. The human foot is rigid enough to support the weight of your entire body, and yet flexible enough to allow you to run, dance, play sports, and take you anywhere you want to go. Without your feet and toes, your ability to work at your job would be greatly reduced.

Potential Hazards to the Foot

Impact Injuries

If you have ever stubbed your toe, you know that impact injuries can hurt. At work, heavy objects can fall on your feet. If you work around sharp objects, you might step on something sharp and puncture your foot.

Injuries from Spills and Splashes

Liquids such as acids, caustics, and molten metals can spill onto your shoes and boots. These hazardous materials can cause chemical and heat burns.

Compression Injuries

Heavy machinery, equipment, and other objects can roll over your feet. The result of these types of accidents is often broken or crushed bones.

Electrical Shocks

Accidents involving electricity can cause severe shocks and burns.

Extremes in Cold, Heat, and Moisture

If not protected, your feet can suffer from frostbite if you must work in an extremely cold environment. Extreme heat, on the other hand, can blister and burn your feet. Finally, extreme moisture in your shoes or boots can lead to fungal infections.

Slipping

Oil, water, soaps, wax, and other chemicals can cause you to slip and fall.

Preventative Measures for Foot Safety

Housekeeping

Poorly maintained machinery, tools, sloppy work areas, and cluttered aisles all contribute to foot injuries.

Wearing and Using Safety Footwear

Select and use the right kind of footwear for the job you are going to be performing. Footwear should meet or exceed the standards set by ANSI (ANSI Z41-1991) or the newer ASTM F 2413 Specifications for Performance Requirements for Protective Footwear.

Avoid footwear made of leather or cloth if you work around acids or caustics. These chemicals quickly eat through the leather or cloth and can injure your feet.

Remember to:

- Select footwear that fits properly.
- Inspect your footwear before you use it. Look for holes and cracks that might leak.
- Replace footwear that is worn or torn.
- After working with chemicals, cleanse your footwear appropriately to rinse away any chemicals or dirt before removing footwear.
- Avoid borrowing footwear; footwear is personal protective equipment.
- Store footwear in a clean, cool, dry, ventilated area.

Lesson Summary

Head injuries may include neck sprains, concussions, and skull fractures, or electrical shocks and burns. OSHA does not dictate specifically when an employer must provide hard hats; rather it is up to each employer to make that determination based on the hazards of the workplace.

When employers determine that noise levels in excess of the "Action Level" of 85 dBs has been reached, they must create a formal written hearing conservation program.

Liquids such as acids, caustics, and molten metals can spill onto your shoes and boots. These hazardous materials can cause chemical and heat burns, and extreme moisture in your shoes or boots can lead to fungal infections.

Because poorly maintained machinery, tools, sloppy work areas, and cluttered aisles all contribute to foot injuries, footwear should meet or exceed the standards formerly set by ANSI and now set by ASTM F2413. Avoid borrowing footwear; footwear is personal protective equipment.

Module 5: Health Hazards in Construction

Module Description

The Hazard Communication Standard (HCS) provides information to workers and employers about various chemical hazards that exist in the workplace, and what protective measures they can take to prevent the adverse effects of such hazards.

This module will give you a basic understanding of how to deal with hazardous chemicals and how workers can prevent and protect themselves from chemical hazards at a construction worksite.

Module Learning Objectives

At the conclusion of this module, you should be able to:

- Describe the purpose of The Hazard Communication Standard (HCS).
- Discuss labels and Safety Data Sheets.
- Differentiate between physical and health hazards associated with hazardous chemicals.
- Distinguish between symbols used to identify hazards.
- State how to prepare and implement a written hazard communication program.
- Define training and its importance.

Lesson 1: Introduction to Hazard Communication Standard

Lesson Focus

This lesson focuses on the following topics:

- The Hazard Communication Standard (HCS)
- Hazardous Materials
- Important Definitions

The Hazard Communication Standard (HCS)

The Need of a Hazard Communication Standard (HCS)

According to OSHA, over 650,000 hazardous chemical products exist and hundreds of new ones are being introduced annually. More than 32 million workers are potentially exposed to one or more chemical hazards in more than 3 million American workplaces.

The Concept of Hazard Communication Standard (HCS)

The simple idea behind the Hazard Communication Standard (HCS) is that workers have both a need and a *right to know* about the hazards and identities of the chemicals they are exposed to when performing their tasks and duties.

The Hazard Communication Standard Coverage

Implementation of HCS for all those companies who import, produce, distribute or use hazardous chemicals in the United States is mandatory. They must provide proper information and training to all of their affected employees.

The Hazard Communication Standard covers both physical (such as explosive, flammable) and health (acute and chronic) hazards. Being a worker or an employer there is a need and a "right to know" how you can perform job responsibilities safely.

Hazardous Materials

Hazardous and toxic materials are those chemicals that may be present in a workplace and have the capacity to cause harm. Mixtures, fuels, solvents, paints, and dusts are all considered hazardous substances or materials.

Recognition of Hazardous Chemicals

Before working with or using chemicals, it is important to recognize those that may be physically hazardous or are capable of posing health problems to you. Recognition of hazardous chemicals prior to work can reduce the risk of chemical accidents. Depending on exposure, chemicals can cause many serious health effects such as cancer, nervous system damage, lung damage, liver damage, kidney damage, and reproductive system effects.

Important Definitions

Personal Protective Equipment

The devices or clothing used by workers to protect against hazards in the environment are called personal protective equipment (PPE).

Example:
Some common examples of PPE are the items that follow.

- Respirators
- Gloves
- Chemical splash goggles

Toxicity

The term toxicity is used to describe the ability of a substance to cause a harmful effect. Almost everything is toxic at some dose or concentration.

Flashpoint

The factor that determines whether a liquid is flammable or not is its flashpoint.

The flashpoint is a minimum temperature at which a liquid produces enough vapor within a test vessel in adequate concentration to form a flammable mixture with air near the surface of the liquid.

Flammable Liquids

Flammable liquids are those that have a flashpoint below 100 °F (37.8 °C). Flammable materials require more care than combustible materials because they ignite at lower temperatures.

Combustible Liquids

Combustible liquids are those which have a flashpoint at or above 100 °F (37.8 °C).

Container

Container means any bag, barrel, bottle, box, can, cylinder, drum, reaction vessel, storage tank, or the like that contains a hazardous chemical. For the purposes of this section, pipes or piping systems, and engines, fuel tanks, or other operating systems in a vehicle, are not considered to be containers.

Exposure or Exposed

Exposure (or exposed) means that an employee is subjected, as a condition of employment to a chemical that is a physical or health hazard, including potential (accidental or possible) exposure. "Subjected" in terms of health hazards includes any route of entry (such as inhalation, ingestion, skin contact, absorption, or injection.)

Hazard Warning

Hazard warning means any pictograms, words, pictures, symbols, or combination thereof appearing on a label or other appropriate form of warning which conveys the specific physical and health hazard(s), including target organ effects of the chemical(s) in the container(s).

Immediate Use

Immediate use means that the hazardous chemical will be under the control of and used only by the person who transfers it from a labeled container and only within the work shift in which it is transferred.

Any hazardous material decanted—transferred from a primary to a secondary container—should have the labeling information transferred to the secondary container also.

Organic Peroxide

Organic peroxide is any carbon-containing compound with two oxygen atoms joined together. Organic peroxides can be severe fire and explosion hazards.

Oxidizer

An oxidizer is a chemical other than a blasting or explosive agent that initiates or promotes combustion in other materials, thereby causing fire either by itself or through the release of oxygen or other gases.

Pyrophoric

Pyrophoric means a chemical will ignite spontaneously in air at a temperature of 130 °F (54.4 °C) or below.

Unstable (Reactive)

Unstable (reactive) means a chemical that in its pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or become self-reactive under conditions of shocks, pressure, or temperature.

Water-Reactive

Water-reactive means a chemical that reacts with water to release a gas that is either flammable or presents a health hazard.

Lesson Summary

The simple idea behind the Hazard Communication Standard (HCS) is that workers have both a need and a right to know about the hazards and identities of the chemicals they are exposed to when performing their tasks and duties. This standard covers both physical and health hazards.

As a worker or an employer there is a need and a right to know how you can perform your job responsibilities safely. Hazard warning means any pictograms, words, pictures, symbols, or combination thereof appearing on a label or other appropriate form of warning which conveys the specific physical and health hazards of the chemicals contained.

Lesson 2: Labels, SDSs, Symbols, Hazards, and Training

Lesson Focus

This lesson focuses on the following topics:

- Labels
- Safety Data Sheet (SDS)
- Symbols
- Hazards
- Controlling Physical and Health Hazards
- Written Hazard Communication Program
- Training

Labels

Any written, printed, or graphic materials displayed on or affixed to containers of hazardous chemicals are called labels. Labels are considered the most immediate source of information about chemicals and their hazard potential. It is obligatory that all hazardous chemicals containers be labeled.

The following information must be included on all labels:

- Complete chemical name or names, no abbreviations; formula may be used as an option.
- A warning statement (symbol or message) conveying hazardous substances contained.
- The manufacturer's name, address, and contact information.
- Labels must appear on each container. Labels must be legible and must be written in English, although other languages can be used if required.

Note: Many manufacturers of chemicals include safe handling procedures on labels.

Colors on Labels

This is a label created by the Paint and Coatings Association. Its use is voluntary and is not part of OSHA's Haz Com Standard, but many manufacturers use it on containers used, or shipped, to help further identify hazards of the material in the container.

The following colors are used on this voluntary label to represent different types of hazards:

- **Blue** is used to indicate the degree of health hazards.
- **Red** indicates how flammable the chemical is.
- **Yellow** represents the reactivity characteristics of the material.
- The **white** field is used to display any other special symbols such as PPE or if the material is an oxidizing agent or is water reactive.

Safety Data Sheet (SDS)

Safety Data Sheet (SDS) provides detailed information about a specific hazardous material. Although labels are a good way to provide information about hazardous chemicals, sometimes you need more information about the chemical, but it may not be possible to provide all the information on a label.

SDS must be maintained in the facility for use by personnel while the material is in the facility, and must be retained for a period of at least 30 years.

SDS Presentation

The following information must be included in an SDS.

- Identification of the substance or mixture and of the supplier
- Hazard Identification
- Composition/Information on ingredients
- First aid measures
- Fire-fighting measures
- Accidental release measures
- Handling and storage
- Exposure controls/personal protection
- Physical and chemical properties
- Stability and reactivity
- Toxicological information

The following information may also be included on a SDS, if desired:

- Ecological information
- Disposal information
- Transport information
- Regulatory information
- Other information

Note: It is the employer's responsibility to translate the information contained on the SDS, into any understandable format, and convey that information about the hazards associated with working with any of the hazardous materials in the facility, before an employee is ever exposed to the hazard.

SDS must always be immediately available to all affected employees for review; however, they can be stored electronically.

Click "PDF" for more information

Chemical Manufacturer and SDSs

It is obligatory that chemical manufacturers include all the hazard information on SDSs and distribute it to their customers/clients at the time of first shipment of the hazardous chemicals or materials.

Note: It is necessary that manufacturers or importers of hazardous chemicals must update an SDS within three months of discovering new and important information about chemical hazards.

Availability of SDSs

Every employer must train every affected employee in the information derived from the SDS for each hazardous material in the facility, before exposing the employee to the hazard. An employee should ideally only need to consult an SDS on an infrequent or emergency basis.

Note: Remember, it is the employer's responsibility to ensure that each employee who handles or uses any hazardous material knows where SDSs are located and how to read and understand them.

Symbols

OSHA created no symbols or specific color designation as part of the Haz Com Standard. However, OSHA does endorse the use of U.S. Dept. of Transportation's hazard class symbol and color system in any employer's training programs.

Whenever you are working with materials that have a DOT hazard class shipping label, you should be aware that this represents a specific hazard. Information regarding specific hazards denoted by DOT labels is contained on the material's SDS.

Explosive symbols (DOT hazard class labels) are used with those materials which release a great amount of energy in the form of light, expanding pressure, and heat within a short passage of time. Water reactive materials react with water and can explode. Furthermore, unstable reactive materials can react or become self-reactive subject to pressure, temperature, or shock.

Compressed gas cylinder symbols were created by the Compressed Gas Association and adopted by OSHA, and should appear on every cylinder of compressed hazardous gas.

Gases are used in various manufacturing processes. Because these gases are bottled under great pressure, misuse or unsafe handling could lead to an accident.

> **Note:** Do not expose flammable or combustible materials to fire, heat, sparks, flames or any other source of heat or ignition.

Hazards

There are frequently two types of hazards (physical and health) present in a workplace where hazardous chemicals or materials are present. Physical hazards are one of two major definitions of hazards covered by OSHA's Hazard Communication Standard. These hazards are responsible for hundreds of deaths and injuries each year in the United States. Accidents involving physical hazards are often the consequence of a lack of training or neglect, concerning the flammability of chemicals. Fire and explosion are common physical hazards.

Health Hazards

Hazardous chemicals can affect our health in different ways. Generally, two terms—acute and chronic—are used in order to understand the nature of the health hazards.

Determination of Health Hazards

Determining whether a hazard is affecting the health of a worker or not can be very difficult. Often, the signs and symptoms of acute or chronic health effects are the same as those possessed by a non-occupationally exposed person.

For example, lung cancer, kidney failures, and nervous system breakdowns are some common health problems that may occur in occupationally exposed persons but, of course, can also be found in non-occupationally exposed persons as well.

Acute effects indicate that symptoms have occurred rapidly as compared to chronic effects, which means symptoms have manifested themselves over a period of time. The former are of short duration and/or the result of short-term exposures.

Example: If you accidentally spill a strong acid on your hand and the acid begins to burn your skin, this is an accident (an acute effect) as opposed to an illness effect.

Chronic Health Hazards

Chronic effects develop as a result of long-term exposures. Some manifestation examples of chronic effects are:

- Silicosis
- Some dermatitis (others may be from an acute exposure)
- Lung Cancer (from occupational exposure to carcinogens)

Note: Asbestos is a good example of a chronic health hazard. Those people who are exposed to asbestos may take several years to develop serious lung diseases.

Health Hazard Symbols

The following symbols are used to identify various kinds of health hazards:

- The skull and crossbones symbol represents a poisonous material.
- The hand and test tubes symbols are used to identify corrosive materials.
- The radiating fan symbol is used to represent radioactive materials.

Routes of Exposure-Health Hazards

Health hazards can affect a body through four routes of entry:

1. Absorption
2. Inhalation
3. Ingestion
4. Injection

Note: Be sure you understand the information contained on labels and SDSs before working with hazardous chemicals.

Skin Absorption

Some chemicals enter into the body by absorption through the skin. Always use personal protective equipment or clothing in order to protect your body from skin contact with hazardous material. If you are exposed, the proper response should be initiated, based on the chemical involved and the nature of the exposure.

Inhalation

Inhalation is the most common route of entry into the body. It normally occurs when you inhale fumes, vapors, hazardous gasses, or dust. It is the employer's responsibility to be aware of such hazards in the workplace and to protect employees from inhalation hazards.

Ingestion

Do not eat or smoke immediately after handling any hazardous material. When working with hazardous materials, wear appropriate PPE, and then always wash your hands properly before eating, drinking, or smoking.

Basic First Aid

First aid should be provided only by individuals who are properly trained and provided with the proper protective equipment.

The employer must ensure prompt first aid treatment for injured employees, either by providing for the availability of a trained first aid provider at the worksite, or by ensuring that emergency treatment services are within reasonable proximity of the worksite. Adequate first aid must be available in the critical minutes between the occurrence of an injury and the availability of physician or hospital care for the injured employee.

While OSHA does not prescribe a number of minutes, they have long interpreted the term 'near proximity' to mean that emergency care must be available within no more than 3-4 minutes from the workplace. Medical literature establishes that, for serious injuries such as those involving stopped breathing, cardiac arrest, or uncontrolled bleeding, first aid treatment must be provided within the first few minutes to avoid permanent medical impairment or death. Accordingly, in workplaces where serious accidents such as those involving falls, suffocation, electrocution, or amputation are possible, emergency medical services must be available within 3-4 minutes, if there is no employee on the site who is trained to render first aid.

OSHA does exercise discretion in enforcing the first aid requirements in particular cases. For example, they recognize that in workplaces, such as offices, where the possibility of such serious work-related injuries is less likely, a longer response time of up to 15 minutes may be reasonable.

Blood-borne Pathogens

Bloodborne pathogens are pathogenic microorganisms that are found in human blood, tissue, and organs. These pathogens can cause various diseases including the Human Immunodeficiency Virus (HIV) and the Hepatitis B virus (HBV).

Employees must make sure that they never come in contact with any blood or body fluids without proper safeguards in place. If they have to handle any such fluids, they must wear all appropriate personal protective equipment, especially gloves and safety glasses.

Employees must handle and dispose of all sharps—such as needles and syringes—carefully in order to avoid suffering a puncture wound or laceration.

- Appropriate use of Personal Protective Equipment (PPE) is required by the Bloodborne Pathogens Standard (if exposure to blood and other potentially infectious materials is anticipated and where occupational exposure remains after institution of engineering and work practice controls).
- Wear appropriate gloves and other required PPE when hand contact with blood, mucous membranes, other potentially infectious materials (OPIM), or non-intact skin is anticipated, and when performing vascular access procedures, or when handling contaminated items or surfaces.
- Employer must ensure that employees wash hands and any other exposed skin with soap and water or flush mucous membranes with water as soon as feasible after contact with blood or OPIM.
- Employers must provide readily accessible hand washing facilities.
- Properly dispose of PPE. Protective clothing must be removed before leaving the work area, and placed in an appropriately designated area or container for storage, washing, decontamination, or disposal.

Temperature Stress

Extremely hot or cold temperatures at the work site can cause various disorders. Employees must make sure to take protective measures against heat and cold stresses.

Heat Stress

Heat stress is one of the most common occurrences in the workplace. It can cause various disorders, including heat exhaustion, heat cramps, and heat stroke. The symptoms of heat stress may include headaches, thirst, nausea, muscle cramps, dizziness, and weakness. Due to the severity of the consequences of heat stress, employers must regularly monitor all potentially affected employees and their workplaces and take appropriate preventive measures.

Sunburns can be avoided by keeping the skin covered with sun blocking material. If an employee experiences heat cramps, she or he should first be taken to an air-conditioned or fanned area, provided water to drink, and monitored appropriately.

Heat exhaustion is caused by excessive exposure to heat and/or physical activity. Medical attention should immediately be sought for any employee suffering from heat exhaustion.

If left untreated, heat stroke can be fatal. Therefore, heat stroke should be considered a medical emergency. Until the paramedics arrive, the employee must be kept cool.

Cold Exposure

Frostbite and hypothermia are two disorders that can be caused by exposure to cold temperatures. If there is a risk of cold exposure, employees must always dress warmly and there should be limited exposure to the skin.

Cold temperatures that result in inadequate circulation of the blood to the extremities, such as the fingers and toes, may cause frostbite. Employees with frostbite must not move or rub the affected area, but must instead seek medical attention immediately and warm the affected areas slowly to avoid causing irreversible tissue damage.

Hypothermia is characterized by lowered body temperature. If an employee experiences hypothermia, he must immediately receive appropriate medical attention.

Controlling Physical and Health Hazards

There are a number of ways through which you can control physical and health hazards associated with chemicals in a workplace. The following measures can protect you from physical and health hazards.

- Safe Work Practices
- Product Substitution
- Engineering Controls
- Training and Communication
- Environmental Monitoring
- Personal Monitoring
- Personal Protective Equipment

Safe Work Practices

Safe work practices help assure that you are using chemicals safely and correctly.

Product Substitution

There are many chemicals that perform similar jobs. One of the many responsibilities an employer has is to attempt to find a chemical that is less toxic but able to accomplish the same job.

Engineering Controls

An orderly and well-designed workplace can minimize exposure to hazardous chemicals. Some engineering controls, like exhaust systems and wetting systems used to control dust, are good examples of hazard control.

Training and Communication

Training and communication play an essential role in every field of life. It is vital to know how to work safely with hazardous chemicals.

Environmental Monitoring

Environmental monitoring is a component in keeping an environment free from a buildup of hazardous chemicals that could lead to an unsafe working environment.

Personal Monitoring

Monitor yourself and coworkers for symptoms (such as dizziness, eye or throat irritation, skin rashes) that would indicate that you or your coworkers have been exposed to a hazardous material or chemical. If these or other symptoms appear, report them to your supervisor immediately.

Personal Protective Equipment

Always use gloves, aprons, masks, or other PPE whenever called for on a label or SDS.

Hazard Communication Program

It is required that all chemical manufacturers, importers, and distributors convey complete information about a chemical and its hazards in the form of labels and SDSs. It is also mandatory that employers conduct hazard communication training programs in order to provide complete information to their employees through SDSs, labels, and training sessions.

Note: Employers are responsible for informing and training their employees about the hazards that exist in their workplaces.

Written Hazard Communication Program

A written program must be established in all workplaces where employees are exposed to hazardous chemicals. It should include a list of all hazardous chemicals that are present in the workplace and indicate where employees can get copies of written information about safe chemical handling procedures.

A written program also indicates the person in the facility that is responsible for the various aspects of the program. The written program must also describe requirements and information about labels, SDSs, and employee training.

Note: Written programs may not be required in laboratories and those workplaces where employees are dealing with sealed containers.

Training

Training must be provided to all employees exposed to hazardous chemicals. It must include information on how to handle chemicals safely, how to read and understand labels, SDSs, and other warning information, and what PPE is required before handling or using the hazardous material. It is required, and critical, that employees be trained before working with materials that represent a hazard.

Note: Remember, it is not sufficient to just provide SDSs to read.

Lesson Summary

Labels are considered the most immediate source of information about chemicals and their hazard potential. It is obligatory that all hazardous chemical containers be labeled.

It is the employer's responsibility to translate the information contained on the SDS, into any understandable format, and convey that information about the hazards associated with working with any of the hazardous materials in the facility, before an employee is ever exposed to a hazard.

Lesson 3: Hazardous Materials

Lesson Focus

This lesson focuses on the following topics:

- Introduction
- Silica
- Asbestos
- MDA—Methylenedianiline
- Lead

Introduction

What are some of the health hazards in a construction site?

Degreasers: These solvents can cause many serious health effects, including lung cancer.

Chemically treated materials: For example, chemically treated wood particles, which one might breathe in.

Asbestos: Handling asbestos containing materials, like pipe insulation.

Silica: Rocks, bricks, and masonry products that when crushed, ground, cut, or drilled create silica dusts, which can cause silicosis, an irreversible scarring of the lungs.

> **Note:** Silica, or crystalline silica, is basically quartz; one of the minerals found in the earth's crust. Tridymite, and Cristobalite are other forms of silica.

Silica

Permissible Exposure Limit for Silica Dust

Employee exposure to silica dust (breathable quartz) must not exceed 50 micrograms per cubic meter of air averaged over an 8-hour work shift as of June 23, 2016.

Preventing exposure to silica dust can be achieved by using engineering and administrative controls, like wetting down soil at a construction site, having workers use respirators, monitoring dust level, and using drill systems and grinding tools that apply water to minimize the creation of dust at the point of generation.

More Information:

The Effects of Silica to Your Health

Silicosis can disable a person in many ways, making breathing difficult and painful. Silicosis may also cause death, or cause lung cancer. Symptoms associated with silicosis also include loss of appetite, fevers, and loss of body weight.

Silicosis Types

Silicosis can be classified in two degrees:

Acute Silicosis: Develops after a few months or as long as 2 years following exposures to extremely high concentrations of respirable crystalline silica.

Chronic Silicosis: Usually occurs when exposed at moderate to low concentrations of respirable crystalline silica for 15-20 years.

Note: ***Where can silica be found and what work tasks can expose you to silica dust?***

Silica can be found in construction materials (bricks, tile, concrete, sand, and masonry products), on demolition sites, and in such tasks as:

- Sand blasting, abrasive work that can create respirable crystalline silica
- Transportation or dumping of sand, crushed rock, and blocks
- Drilling operations
- Sanding, sawing, cutting, or grinding of masonry materials

Asbestos

Asbestos is the generic term for a group of naturally occurring, fibrous minerals with high tensile strength, flexibility, and resistance to heat, chemicals, and electricity.

In the construction industry, asbestos is found in installed products such as sprayed-on fireproofing, pipe insulation, floor tiles, cement pipe and sheet, roofing felts and shingles, ceiling tiles, fire-resistant drywall, drywall joint compounds, and acoustical products. Because very few asbestos-containing products are being installed today, most worker exposures occur during the removal of asbestos and during the renovation and maintenance of buildings and structures containing asbestos.

Exposure by inhaling loose asbestos fibers can cause disabling or fatal diseases such as gastrointestinal cancer, cancers of the lung or lung-cavity lining, and the severe lung impairment asbestosis. The symptoms of these diseases often do not appear for 20 or more years after initial exposure.

Classification of Asbestos Work

Class I is the most potentially hazardous class of asbestos job and involves the removal of thermal system insulation and sprayed-on or troweled-on surfacing asbestos-containing materials.

Class II includes the removal of other types of asbestos-containing materials that are not thermal system insulation, such as resilient flooring and roofing materials containing asbestos.

Class III focuses on repair and maintenance operations where asbestos- containing or presumed asbestos-containing materials are disturbed.

Class IV pertains to custodial activities where employees clean up asbestos-containing waste and debris.

PEL—Permissible Exposure Limit

Employee exposure to asbestos must not exceed 0.1 fibers per cubic centimeter (f/cc) of air, averaged over an 8-hour work shift. Short-term exposure must also be limited to not more than 1 f/cc, averaged over 30 minutes. Rotation of employees to achieve compliance with either permissible exposure limit (PEL) is prohibited.

Asbestos and Smoking

Studies show that smokers who are exposed to asbestos have a greatly increased risk of lung cancer. Quitting smoking will reduce the risk of lung cancer. People who were exposed to asbestos on the job at any time during their life, or who suspect they may have been exposed, should not smoke. If they smoke, they should stop.

General Compliance Requirements

For any employee exposed to airborne concentrations of asbestos beyond the allowable limits, the employer must provide and ensure the use of protective clothing, such as coveralls or similar full-body clothing, head coverings, gloves, foot coverings, face shields, vented goggles, or other appropriate protective equipment wherever the possibility of eye irritation exists. The employer must also provide and ensure the use of respirators where necessary. The employer must provide medical examinations for workers who, for 30 or more days per year, engage in Class I, II, or III work or experience related to asbestos.

Recordkeeping

The employer must keep an accurate record of all measurements taken to monitor employee exposure to asbestos. This record must include: the date of measurement, operation involving exposure, sampling and analytical methods used, and evidence of their accuracy; number, duration, and results of samples taken; types of protective devices worn; name, social security number, and the results of all employee exposure measurements. This record must be kept for 30 years.

What Kinds of Building Materials May Contain Asbestos?

Exposure to asbestos dust can occur at major construction job sites, in shipyards, in industry, and during construction or renovation of buildings. Even workers' families and friends can be at risk, as asbestos can often be carried on clothing.

There are many products containing asbestos. The following list gives an idea of the widespread use of asbestos, even though more products than those listed here may contain asbestos.

More Information:

Product	Location Includes	Approximate Range of %	Primary Dates of
Roofing tiles	Roofs	20 – 30	1930 – present
Roofing shingles	Roofs	20 – 32	1930 – present
Sprayed coating	Ceilings, walls, and Steelwork	1 – 95	1935 – 1978
Troweled coating	Ceilings, walls	1 – 95	1936 – 1978
Asbestos—cement sheet	Fireplaces, boilers	20 – 50	1930 – present
Millboard, rollboard	Walls, commercial buildings	80 – 85	1925 – present
Asphalt—asbestos tile	Floor	26 – 30	1920 – 1980
Preformed pipe wrap	Pipes	50	1926 – 1975

Paper tape	Furnaces, steam valves, flanges, electrical wiring	80	1901 – 1980
Putty (mudding)	Plumbing joints	20 – 100	1900 – 1973
Gaskets/Packing	Pipe flanges, boiler doors, valves, pipes	10 – 80	1900 – 1989
Hot tops	Used with ingot molds in the steel pouring process	10 – 80	1960 – 1980

MDA—Methylenedianiline

Introduction

Mehyhlenedianiline (MDA) is a light-brown crystalline solid with a faint amino-like odor. It is slightly soluble in water and soluble in alcohol and benzene. It is used for making polyurethane foams, which have a variety of uses, such as insulating materials. It is also used for making coating materials, epoxy glues, dyes, and rubber.

Routes of exposure to MDA include skin absorption, inhalation, and ingestion. Short-term (acute) overexposure to MDA may produce symptoms such as fever, chills, loss of appetite, vomiting, and/or jaundice. Short-term contact with MDA may irritate the skin, eyes, and mucous membranes, and sensitization to MDA may also occur. Long-term (chronic) overexposure may cause cancer as well as damage to the liver, kidneys, blood, and spleen.

In the construction industry, MDA is used to coat exterior surfaces, such as concrete structures, pipes, and floors. These surfaces, located inside or outside of buildings, are often coated by spray application. The standard, however, covers both spray and roll-on applications.

Permissible Exposure Limit

Time-Weighted Average and Short-Term Exposure Limit

No employee may be exposed to MDA above the permissible exposure limit (PEL) of 10 parts per billion (ppb) as an 8-hour time-weighted average (TWA), or above a short-term exposure limit (STEL) of 100 ppb over a 15-minute sampling period.

Action Level

The action level for a concentration of airborne MDA is 5 ppb as an 8-hour TWA. When the action level is reached, an employer must begin compliance activities such as exposure monitoring, medical surveillance, or temporary removal. The employer shall repeat such monitoring for each such employee at least every six months.

Regulated Areas

Regulated areas must be established where airborne concentrations exceed or are expected to exceed the PEL, and where employees handle or use non-airborne MDA liquids or mixtures. These areas must be marked off from the rest of the workplace to minimize the number of persons potentially exposed.

No eating, drinking, smoking, chewing of tobacco or gum, or applying of cosmetics is permitted in regulated areas. Access to regulated areas must be limited to authorized persons only, and employees working in these areas must be required to wear appropriate personal protective equipment and protective clothing which will prevent or minimize exposure.

Decontamination Areas

Decontamination areas, located outside of, but as near as practical, to the regulated area must also be established for decontaminating workers, materials, and equipment contaminated with MDA. The decontamination area must include an equipment storage area, wash area, and clean change area.

Emergency Situations

The employer must develop a written plan for emergency situations for each construction operation. The employer must identify emergency escape routes at each specific construction site before construction operations begin. The plan must also make use of appropriate protective equipment and clothing for employees and a means to alert and evacuate employees in the case of an emergency.

Exposure Monitoring

Breathing-zone air samples that are representative of each employee's exposure to airborne MDA over an 8-hour period will determine employee exposure. Determination of employee exposure to the STEL must be made from breathing zone air samples collected over a 15-minute sampling period. The MDA standard requires that initial monitoring be performed for employees exposed to MDA unless objective or historical monitoring data prove that exposures are below the action level. MDA operations within a regulated area need not be monitored periodically if all employees are wearing supplied-air respirators while working in that regulated area.

Medical Surveillance

A medical surveillance program is required under the supervision of a licensed physician, without cost, for those employees who are:

- Exposed at or above the action level for more than 30 days per year.
- Subject to 15 or more days of dermal exposure.
- Exposed in an emergency.
- Showing signs and symptoms of MDA exposure.

The employer must conduct exams at least annually or more often following the initial exam, emergency situations, or when the employee develops signs and symptoms associated with MDA exposure. The examining physician must provide in writing the results of these exams to the employer or employee.

The employer must provide the examining physician(s) with:

- A copy of the MDA standard and its appendices.
- A description of the affected employee's duties related to potential MDA exposure.
- The employer's current actual or representative MDA exposure level.
- A description of the protective equipment or clothing used.
- Information from previous employment-related medical exams.

An employer must temporarily remove an employee from work when occupational exposure to MDA is at or above the action level, or where dermal exposure to MDA may occur, in the following circumstances:

- Following an initial exam
- Following periodic exams
- Following an emergency situation
- When an employee has signs/symptoms indicative of acute MDA exposure
- When the examining physician determines that an employee's abnormal liver function tests are not associated with MDA exposure but may be exacerbated as a result of occupational exposure to MDA

An employee may return to her or his former job status when:

- The employee no longer shows signs or symptoms of MDA exposure.
- The physician so advises.

- A subsequent medical determination shows the employee no longer has a detected medical condition that poses an increased health risk from MDA exposure.

Control Methods

Respiratory Protection

Employers must provide (at no cost to the employee) and ensure the use of respirators when engineering and work practice controls are being installed; when engineering and work practice controls are not sufficient to reduce exposure to or below the PEL; when engineering controls are not feasible in repair or maintenance and spray application processes; and during emergencies. Keep in mind that engineering controls MUST BE USED to the fullest extent feasible.

Protective Clothing and Equipment

The employer must provide personal protective equipment and clothing, at no cost to the employee, and ensure the proper use of such equipment when the employee is subject to dermal exposure to MDA; where liquids containing MDA can be splashed into the eyes; or where airborne concentrations of MDA are in excess of the PEL.

Recommended protective clothing and equipment may include, but are not limited to, aprons, coveralls, gloves, foot coverings, face-shields, and/or goggles. It is the employer's responsibility to determine the appropriate PPE and ensure it is used. However, employees informed of the possibility of their exposure to MDA should take precautions including reading of the standard associated with it (see 29 CFR 1926.60).

Recordkeeping

MDA exposure is a rare occurrence in the construction industry.

The employer must keep an accurate record of all measurements taken to monitor employee MDA exposure for at least 30 years. This record must include:

- The date of measurement.
- The operation involving MDA exposure.
- The sampling and analytical methods used and evidence of their accuracy.
- The number, duration, and results of samples taken.
- The description of the type of respiratory protective devices used.
- The name, social security number, and exposure of the employees whose exposures are represented through the information.

Lead

Pure lead (Pb) is a heavy metal at room temperature and pressure. As a basic chemical element, lead can combine with various other substances to form numerous lead compounds. Lead has been poisoning workers for thousands of years. Lead can damage the central nervous system, cardiovascular system, reproductive system, hematological system, and kidneys. When absorbed into the body in high enough doses, lead can be toxic. In addition, a worker's lead exposure can harm the development of the worker's children.

Reproductive Risks

Lead is toxic to both male and female reproductive systems. Lead can alter the structure of sperm cells, and there is evidence of miscarriage and stillbirth in women exposed to lead or whose partners have been exposed. Children born to parents who were exposed to excessive lead levels are more likely to have birth defects, mental development issues, or behavioral disorders.

Worker Exposure

Lead is most commonly taken into the body by inhalation. When workers breathe in lead as a dust, fume, or mist, their lungs and upper respiratory tract deliver the lead into the body. They can also absorb lead through the digestive system if it enters the mouth and is ingested.

In construction, lead is used for roofs, cornices, paints, and tank linings. In plumbing, soft solder, used chiefly for soldering tinplate and copper pipe joints, is often an alloy of lead and tin.

Workers potentially at risk for lead exposure include those involved in iron work, demolition work, painting, lead-based paint abatement, plumbing, heating and air conditioning maintenance and repair, electrical work, carpentry, renovation, and remodeling work. Plumbers, welders, demolition workers, and painters are among those workers most often exposed to lead.

Among workers at the highest risk of lead exposure are those involved in:

- Abrasive blasting.
- Welding, cutting, and burning on steel structures.

Other operations with the potential to expose workers to lead include:

- Lead burning.

- Using lead-containing mortar.
- Power tool cleaning without dust collection systems.
- Rivet busting.
- Cleanup activities where dry expendable abrasives are used.
- Movement and removal of abrasive blasting enclosures.
- Manual dry scraping and sanding.
- Manual demolition of structures.
- Heat-gun applications.
- Power tool cleaning with dust collection systems.
- Spray painting with lead-based paint.

Symptoms of Chronic Overexposure

Some common symptoms of chronic overexposure include:

- Loss of appetite
- Constipation
- Nausea
- Excessive tiredness
- Headache
- Fine tremors
- Colic with severe abdominal pain
- Metallic taste in the mouth
- Weakness
- Nervous irritability
- Hyperactivity
- Muscle and joint pain or soreness
- Anxiety
- Pallor
- Insomnia
- Numbness
- Dizziness

Worker Protection

The most effective means of protecting workers is to minimize their exposure through engineering controls, good work practices and training, and use of personal protective clothing and equipment, including respirators, where required. The employer should, as needed, consult a qualified safety and health professional to develop and implement an effective worker protection program.

More Information:

1. Equip power tools used to remove lead-based paint with dust collection shrouds or other attachments.
2. For abrasive blasting operations, build a containment structure that is designed to optimize the flow of clean ventilation air past the workers' breathing zones.
3. Maintain the affected area under negative pressure to reduce the chances that lead dust will contaminate areas outside the enclosure.
4. Equip the containment structure with an adequately sized dust collector to control emissions of particulate matter into the environment.
5. Choose materials and chemicals that do not contain lead for construction projects.
6. Replace lead-based painted building components such as windows, doors, and trim with new components free of lead-containing paint.
7. When applying lead paints or other lead-containing coatings, use a brush or roller rather than a sprayer.
8. Use non-silica-containing abrasives, such as steel or iron shot/grit sand, instead of sand in abrasive blasting operations when practical.
9. Put all lead-containing debris and contaminated items accumulated for disposal into sealed, impermeable bags or other closed impermeable containers.

Employers are required to post these warning signs in each work area where employee exposure to lead is above the PEL:

- Warning
- Lead work area
- Poison
- No smoking or eating

All signs must be well lit and kept clean so that they are easily visible.

Protective Clothing and Equipment

Employers must provide workers who are exposed to lead above the PEL, or for whom the possibility of skin or eye irritation exists, with clean, dry protective work clothing and equipment that are appropriate for the hazard. Employers must provide these items at no cost to employees. Appropriate protective work clothing and equipment used on construction sites includes:

- Coveralls or other full-body work clothing.
- Gloves, hats, and shoes or disposable shoe coverlets.
- Vented goggles or face shields with protective spectacles or goggles.
- Welding or abrasive blasting helmets.

- Respirators.

The Permissible Exposure Limit (PEL) to lead is 50 micrograms of lead per cubic meter of air (50 µg/m3) averaged over an 8-hour period. Employers must provide workers who are exposed to lead above the PEL with clean, dry protective work clothing and equipment that are appropriate for the hazard.

Workers responsible for handling contaminated clothing, including those in laundry services or subcontractors, must be informed in writing of the potential health hazard of lead exposure. At no time shall lead be removed from protective clothing or equipment by brushing, shaking, or blowing. These actions disperse the lead into the work area.

Recordkeeping

The employer must maintain any employee exposure and medical records to document ongoing employee exposure, medical monitoring, and medical removal of workers. This data provides a baseline to evaluate properly the employee's health.

Lesson Summary

Lead most commonly enters the body by inhalation. When workers breathe in lead as dust, fume or mist, their lungs and upper respiratory tract delivers the lead into the body. They can also absorb lead through the digestive system if it enters the mouth and is ingested.

The employer should, as needed, consult a qualified safety and health professional to develop and implement an effective worker protection program. Workers potentially at risk for lead exposure include those involved in iron work, demolition work, painting, lead-based paint abatement, plumbing, etc. Plumbers, welders, and painters are among those workers most often exposed to lead.

Children born to parents who were exposed to excess lead levels are more likely to have birth defects, mental development delays, or behavioral disorders. The employer must keep an accurate record of all measurements taken to monitor employee Methylenedianiline (MDA) exposure for at least 30 years.

The employer must conduct exams at least annually or more often following the initial exam, emergency situations, or when the employee develops signs and symptoms associated with MDA exposure. The examining physician must provide in writing the results of these exams to the employer and employee.

When the action level is reached, an employer must begin compliance activities such as exposure monitoring, medical surveillance, or temporary removal. The employer will repeat such monitoring for each such employee at least every six months.

Module 6: Stairways and Ladders

Module Description

Stairways and ladders are the major sources of workplace injuries and fatalities for construction workers. According to Bureau of Labor statistics, 24% of the 645 construction fatalities in 2009 resulted from falls from ladders and on stairs. Additionally, tens of thousands of workers were injured in these types of accidents with almost half of these injuries being serious in nature.

This module gives you a basic understanding of OSHA standards and the role they play in the prevention and elimination of work-related injuries and fatalities due to stairways and ladders at workplaces.

Module Learning Objectives

At the conclusion of this module, you should be able to:

- Discuss OSHA standards related to stairways and ladders.
- Discover methods of protection concerning stairways and ladder hazards.
- Explore safety guidelines and requirements of stairways and ladders used at construction sites.
- Explain training and other essential factors associated with stairways and ladders.

Lesson 1: OSHA Standards and Stairways

Lesson Focus

This lesson focuses on the following topics:

- OSHA Standards
- Stairways
- Stair rails and Handrails

OSHA Standards

OSHA Standards Application

The OSHA standards are applicable to all stairways and ladders used in alteration, construction, repair (including painting and decorating), and demolition work sites covered by OSHA's construction safety and health standards.

OSHA Standards Exemptions

The OSHA standards are not applicable to ladders that are purposely manufactured and used for scaffolds access and egress. These ladders are covered under the Scaffolding standard.

The Need for Stairways and Ladders

It is mandatory for employers to provide a stairway or ladder at points of access where the elevation between 2 steps is 19 inches or more.

Stairways

Stairways should be installed at an angle between 30 and 50 degrees from horizontal. Stairway must have uniform riser height and tread depth; variations in riser height or tread depth shall not be over ¼ inch in any stairway system.

In those places where doors or gates open directly to a stairway, a platform must be provided that is at least 20 inches in width beyond the swing of the door.

Stairways Landings

Stairway landings at least 30 inches deep and 22 inches wide, at every 12 feet or less of vertical rise, are essential for stairways which are not a permanent part of the structure. Stairways must be installed at least 30 degrees, and no more than 50 degrees, from the horizontal. Metal pan landings and metal pan treads must be secured in place before filling.

Note: Remember that a guardrail system is also required on a platform with a swinging door to protect from potential falls of 30 inches or more.

Stair rails and Handrails

Handrails and stair rails are used to protect workers from falling when using stairways. The clearance of temporary handrails must be at least three inches between handrail and walls, stair rail systems, and other objects.

Handrails must be provided to all stairways that have four or more risers, or are higher than 30 inches. If there is a fall hazard of more than 30 inches on an exposed side of the stairs, then a stair rail system must be provided to prevent workers from falling off the side.

More Information: Stairways must be protected along each unprotected edge.

Handrails and top rails must be capable of withstanding a load/force of 200 pounds. The ends of stair rail systems and handrails must be constructed to prevent dangerous projections such as rails protruding beyond the end posts of the system.

Stair rail systems and handrails must be surfaced to prevent injuries such as punctures or lacerations and to keep clothing from snagging. Furthermore, unprotected sides and edges of stairway landings must be provided with a guardrail system.

Handrail and Stairwell System Height

The height of stair rails must not be less than 36 inches (91.5cm) from the upper surface of the stair rail system to the surface of the tread, in line with the face of the riser at the forward edge of the tread.

The height of handrails shall be not more than 37 inches (94 cm) nor less than 30 inches (76 cm) from the upper surface of the handrail to the surface of the tread, in line with the face of the riser at the forward edge of the tread.

When the top edge of a stair rail system also serves as a handrail, the height of the top edge shall be not more than 37 inches (94 cm) nor less than 36 inches (91.5 cm) from the upper surface of the stair rail system to the surface of the tread, in line with the face of the riser at the forward edge of the tread.

Dangerous Conditions

It is vital to fix or address potentially dangerous conditions (such as slippery steps or rungs) immediately; otherwise, they could be the cause of an accident. Furthermore, all stairway parts must be free from dangerous projections such as protruding nails.

Case Study

Victim Fell Due to Grease on Stairways

A worker in an under-construction building was wearing a pair of tennis shoes and was using a stairway to reach the second floor of the building. The victim fell 10 feet from the stairway directly onto the ground. He was immediately transferred to the hospital where doctors examined his body.

According to doctors, his spinal cord was severely damaged when he hit the ground.
Reasons:

- There was some grease or other slippery substance on the stairway at the time of the incident.
- The victim was wearing tennis shoes at the time of the incident—tennis shoes may become extremely hazardous with any greasy or slippery substance.
- No safety measures had been taken (such as a guardrail, stair rail).
- The victim had not received any safety and health education.

Lesson Summary

Handrails must be provided on all stairways that have four or more risers, or are higher than 30 inches. If there is a fall hazard of 30 inches or more on an exposed side of the stairs, then a stair rail system must be provided to prevent workers from falling off the side. The clearance of temporary handrails must be at least three inches between handrail and walls, stair rail systems, and other objects. Also, handrails and top rails must be capable of withstanding a load/force of 200 pounds.

Stair rail systems and handrails must be surfaced to prevent injuries such as punctures or lacerations and to keep clothing from snagging. Furthermore, unprotected sides and edges of stairway landings must be provided with a guardrail system.

Lesson 2: Ladders and Training

Lesson Focus

This lesson focuses on the following topics:

- About Ladders
- Training

About Ladders

Ladders must be kept in a safe and good working condition. The following points are important to consider while using or working with ladders:

- The area around the top and bottom of the ladder must be kept clean.
- Always keep ladders away from slipping hazards.
- Ensure that rungs are spaced 10 to 14 inches from each other. Also, ensure that cleats and steps are uniformly spaced.

Always use ladders only for their designed purposes. Do not lash ladders together to make a long ladder, unless they are designed for that purpose. Never over load ladders beyond their capacities. The manufacturer's rated capacity must be taken into consideration when using ladders.

Note: Do not use single-rail ladders.

Securing Ladders

Always use ladders on stable and level surfaces, unless they are precisely designed for other surfaces. Ladders placed in areas such as passageways, doorways, or where they can be displaced by workplace activities or traffic must be secured to prevent accidental movement, or a barricade must be used to keep traffic or activities away from the ladder. Do not use ladders on slippery surfaces, unless they are adequately protected with slip resistant feet/material.

Case Study

Two Painters Electrocuted

Two workers were painting the light poles outside of a restaurant. The victims were using an airless spray gun to paint the pole and a 36-foot aluminum extension ladder to reach the top of the pole.

A 12,460-volt power line was located approximately 21 feet above the ground. The actual length to which the ladder had been extended at the time of the accident is unknown (no eyewitnesses), but it is known to have at least extended beyond the crossbar.

One victim was standing on the ladder painting the crossbar at the top of the light pole. The second victim was standing on the ground steadying the ladder. The owner of the restaurant, who had been checking the progress of the two workers, heard a scream as he was walking back to the restaurant.

The owner turned and saw the painter and the ladder falling to the ground. The other worker who had been steadying the ladder was lying on the ground.

The owner called the fire department rescue squad and they reached the place immediately, but after a few minutes of their life saving efforts the painters were pronounced dead.

Reasons

There were no eyewitnesses of the accident; therefore the following reasons are based on the investigation conducted immediately after the accident:

- It is assumed that the ladder slid horizontally along the crossbar and the victim on the ladder contacted the power line.
- The current passed through the victim and the ladder to the ground. The current also passed through to the second victim (holding the ladder) to the ground.
- There were two factors present that may have contributed to this accident.
    - First, the ladder was placed on uneven ground and wooden blocks were placed under one leg of the ladder in an effort to provide an even surface. It is possible the blocks may have slid out from under the ladder.
    - Secondly, the top rung of the ladder was damaged. The victim may have leaned on this damaged rung and lost his balance, causing the ladder to slide along the crossbar.
- The victims had not received any safety and health training.

Portable Ladders

Portable ladders are those ladders that can be readily moved or carried. Before using portable ladders always inspect for cracks, dents, and missing rungs; rungs must be designed to minimize slipping risk.

The rungs and steps of portable metal ladders manufactured after March 15, 1991 must be corrugated, knurled, dimpled, coated with skid-resistant material, or treated to minimize slipping. Furthermore, portable ladders must be able to withstand four times their maximum load.

Note: Side rails of portable ladders must be at least 11.5 inches apart.

Top step

Never use the top or top step of a stepladder as a step; otherwise, it could lead to a severe accident.

Cross bracing

Do not use cross bracing given on the rear of a stepladder for climbing, unless the ladder is designed for that purpose. A metal spreader or locking device must be provided on each stepladder to hold the front and back sections in an open position when the ladder is being used.

Damaged and Defective Ladders

It is necessary that a competent person inspect ladders for visible defects, like broken or missing rungs; if a defective ladder is found, immediately mark it defective, discard the ladder in a manner that it will not be recovered and reused, or tag it "Do Not Use."

Defective ladders need to be immediately removed from the service until repaired. Furthermore, ladders must be inspected on a periodic basis and after any incident that could affect their safe use.

Ladders near Energized Electrical Equipment

Ladders must be constructed with nonconductive side rails if they are used in places where the employee or the ladder could contact exposed energized electrical equipment.

Case Study

Fall Due to Electrocution

An employee was holding a small aluminum ladder beneath energized power lines. As he climbed to the top of the ladder to access a roof, the small ladder came into contact with 3600-volt power lines.

A bystander who witnessed the accident said that the victim shook for a few moments, and then fell backwards from the ladder onto the hard ground below. The worker was taken to the hospital where he died the next day as a result of injuries sustained from the fall.

Reasons

- The worker moved the aluminum ladder only a few feet and proceeded to climb the ladder.
- As the aluminum ladder came in contact with the high-voltage power lines, the worker was immediately electrocuted and fell backwards from the ladder.
- The worker was not wearing electrical safety gloves.
- His death was directly related to his injuries from the fall and indirectly related to the electrical shock.

How to Climb a Ladder

Employees should always face the ladder when going up or down. They should grab the ladder with at least one hand while mounting or dismounting, and each employee must never carry any load or object that could cause the employee to lose balance and fall.

Double-Cleated Ladders

A double-cleated ladder or two or more single ladders should be provided when ladders are the only way to enter and exit a working area with 25 or more employees and when ladders are used for two-way simultaneous traffic.

Structural Defects

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 be immediately marked or tagged with "Do Not Use" or similar language, and should be removed from service until they have been properly repaired.

It is important that ladders be repaired according to their original design criteria, before they are returned to use.

> **Note:** Defective ladders can also be blocked with a plywood attachment that spans several rungs.

> **More Information:** Remember, structural defects standards are applicable on both portable and fixed ladders.

Slipping Hazards

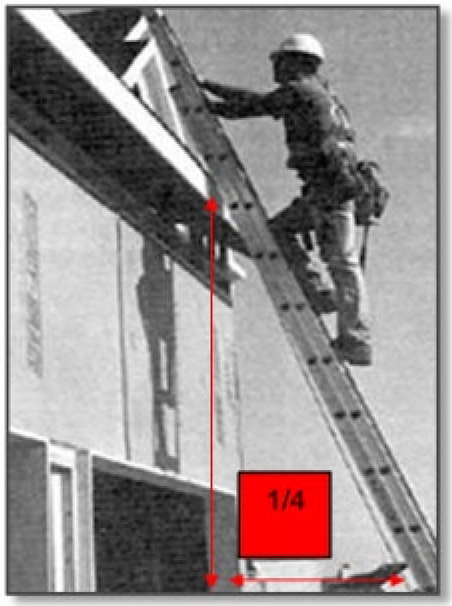
Ladders must be kept free of paint, oil, grease or other slipping hazards.

Never use varnish or any other opaque covering on wood ladders that might hinder a proper inspection of the equipment.

> **More Information:** According to OSHA standards, warning labels on one face of a side rail are allowed. For example, this ladder is not provided with a metal spreader or locking device as required.

Ladder Angle

Non-self-supporting ladders must be placed or positioned at an angle where the horizontal distance from the top support to the foot of the ladder is 1/4 the working length of the ladder. Working length of a ladder is the distance along the ladder between foot and top support.



Ladder Rail Extension

When portable ladders are used to access an upper landing surface, the side rails must extend at least three feet 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.

Tall Fixed Ladders Requirements

It is mandatory to equip fixed ladders of 24 feet or more in height by using at least one of the following methods of protection:

- Ladder safety device
- Self-retracting lifelines with rest platforms every 150 feet or less
- Cage or well, and multiple ladder sections, each section not exceeding 50 feet

Fixed ladders must be able to support at least two loads of 250 pounds each, concentrated between any two consecutive attachments. They must also support added anticipated loads caused by ice buildup, winds, rigging and impact loads resulting from using ladder safety devices.

Training

It is essential that employers must provide training to their employees for using stairways and ladders. The training program must enable each employee to recognize hazards associated with stairways and ladders. Furthermore, employees should be capable of using proper procedures and methods to protect themselves from various hazards of stairways and ladders.

Training Results

- Employees must be trained by a competent person to be:
- Aware of the maximum load-carrying capacities of ladders used in the construction industry.
- Capable of identifying and addressing fall hazards in the workplace.
- Aware of the correct procedures or methods for maintaining, erecting, assembling and disassembling fall protection systems.
- Able to safely position and use ladders and stairways.

Lesson Summary

A double-cleated ladder or two or more single ladders should be provided when ladders are the only way to enter and exit a working area with 25 or more employees and when ladders are used for two-way simultaneous traffic. Portable ladders must be able to withstand four times their maximum load. Never overload ladders beyond their capacities; be mindful of the manufacturer's rated capacity and adhere to it accordingly.

Always use ladders only for their designed purposes. Do not lash ladders together to make a long ladder, unless they are designed for that purpose. Employees should always face the ladder when going up or down. They should grab the ladder with at least one hand while mounting or dismounting and never carry any load or object that could cause them to lose balance and fall. It is necessary that a competent person inspect ladders for visible defects, like broken or missing rungs; if a defective ladder is found, one must immediately mark it defective or tag it "**Do Not Use.**"

Lesson 3: Safety Measures

Lesson Focus

This lesson focuses on the following topics

- General Requirements
- Design, Construction, Maintenance, and Inspection

General Requirements

Training

Employers shall ensure that all employees who use ladders with a working height of six feet (1.82 m) or more receive the necessary training, such as how to inspect ladders and use such ladders properly.

Proper Usage

Ladders shall be used only for the purposes for which they were designed. Non-self-supporting ladders shall be used at an angle such that the horizontal distance from the top support to the foot of the ladder is approximately one-fourth of the working length of the ladder (the distance along the ladder between the foot and top support).

Rails

When ladders are used for access to an upper landing surface, the ladder side rails shall extend at least three feet (0.9 m) above the upper landing surface to which the ladder is used to gain access. When such an extension is not possible because of the ladder's length, the ladder shall be secured at the top and a grasping device, such as a grab rail, shall be provided to assist employees in mounting and dismounting the ladder.

Stability

Ladders shall be used only on stable and level surfaces unless secured to prevent their accidental displacement. Non-self-supporting ladders shall not be used on slippery surfaces unless secured or provided with slip-resistant feet to prevent accidental displacement. Single-rail ladders shall not be used.

Safety

Ladders shall not be moved, shifted, or extended while occupied by employees. Ladders placed in any location where they can be displaced by other activities or traffic, such as in passageways, doorways, or driveways shall be secured to prevent accidental displacement, or a barricade shall be used to keep the activities or traffic away from the ladder.

Ladder Repairs

All ladder repairs shall be made by a qualified person trained and familiar with the design and the proper procedures for repairing defective components. Ladders shall be inspected for visible defects prior to the first use each work shift, and after any occurrence that could affect their safe use.

Ladder Tops

The top of a non-self-supporting ladder shall be placed with the two rails supported, unless it is equipped with a single support attachment.

Emergency escape ladders shall comply with all applicable requirements of this section except those requiring fall protection systems. The top of a stepladder shall not be used as a step.

Design, Construction, Maintenance, and Inspection

Portable Ladders: Load Capacity

Portable ladders shall be capable of supporting, without failure, the following loads:

- Each non-self-supporting ladder shall support at least four times the maximum intended load applied or transmitted to the ladder in a downward and vertical direction when the ladder is placed at a 75 1/2degree angle from the horizontal.
- Each self-supporting ladder shall support at least four times the maximum intended load in a fully opened position on a level surface.

Portable Ladders: Duty Ratings

The working loads corresponding to the duty ratings of portable ladders that pass the applicable ANSI test requirements shall be as follows:

Duty Rating	Ladder Type	Working Load (lbs)	Working Load (kg)
Special Duty	IAA	375	170.4
Extra heavy duty	IA	300	136.2
Heavy duty	I	250	113.5
Medium duty	II	225	102.2
Light duty	III	200	90.8

Portable Ladders: Maximum Load

The maximum intended load used for the design of portable ladders shall be at least 200 pounds (90.6 kg). The combined weight of the employee using the portable ladder and any tools and supplies carried by the employee shall not exceed the maximum intended load of the ladder.

Fixed Ladders: Load Capacity

Fixed ladders shall be capable of supporting at least two loads of at least 250 pounds (114 kg) each, concentrated between any two consecutive attachments, plus anticipated loads caused by ice buildup, winds, rigging, and impact loads resulting from the use of ladder safety devices.

The number and position of additional concentrated loads of 250 pounds (114 kg) each, determined from anticipated usage of the ladder, shall also be included in determining the capabilities of fixed ladders. Each step or rung shall be capable of supporting at least a single concentrated load of 250 pounds (114 kg) applied in the middle of the step or rung.

Ladder Rungs

Ladder rungs and steps shall be parallel, level, and uniformly spaced when the ladder is in position for use. Ladder rungs and steps shall be spaced not less than 10 inches (25 cm) apart, or more than 14 inches (36 cm) apart as measured between the centerlines of the rungs, cleats, or steps.

Ladder Rung Width

Ladder rungs and steps shall have a minimum clear width of 16 inches (41 cm) for individual-rung and fixed ladders, and 11-1/2 inches (29 cm) for all portable ladders, as measured between the ladder side rails.

Narrow Rungs

Narrow rungs, which are not designed to be stepped on, on the tapered ends of window washer's ladders, fruit pickers' ladders, and similar ladders, are exempt from the minimum rung width requirement.

Wooden and Metal Ladders

Wood ladders shall not be coated with any opaque covering, except for identification or warning labels which may be placed on one face only of a side rail.

Metal ladders shall be protected against corrosion.

Toe Clearance

The minimum toe clearance between the centerline of ladder rungs and steps and any obstructions behind the ladder shall be seven inches (18 cm).

Perpendicular Clearance

The minimum perpendicular clearance between the centerline of fixed ladder rungs and steps and any obstruction on the climbing side of the ladder shall be 30 inches (76 cm).

Obstructions

When unavoidable obstructions are encountered, the minimum perpendicular clearance between the centerline of fixed ladder rungs and steps and the obstruction on the climbing side of the ladder may be reduced to 24 inches (61 cm) provided that a deflection device is installed to guide employees around the obstruction.

Fixed Ladders: Safety Devices

Fixed ladders shall be equipped with personal fall protection systems or with cages, or wells, wherever the length of any climb on any fixed ladder exceeds 24 feet (7.3 m), or wherever the top of the ladder is at a distance greater than 24 feet (7.3 m) above lower levels.

Fixed Ladders: Cages and Wells

Cages and wells provided for fixed ladders shall be designed to permit easy access to or egress from the ladder that they enclose. The cages and wells shall be continuous throughout the length of the fixed ladder except for access, egress, and other transfer points. Cages and wells shall be designed and constructed to contain employees in the event of a fall, and to direct them to a lower landing.

Length of Continuous Climb

The length of continuous climb for any fixed ladder equipped only with a cage or a well shall not exceed 50 feet (15.2 m).

Fixed Ladders: Rest Platforms

Fixed ladders with continuous lengths of climb greater than 150 feet (45.7 m) shall be provided with rest platforms and self-retracting lifelines at least every 150 feet (45.7 m) or a cage or well and multiple ladder sections with each ladder section not to exceed 50 feet (15.2 m) in length.

Landing Platforms

Except where portable ladders are used to access fixed ladders, ladders shall be offset with a landing platform between each ladder when two or more separate ladders are used to reach a work area.

Ladder Surfaces

Ladder surfaces shall be free of puncture or laceration hazards. Fixed individual rung ladders shall be constructed to prevent the employee's feet from sliding off the end. A ladder that might contact un-insulated energized electrical equipment shall have nonconductive side rails.

Pitch

Ladders having a pitch in excess of 90 degrees from the horizontal shall not be permitted. The step-across distance from the centerline of the steps or rungs of a fixed ladder to the nearest edge of the structure, building, or equipment accessed shall not exceed 12 inches (30 cm).

Connecting Ladders

Ladders and ladder sections, unless so designed, shall not be tied or fastened together to provide longer length. Ladders and ladder sections shall not have their length increased by other means unless specifically designed for the means employed.

Lesson Summary

Ladders having a pitch in excess of 90 degrees from horizontal are not permitted. Ladders must be used only for the purposes and in the manner for which they were designed. For instance, non-self-supporting ladders are to be used at an angle such that the horizontal distance from the top support to the foot of the ladder is approximately one-fourth of the working length of the ladder (the distance along the ladder between the foot and top support).

The combined weight of the employee using a portable ladder and any tools and supplies carried by the employee is not to exceed the maximum intended load of the ladder. Ladders with structural or other defects must be immediately tagged with a danger tag reading "Out of Service," "Do Not Use," etc., and be withdrawn from service until repaired. Single-rail ladders must not be used.

Module 7: Concrete and Masonry Construction

Module Description

This module is designed for construction workers who want to learn about safely working with concrete and masonry projects and addresses the requirements necessary to protect all construction employees from the hazards associated with concrete and masonry construction operations performed in workplaces covered under applicable OSHA standards. In addition to the requirements in Subpart Q, other relevant provisions in Parts 1910 and 1926 apply to concrete and masonry construction operations. Topics include general requirements for formwork and masonry construction.

Module Learning Objectives

At the conclusion of this module, you should be able to:

- Describe post-tensioning operations requirements.
- Identify the requirements relating to working under loads.
- Discuss the requirements concerned with Personal Protective Equipment.
- Identify and defend the lockout/tagout procedures requirements.
- Summarize the requirements relating to pre-cast concrete.

Lesson 1: Concrete and Masonry Construction (Part 1)

Lesson Focus

This lesson focuses on the following topics:

- General Requirements
- Post-Tensioning Operations
- Concrete Buckets
- Personal Protective Equipment
- Bulk Concrete Storage
- Concrete Pumping Systems
- Power Concrete Trowels
- Concrete Buckets
- Bull Floats
- Masonry Saws

General Requirements

Employers must not place construction loads on a concrete structure or portion of a concrete structure unless the employer determines, based on information received from a person who is qualified in structural design, that the structure or portion of the structure is capable of supporting the intended loads.

All protruding reinforcing steel must be guarded to eliminate the hazard of impalement.

Post-Tensioning Operations

Employees (except those essential to the post-tensioning operations) must not be permitted to be behind the jack during tensioning operations.

Signs and barriers must be erected to limit employee access to the post-tensioning area during tensioning operations.

Concrete Buckets

Working Under Loads

Employees must not be permitted to ride on or work under concrete buckets while the buckets are being elevated or lowered into position.

To the extent practicable, elevated concrete buckets must be routed so that no employee, or the fewest employees possible, are exposed to the hazards associated with falling concrete buckets.

Personal Protective Equipment

Employees must not be permitted to apply a cement, sand, and water mixture through a pneumatic hose unless they are wearing protective head and face equipment.

Bulk Concrete Storage

Bulk storage bins, containers, and silos must be equipped with conical or tapered bottoms, and mechanical or pneumatic means of starting the flow of material.

Employees must not be permitted to enter storage facilities unless the ejection system has been shut down, locked out, and tagged to indicate that the ejection system is not to be operated.

Concrete Mixers: Concrete mixers with lading skips that are one cubic yard, or larger, shall be equipped with a mechanical device to clear the skip of materials and guardrails installed on each side of the skip.

Concrete Pumping Systems

Concrete pumping systems using discharge pipes shall be provided with pipe supports designed for 100 percent overload.

Compressed air hoses used on a concrete pumping system shall be provided with positive fail-safe joint connectors to prevent separation of sections when pressurized.

Power Concrete Trowels

Powered and rotating type concrete troweling machines that are manually guided shall be equipped with a control switch that will automatically shut off the power whenever the hands of the operator are removed from the equipment handles.

Concrete Buggy Handles

Concrete buggy handles shall not extend beyond the wheels on either side of the buggy.

Concrete Buckets

Concrete buckets equipped with hydraulic or pneumatic gates shall have positive safety latches or similar safety devices installed to prevent premature or accidental dumping.

Concrete buckets shall be designed to prevent concrete from hanging up on top of the sides.

Tremies

Sections of tremies and similar concrete conveyances shall be secured with wire rope (or equivalent materials) in addition to the regular couplings or connections.

Bull Floats

Bull float handles, used where they might contact energized electrical conductors, shall be constructed of nonconductive material or insulated with a nonconductive sheath having electrical and mechanical characteristics that provide the equivalent protection of a handle constructed of nonconductive material.

Masonry Saws

Masonry saws must be guarded with a semicircular enclosure over the blade.

A method for retaining blade fragments must be incorporated in the design of the semicircular enclosure.

Shoring

All shoring equipment (including equipment used in reshoring operations) must be inspected prior to erection to determine that the equipment meets the requirements specified in the formwork drawings. Damaged shoring equipment must not be used for shoring. Erected shoring equipment must be inspected immediately prior to, during, and immediately after concrete placement. Shoring equipment that is found to be damaged or weakened after erection must be immediately reinforced. The sills for shoring must be sound, rigid, and capable of carrying the maximum intended load. All base plates, shore heads, extension devices, and adjustment screws must be in firm contact and secured, when necessary, with the foundation and the form.

If single-post shores are used one on top of another (tiered), then additional shoring requirements must be met. The shores must be as follows:

- Designed by a qualified designer and the erected shoring must be inspected by an engineer qualified in structural design.

- Vertically aligned.
- Spliced to prevent misalignment.
- Adequately braced in two mutually perpendicular directions at the splice level. Each tier also must be diagonally braced in the same two directions.
- Adjustment of single-post shores to raise formwork must not be made after the placement of concrete.
- Reshoring must be erected, as the original forms and shores are removed, whenever the concrete is required to support loads in excess of its capacity.

Lesson Summary

Employees must not be permitted to ride on or work under concrete buckets while the buckets are being elevated or lowered into position. This is just one example of the measures employees on the worksite must take in order to prevent potential injury or death due to negligent behavior. An example of an engineered protective measure is found in powered and rotating type concrete troweling machines that are manually guided and equipped with a control switch that will automatically shut off the power whenever the hands of the operator are removed from the equipment handles.

Lesson 2: Concrete and Masonry Construction (Part 2)

Lesson Focus

This lesson focuses on the following topics:

- Lockout/Tagout Procedures
- General Requirements for Formwork
- Shoring and Re-Shoring
- Tiered Single-Post Shores
- Vertical Slip Forms
- Reinforcing Steel
- Removal of Form Work
- Pre-cast Concrete
- Lift-Slab Operations
- Limited Access Zone for Masonry Construction

Lockout/Tagout Procedures

No employee shall be permitted to perform maintenance or repair activity on equipment (such as compressors, mixers, and screens or pumps used for concrete and masonry construction activities) where the inadvertent operation of the equipment or the inadvertent energization of the equipment could occur and cause injury, unless all potentially hazardous energy sources have been locked out and tagged.

Tags shall read "Do Not Start" or shall have similar language to indicate the equipment is not to be operated.

General Requirements for Formwork

Formwork must be designed, fabricated, erected, supported, braced, and maintained so that it will be capable of supporting, without failure, all vertical and lateral loads that might be applied to the formwork. Formwork that is designed, fabricated, erected, supported, braced, and maintained in conformance with the non-mandatory Appendix to 1926.703 is deemed to be in compliance with the provision of 1926.703(a)(1).

Drawings or plans, including all revisions for the jack layout, formwork (including shoring equipment), working decks, and scaffolds, must be available at the jobsite.

Shoring and Re-Shoring

All shoring equipment (including equipment used in re-shoring operations) must be inspected prior to erection to determine that the equipment meets the requirements specified in the formwork drawings.

Shoring equipment that is damaged such that its strength is reduced to less than that required by OSHA's general requirements for formwork stated in 1926 703(a)(1), must not be used for shoring. Erected shoring equipment must be inspected immediately prior to, during, and immediately after concrete placement. Shoring equipment that is found to be damaged or weakened after erection must be reinforced immediately.

Sills used for shoring should be sound, rigid, and capable of carrying the maximum intended load.

All base plates, shore heads, extension devices, and adjustment screws must be in firm contact, and secured when necessary, with the form and foundation.

Tiered Single-Post Shores

If single-post shores are used one on top of another (tiered), then the employer must comply with the following specific requirements, in addition to the general requirements for formwork. The shores must be designed as follows:

- The shores must be designed by a qualified designer, and the erected shoring must be inspected by an engineer qualified in structural design.

- Single post shoring must be vertically aligned.
- Single post shores must be spliced to prevent misalignment.
- Single post shores must be adequately braced in two mutually perpendicular directions at the splice level. Each tier also must be diagonally braced in the same two directions.

The adjustment of single-post shores to raise formwork must not be made after the placement of concrete.

Vertical Slip Forms

The steel rods or pipes on which jacks climb or by which the forms are lifted must be:

- Specifically designed for that purpose.
- Adequately braced when not encased in concrete.

Forms must be designed to prevent excessive distortion of the structure during the jacking operation. All vertical slip forms must be provided with scaffolds or work platforms where employees are required to work or pass. Jacks and vertical supports must be positioned in such a manner that the loads do not exceed the rated capacity of the jacks.

Reinforcing Steel

Reinforcing steel for walls, piers, columns, and similar vertical structures must be adequately supported to prevent overturning and collapse.

Employers must take measures to prevent unrolled wire mesh from recoiling. Such measures may include, but are not limited to, securing each end of the roll or turning over the roll.

Removal of Form Work

Forms and shores (except those used for slabs on grade and slip forms) must not be removed until the employer determines that the concrete has gained sufficient strength to support its weight and superimposed loads. Such a determination must be based on one of the following:

- The plans and specifications stipulate conditions for the removal of forms and shores (and such conditions have been followed).
- The concrete has been properly tested with an appropriate ASTM standard test method designed to indicate the concrete compressive strength, and the test results indicate that the concrete has gained sufficient strength to support its weight and superimposed loads.

Pre-Cast Concrete

Pre-cast concrete wall units, structural framing, and tilt-up wall panels must be adequately supported to prevent overturning and to prevent collapse until permanent connections are completed.

Lifting inserts that are embedded or otherwise attached to tilt-up wall panels must be capable of supporting at least two times the maximum intended load applied or transmitted to them; lifting inserts for other pre-cast members, excluding tilt-up members, must be capable of supporting four times the load. Lifting hardware members must be capable of supporting five times the maximum intended load applied to the lifting hardware.

Lift-Slab Operations

Lift-slab operations must be designed and planned by a registered professional engineer who has experience in lift-slab construction. Such plans and designs must be implemented by the employer, and must include detailed instructions and sketches indicating the prescribed method of erection. The plans and designs must also include provisions for ensuring the lateral stability of the building or structure during construction.

Jacks or lifting units must be marked to indicate their rated capacity and must not be loaded beyond this capacity.

Jacking equipment must be capable of supporting at least two and one-half times the load being lifted during jacking operations, and the equipment must not be overloaded. For the purpose of this provision, jacking equipment includes any load bearing component that is used to carry out the lifting operation(s). Such equipment includes, but is not limited to, the following: threaded rods, lifting attachments, lifting nuts, hook-up collars, T-caps, shear heads, columns, and footings.

No employee, except those essential to the jacking operation, must be permitted in the building/structure while any jacking operation is taking place, unless the building/structure has been reinforced sufficiently to ensure its integrity during erection. "Reinforced sufficiently to ensure its integrity" means that a registered professional engineer, independent of the engineer who designed and planned the lifting operation, has determined from the plans that if there is a loss of support at any jack location that loss will be confined to that location and the structure as a whole will remain stable.

If used, manual leveling controls shall be centrally located and attended by a competent person while the lifting is in progress. The competent person must be experienced in the lifting operation and with the lifting equipment being used.

Under no circumstances must any employee who is not essential to the jacking operation be permitted immediately beneath the slab while it is being lifted.

Limited Access Zone for Masonry Construction

Whenever a masonry wall is being constructed, employers must establish a limited access zone prior to the start of construction. The limited access zone must be as follows:

- Equal to the height of the wall to be constructed plus four feet, and shall run the entire length of the wall.
- On the side of the wall that will be unscaffolded.

- Restricted to entry only by employees actively engaged in constructing the wall.
- All masonry walls over 8 feet in height shall be adequately braced to prevent overturning and to prevent collapse unless the wall is adequately supported so that it will not overturn or collapse. The bracing shall remain in place until permanent supporting elements of the structure are in place.

Lesson Summary

Jacking equipment must be capable of supporting at least two and one-half times the load being lifted during jacking operations, and the equipment must not be overloaded. Lifting inserts that are embedded or otherwise attached to tilt-up wall panels must be capable of supporting at least two times the maximum intended load applied or transmitted to them. Lifting inserts for other pre-cast members, excluding tilt-up members, must be capable of supporting four times the load. Lifting hardware members must be capable of supporting five times the maximum intended load applied to the lifting hardware.

Erected shoring equipment must be inspected immediately before, during, and after concrete placement. All base plates, shore heads, extension devices, and adjustment screws must be in firm contact, and secured when necessary, with the form and foundation. Shoring equipment that is found to be damaged or weakened after erection must be reinforced immediately.

Module 8: Confined Spaces

Module Description

This module encapsulates the safety regulation of the workers working in spaces meeting the OSHA definitions of "confined space" and/or "permit-required confined space." It instructs about the hazards that may occur during the work in these spaces.

OSHA is striving to provide safety to the workers in all required disciplines by providing courses such as this one, which helps workers to learn about industry hazards, especially those critical to the lives of employees such as those found in confined spaces.

Module Learning Objectives

At the conclusion of this module, you should be able to:

- Describe confined spaces as defined in the module.
- Identify the characteristics of confined spaces.
- Discuss atmospheric conditions found in confined spaces.
- Summarize a prevention program.
- Name the duties of employers and employees.
- Illustrate rescue and emergency services.
- Apply testing protocol.

Lesson 1: Overview of Confined Spaces

Lesson Focus

This lesson focuses on the following topics:

- Introduction
- Examples of Characteristics of Confined Spaces
- Atmospheric Conditions
- Prevention Program

Introduction

Confined Spaces

A "confined space" is a space which meets all of the following criteria:

- Is large enough and configured such that an employee can bodily enter;
- Has an entry and exit that is limited or restricted is some manner; and
- Is not designed for continuous occupancy by one or more employees.

Permit Space

A "permit space" meets ALL of the requirements to be classified as a "confined space" AND meets ONE OR MORE of the following criteria:

- Contains, or has the potential to contain, a hazardous atmosphere;
- Contains a material that has the potential to engulf an employee who enters the space;
- The internal configuration is such that an employee entering the space could be trapped or asphyxiated by inwardly converging walls or by a floor with a downward slope tapering to a smaller cross section; or
- Contains any other recognized safety or health hazard of a serious nature.

Confined spaces can be found in many industrial settings, from steel mills to paper mills, from factories to farms, and from public utilities to the construction industry.

Work Activities Covered by OSHA's Confined Spaces Standard

This standard applies to construction work performed in spaces meeting OSHA's definition of "confined spaces" except certain activities that are subject to the confined spaces provisions of other OSHA construction standards, including the following:

- Diving operations are regulated by 29 CFR 1926 subpart Y
- Excavation work is regulated by 29 CFR 1926 subpart P

- Underground Construction, Caissons, Cofferdams and Compressed Air operations are regulated by 29 CFR 1926, subpart S

It is important to note that employers engaged in exempted activities are required to comply with the Confined Spaces standard if their workers are exposed to confined space hazards that are not specifically covered by the standards noted above.

Employer Responsibilities

All employers involved in construction activities are responsible for identifying all confined spaces that their employees may be working in and then determining whether any of these spaces meet the definition of permit-required confined spaces. The employer is then responsible to ensure that any workers in are properly protected from the identified hazards.

OSHA's Confined Spaces standard establishes duties for "entry employers," "host employers," and "controlling contractors."

If an employer has undertaken the necessary steps to identify permit spaces, and has identified these on the worksite, they are responsible to inform their workers of the location of any such danger(s) presented by the space. This is often accomplished by posting proper warning signs.

An ***entry employer*** is an employer whose employees actually enter a permit space. Multiple entry employers may be present on any given worksite if the employees of multiple employers enter the space. Every employer of workers entering a permit space is responsible for ensuring the safety of their employees and for complying with all applicable provisions of the Confined Spaces standard.

A ***controlling contractor*** is that employer with overall responsibility for construction at the worksite. This contractor is responsible for coordinating the entry operations when more than one employer will have employees in the permit space and when other activities on the site could result in a hazard in the space. Controlling contractors are also responsible for providing all information they have about any permit space hazards and the precautions previously used in the space.

A ***host employer*** is the employer that owns or manages the property where the construction work is taking place. This employer is responsible for sharing with the controlling contractor any information they might have regarding the hazards of any permit site.

There can never be more than one host employer. In those cases where the owner of the property has contracted with another employer to manage any relevant permit space information that it might have, that managing entity becomes the host employer. In the absence of any such contractual agreement and information exchange, the owner of the property is the host employer.

Summary of OSHA's New Confined Spaces Standard

Every employer is responsible for taking the following steps to protect their employees against the hazards associated with confined spaces:

- Designate a competent person to identify all confined spaces in which employees may work. OSHA defines a competent person as "one who is capable of identify and existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has the authority to take prompt corrective measures to eliminate them." It is not required that the competent person be an employee of any particular employer, but they must have the required authority.
- In those cases where confined spaces are present, the employer is required to have a competent person determine if any of these spaces are "permit spaces."
- If one or more permit spaces are present, the entry employer must protect its employees from the hazards in that space.
- The entry employer is required to train every worker who must enter the permit space, as well as others impacted by the presence of the space and/or related operations.
- The entry employer is required to plan for the safe rescue of all entrants who are unable to exit the space under their own power.

This is only a summary of the requirements of OSHA's Confined Spaces standard for construction operations. This new standard requires significant action and attention by those employers completing work on sites with confined spaces, especially permit spaces.

Identifying Permit Spaces

The thorough and proper identification of permit spaces is critical in order to determine whether or not precautions are required to protect employees entering these spaces—and if hazards exist, what controls are necessary. Failing to take these necessary steps can result in death or serious injury to the exposed workers. The competent person must answer four questions to determine if a confined space is a permit space. If the answer to any of these four questions is "yes," the space is a permit space, with all necessary controls required.

1. **Does the space contain or have the potential to contain a hazardous atmosphere?**
   - This requires the identification of numerous potential hazards and testing, as necessary, to evaluate whether any of the following hazards are, or may be present, PRIOR to workers entering the space:

   - Oxygen deficiency or excess concentrations of oxygen. Oxygen concentrations in the space must be between 19.5 and 23.5 percent;
   - Concentration of any flammable gas, vapor, or mist in excess of 10% of its Lower Explosive Limit (LEL);
   - Airborne combustible dust at a concentration equal to or in excess of its Lower Explosive Limit (LEL); and
   - Atmospheric concentrations of any substance that can cause death, incapacitation, impairment of the ability to self-rescue, injury or acute illness.

Note: Proper procedures for all required testing must be established as part of the employer's confined spaces entry program.

2. **Does the space contain a material with the potential to engulf an entrant?**
   Engulfment is the surrounding of a person by liquid or fine solid substance that can be aspirated or that exert sufficient force on the body to cause strangulation, constriction, or crushing. The competent person completing the analysis must consider whether any liquid or flow able solid could enter the space.

3. **Does the space have an internal configuration such that an employee entering the space could be trapped or asphyxiated by inwardly converging walls or by a floor with a downward slope tapering to a smaller cross section?**
   A confined space with a small cross section can develop a hazardous atmosphere rapidly in inadequate ventilation is provided. This type of space can also prevent a worker from escaping the space or render rescue more difficult.

4. **Does the space contain any other recognized serious safety or health hazard that might pose an immediate danger to the worker's life or health or that might impair their ability to escape from the space if necessary?**
   Consideration must be given to all potential hazards, including fire and explosion, mechanical, electrical, hydraulic, and pneumatic energy, temperature extremes, radiation, chemicals, biological hazards, and much more.

Examples of Confined Spaces

Examples of confined spaces may include, but are not limited to, the following:

- Storage tanks
- Compartments of ships
- Process vessels
- Pits
- Silos
- Vats
- Wells
- Sewers
- Digesters
- Degreasers
- Reaction vessels
- Boilers
- Ventilation and exhaust ducts
- Tunnels
- Underground utility vaults
- Pipelines

Examples of Characteristics of Confined Spaces

Internal Configuration

Open Space: There are no obstacles, barriers, or obstructions within the space. An example of this might be some large, open water tanks with no internal walls, barriers, or baffles.

Obstructed Space: The permit space contains some type of obstruction that a rescuer would need to maneuver around. An example of this type of space would be a baffle or mixing blade.

Elevation

Elevated space: A permit space where the entrance portal or opening is above grade by four feet or more. This type of space usually requires knowledge of high-angle rescue procedures.

Non-elevated space: A permit space with the entrance portal located less than four feet above grade. This type of space will allow the rescue team to transport an injured employee normally, without special procedures.

Portal Size
Restricted Portals: A restricted portal is one of 24 inches or less in the least dimension. Portals of this size are too small to allow a rescuer to simply enter the space while using a Self-Contained Breathing Apparatus (SCBA).

Unrestricted Portals: An unrestricted portal is one of greater than 24 inches in the least dimension. These portals allow relatively free movement into and out of the permit space.

Space Access
Horizontal Portal: This type of portal is located on the side of the permit space. Use of retrieval lines could be difficult when using this type of portal to access a confined space.

Vertical Portal: This type of portal is located either on the top of the permit space (rescuers must climb down to enter the space) or at the bottom of the permit space (rescuers must climb up to enter the space). Vertical portals may require knowledge of rope techniques.

Hazards

The hazards associated with confined spaces that can cause serious injury and death to workers are numerous and potentially complex. Two of the major factors which lead to fatal injuries in confined spaces are:

- The failure to recognize and control the hazards associated with confined spaces.
- Inadequate or incorrect emergency response. If the emergency response is a spontaneous reaction to an emergency situation, as opposed to an appropriately planned and executed response, this can lead to multiple fatalities.

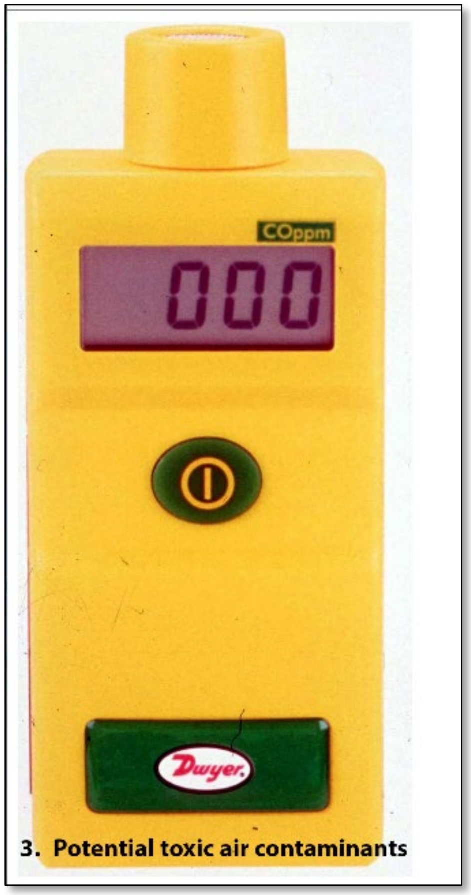
Atmospheric Conditions

In those instances where there is reason to believe that unsafe atmospheric conditions might be encountered, it is critical to test the atmosphere of a confined space prior to entry being made, except in certain circumstances. Dependent upon the findings of the initial monitoring, activities taking place in the space, the history of the space, and other factors, it may be necessary to continue monitoring the atmosphere throughout entry operations.

1. **Oxygen content**

2. **Flammable gases and vapors**

3. **Potential toxic air contaminants**



Oxygen Deficiency

Oxygen deficiency occurs from chemical or biological reactions which displace or consume oxygen from within a confined space. Consumption of oxygen takes place during combustion of flammable substances, as occurs in welding, cutting, or brazing operations. Oxygen may also be displaced by other gases which may inert, hazardous or flammable.

A more subtle form of consumption of oxygen occurs during bacterial action, as in the fermentation process.

Oxygen deficiency can result from bacterial action in excavations and manholes which are near garbage dumps, landfills, or swampy areas.
Oxygen may also be consumed during slow chemical reactions, as in the formation of rust on the exposed surface of metal tanks, vats, and ship holds.

Important Facts about Oxygen and Oxygen Deficiency:

- Ambient air has an oxygen content of approximately 21 percent.
- When the oxygen level drops below 17 percent, one of the first signs of hypoxia is deterioration of night vision, which is usually not noticeable.
- Physiologic effects include increased breathing volume and an accelerated heartbeat.
- Between the oxygen concentrations of 14 percent and 16 percent, the physiologic effects consist of:
  - Increased breathing volume
  - An accelerated heartbeat
  - Poor muscular coordination
  - Impaired judgment
  - Impaired attention
  - Impaired coordination
  - Rapid fatigue
  - Intermittent respiration
- Between the oxygen levels of 6 percent and 10 percent, the physiological effects are:
  - Nausea
  - Vomiting
  - Inability to perform
  - Unconsciousness
- At concentrations of less than 6 percent, there is a rapid loss of consciousness and death in minutes.

Oxygen Displacement: Inert Gases and Simple Asphyxiants

A simple asphyxiating atmosphere contains a gas, or gases, that are physiologically inert and which do not produce any ill effects on the body. However, in sufficient quantity, a simple asphyxiant will displace oxygen and may result in an atmosphere unable to support life.

The ambient, or normal, atmosphere is composed of approximately 21 percent oxygen, 78 percent nitrogen, and 1 percent argon, with small amounts of various other gases.

> **Example:** Examples of simple asphyxiants that have claimed lives in confined spaces include carbon dioxide, argon, and helium.

For example, if 100 percent nitrogen-a non-toxic, colorless, odorless gas-is used to inert (displace oxygen in) a confined space, it will cause immediate collapse and death to the worker if the confined space is not adequately ventilated before worker entry.

Safe Work Practices

- Consider each entry to a confined space to be potentially deadly. Proper testing and safe entry procedures must be followed for each entry.
- Identify and label confined spaces in the workplace.
- Provide written safe-work procedures for entering a confined space and ensure that workers are trained in these procedures.
- Isolate the confined space from adjacent piping by blanking, blinding, or disconnecting the piping.
- Assess the hazards before entering a confined space, including testing for oxygen levels if necessary.

Flammable Atmospheres

A flammable atmosphere generally results from vaporization of flammable liquids, by-products of chemical reaction, enriched oxygen atmospheres, or concentrations of flammable gases or combustible dusts. Three components are necessary for an atmosphere to become flammable: fuel and oxygen, the proper mixture of fuel and oxygen, and a source of ignition.

The proper mixture of fuel and oxygen will vary from gas to gas within a fixed range. This range is between the lower flammability limit (LFL) and the upper flammability limit (UFL). These terms are synonymous with the lower explosive limit (LEL) and the upper explosive limit (UEL).

Example: For example, the explosive range for methane is between 5% and 15% in air. Concentrations below 5% methane are below the explosive range, and concentrations above 15% are too rich to support combustion. If a confined space contains 27% methane and forced ventilation is started, the introduction of air into the confined space may dilute the methane in air, taking it into the explosive range. Extreme care must be taken until the concentration is no greater than 10% of the LEL, at which time entry may be permitted if all other conditions are safe and stable.

Toxic Gases

Toxic gases may be present in confined spaces because:

- The manufacturing process may use any of a wide variety of toxic gases. For example, in producing polyvinyl chloride, hydrogen chloride is used, as well as vinyl chloride monomer.
- There may be biological or chemical processes occurring within the product stored in the confined space. For example, decomposing organic material in a tank or sump can liberate hydrogen sulfide.
- The operation performed in the confined space can liberate a toxic gas. For example, welding can liberate oxides of nitrogen, ozone, and carbon monoxide.

More Information: Toxic gases may be evolved when acids are used for cleaning the interior of a confined space.

Solvents

Hydrocarbon solvents are frequently used in industry as degreasing agents. These agents can cause unconsciousness by depressing the central nervous system. Some chlorinated hydrocarbon solvents, such as chloroform, have been used as anesthetic agents.

In addition, certain chlorinated or fluorinated hydrocarbon solvents are toxic to the heart and have been associated with sudden death in confined spaces. The solvent methylene chloride can be toxic both because of its solvent properties and also because it is metabolized in the body to form carbon monoxide.

Physical Hazards

In addition to the atmospheric hazards in a confined space, physical hazards also must be addressed. Physical hazards cover the entire spectrum of hazardous energy and its control, the physical layout of the environment, and processes underway or previously underway. These hazards include those associated with:

- Mechanical, electrical, and hydraulic energy
- Engulfment
- Communication problems
- Noise
- The size of the openings into the confined space itself

Engulfment

Engulfment in liquids or loose materials is one of the leading causes of death from physical hazards in confined spaces. Engulfment and suffocation are hazards associated with storage bins, silos, and hoppers where grain, sand, gravel, or other loose materials are stored, handled, or transferred, as well as vessels used for liquid storage. The behavior of such materials can be unpredictable, and entrapment and burial can occur in a matter of seconds.

In some cases, material being drawn from the bottom of storage bins can cause the surface to act like quicksand. When a storage bin is emptied from the bottom, the flow of material may form a funnel-shaped path over the outlet. The rate of material flow increases toward the center of the funnel. During an unloading operation, the flow rate can become so great that once a worker is drawn into the flow path, escape is virtually impossible.

Other Physical Hazards

The nature of confined-space work may make it difficult to separate the worker from hazardous forms of energy (e.g., isolation) such as powered machinery, electrical energy, and hydraulic or pneumatic lines.

Examples of physical hazards often encountered in a confined space include the following:

1. Activation of electrical or mechanical equipment can cause injury to workers in a confined space. Therefore, it is essential to de-energize and lockout all electrical circuits and physically disconnect mechanical equipment prior to any work in confined spaces.
2. Release of material through lines which are an integral part of the confined space pose a life-threatening hazard. All lines should be physically disconnected, blanked off, or should use a double block and bleed system.
3. Falling objects can pose a hazard in confined spaces, particularly in spaces which have topside openings for entry, through which tools and other objects may fall and strike a worker.
4. Extremely hot or cold temperatures can make work inside a confined space hazardous. If a confined space has been steam cleaned, for example, it should be allowed to cool before any entry is made.
5. Wet or slick surfaces can cause falls in confined spaces. In addition, wet surfaces can provide a grounding path and increase the hazard of electrocution in areas where electrical equipment, circuits, and tools are used.

6. Noise within confined spaces can be amplified because of the design and acoustic properties of the space. Excessive noise is not only harmful to the worker's hearing, but can affect communication and cause shouted warnings to go unheard.

Prevention Program

The worker who is required to enter and work in a confined space may be exposed to a number of hazards, ranging from an oxygen-deficient or toxic atmosphere to the release of hazardous energy (electrical/mechanical/hydraulic/chemical). Therefore, it is essential for employers to develop and implement a comprehensive, written confined-space entry program.

The following elements are recommended as a guide in developing a confined space program:

1. Identification of all confined spaces at the facility/operation
2. Posting a warning sign at the entrance of all confined spaces
3. Evaluation of hazards associated with each type of confined space
4. Performing a job safety analysis for each task to be performed in the confined space

Confined Space Entry Procedures

Confined space entry procedures include the following:

- Initial plan for entry
- Assigned standby person(s) i.e., attendant(s)
- Communication between workers inside the confined space and standby attendants/persons about rescue procedures, conditions, monitoring information, and more
- Specified work procedures within the confined space

Issuance of Confined Space Entry Permit

A confined-space entry permit is an authorized approval in writing that:

- Specifies the location and type of work to be done.
- Certifies that the space has been evaluated and tested by a qualified person, and that all necessary protective measures have been taken to ensure the safety of the worker.

Testing and monitoring the air quality in the confined space to ensure that the oxygen level is between 19.5 and 23.5 percent by volume and the flammable range is less than

10 percent of the LFL (lower flammable limit) for any flammable materials is required for the permit to be issued.

Confined Space Preparation

Confined space preparation activities may include:

- Isolation, lockout/tagout
- Purging and ventilation
- Cleaning processes
- Requirements for special equipment and tools

Safety Equipment and Protective Clothing

Safety equipment and protective clothing including the following may be required for use in confined space entry operations:

- Head protection
- Hearing protection
- Hand protection
- Foot protection
- Body protection
- Respiratory protection
- Safety belts
- Lifelines, harness
- Mechanical-lift device-tripod

Training

Workers and supervisors must be trained in the selection and use of the following:

- Safe entry procedures
- Respiratory protection
- Lifelines and retrieval systems
- Protective clothing

Safety Meetings

Employers must conduct safety meetings to discuss confined space safety, including the following:

- The availability and use of proper ventilation equipment.
- Monitoring the air quality while workers are in the space.

Lesson Summary

Material being drawn from the bottom of storage bins can cause the surface to act like a quicksand. When a storage bin is emptied from the bottom, the flow of material may form a funnel-shaped path over the outlet. The rate of material flow increases toward the center of the funnel. During an unloading operation, the flow rate can become so great that once a worker is drawn into the flow path, escape is virtually impossible.

Testing and monitoring the air quality in a confined space to ensure that the oxygen level is between 19.5 and 23.5 percent by volume and the flammable range is less than 10 percent of the LFL (lower flammable limit) of any flammable materials is required for a permit to be issued.

Oxygen deficiency occurs from many sources, including chemical or biological reactions that displace or consume oxygen from within a confined space. The consumption of oxygen takes place during combustion of flammable substances, as occurs in welding, cutting, or brazing operations. A more subtle form of consumption of oxygen occurs during bacterial action, such as in the fermentation process.

Lesson 2: Safety and Training Education

Lesson Focus

This lesson focuses on the following topics:

- Duties of Employers and Employees
- Rescue and Emergency Services
- Testing Protocol

Duties of Employers and Employees

All employees required to enter into confined spaces must be instructed as to the nature of the actual and potential hazards involved, the necessary precautions to be taken, and in the use of protective and emergency equipment required.

Duties of Attendants

An attendant:

- Knows the hazards that may be faced during entry, including information on the mode, signs or symptoms, and consequences of potential exposures.
- Is aware of possible behavioral effects of chemical and environmental hazard exposure on authorized entrants.
- Continuously maintains an accurate count of authorized entrants in the permit space and ensures that the means used to identify authorized entrants is accurate and effective.
- Remains outside the permit space during entry operations until relieved by another attendant.
- Communicates with authorized entrants as necessary to monitor entrant status.
- Monitors activities inside and outside of the space.

An entrant has to exit the space:

- If the attendant detects a prohibited condition.
- If the attendant detects the behavioral effects of hazard exposure on an authorized entrant.
- If the attendant detects a situation outside of the space that could endanger the authorized entrants.

Providing Assistance

An attendant must summon rescue and other emergency services as soon as she or he determines that authorized entrants may need assistance to escape from permit space hazards.

The attendant must:

- Warn unauthorized persons that they must stay away from the permit space.
- Inform the authorized entrants and the entry supervisor if unauthorized persons have entered the permit space.
- Perform non-entry rescues as specified by the employer's rescue procedure.
- Perform no duties that might interfere with the attendant's primary duty to monitor and protect the authorized entrants.

Rescue and Emergency Services

The employer of the members of a designated rescue team are required to ensure that the team members have received all training required for authorized entrants and have also been trained to perform their assigned rescue duties. That employer is also responsible for providing all members of the rescue team with necessary personal protective and rescue equipment, including respirators, and must train them on how to use it.

All rescuers must be trained in first aid and CPR. At a minimum, one rescue team member must be certified in first aid and CPR. Employers must ensure that the team practices or performs rescue exercises at least annually and that rescue services are provided access to permit spaces in order to allow for the practicing of rescue operations.

All members of the rescue team must be informed of the hazards of each permit space before entering a space. All rescue services must agree to notify the employer in the event the service becomes unavailable. The employer must provide the service with access to the permit space so the service can develop an appropriate rescue plan and practice rescue as necessary.

If the entry employer designates an off-site rescue service, including a local fire department, it must determine that the service has the ability and equipment to carry out a rescue in the particular permit space or type of permit space in which the entrant is working.

Whether using their own on-site rescue team (consisting of its own or another contractor's employees) or an off-site team, such as a local fire department or other rescue service, the employer must make certain that the rescue team is able to respond in time to enable the injured worker to receive needed medical attention in light of the hazards present in the permit space. This must be done by contacting the rescue team prior to entry and informing them of the nature of the space and the hazards involved. In some cases, this may require a standby rescue team, such as when the entrant is working in an atmosphere that is immediately dangerous to life or health (IDLH) and is wearing an airline respirator or a self-contained breathing apparatus.

Employees Designated to Rescue

An employer whose employees have been designated to provide permit space rescue and emergency services shall take the following measures:

- Provide affected employees with the personal protective equipment (PPE) needed to conduct permit space rescues safely, and train affected employees so they are proficient in the use of that PPE, at no cost to those employees.
- Train affected employees to perform assigned rescue duties. The employer must ensure that such employees successfully complete the training required to establish proficiency as an authorized entrant.
- Train affected employees in basic first-aid and cardiopulmonary resuscitation (CPR). The employer shall ensure that at least one member of the rescue team or service holding a current certification in first aid and CPR is available.
- Ensure that affected employees practice making permit space rescues at least once every 12 months, by means of simulated rescue operations in which they remove dummies, mannequins, or actual persons from the actual permit spaces or from representative permit spaces.

Duties of Authorized Entrants

The duties include:

- Knowing the hazards that may be faced during entry, including information on the mode, signs or symptoms, and consequences of the exposure.
- Properly using equipment as required.
- Communicating with the attendant as necessary to enable the attendant to monitor entrant status and to enable the attendant to alert entrants of the need to evacuate the space.

An authorized entrant must alert the attendant whenever:

- The entrant recognizes any warning sign or symptom of exposure to a dangerous situation.
- The entrant detects a prohibited condition.

Duties of Entry Supervisors

Duties include:

- Knowing the hazards that may be faced during entry, including information on the mode, signs or symptoms, and consequences of the exposure.

- Verifying, by checking that the appropriate entries have been made on the permit, that all tests specified by the permit have been conducted and that all procedures and equipment specified by the permit are in place before endorsing the permit.
- Verifying that rescue services are available and that the means for summoning them are operable.
- Removing unauthorized individuals who enter, or who attempt to enter, the permit space during entry operations.
- Determining whenever responsibility for a permit space entry operation is transferred and doing so at intervals dictated by the hazards and operations performed within the space.

Rescue and Emergency Services

Each authorized entrant shall use a chest or full body harness, with a retrieval line attached at the center of the entrant's back, near shoulder level, above the entrant's head, or at another point from which the employer can establish the ability to successfully remove the entrant.

Wristlets may be used in lieu of the chest or full body harness if the employer can demonstrate that the use of a chest or full body harness is infeasible or creates a greater hazard and that the use of wristlets is the safest and most effective alternative.

The other end of the retrieval line shall be attached to a mechanical device or a fixed point outside the permit space in such a manner that rescue can begin as soon as the rescuer becomes aware that rescue is necessary. A mechanical device shall be available to retrieve personnel from vertical-type permit spaces more than five feet deep.

Safety Data Sheet

If an injured entrant is exposed to a substance for which a Safety Data Sheet (SDS) or other similar written information is required to be kept at the worksite, that SDS or written information shall be made available to any emergency responders and medical facility treating the exposed entrant.

Testing Protocol

Before an employee enters the space, and when necessary and appropriate, the internal atmosphere must be tested, with a calibrated direct-reading instrument, for the following conditions, in the order given:

1. Oxygen content
2. Flammable gases and vapors
3. Potential toxic air contaminants

Lesson Summary

A rescue retrieval line should be attached at one end to a mechanical device or a fixed point outside of the permit space in such a manner that rescue can begin as soon as the rescuer becomes aware that it is necessary and a full body harness is worn by the entrant on the other end. A mechanical device shall be available to retrieve personnel from vertical-type permit spaces more than five feet deep.

An authorized entrant must alert the attendant if he or she recognizes any warning sign or symptom of exposure to a dangerous situation or if the entrant detects a prohibited condition. An entrant must also exit the space if the attendant detects a prohibited condition, the behavioral effects of hazard exposure, or any situation outside of the space that could endanger the entrant.

Module 9: Cranes, Derricks, Hoists, Elevators and Conveyors

Module Description

This module is intended for workers who want to learn more about cranes, derricks, hoists, elevators, and/or conveyors. We will discuss the topics of cranes and derricks, helicopters, base-mounted drum hoists, overhead hoists, conveyors, and aerial lifts in detail in this module along with the safety measures required when handling such machinery. This module will also cover the topics included in OSHA 29 CFR 1926 Subparts N and CC.

Module Learning Objectives

At the conclusion of this module, you should be able to:

- Identify the OSHA regulations which provide the information for this course.
- Distinguish between the different types of cranes.
- Name the procedures for proper inspection and maintenance.
- Summarize guidelines for proper equipment testing and load rating capacities.
- Discuss the proper procedures for crane operators and co-workers.
- Outline regulations for load handling and handling equipment.

Lesson 1: General Standards

Lesson Focus

This lesson focuses on the following topics:

- Definition of Competent Person
- Hazards Associated with Crane Operations
- Accidents

Definition of Competent Person

A competent person is defined as being one who is capable of identifying working conditions which are unsanitary, hazardous, or dangerous to employees and who has the authorization to take prompt corrective measures to eliminate such hazards.

> **Note:** The employer should designate a competent person to inspect all of the machinery and equipment before and during use to ensure that they are within safe working parameters. All deficiencies must be promptly repaired and defective parts replaced before the machine can be used.

Hazards Associated with Crane Operations

OSHA's analysis of crane accidents in general industry and construction identified an average of 71 fatalities per year. A study conducted by OSHA showed that nearly 30 percent of work-related electrocutions involved cranes.

Although mechanical failures represent only 11 percent of the causes of crane accidents, they may result in major accidents involving injuries, fatalities, substantial material costs, and negative media coverage. Studies and analyses show that mechanical failures are frequently due to the result of a lack of preventive maintenance or adequate training, and/or experience on the part of the personnel involved.

Cranes and associated rigging equipment must be inspected regularly to identify any existing or potentially unsafe conditions. Regular inspections should be conducted before and during use. If there are problems, necessary repairs must be made before continuing work. Preventive maintenance must also be performed according to the crane manufacturer and/or the supplier specifications.

Windows in the crane cab must be made of safety glass that prevents distortion, which could interfere with the safe operation of the crane.

Crane Hazards

The following are examples of various crane hazards:

- Improper load rating
- Excessive speeds
- No, unclear, or improper hand signals
- Inadequate inspection and maintenance
- Unguarded parts
- Unguarded swing radius
- Working too close to power lines
- Improper exhaust system
- Shattered windows
- No steps/guardrails walkways
- No boom angle indicator
- Not using outriggers

Planning before Start-Up

Follow the listed safety guidelines before initial start-up:

- Level the crane and ensure support surface is firm and able to support the load
- Contact power line owners and determine precautions; know the location and voltage of overhead power lines
- Know the basic crane capacities, limitations, and job site restrictions, such as the location of power lines, unstable soil, or high winds.
- Make other personnel aware of hoisting activities
- Barricade areas within the swing radius
- Ensure proper maintenance and inspections
- Determine safe areas to store materials and place machinery

Accidents

OSHA has identified the major causes of crane accidents to be:

- Boom or crane contact with energized power lines
- Overturned cranes
- Dropped loads
- Boom collapse
- Crushing by the counter weight
- Outrigger use
- Falls
- Rigging failures

How Do Accidents Occur

Accidents generally occur due to:

- Instability—unsecured load, load capacity exceeded, or ground not level or too soft
- Lack of communication—the point of operation is at a distance from the crane operator or not in full view of the operator
- Lack of training—untrained crane operators are likely to have accidents
- Inadequate maintenance or inspection—cranes or other heavy machinery must not be operated without proper inspection and regular maintenance

Lesson Summary

Cranes and associated rigging equipment must be inspected regularly to identify any existing or potentially unsafe conditions. Regular inspections should be conducted before and during use. If there are problems, necessary repairs must be completed before continuing work. Preventive maintenance must also be performed according to the crane manufacturer and/or the supplier specifications. Studies and analyses show that mechanical failures are frequently due to the result of a lack of preventive maintenance or adequate training, and/or experience on the part of the personnel involved.

Lesson 2: Cranes

Lesson Focus

This lesson focuses on the following topics:

- Types of Cranes
- Load
- Guarding
- Sheaves
- Inspection

Types of Cranes

Among the most commonly used cranes are:

- Truck-mounted cranes, of both the lattice and hydraulic types.
- Crawler cranes, of both the lattice and hydraulic types.
- Tower cranes.

There are several significant differences between these cranes, primarily in boom hoist and load line controls. The somewhat smooth operation of the boom control adjustments on hydraulic cranes may falsely suggest that they are simple to operate. The lattice boom crane's movement, in its boom or in its adjustment in load position, tends to extend and retract less smoothly and may require additional experience to operate smoothly.

Other types of cranes

- Mobile
- Hydraulic
- Overhead
- Gantry
- Tower

The differences between cranes are significant enough to require specific training on each type of crane and with each specific model. It may be unrealistic to expect that every crane operator has the requisite knowledge and proficiency to safely and efficiently operate all of the many diverse types of cranes available today. Furthermore, they cannot be expected to move from one type of crane to another without adequate education and training on the specifics of each piece of equipment.

Load

All equipment must have the recommended operating speeds, rated load capacities, and special hazard warnings conspicuously posted. Instructions and/or warnings shall be posted in such a manner that they are visible to operators when they are at their control stations.

Overturning Accidents

Overloading is responsible for a relatively small portion of mobile crane accidents. Load and load-moment indicators used properly help to ensure that cranes will not be overloaded. In practice, however, they are not fail safe and must not be relied upon without the requisite operator skills and experience for these reasons:

- The device can be turned off or malfunction.
- The device may be out of calibration.
- Operating conditions (such as wind or operating speeds) beyond the published rating information.

The existence of a device alone is not adequate to assure safe crane operation. These devices are not fail-safe devices. They are indicators to advise the crane operator of load parameters to support logical operating decisions.

Crane operators must know the load limits of the crane and the approximate weight of the load about to be lifted. Load weights can often be determined by referring to shipping documentation that accompanies the load. Once the load weight is known, the operator must verify lift calculations and determine if the load is within the load rating of the crane.

The operator must also take into consideration certain conditions that may limit the load rating of a crane:

- The crane is not placed upon a level ground.
- Wind conditions at the time.
- The existence of side loads which may destabilize the crane.
- Lifting over the side, which places the load at an angle to the center of gravity—this may lead to lessened stability.
- The use of extensions, jibs, and other attachments.
- The weight limits of wire ropes, slings, and other lifting devices.

There are four basic lifting principles that govern a crane's mobility and safety during lifting operations: center of gravity, leverage, stability, and structural integrity.

Center of Gravity

This is the point in the object around which its weight is evenly distributed. The location of the center of gravity of a mobile crane depends primarily on the weight and location of its components (boom, carrier, upper-works, and counterweight).

Leverage

Cranes use leverage to lift loads. Rotation of the upper-works (cab, boom, counterweight, and load) changes the location of the center of gravity, known as the leverage point or fulcrum.

Stability

Relationship of the load weight, angle of the boom, and its radius (distance from the crane's center of rotation to the center of the load) to the center of gravity of the load. Stability may also be affected by the support on which the crane is resting. A crane's load rating is generally developed for operations under ideal conditions, i.e., a level firm surface. Unsteady surfaces or soft grounds, therefore, must be avoided. In areas where soft ground poses a support problem, mats and/or blocking should be used to distribute a crane's load and to maintain a level stable condition.

Structural Integrity

The crane's main frame, crawler track, and/or outrigger supports, boom sections, and attachments are all considered part of the structural integrity of lifting. In addition, all wire ropes, including stationary supports or attachment points, help determine lifting capacity and are part of the overall structural integrity determining a crane's lifting capacity.

These elements may also affect structural integrity:

- The load chart capacity in relationship to stability.
- The boom angle limitations that affect stability and capacity.
- The length of boom and radius in determining capacity.

Guarding

Rotating and other moving parts such as gears, shafts, pulleys, sprockets, spindles, drums, fly wheels, and chains must be guarded if they are otherwise exposed to employee contact.

Swing Radius

It is advised that all employees stay out of the swing radius of the crane. A practical method of making sure that the swing radius is clearly visible is to erect barriers. OSHA determined that the preferred way to protect employees in these situations is to completely barricade the entire swing radius of the equipment and prevent employee access to the area.

Guardrails

Runways and steps need to have guardrails, handholds, and slip-resistant surfaces.

Boom Angle Indicator

A boom angle indicator must be located on the crane in a position where it will be clearly visible to the operator.

Supporting Surface

The crane must be uniformly level within one percent of level grade and located on firm footing or operated within the manufacturer's guidelines.

Sheaves

Sheave grooves shall be smooth and free from surface defects which could cause rope damage. All sheave bearings shall be provided with means for lubrication. Permanently lubricated bearings are acceptable. The boom hoisting sheave must have pitch diameters of no less than 18 times the nominal diameter of the rope used.

Inspection

Annual Inspections

A thorough documented inspection of hoisting machinery must be carried out by a competent person on at least an annual basis. In addition to the annual documented inspection, the OSHA standards require a visual inspection before and during each shift and an additional inspection at least once a month. The employer must maintain a record of these inspections and their results.

The following must be inspected on a regular basis:

- Correct air pressure and no leaks
- Tires properly inflated
- Clearance for rotating superstructure

- Wire rope wear
- Physical damage to crane
- Loose or missing hardware, nuts, or bolts
- Fluid leaks

Remove from Use

Immediately remove damaged or defective wire rope from use. Wire ropes should not be used in any of the following conditions:

- In running ropes, with six randomly distributed broken wires in one lay or three broken wires in one strand in one lay.
- Wear of one-third the original diameter of outside individual wires with kinking, crushing, bird caging, or any other damage resulting in distortion of the rope structure.
- Evidence of any heat damage from any cause.
- In standing ropes, more than two broken wires in one lay in sections beyond end connections or more than one broken wire at an end connection.

Training

All operators must be certifiably qualified to operate a specific type of crane before they are allowed to do so. Furthermore, all operators must undergo a period of on-the-job training, so as to familiarize them with any conditions specific to the workplace. Also, there must always be a competent supervisor present at all times.

Lesson Summary

Rotating and other moving parts such as gears, shafts, pulleys, sprockets, spindles, drums, fly wheels, and chains must be guarded if they are otherwise exposed to employee contact. Additionally, it is advised that all employees stay out of the swing radius of a crane. A practical method of making sure that the swing radius is clearly visible is to erect barriers.

Crane operators must know the load limits of the crane and the approximate weight of the load to be lifted. Load weights can often be determined by referring to shipping documentation that accompanies the load, and once the load weight is known, the operator must verify lift calculations to determine if the load is within the load rating of the crane.

In concept, load and load-moment indicators are an ideal means of ensuring that cranes will not be overloaded. In practice, however, they may fall short. The reasons that load or load-moment indicators are not necessarily reliable are:

- The device can be turned off or malfunction.
- The device may be out of calibration.
- Operating conditions might be so far from ideal that the published rating is insufficient to prevent failure.

Also, the somewhat smooth operation of the boom control adjustments on hydraulic cranes may falsely suggest that they are simple to operate. In short, one must account for the four basic lifting principles that govern a crane's mobility and safety during lifting operations: center of gravity, leverage, stability, and structural integrity.

Lesson 3: Cranes and Rigging

Lesson Focus

This lesson focuses on the following topics:

- Cranes and Derricks
- Floating Cranes and Derricks
- Personnel Platforms
- Platform Specifications
- Rigging
- Platform-Related Work Practices

Cranes and Derricks

A machine with a long projecting arm, which is used to move heavy objects from one place to another, is called a crane.

A derrick is a lifting device composed at minimum of a one guyed mast, as in a gin pole, which may be articulated over a load by adjusting its guys.

Floating Cranes and Derricks

Mobile Cranes Mounted on Barges

Always make sure that the rated load of the crane does not exceed the original capacity specified by the crane's manufacturer. To avoid accidents, a load rating chart with clearly visible letters and figures shall be provided with each crane, and it should be fixed at a location where the chart can easily be read by the operator of the crane. In addition, on barges, always secure mobile cranes positively.

Note: Do not forget to provide the load rating charts to the operators.

Permanently Mounted Floating Cranes and Derricks

When installing cranes and derricks permanently on a barge, make sure their capacity and limitations of use are in compliance with current design criteria.

The Provision

Employers and employees should know that using a derrick or crane to hoist workers on a personnel platform is prohibited in most circumstances. The primary exception is when the conventional means of reaching a worksite, such as a ladder, stairway, personnel hoist, scaffold, aerial lift, or elevating platform would be more dangerous or the design of the structure does not allow employees to access the area. In such exceptions, a personnel platform may be used. This restriction varies for work completed under OSHA 1926, Subpart R, Steel Erection. Also, specific exemptions exist for some work related to drill shafts, pile driving, marine worksites, storage tanks, and chimney operations.

Operational Criteria

The activity of hoisting a personnel platform should be performed in a controlled, slow, and cautious manner.

Personnel platforms, wire rope, shackles, and other rigging hardware must not exceed 50 percent of the rated capacity for the radius and configuration of the equipment.

Locking devices (pawls or dogs), load and boom hoist drum brakes, and swing brakes must be engaged when the occupied worker's platform is in a stationary position.

The following manufacturer's specifications should be met when cranes are used for lifting personnel:

- Always make sure that the total weight of the loaded personnel platform and related rigging does not exceed 50 percent of the manufacturer's rated capacity for the configuration and radius of the crane or derrick.
- The load line hoist drum must have a system, other than the load line hoist brake, which regulates the lowering rate of speed of the hoist mechanism. This system or device must be used when hoisting personnel.

Instruments and Components

Cranes and derricks that have variable angle booms should be equipped with a boom angle indicator. The indicators must be placed where they can be easily seen by the operators.

Cranes having telescoping booms must be equipped with an indicator. The indicator should be visible to the operator.

Personnel Platforms

It is important that the suspension system and the personnel platform is designed by a qualified engineer or by a competent person qualified in structural design.

A suspension system should be designed to minimize tipping the platform due to the movement of workers on it. Moreover, the personnel platform should be capable of supporting its own weight and at least five times the maximum intended load without any failure.

Platform Specifications

Guardrail and Grab Rail Systems

A guardrail system must be placed on each personnel platform. The guardrail system should meet the requirements of Subpart M. In addition, the guardrail system must be enclosed from the toe-board to mid-rail with expanded metal having openings no greater than 0.5 inch.

The installation of a grab rail inside the entire perimeter of the personnel platform is very important.

Access Gates

If access gates are installed in the area, make sure that they do not swing outward during hoisting. In addition, to prevent accidents, the gates must be equipped with a restraining device.

Headroom on the Platforms

In order to stand upright on the platform, headroom should be provided for the employees. Furthermore, hard hats must be provided to the employees working on the personnel platform to protect their heads from falling objects.

Rough Edges, Welding and Markings

Always make sure that all rough edges are smoothed or surfaced as they could injure employees who come into contact with them.

Only a qualified welder who is familiar with the weld types, material, and grades is allowed to perform all welding of the personnel platform.

The personnel platforms should have a plate or other permanent markings that indicate the platform's rated load capacity or maximum intended load and the weight of the platform.

Occupancy of the Platform

Only necessary employees (employees required to perform the work) can occupy the personnel platform. The platform can only be used for employee tools and materials necessary to perform the work. When employees are not being hoisted, the personnel platform should not be used for hoisting tools and materials.

Rigging

If you are using a wire rope bridle to connect the personnel platform to the load line, always make sure that each bridle leg is connected to the shackle or master link and that the load is equally divided among the bridle legs.

Master links, shackles, wire rope, and all other rigging hardware must be capable of supporting at least five times the maximum intended load without failure. Furthermore, when using rotation resistant rope, the slings must be capable of supporting at least ten times the maximum intended load without failure.

Bridles and associated rigging for attaching the personnel platform to the hoist line can only be used for the platform, necessary employees, their tools, and the materials necessary for work. When bridles and associated rigging are not hoisting personnel, they should not be used for other purposes.

Platform-Related Work Practices

When a platform is being raised, lowered, and positioned, it is vital that employees keep all parts of the body inside, as doing otherwise could lead to an accident.

When possible, ensure that the platform is secured to the structure where the work is to be performed. If a hoisted platform is not secured, employees should not leave or enter the platform.

In addition, when the crane engine is running and the platform is occupied, the crane or derrick operator should remain at the controls at all times.

Dangerous Conditions

Do not hoist employees if weather conditions are bad, or if any other indication of impending danger exists. If employees are hoisted and a dangerous situation arises, they should be grounded immediately and safely.
Always remember, when employees are suspended on a platform, not to lift anything on another of the crane's or derrick's load lines as it could lead to an emergency situation.

Lesson Summary

Only necessary employees should occupy a personnel platform, and the platform must only be used for employee tools and materials necessary to perform the work. When employees are not being hoisted, the personnel platform should not be used for hoisting tools and materials.

Additionally, a suspension system should be designed to minimize tipping the platform due to the movement of workers. Moreover, the personnel platform should be capable of supporting its own weight and at least five times the maximum intended load without any failure. The activity of hoisting a personnel platform should be performed in a controlled, slow, and cautious manner.

When the crane engine is running and the platform is occupied, the crane or derrick operator should remain at the controls at all times. When a platform is being raised, lowered, and positioned, it is vital that employees keep all parts of the body inside, as doing otherwise could lead to an accident.

Employers and employees should know that using a derrick or crane to hoist workers on a personnel platform is normally prohibited. The primary exception is when the conventional means of reaching a worksite such as a ladder, stairway, personnel hoist, scaffold, aerial lift, or elevating platform would be more dangerous, or the design of the structure does not allow employees to access the area. In such exceptions, a personnel platform may be used. Additional exceptions related to specific operations also exist.

Module 10: Ergonomics

Module Description

Employees who work in non-office environments are routinely required to carry out tasks that involve movement and physical exertion. These forceful exertions associated with such tasks may lead to fatigue, musculoskeletal disorders, and other serious injuries.

This module is designed to help employees identify work-related problems and learn to apply the principles of ergonomics in order to make their jobs less physically demanding, thereby increasing their overall efficiency.

Module Learning Objectives

At the completion of this module, you should be able to:

- Discuss what is meant by ergonomics.
- Name the factors that may contribute to problems in a non-office work environment.
- Identify the causes of musculoskeletal disorders.
- Apply effective ergonomic principles at your workplace.

Lesson 1: Ergonomics in the Workplace

Lesson Focus

This lesson focuses on the following topics:

- Introduction
- Musculoskeletal Disorders (MSDs)
- Risk Factors

Introduction

Many workers across the United States have to carry out physically demanding tasks each day while on the job. If these tasks are not carried out in proper postures, they may cause fatigue or discomfort.

Musculoskeletal Disorders (MSDs)

Carrying out such tasks for prolonged periods may cause severe damage to muscles, ligaments, tendons, blood vessels, and nerves. Such injuries include musculoskeletal disorders (MSDs). MSDs not only affect individual workers but also increase the cost of business in terms of higher workers' compensation premiums, increased employee turnover, absenteeism, and decreased efficiency. Overall productivity can also be greatly affected.

In order to reduce the costs associated with MSDs and avoid the problem of work-related injuries, employers must implement the principles of ergonomics in their workplaces.

Why Are MSDs a Problem?

Many reasons exist for considering MSDs a problem, including the following:

- MSDs are among the most prevalent lost-time injuries and illnesses in almost every industry [Bureau of Labor Statistics 1995, 1996; National Safety Council 1995; Tanaka et al., 1995].
- MSDs, specifically those involving the back, are among the most costly occupational problems [National Safety Council 1995; Webster and Snook 1994; Guo et al., 1995; Frymoyer and Cats-Baril 1991].

- Job activities that may cause MSDs span diverse workplaces and job operations (see Table 1; see also Tray 1-A of the Toolbox).
- MSDs may cause a great deal of pain and suffering among afflicted workers.
- MSDs may decrease productivity and the quality of products and services. Workers experiencing aches and pains on the job may not be able to do quality work.
- Because musculoskeletal disorders have been associated with non-work activities (e.g., sports) and medical conditions (e.g., renal disease, rheumatoid arthritis), it is difficult to determine the proportion due solely to occupation. For example, in the general population, non-occupational causes of low back pain may be more common than workplace causes [Liira et al., 1996]. However, even in these cases, the musculoskeletal disorders may be aggravated by workplace factors.

Medical Conditions Associated with Musculoskeletal Symptoms

- Conditions associated with MSDs include:
- Muscle strain or fatigue
- Tendonitis
- Epicondylitis or "tennis elbow"
- Carpal tunnel syndrome
- Other "pinched" nerve entrapment syndrome
- Nerve injury/irritation from external compression
- Arthritis and other rheumatological disorders

Ergonomics, also known as human engineering, is the practice of designing machines, products, and places to better accommodate people. The principles of ergonomics are geared towards adapting the design and engineering of products and workplaces to people's sizes and shapes, physical strengths and limitations, biological needs, ability to handle information and make decisions, as well as their capacities for dealing with such psychological factors as isolation and stress.

Risk Factors

Risk Categories

There are certain aspects of tasks that can increase the risk of fatigue, musculoskeletal disorder (MSD) symptoms and injuries, or other types of problems. These risk factors can be found in a variety of tasks that an employee is required to carry out and can be divided into two categories: physical factors and environmental factors.

Physical factors

These are fundamentally the interactions between the work area and the worker, and include:

- Awkward postures
- Forceful exertions
- Repetitive tasks or motions
- Pressure points
- Recovery time
- Vibration

Awkward Postures

The position of the body while performing a task is known as posture. The muscle groups used while performing a task are affected by the worker's posture. An awkward position can make the task more physically demanding by overexerting small muscle groups and not using larger muscle groups. This can increase the likelihood of poor blood-flow, which can lead to fatigue and injury.

Some examples of awkward postures include repeated or prolonged reaching, bending, twisting, kneeling, holding fixed positions, or squatting. Several areas of the body can be affected due to these postures including shoulders, arms, wrists, hands, knees, neck, and back. Awkward postures are often caused by poorly designed work areas, equipment, and tools along with poor work practices.

Postures to Avoid:

- Prolonged or repetitive flexion or extension of the wrist
- Prolonged or repetitive bending at the waist
- Prolonged standing or sitting without shifting your position
- Suspending an outstretched arm for extended periods of time
- Holding or turning your head consistently to one side
- Any posture that is held repeatedly or for a prolonged time

Motions to Avoid:

- Repeated motion without periods of rest
- Repeated motion with little or no variation
- Repeated motions done with force
- Resting or compressing a body part on or against a surface
- Lifting heavy objects away from the body
- Frequent reaching or working above shoulder height

The following types of employee behavior may indicate the presence of ergonomics-related problems:

- Employees shaking arms and hands or rolling shoulders due to discomfort.
- Employees voluntarily modifying workstations and equipment to increase comfort.
- Employees bringing in ergonomic products to the worksite (such as wrist braces).

Forceful Exertions

The amount of muscular effort required to perform a task is called force. Exerting more force than a body can sustain can cause severe damage to muscles and ligaments. The amount of force required for tools or machinery depends upon various factors, including those that follow:

- Load weight, shape, and bulkiness
- Grip type
- Amount of pressure required to accelerate, or decelerate, the load
-

The degree of risk generally increases with increasing force. Various parts of the body can be affected due to high force, including shoulders, neck, lower back, forearm, wrist, and hands.

> **Note:** The risk of injury due to forceful exertions may increase if other risk factors such as awkward posture, repetitive tasks, and extended duration are also present.

Repetitive Tasks or Motions

Repetitive tasks require workers to perform the same task over and over again, using the same muscles, ligaments, and tendons. Repetitive motion may cause severe damage, injury, and discomfort to the worker. The risk of injury increases if the worker fails to take any breaks to relax his or her muscles.

Pressure Points

Exerting pressure on different parts of the body by pressing them against hard or sharp surfaces may cause injury. Some body parts are at a greater risk as nerves, blood vessels, and tendons are present just under the skin in certain areas. Fingers, wrists, palms, elbows, forearms, and knees are examples of such body parts.

Recovery Time

Recovery time is the amount of time allocated to rest the muscles and tendons in any strained part of the body. It is very important for workers to take pauses between tasks that require forceful exertions. These breaks not only provide relief to workers but also enhance their performance. Employers must assess the duration of breaks according to the workload along with the risk factors present.

Vibration

Exposure to continuous vibration can cause damage if uncontrolled. Exposure to vibration can occur with the use of vibrating tools such as sanders, chippers, chain saws, drills, grinders, routers, and impact guns. Vibrations can cause fatigue, numbness and pain in the exposed area. It may also cause decreased sensitivity to touch and increased sensitivity to cold.

Environmental Factors

Heat Stress

Heat stress is the amount of heat that a body is exposed to while performing a task. Heat stress can be attributed to the worker's environment and also his or her own internal metabolism.

Exposure to excessive heat can cause various disorders, including heat exhaustion, heat cramps and heat stroke. The symptoms of heat stress may include headaches, thirst, nausea, muscle cramps, dizziness, and weakness. Due to the severity of the consequences of heat stress, employees must regularly monitor the workplace and take appropriate preventive measures.

Cold Stress

Cold stress occurs when a worker is exposed to cold temperatures. Cold stress results in the decrease of the worker's body temperature and may cause shivering, unconsciousness, pain, and inadequate circulation of the blood. Cold stress may also cause the worker to lose the ability to grasp due to the decrease in body strength. Cold temperatures combined with the risk factors above may increase the risk of musculoskeletal disorders.

Noise

Continuous sound at levels above 80-85 dB in the workplace can cause severe damage to a worker's hearing. Continued exposure to high noise levels may also result in impaired hearing or permanent deafness, tinnitus, or speech misperception. Furthermore, high levels of noise may also affect the worker's ability to concentrate on his or her work.

Lighting

Improper lighting in the workplace may cause eye fatigue and may result in headaches and a loss of focus. A worker's ability to perform tasks efficiently depends greatly on the proper lighting of the work area.

Lesson Summary

Repetitive tasks require workers to perform the same task over and over again, using the same muscles, ligaments, and tendons. Repetitive motion may cause severe damage, injury, and discomfort to the worker. The risk of injury increases if the worker fails to take breaks to relax his or her muscles.

Recovery time is the amount of time allocated to rest the muscles and tendons in any strained body part. It is very important for workers to take adequate pauses between tasks that require exertions. These breaks not only provide relief to workers but also enhance their performance.

High or continuous vibrations can cause fatigue, numbness, and pain in the exposed area. It may also cause decreased sensitivity to touch and increased sensitivity to cold. To prevent the consequences of heat stress, employers must regularly monitor the workplace and take the appropriate measures to ensure that all employees are adequately protected. In short, in order to reduce the costs associated with musculoskeletal disorders and to avoid the problem of work-related injuries, employers must implement principles of ergonomics in their workplaces.

Lesson 2: Improving the Workplace

Lesson Focus

This lesson focuses on the following topics:

- Introduction
- Engineering Improvements
- Administrative Improvements
- Use of Protective Equipment
- Training

Introduction

Employers can adopt various ergonomic improvements in their workplaces in order to improve the working environment for their employees. Ergonomic improvements can be divided into three categories:

- Engineering Controls
- Administrative Controls
- Use of Protective Equipment

Engineering Controls

Employees can make engineering controls in their workplaces by redesigning, rearranging, modifying or replacing tools, equipment, workstations, products, or actions that increase the risks of injury. Implementing effective engineering controls can greatly reduce the risk factors. The engineering controls that follow are recommended.

Install work tables with work surfaces that can be raised or lowered according to the employee's body size and position. This can reduce bending, reaching, and awkward postures that can contribute to body damage.

Cutout work surfaces may be appropriate to allow employees to adjust their distance from the work table. This can help reduce awkward postures.

By allowing employees to reposition their work, their bending and reaching efforts can be reduced.

Modifying the work surface according to the task can reduce the effort needed to complete the task. For example, to deliver packages from one area to another, workers can slide and roll the packages on the surface rather than lifting and carrying them manually.

Ladders, scaffolds, steps or work platforms must be provided to employees who are required to reach a surface high off the ground to retrieve packages or containers.

If employees are required to place packages and containers on surfaces high off the ground, certain mechanical lifting devices can be used to lift them. This can reduce stress to shoulders, neck, back, and other body parts. This can also reduce force, repetition, and awkward postures in tasks related to lifting or handling heavy objects.

Certain jobs, such as loading and unloading packages from delivery trucks, may require workers to bend their torsos repeatedly. This can again increase the risk of damage to a variety of body parts. This type of operation can be improved significantly by implementing lifting devices, altering the work site, and adopting a wide range of ergonomic solutions.

Employers should provide adjustable equipment that allows employees to accomplish tasks in a comfortable, upright working posture.

All materials, products, and tools that have to be used frequently must be stored in a place that can be accessed easily without requiring the worker to reach high or adopt awkward postures.

Materials should be transported around the workplace using mechanical aids when possible and appropriate. This may reduce the force required, repetition of motions, and awkward postures, while increasing workers' efficiency.

Unnecessary repetitive reaching, twisting, bending, and forceful exertions can be avoided by properly organizing the equipment and materials stored by grouping stored items by container size or shape.

Installing proper lighting systems in the workplace, including all storage facilities, can help reduce eye strains and headaches.

By utilizing good design and carrying out proper maintenance of all machinery and equipment, employees can ensure pressure points on the hands and wrists, awkward postures, and forceful exertions are minimized or avoided.

Exposure to vibration may be reduced by routine maintenance of vibrating equipment, covering handles with vibration-dampening wraps, operating the tool from a distance when possible, using vibration-dampening gloves, using alternate tools that produce less vibration, utilizing vibration isolators for workers who are seated, employing cushioned floor mats for tasks that have to be carried out while standing, or using vibrating tools at low speeds.

Administrative Controls

Administrative controls involve developing work practices and methods that best protect the worker. These are often focused towards devising and implementing new practices and policies in order to allow employees to carry out their jobs effectively and efficiently and avoid any on-the-job injuries, illnesses, and accidents. Administrative controls rely on communication and training, as well as feedback from management and employees on the effectiveness of the controls. Administrative controls may include:

- Job Rotation
- Adjusting Work Schedules and Work Pace
- Allowing More Frequent Breaks
- Modifying Work Practices
- Regular Housekeeping and Maintenance
- Encouraging Regular Exercise

Job Rotation

Adopting a job rotation system may be one effective measure to reduce damage caused to employees by using the same muscle groups every day. With a properly designed and implemented system, employees are rotated through different jobs, thus increasing job and muscle-use variety. Another system through which employees can increase job variety is through job enlargement. Through this system, employers combine two or more jobs or add different tasks to an existing job.

These systems aim to prevent overuse and overexertion of muscles and body parts, by reducing the amount of repetition, altering the pace of work, reducing the physical exertion required, and controlling visual and mental demands.

Adjusting Work Schedules and Work Pace

Employers must be careful not to assign too heavy of a workload to employees. They also must limit the amount of time that an employee spends performing a particularly challenging job in awkward positions even when physical improvements have been incorporated.

Allowing More Frequent Breaks

Breaking work into smaller tasks allows employees to take adequate breaks between them. These breaks may help employees relax their muscles, thus preventing fatigue and injury.

Modifying Work Practices

Supervisors and managers should regularly observe how workers perform their jobs. When employees perform all jobs while in a neutral posture, the body is less susceptible to injury. Employees may be able to adopt this posture by sitting or standing upright and not bending any joints into extreme positions; they should keep their necks, backs, arms, and wrists in a neutral position. Supervisors should encourage employees to work in a comfortable position and shift their positions or stretch often.

Other work practices:

- Minimize distances for carrying, pushing, and pulling
- Manage an equal amount of weight in each hand
- Avoid unnecessarily twisting of the body
- Use smooth and even motions, avoiding jerking
- Utilize legs to accomplish tasks rather than using the upper body or back
- Ensure that all paths are free from obstacles and even-surfaced
- Organize tasks to provide a gradual increase in the amount of force required
- Ensure shoes worn are slip-resistant.

Regular Housekeeping and Maintenance

Employers must devise a system to carry out regular housekeeping and maintenance of workspaces, equipment, machinery, and tools. There should be no cluttering in the workspace, as clutter can force employees to reach, bend, or twist their bodies while handling different objects. Additionally, employers must ensure that workspaces comply with the following points:

- All floor surfaces must be kept dry and free of any obstacles when possible. This can minimize hazards associated with slipping or tripping in the work area. Problems related to overexertion can often be minimized by carrying out regular maintenance of all tools and equipment.
- Ensure that handles and padding on vibrating tools are well maintained to help reduce vibration and awkward postures while tasks are being performed.
- All moving or mechanical parts on carts and pulleys are properly lubricated and maintained so as to reduce the amount of force required to move them.

Encouraging Regular Exercise

Regular exercise is very important to one's well-being. It not only keeps the body fit, it reduces the risk of injury. Individuals who are in good physical condition are more productive and sustain fewer injuries.

Employers may encourage their workers to increase their energy levels, coordination, and alertness by exercising regularly. Regular exercise can also increase the efficiency of their joints and improve blood circulation.

Some organizations allow and encourage employees to warm up and engage in proper stretching before beginning work and while taking a break from work.

Use of Protective Equipment

Personal Protective Equipment (PPE) includes all protective equipment, such as gloves, footwear, knee and elbow pads, eye protection and other equipment that employees wear according to the type of task they are involved in.

Gloves

Properly selected gloves help to protect hands from sustaining injuries, improve grip, and avoid contact with chemicals. However, if gloves do not fit properly or are not made of the proper materials, they can restrict hand movement and make it harder for employees to grip things.

Footwear

Choosing the proper footwear according to the nature of the job can greatly reduce the risk of slipping. Some soles are designed to reduce fatigue for employees who are required to stand for long hours while performing a task.

Knee and Elbow Pads

Knee and elbow pads can protect body parts that are pressed against hard or sharp surfaces. These aim to minimize the risk of negatively affecting pressure points until proper engineering improvements can be made.

Back Belts

OSHA does not recognize back belts as effective engineering controls to prevent back injury. While they may be accepted by individual workers because they feel as if they provide additional support, the effectiveness of back belts in the prevention of low back injuries has not been proven in the work environment.

OSHA's preferred approach to prevention of injuries and illnesses, including back injuries, is to eliminate the hazardous conditions in the workplace, primarily through engineering controls.

Training

Training is also an important element of the ergonomics process. Training ensures that employees are informed about ergonomic concerns in the workplace and ways to minimize the risk of injury. Training is best provided by individuals who have experience with ergonomic issues in their workplace. Training should be provided annually in a manner and language that all employees can understand.

Training prepares employees for active participation in the ergonomics process, including identifying potential problems, implementing solutions, and evaluating the process. Effective training includes:

- Proper use of equipment, tools, and machine controls
- Good work practices, including proper lifting techniques
- Awareness of work tasks that may lead to pain or injury
- Recognition of MSDs and their early indications
- Addressing early indications of MSDs before serious injury develops
- Procedures for reporting work-related injuries and illnesses

Employees will benefit from orientation and hands-on training received before starting tasks with potential ergonomic risk factors. Employees should also be notified of workplace changes, instructed on using new equipment, and notified of new work procedures.

An effective ergonomics program involves training and education. In order to thoroughly implement the principles of ergonomics, all employees must be trained and provided with guidance about how to use new tools, machinery, equipment, and proper work procedures. An effective training program includes a mix of theoretical and practical ways in which employees can develop their skills to work safely.

An ergonomics training program must include:

- All employees who are exposed to different risk factors
- Supervisors
- Managers
- Appropriate engineers and maintenance personnel

Qualified persons who have a thorough knowledge about the principles of ergonomics greatly improve the quality of training. Additionally, trainers must thoroughly familiarize themselves with the workplace before devising a program.

All supervisors who have to administer an ergonomics program should be provided with special training focusing on how to effectively incorporate sound ergonomic principles and practices into the workplace.

Trainers must consider communication levels before devising the training program. They should adopt a language and style that is easy for all employees to understand and relate to.

Apart from ergonomic principles, the training must also include the risk potential of damage to the body and injuries that can result from the failure to adopt sound ergonomic principles and practices.

Employee training must consist of both general and specific job-related skill sets.

General Training

Employers must provide formal training to all employees who could be exposed to ergonomic hazards to inform them about the hazards associated with their jobs and the tools, machinery, and equipment they use. Information that must be included in the training includes specific risk factors, their causes, recognizing and reporting symptoms, and the prevention of these occurrences.

Job Specific Training

All new employees and those assigned new tasks must be made aware of the specific risks associated with a particular job before they start their work. A practical demonstration should be arranged in order to show the employees how to use all the tools and equipment properly and how to carry out all procedures efficiently. The initial training program should incorporate the following:

- How to use, handle, and maintain all tools, machinery, and equipment that have to be used as a part of the job
- How to use the special tools, if any, associated with a particular job
- How to use safety equipment and guards along with personal protective equipment to ensure safety
- How to properly lift and the proper procedures to follow when an object is too heavy to lift safely without assistance

Training for Supervisors

It is the responsibility of supervisors to ensure that all employees are properly trained to follow safe work practices and that these practices are followed on a consistent basis. In addition to the training received by employees, supervisors should receive additional training that enables them to recognize early risk signs and symptoms, hazardous work practices, how to correct those practices, and how to reinforce the ergonomic program.

Training for Managers

Apart from employees and supervisors, managers must also be made aware of their responsibilities to implement ergonomic principles that ensure the safety and health of all employees. They must also be familiar with the problems and risks associated with all tasks.

Training for Engineers and Maintenance Personnel

On-site engineers and maintenance personnel must also be trained so that they can recommend and implement the best possible machinery, equipment, designs, work practices, and tools to reduce the risk of injury and bodily damage to employees.

Lesson Summary

All supervisors required to administer an ergonomics program should be provided with special training focusing on how to effectively make the workplace safe by adopting sound ergonomic principles and practices. Apart from ergonomic principles, the training must also include the risk potential of damage to the body and injuries that can result from the failure to adopt proper ergonomic practices.

Employers must provide formal training to all employees who could be exposed to hazards to inform them about the hazards associated with their jobs and the tools, machinery, and equipment they use. New employees and those assigned new tasks must be made aware of the specific risks associated with a particular job before they start their work.

An ergonomics training program must include:

- All employees who are exposed to different risk factors
- Supervisors
- Managers
- All engineers and maintenance personnel

An effective training program includes a mix of both theoretical and practical ways in which employees can develop their skills to work safely. They must manage the amount of time that an employee spends performing a particularly challenging job.

Module 11: Excavations

Module Description

Cave-ins are considered the most dangerous trench and excavation hazard. Other potentially fatal hazards also exist in excavations, such as asphyxiation due to lack of oxygen in a confined space, inhalation of toxic fumes, flammable gases, falls, and water accumulation that can cause drowning. The OSHA standards exist to protect workers in trenches and excavations.

This module gives you a basic understanding of how to work safely in excavations and what important points and requirements must be considered when working in an excavation.

Module Learning Objectives

At the conclusion of this module, you should be able to:

- Identify factors that pose a hazard to employees working in excavations
- Discover how to protect employees from cave-ins
- Describe the role of a competent person at an excavation site
- Explore other related issues associated with excavations

Lesson 1: Standards and Protection

Lesson Focus

This lesson focuses on the following topics:

- OSHA Standards
- The Dangers of Excavations
- Protection of Employees
- Choosing a Protective System
- Installation and Removal of Protective Systems
- Warning System for Mobile Equipment

OSHA Standards

OSHA Standards Application

The OSHA standards are applicable to all man-made open excavations in the earth's surface. Excavations by definition include trenches.

OSHA Standards Exemptions

House foundation/basement excavations (including those that become trenches by definition when formwork, foundations, or walls are constructed) are exempt from the OSHA requirements for protective systems if they meet the following conditions:

- *The house foundation/basement excavation is less than seven and one-half feet in depth or is benched for at least two (2) feet horizontally for every five (5) feet or less of vertical height.*
- *The minimum horizontal width (excavation face to formwork/wall) at the bottom of the excavation is as wide as practicable but not less than two (2) feet.*
- *There is no water, surface tension cracks, nor other environmental conditions present that reduce the stability of the excavation.*
- *There is no heavy equipment operating in the vicinity that causes vibration to the excavation while employees are in the excavation.*
- *All soil, equipment, and material surcharge loads are no closer in distance to the top edge of the excavation than the excavation is deep; however, when front-end loaders are used to dig the excavations, the soil surcharge load shall be placed as far back from the edge of the excavation as possible, but never closer than two (2) feet.*
- *Work crews in the excavation are the minimum number needed to perform the work.*

- *The work has been planned and is carried out in a manner to minimize the time employees are in the excavation.*

Note: While some residential construction operations may be exempt from the OSHA standards, this does not imply that no related hazards exist. Employers and employees should remain vigilant in ensuring the safety of all workers exposed to the associated dangers.

The Dangers of Excavations

Excavating is considered one of the most hazardous operations in the field of construction. An excavation is any man-made cut, cavity, trench, or depression in the earth's surface formed by earth removal.

Hazards

The dangers of excavations come from the possibility of cave-ins, in addition to the possibility of the following:

- Lack of oxygen-asphyxiation
- Fire
- Accidental break of underground utility (such as gas, electricity) lines
- Collapse due to moving machinery near the edge of the excavations
- Inhalation of toxic materials
- Water accumulation

Adjacent Structure

Any structure that is built or constructed in the surrounding area of an excavation is called an adjacent structure. The main concern when excavations are created near an adjacent structure is the structure's stability. Excavations near adjacent structures may create surcharges, changes in soil conditions, or other disruptions that could lead to an excavation accident.

Protection of Employees

OSHA's primary purpose is to protect employees from hazards present in the workplace. Employers must protect employees from accidents related to cave-ins by designing, implementing, and enforcing use of excavation protective systems.

Exceptions to the requirement for excavation protective systems include circumstances where:

- Excavations are made entirely in stable rock.

- Excavations are less than 5 feet (1.52 m) in depth, and examination of the ground by a competent person provides no indication of a potential cave-in.

Protective systems shall have the capacity to resist without failure all loads that are intended or could reasonably be expected to be applied or transmitted to the system.

Sloping

Protective systems include sloping and benching systems, shield systems, and support systems. A well designed protective system is one that works for the type of soil, depth of cut, and the type of construction being performed in the trench.

> **More Information:** Correct design of sloping, support, shield, benching, and other protective systems is crucial.

Benching

Benching refers to the formation of one or a series of horizontal levels or steps along the side walls of an excavation, often with vertical or near-vertical surfaces between levels.

Shoring or Shielding

Shoring provides support to excavation walls. It is often used where the location or depth of the cut makes sloping back to the maximum allowable slope impractical.

Trench Boxes or Shields

Both trench boxes and shoring serve to protect workers from cave-ins. Trench boxes differ from shoring, however, in that trench boxes are shields provide continuous equal protection on two sides of an excavation for the entire length of the box.

Some important factors related to the proper installation of trench boxes are:

- The excavated area between the outside of the trench box and the face of the trench should be as small as possible.
- The space between the trench box and the excavation side may be backfilled (or other means may be used) to prevent lateral movement of the box.
- Shields may not be subjected to loads exceeding those which the system was designed to withstand.

Trench boxes are usually made of aluminum or steel, and may be used in combination with sloping and benching. In addition, trench boxes must be inspected regularly, properly maintained, and used under the supervision of a competent person.

More Information: Vibrations from continuous traffic along the adjacent road can undermine the soil and cause a cave-in.

Aluminum Hydraulic Shoring

Hydraulic trench support systems can be directly dropped into an excavation. By increasing hydraulic pressure, the qualified operator can prevent the forms from moving or shifting while workers are in the trench. In addition, trench pins are installed in case of hydraulic system failure.

Choosing a Protective System

The following factors should be considered when designing an effective excavation protective system:

- Soil classification
- Depth of cut
- Water content of soil
- Changes due to weather and climate
- Other operations in the vicinity
- Availability of various protective equipment

Note: Excavations 20 feet and greater in depth must have a protective system that is planned and designed by a professional engineer. The plan must be stamped by the registered professional engineer and kept on the project site.

Installation and Removal of Protective Systems

When installing support systems, the following requirements are vital for proper employee protection:

- Securely connect members of support systems
- Safely install support systems
- Never overload members of support systems
- Install other structural members to carry loads imposed on the support system when temporary removal of individual members is necessary
- Backfilling shall progress together with the removal of support systems from excavations

Warning System for Mobile Equipment

If mobile equipment is operated adjacent to or near 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, some type of warning system must be implemented.

Types of warning systems include:

- Barricades
- Hand or mechanical signals
- Stop logs

Likewise, the grade should slope away from the excavation, if possible.

Excavations

Excavations must be immediately filled back to their normal state after completing the work. Once the excavation has been cleared, workers should carefully remove the protective system, starting from the bottom up, while taking care in releasing all supporting members.

Excavations under sidewalks and pavements are prohibited unless you provide an appropriately designed support system or another effective means of support. The standard requires you to take the following steps to protect employees when installing support systems:

- Connect members of support systems securely,
- Install support systems safely,
- Avoid overloading members of support systems, and
- Install other structural members to carry loads imposed on the support system when you need to remove individual members temporarily.

More Information: Construction of excavations under sidewalks and pavement are not allowed unless a properly designed support system is in place, or other effective supporting means have been implemented.

Case Study

An Excavation Collapsed

This accident occurred when earth that fell into an excavation at an agricultural channel was being removed.
The original project called for a trench to be excavated so that two drainage pipes could be installed. On the day of the accident, a water pipe that was already buried in the trench at a depth of 28 inches was broken by a landslide. This caused earth to fall into the trench.

There were three workers on this project. Soon after the project began, a worker, not working inside the trench, noticed a crack in the earth near the edge of the excavation. The worker immediately warned the workers inside the excavation. All three workers attempted to exit the trench, but all could not get out before the slope of the trench collapsed. One worker who was working at the bottom of the trench was buried by the fallen earth and later died.

Reasons

- Lack of appropriate operations plans.
- Sufficient measures were not taken to protect against collapse of the ground.
- The work was being performed without proper supervision.
- Protective systems were not in place.

Lesson Summary

Excavating is considered one of the most hazardous operations in the field of construction. Excavations must be immediately filled back to their normal state after work is completed.

Trench boxes are usually made of aluminum or steel, and may be used in combination with sloping and benching. Trench boxes must be inspected regularly, maintained properly, and used under the supervision of a competent person. Once the excavation has been cleared, workers should carefully remove the protective system, starting from the bottom up, while taking care with the releasing of supporting members.

Lesson 2: Essentials of Excavations

Lesson Focus

This lesson focuses on the following topics:

- Hazardous Conditions
- Access and Egress
- Falls and Equipment
- Planning
- Competent Person

Hazardous Conditions

Materials and Equipment

Employers are responsible for ensuring that materials and equipment are in good working condition since damaged and defective materials and equipment could cause excavation accidents.

To prevent accidents and hazards, the employer must ensure that:

- Equipment and materials are not damaged or defective.
- Manufactured equipment is stored according to the directions of the manufacturer and in such a way that will prevent employees' exposure to any related hazards.
- Any damaged equipment or defective material is removed from service and not used until it is evaluated and approved or rejected by a registered professional engineer or competent person, as appropriate.

Spoils

Employees must be protected from material or equipment that could fall or roll into excavations. Adequate retaining devices must be installed to protect exposed excavation workers. Spoils (removed soil) must be placed in such a way that water (rain, ruptured pipes, etc.) is diverted away from the excavation.

More Information: Never place spoils within two feet of an excavation's edge.

Water Accumulation

OSHA standards prohibit excessive water accumulations or any water accumulation where properly monitored water removal equipment is not in place when workers are in the trench.

Employees shall not work in excavations in which there is accumulated water, or in excavations in which water is accumulating, unless adequate precautions have been taken to protect employees against the hazards posed by water accumulation.

The precautions necessary to protect employees adequately vary with each situation, but could include special support or shield systems to protect them from cave-ins, water removal to control the level of accumulating water, or the use of safety harnesses and lifelines.

A competent person must monitor any excavation project until it is completed when workers are in the trench, and water removal equipment is being used.

Surface Water

Diversion ditches, dikes, or any other suitable method can be used to prevent surface water from entering into an excavation. Furthermore, a competent person must inspect excavations after heavy rains.

More Information: Remember! Water in an excavation is potentially lethal.

Hazardous Atmospheres

Where oxygen deficiency (atmospheres containing less than 19.5 percent oxygen) or a hazardous atmosphere exists or could reasonably be expected to exist, such as in excavations in landfill areas or excavations in areas where hazardous substances are stored nearby, the atmospheres in the excavation shall be tested before employees enter excavations greater than 4 feet (1.22 m) in depth.

If a hazardous condition is present or likely to be present in an excavation, controls such as ventilation or proper respirators must be provided. Atmospheric contaminants must be tested regularly while performing work in a hazardous atmosphere/environment.

Emergency Rescue Equipment

Easily accessible emergency rescue equipment must be provided by the employer in the event that adverse atmospheric conditions exist or may reasonably be expected to develop during work in an excavation.

Types of emergency rescue equipment include:

- Safety harness and line.
- Breathing apparatus.
- Basket stretcher.

This equipment shall be attended when in use.

Do Not Work Conditions

Employees must not be allowed to work in the following hazardous or toxic atmospheres:

- Atmospheres where oxygen is less than 19.5% or higher than 23.5%.
- Atmospheres where combustible gas concentrations are greater than 20% of the lower flammable limit.
- Atmospheres where threshold limit values for airborne contaminants exceed the American Conference of Industrial Hygienists' (ACGIH) specified limit unless appropriate controls are in place, such as the use of proper respiratory protection.

Access and Egress

Access to and egress from an excavation, are two important issues that must be addressed when working in excavations. It is essential that a stairway, ladder, or ramp be provided in trench excavations 4 feet or more in depth, so as to require no more than 25 feet of lateral travel for employees.

More Information:

- Ramps and runways constructed of two or more structural members shall have the structural members connected together to prevent displacement.
- Structural members used for ramps and runways shall be of uniform thickness.

Surface Crossing

Surface crossings over trenches are not allowed unless conditions dictate such crossings are necessary.

If surface crossings are necessary, such crossings must be constructed under the supervision of a registered professional engineer.

Other crossing requirements include the following:

- Crossings must have a minimum width of 20 inches.
- Crossings must be equipped with standard rails.
- Crossings must extend a minimum of 24 inches past the surface edge of the trench.

Falls and Equipment

In addition to cave-in hazards, other hazards that may exist in excavations include falling loads, movement of mobile equipment, and worker falls.

To reduce the dangers from these hazards, employers must:

- Keep materials or equipment that might fall or roll into an excavation at a minimum distance of two feet from the edge of the excavation, and/or have retaining devices in place to keep materials or equipment out of the excavation site.
- Provide warning systems for mobile equipment such as barricades, hand or mechanical signals, or stop logs to alert the equipment operators when they are approaching the edge of an excavation. In addition to these warning systems, the grade should slope away from the excavation when possible.
- Remove loose rock or soil, or install protective barricades and equivalent protection, to protect employees against falling rock, soil, or materials.
- Prohibit employees from working on faces of sloped or benched excavations at levels above other employees, unless employees at lower levels are adequately protected from the hazard of falling, rolling, or sliding material or equipment.
- Prohibit employees from being underneath loads that are being handled by lifting or digging equipment.
- Require employees to stand away from vehicles that are being loaded or unloaded to avoid being struck by any spillage or falling materials. Operators may remain in the cabs of such vehicles if the cabs provide adequate protection from falling loads during loading and unloading operations.

Planning

Before any excavation work begins, site evaluation and planning must be completed. During the planning stage, the following must be done:

- Soil conditions must be evaluated.
- Protective systems must be designed and put in place.
- Approved safety equipment must be on site and readily accessible.
- Potentially dangerous contact points with utilities such as gas or electric services must be identified.
- Oxygen levels must be tested when conditions exist that indicate that dangerous levels could be present.
- Potentially hazardous fumes or gases must be tested for when conditions exist that indicate the potential presence of these.
- Safe entry and exit points must be determined.

Competent Person

A competent person is an individual who, through training and/or experience, is capable of identifying existing and predictable hazards and who has the necessary authority to ensure that all necessary safety precautions are in place.

Hazardous, unsanitary, or dangerous working conditions must be identified by the employer. In addition, the employer must take immediate action to eliminate or control these hazards and conditions.

A competent person must be designated by the employer and have knowledge related to soil classification, protective systems, and safety standards related to excavation.

Inspections of Excavations

A competent person must make daily inspections of excavations, adjacent areas, and protective systems for evidence of a situation that could result in possible cave-ins, indications of failure of protective systems, hazardous atmospheres, or other hazardous conditions to ensure safe operations.

Inspections must take place:

- Before work starts and as needed throughout shifts.
- After rainstorms, high winds, or other occurrences that may increase hazards.
- When employees are exposed to potential hazards.

Employees must be immediately evacuated from any excavation under the following circumstances:

- A possible cave-in is identified.
- Hazardous atmospheres are detected.
- Protective systems fail.
- When any other potentially dangerous situation arises.

Employees must not be allowed to return to the excavation until the necessary precautions have been taken to ensure their safety. For example, the hazardous condition has been corrected and the corrective system has been returned to its fully operational condition.

Lesson Summary

It is essential that a stairway, ladder, or ramp be provided in trench excavations four feet or more in depth, so as to require no more than 25 feet of lateral travel for employees.

When workers are in the trench, and water removal equipment is being used, a competent person must monitor any excavation project until it is completed.

Employees are not to work in excavations in which there is accumulated water, or in excavations in which water is accumulating, unless adequate precautions have been taken to protect employees against the hazards posed by water accumulation.

Lesson 3: Soil Classification Systems

Lesson Focus

This lesson focuses on the following topics:

- Soil Classification
- Classification of Soil and Rock Deposits

Soil Classification

A competent person must decide when to install a protective system when trenches are less than five feet deep. Soil classification is one of the factors that influences the construction of a protective system.

Cohesive Soil

Cohesive soil has high clay content and is very durable and strong. It doesn't break up or decay easily and can often be excavated using vertical side slopes. When cohesive soil is moist, it is said to be in plastic form. Cohesive soil doesn't disintegrate when dry and is solid and perseverant when submerged.

Fissured

Fissured soil is soil that tends to break up. Lines of fracture, which may further develop into open cracks, can form along the surface of fissured soil due to tension in the soil.

Granular

Granular soil is gravel, sand, or silt (coarse grained soil), with little or no clay content. These types of soils do not hold any form and are not pliable or flexible when wet. Granular soils easily disintegrate when dry.

Type A

Type A soil is a type of cohesive soil with an unconfined compression strength value of 1.5 ton per square foot (tsf) or greater.

Type A soils with an unconfined compressive strength of 1.5 tsf can be readily indented by the thumb; however, they can be penetrated by the thumb only with very great effort. This test should be conducted on an undisturbed soil sample, such as a large clump of spoil, as soon as practicable after excavation to keep to a minimum the effects of exposure to drying influences.

If the excavation is later exposed to wetting influences (rain, flooding), the classification of the soil must be changed accordingly.

Examples of Type A soil include:

- Clay.
- Silty clay.
- Sandy clay.
- Clay loam.
- Cemented soils, such as caliche and hardpan.

Note: In some cases, silty clay loam and sandy clay loam also are considered Type A soils.

Soils which have the following characteristics, however, are not considered Type A soils:

- The soil is fissured.
- The soil is subject to vibration from heavy traffic, pile driving, or similar effects.
- The soil has been previously disturbed.
- The soil is part of a sloped, layered system where the layers dip into the excavation on a slope of four horizontal to one vertical (4H:1V) or greater.
- The material is subject to other factors that would require it to be classified as a less stable material.

Type B

Cohesive soil with an indefinite strength of more than 0.5 tsf, but less than 1.5 tsf, is called Type B soil. Estimates of unconfined compressive strength of soils can also be obtained by use of a pocket penetrometer or by using a hand-operated shear vane.

Granular soils lacking cohesion, including angular gravel, silt, silt loam, sandy loam—and in some cases, silty clay loam and sandy clay loam—are all examples of Type B soil. Previously disturbed soil (except those types that fall under the category of Type C) can also be classified as Type B.

Type C

Cohesive soils with an unlimited compressive strength of 0.5 tsf or less fall under the category of Type C soils. Type C soils with an unconfined compressive strength of 0.5 tsf can be easily penetrated several inches by the thumb and can be molded by light finger pressure. Gravel, sand, and loamy sand are examples of Type C soils. Submerged soil, soil from which water is freely oozing, and submerged rock that is not stable may also be classified as Type C soils.

Classification of Soil and Rock Deposits

Classification must result from the outcome of at least one visual and at least one manual test carried out by a competent person.

In a layered soil system, the weakest layer is used to categorize the system. However, each layer may be classified individually where a more stable layer lies under a less stable layer.

Visual Tests

Visual analysis is conducted to determine qualitative information regarding the excavation site in general, the soil adjacent to the excavation, the soil forming the sides of the open excavation, and the soil taken as samples from excavated material.

Visual inspections include an examination of soil samples that have been dug up and also soil at the sides of the excavation. The inspector roughly calculates the array and approximate amounts of particle sizes. The inspector should understand that cohesive soil is chiefly composed of fine-grained material, whereas coarse-grained sand or gravel is granular material.

Soil Observation

Observe soil as it is dug up. Cohesive soil is that which stays in clumps when excavated, whereas soil that disintegrates quickly and does not form clumps is granular.

Inspecting Excavation Sites

Inspect the sides of the opened excavation and the surface area adjacent to the digging. Crack-like openings such as tension cracks could point toward fissured material. If clods of soil spall (spall is the flaking or otherwise breaking off from the main portion) off a vertical side, the soil could be fissured. Small spalls may indicate moving ground and can pose potentially dangerous situations.

Disturbed Soil

Examine the area next to the dig to identify previously disturbed soil (proof of existing utility and other underground structures).

Observe the opened side of the digging to identify layered systems. Examine layered systems to identify whether the layers slope upwards towards the dig. Estimate the degree of slope of the layers.

Water and Vibrations

Inspect the area next to the excavation and the sides of the opened excavation for traces of surface water, water seeping from the sides, or signs of the water table level.

Observe the area adjacent to the excavation and the area within the digging for sources of vibration that may affect the strength of the excavation face.

Manual Tests

Plasticity and Pat Test

Shape a moist or wet sample of soil into a ball and try to roll it into threads as thin as 1/8 inch in diameter. Cohesive soil will usually roll into threads without disintegrating. If at least a 2-inch length of 1/8-inch thread can be held by one end without tearing, the soil is cohesive.

On the palm of the hand, spread out a 1/8 or 1/4-inch-thick sample of wet soil. Wipe the surface of the sample with a finger to clear away visible water. Face the surface of the palm upwards and slap the back of the hand moderately 5 to 10 times. If water oozes out to the surface of the sample (surface will appear shiny), the soil is mostly cohesion lacking silt or sand. If no water shows up, then the soil is mostly cohesive clay.

Dry Strength

Granular soil disintegrates on its own, or with controlled pressure, into individual grains or powder when dry. Soils with clay content will break into clumps when dry, and crumble into smaller clumps that can only be broken with considerable pressure. If the dry soil breaks into clumps that cannot be further broken into smaller pieces then the soil may be classified as un-fissured.

Thumb Penetration

The thumb penetration test can be used to evaluate the compressive strength of cohesive soils. This test should be carried out on an undisturbed soil sample as soon as is practical after digging up to reduce the chance of air drying the sample. If, at a later time, the trench is flooded or exposed to rain, etcetera, the soil classification must also be changed.

Type A soils can be indented by the thumb but require greater thumb pressure to penetrate the soil.

Type C soils can be penetrated several inches by the thumb and can be shaped by applying relatively light finger pressure.

Other Strength Tests

Estimates of unconfined compressive strength of soils can also be made by using a pocket penetrometer or a hand-operated shear vane. Other tests include drying and sedimentation.

Lesson Summary

Visual analysis is conducted to determine qualitative information regarding the excavation site in general, the soil adjacent to the excavation, the soil forming the sides of the open excavation, and the soil taken as samples from excavated material. Visual inspections include an examination of soil samples that have been dug up and also soil at the sides of the excavation. The inspector roughly calculates the array and approximate amounts of particle sizes and analyzes the likelihood of a cave-in.

Module 12: Fire Protection and Prevention

Module Description

This module has been designed to deliver firsthand information about fires and fire protection measures. After completing this module, you will be able to identify different types of fires and define the safety measures that can be taken to avoid a disastrous situation. We will also discuss the different types of fire extinguishers in use and discover how careful planning and precautionary measures can be taken to save lives and property.

This module is intended for the general audience. For more information, please contact your local fire department and consult your fire safety and security maintenance supervisor.

Module Learning Objectives

At the conclusion of this module, you should be able to:

- Identify different types of fires and fire extinguishers.
- Discuss fire related-injuries and their immediate remedies.
- Discuss fire protection systems and evacuation during a fire.
- Create evacuation plans and prepare for emergencies.

Lesson 1: Fire Safety Essentials

Lesson Focus

This lesson focuses on the following topics:

- Fires
- Fire Extinguishers
- Fire Safety Alarms
- Rescue and Evacuation
- Injuries and First Aid
- Burns

Fires

The event of something burning (often destructive) is called a fire. Fires occur when the following elements are present:

- Oxygen—air, compressed oxygen
- Burning medium—wood, combustible materials, paper, gasoline, etc.
- Heat source—flames, sparking elements, heaters

Fire Prevention Is Important

Employers should:

- Plan how to prevent fires.
- Train employees on fire prevention.
- Promote strong fire prevention practices, and methods.
- Perform regular inspection of workplaces.

Fire Prevention Plan

OSHA standards require a fire prevention plan to prevent fires and protect all employees from fire hazards.

A fire prevention plan details:

- Names of employees responsible for controlling fire hazards from fuel sources.
- Names of employees responsible for fire prevention equipment or equipment to control fires.
- Safeguarding controls and maintenance of safeguards to prevent accidental fires caused by heat causing machinery, equipment, and materials.
- Handling and storage of combustible or flammable materials.

- Naming specific fire sources and locations and available equipment for fighting fires.

Note: What can start a fire?

A fire can start because of:

- Malfunctioning electrical equipment
- Cigarettes and tobacco related products
- Overheated wiring and equipment
- Welding arcs
- Heating equipment

Types of Fire

Following are the different types of fires:

- **Class A:** Ordinary combustible (rags, paper)
- **Class B:** Combustible/flammable liquids (petroleum, diesel)
- **Class C:** Electrical fires (equipment, breakers)
- **Class D:** Flammable/combustible metal fires (magnesium, potassium)

Class A: Ordinary Combustible

Class A fires involve ordinary combustible materials such as wood, paper, rags, rubbish, and other solids.

Class B: Combustible / Flammable Liquids

Class B fires occur due to flammable and combustible liquids such as gasoline, fuel oil, paint thinner, hydraulic fluids, flammable cleaning solvents, and other hydrocarbon fuels.

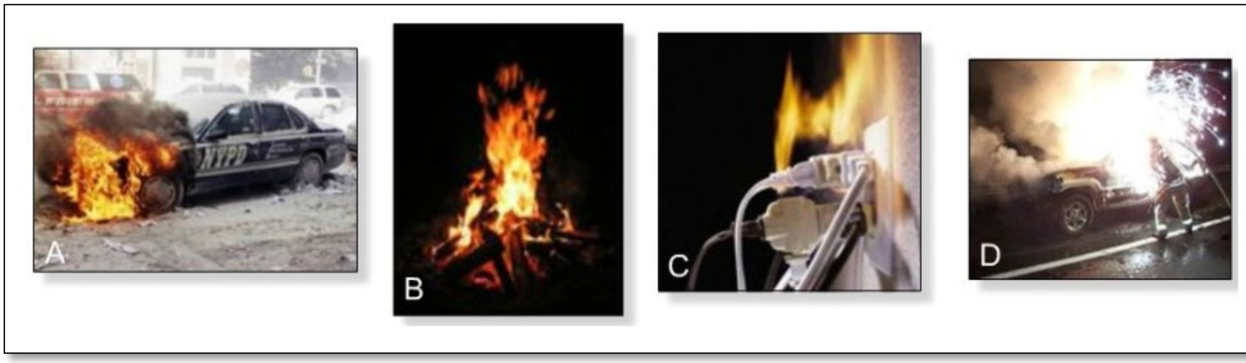
Class C: Electrical Fires

Class C fires involve energized electrical equipment such as power outlets, circuit breakers, defective wiring, and overloaded circuits.

Class D: Flammable/Combustible Metal Fires

Class D fires occur in combustible metals such as magnesium, aluminum powder, and alkali metals.

Many newer model autos have magnesium parts. Auto fires should never be countered with water. Magnesium will react violently to water. In the picture (D) below, the reaction was caused by spraying water onto a magnesium part on the steering column.



Fire Extinguishers

A fire extinguisher is a device used for putting out fires.

There are four different types of fire extinguishers classified according to the type of fire they extinguish. The four different types of fire extinguishers are Class A, B, C, and D. The classes relate to the type of fire they extinguish. Older fire extinguishers used geometric shapes to identify their type, but more current extinguishers use a labeling system that incorporates both words and pictures to distinguish the type of fire they are best suited for.

> **More Information:** Class A and Class B fire extinguishers have a numerical rating that is designed to determine the extinguishing potential for each size and type of extinguisher.

Classification of Fire Extinguishers

The types of extinguishers and their uses are given below:

- **Class A**-Pressurized water cans, clean agent/halogen, and wet chemical for specific applications
- **Class B**-Carbon dioxide, dry chemical, wet chemical, clean agent/halogen
- **Class C**-Dry chemical, carbon dioxide, clean agent/halogen
- **Class D**-Dry powder
- **Multi-class extinguishers**-carbon dioxide/dry chemical

More Information: Extinguishers must be placed in an easily accessible location and should be in good operating condition. Extinguishers should be placed adjacent to a normal path of travel. At a minimum, fire extinguishers must be placed at all points of egress on construction projects and in close proximity of combustible/flammable materials stored on the site. The proper class must be marked on the extinguisher, so that it can be used according to the class of fire.

Class A Extinguishers

Class A extinguishers are water-based or wet chemical solutions that are used on paper, cloth, wood, trash, and other common combustible fires. These extinguishers utilize a cooling and soaking stream that is effective on Class A fires. The numerical rating for this class of fire extinguisher refers to the amount of water the fire extinguisher holds and to the amount of fire it will extinguish.

Class B Extinguishers

Class B extinguishers are pressurized with non-flammable carbon dioxide gas, dry chemical, wet chemical, or clean agent/halogen. Carbon dioxide reduces, or smothers, the oxygen content to a point where combustion cannot continue. Carbon dioxide is a clean, non-contaminating, odorless gas and can safely be applied to clothing, equipment, and valuable documents without causing extreme damage.

Class B extinguishers are used on fires involving flammable liquids including grease, gasoline, oil, paint thinner, hydraulic fluids, flammable cleaning solvents, and other hydrocarbon fuels. Carbon dioxide is extremely cold when disbursed from the extinguisher.

The numerical rating for this class of fire extinguisher denotes the area in square feet of a flammable liquid fire that a person can expect to extinguish.

Class C Extinguishers

Class C fire extinguishers are used on fires involving energized electrical equipment. Such fires must be extinguished using a non-conductive extinguishing agent such as carbon dioxide or a dry chemical or a clean agent/halogen. Carbon dioxide is most effective in extinguishing electrical fires, as it does not leave a residue that can harm sensitive electronics.

This class of fire extinguishers does not have a numerical rating. Class C extinguishers have only a letter rating because there is no readily measurable quantity for Class C fires. The presence of the letter "C" indicates that the extinguishing agent is non-conductive.

Class D Extinguishers

Class D extinguishers are designed for use on flammable metals and are often specific to the metal in question. Metals such as magnesium, potassium, titanium, and sodium burn at high temperatures and give off sufficient oxygen to support combustion. These metals react violently with water or other chemicals and must be handled with great care. The most common extinguishers for Class D fires use a dry powder designed specifically for this purpose. A common method of extinguishing small flammable metals fires is to cover the fire in dry sand.

No picture designator is used on Class D extinguishers and this type of extinguisher generally has no rating.

Multi-Class Fire Extinguishers

Many fire extinguishers can be used on more than one class of fire and are called multipurpose extinguishers. Multi-class fire extinguishers are labeled with more than one class designator, such as A-B, B-C, or A-B-C. Multi-class fire extinguishers typically contain dry chemicals and an extinguishing agent that uses a compressed, non-flammable gas as a propellant.

Fire Safety Alarms

Smoke Alarms

In case of a building fire, the first step is to warn the occupants and to evacuate the building as soon as possible. Early fire warnings can be given by means of active smoke and fire alarms installed in strategic locations throughout a building.

The two primary types of smoke alarms in use are ionization and photoelectric alarms. Ionization smoke detectors activate more quickly in fast, flaming fires that consume combustible materials rapidly and spread quickly.

The photoelectric type of smoke detector is quicker to respond in slow, smoldering fires. These types of detectors provide early detection of smoke. When installed correctly, they provide accurate and dependable smoke detection.

> **Note:** A combination of both types of detectors provides the greatest protection against fast moving fires and smoldering fires.

Fire Sprinklers

Fire sprinklers are designed to provide 24-hour protection by detecting and controlling fires before they become a threat to lives or property.

Fire sprinklers are designed to react quickly and independently of one another so that only those detectors in the affected area activate. Most fires are controlled by one or two sprinklers disbursing a minimal amount of water, which reduces the fire and water damage significantly.

Rescue and Evacuation

Comprehensive evacuation plans are designed to assist employers in meeting or exceeding workplace safety standards. These plans must be a cooperative effort between the employers and the employees. Copies should be posted near all exits, stairways, fire extinguishing equipment, and at any other location suitable for maximum exposure.

These plans must contain pre-assessed escape and exit routes, designated assembly points, emergency call points, and the locations of fire extinguishing equipment.

Injuries and First Aid

The majority of fire-related deaths (50-80 percent) are caused by smoke inhalation. Actual flames and burns are second to smoke inhalation as the cause of deaths in fires.

The National Traumatic Occupational Fatalities surveillance system recorded 1,587 fire and flame-related occupational fatalities among the civilian workforce in the United States between 1980 and 1995. Of these fatalities, 433 resulted from 127 incidents that involved 2 or more victims.

> **More Information:** Never enter a fire scene unless you are properly trained to do so and have the appropriate safety equipment immediately available.

Smoke Inhalation

Although smoke inhalation is the primary cause of deaths in fires, it is second to burns in the cause of injuries. Smoke from a fire may contain poison gases or may be hot enough to burn a victim's throat and lungs, resulting in serious breathing problems and even death. Symptoms of heavy smoke inhalation include breathing trouble, coughing, drowsiness, an upset stomach, vomiting, unconsciousness, and death.

It is important to evacuate from a smoky room as quickly as possible. If available, use a piece of wet cloth to cover your mouth and nostrils as you crawl as close to ground level as possible to safety. Once you're in fresh air, rest while taking deep breaths, and do not enter the smoky area until the fire is completely extinguished, all smoke has been removed, and fire officials have cleared the area.

Burns

Treatment of Burns

For all burns beyond mild first degree burns, seek medical attention immediately. Improper treatment can exacerbate damage. Minor first degree burns can be treated by flushing the area with cold running water. Apply a clean, water-cooled cloth over the area to relieve pain. Do not apply ointment. Seek medical attention if the pain persists or if the burn appears worse.

Electrical Burns

Even if there is no visible evidence on the surface of the skin, electrical burns can cause deep tissue damage. Commence CPR/EAR if pulse and breathing are absent. Immediately seek medical attention.

Lesson Summary

While the majority of fire-related deaths are caused by smoke inhalation, actual flames and burns follow this. Although fire sprinklers are designed to provide 24-hour protection by detecting and controlling fires before they become a threat to lives or property, a combination of both types of fire detector (ionization and photoelectric) provide the greatest protection against fast moving and smoldering fires.

Some of the newer fire extinguishers can be used on more than one type of fire. Multi-class fire extinguishers are labeled with more than one class designator, whereas class C extinguishers have only a letter rating because there is no readily measurable quantifier for this type of fire.

Class B extinguishers are pressurized with non-flammable carbon dioxide gas or other product designed for this application. Carbon dioxide reduces, or smothers, the oxygen content to a point where combustion cannot continue. The numerical rating for this class of fire extinguisher denotes the area in square feet of a flammable liquid fire that a person can expect to extinguish.

Class A and Class B fire extinguishers have a numerical rating that is designed to determine the extinguishing potential for each size and type of extinguisher. Class A extinguishers typically have water-based solutions. The numerical designator here refers to the amount of water the fire extinguisher holds and the amount of fire it will extinguish.

Lesson 2: Fire Prevention and Safety Measures

Lesson Focus

This lesson focuses on the following topics:

- Ignition Hazards
- Temporary Buildings
- Open Yard Storage
- Indoor Storage
- Emergency Planning
- Portable Firefighting Equipment
- Fixed Firefighting Equipment

Ignition Hazards

Electrical wiring and equipment should be installed by an experienced electrical professional in compliance with the requirements of applicable safety and building standards.

Smoking should be strictly prohibited in any area that could pose a potential fire hazard. Such areas should be clearly marked with "No Smoking" signs.

Pipe joints to tanks or vessels that carry flammable gases or liquids must be liquid and vapor tight. Above-ground piping must be secured to prevent disengagement at the fitting or at the piping system. This design is mandatory to ensure that any spill resulting from any disengagement could not unduly expose persons, buildings, or structures.

Temporary Buildings

Temporary buildings should not be constructed in any location where the means of exit could be adversely affected.

If a temporary structure is constructed within a building, it is recommended that the structure be made of non-combustible material.

Temporary combustible structures, covering a maximum area of 2,000 square feet, should be constructed at least 10 feet away from any other building and should never be used for storage and handling of flammable or combustible liquids, gases, explosives, or blasting agents or similar hazardous materials.

Open Yard Storage

The following information pertains to open yard storage:

- Combustible materials should be stored in a stable condition and should not be stacked or piled higher than 20 feet.
- Driveways between combustible storage spaces should be at least 15 feet wide and should be properly maintained for easy access.
- The storage site should be kept free from the accumulation of unnecessary combustible materials. Weeds and grass shall be properly maintained and regular checks should be made to ensure cleanup of the storage areas.
- No combustible material shall be stored outdoors within 10 feet of a building or structure.
- Portable fire extinguishing equipment, clearly labeled for the type of fire, should be provided at convenient and conspicuously accessible locations.
- The maximum travel distance to the nearest fire extinguishing unit should not exceed 100 feet.

Indoor Storage

The following information applies to indoor storage:

- Storage should not obstruct exits, no matter how secure the fire evacuation plan may seem. Material shall not be stored within 36 inches of a fire door opening.
- All materials should be stored, handled, and piled with due regard to their fire or ignition characteristics.
- Material should be stacked to minimize the spread of fire internally and to permit convenient access for firefighting.
- The distance from the top of the storage pile to the nearest sprinkler should be at least 18 inches.
- Lighting and heating units should be properly installed and regularly checked to prevent accidental ignition.
- A clearance of 24 inches should be maintained for the path of travel, unless a barricade is provided, in which case no clearance is needed.

Emergency Planning

In the event of a fire, a safe and speedy response depends on how well employees and employers are prepared for emergencies. The response requires proper planning and cooperation among workers, including the planning of escape routes, prevention of fires spreading, and safe evacuation procedures. These well-executed plans can ensure that every worker will safely evacuate in the event of a fire.

Proper planning includes regularly-scheduled safety inspections, and methods of informing fire and rescue personnel if, and when, fires are discovered.

More Information: It is essential that an emergency plan be reviewed at least annually and modified as required. All workers must be provided access to the fire safety plan.

General Requirements

The following are some general requirements for a fire protection plan:

- It is the employer's responsibility to develop a fire protection plan that can be implemented and enforced throughout a company or workforce.
- The employer is also responsible for providing any and all required firefighting equipment and for providing immediate access to such equipment at all times.
- Firefighting equipment must be conspicuously located and maintained in good operating condition at all times. Any defective equipment must be immediately replaced. Employees should either be instructed in the use of this equipment or instructed to not use the equipment.
- The employer should consult with a professional fire protection organization should assistance be needed in implementing an effective fire protection plan.

Water Supply

The following information describes the requirements for maintaining a water supply:

- A temporary or permanent water supply that can provide a sufficient volume, duration, and pressure should be available for the proper operation of firefighting equipment.
- The water supply must be installed and tested as soon as possible.

Portable Firefighting Equipment

Fire Extinguishers and Small Hose Lines

The following information concerns fire extinguishers and small hose lines:

- If employees are expected to use fire extinguishers, they must be selected and placed based on the potential type and size of fire that can occur. The employer shall distribute portable fire extinguishers for use by employees on Class A fires so that the travel distance for employees to any extinguisher is 75 feet (22.9 m) or less.
- At least one fire extinguisher should be located adjacent to a stairway.
- Extinguishers and water drums which are subject to freezing should be protected from cold conditions.

- Carbon tetrachloride and other toxic vaporizing liquid fire extinguishers are prohibited.
- Portable fire extinguishers shall be inspected periodically and maintained in accordance with safety standards.

Fire Hose and Connections

The following information concerns fire hoses and connections:

- Uniformly spaced standpipe systems or hose stations and 1 ½" or smaller hose connected to a sprinkler system installed for emergency use by employees are acceptable as long as they provide total coverage and the employees are trained at least annually in their use.
- If fire connections are not compatible with local firefighting equipment, the contractor should provide adapters, or the equivalent, to permit connections.

Fixed Firefighting Equipment

Sprinkler Protection

Automatic sprinkler protection should be installed, if possible, and should be placed in service as soon as possible.

During demolition or alterations, existing automatic sprinkler installations should be retained in service as long as is reasonable.

Fire Alarm Devices

The following information applies to fire alarm devices:

- An alarm system, telephone system, siren, etc., should be established by the employer so that the employees on the site, as well as the local fire department, can be alerted during an emergency.
- The alarm code and reporting instructions should be posted at or near phones and employee entrances.
- Fire walls and exit stairways, which are required for completed buildings, should be given construction priority.
- Fire cutoffs must be retained in buildings undergoing alterations or demolition until operations necessitate their removal.

Lesson Summary

In the event of a fire, a safe and speedy response depends on how well employees and employers are prepared for an emergency. Thus, proper response requires planning and cooperation among workers, and includes the planning of escape routes, guidelines to prevent fires from spreading, and safe evacuation procedures.

Module 13: Materials Handling, Use and Disposal

Module Description

This module introduces the hazards that are involved in the handling and storage of materials. Different methods of handling and storage are discussed, the hazards they pose to workers, and the methods by which these hazards can be reduced or eliminated from the workplace.

Module Learning Objectives

At the conclusion of this module, you should be able to:

- State the major causes of injury suffered from handling and storing materials.
- Identify the various methods that can be used to prevent injuries.
- Discuss the safety measures involved when operating mechanical handling devices.
- Discuss the various safety and health principles that can be adopted in the workplace.

Lesson 1: The Hazards and Methods of Prevention (Manual Handling)

Lesson Focus

This lesson focuses on the following topics:

- Introduction
- Body Movement
- Methods of Prevention

Introduction

Every industry needs a continuous inflow and outflow of resources and materials. Therefore, there is an ever-present need to handle and store materials that are so vital to industry. However, improper handling and storage of materials can be hazardous if precautions are not taken.

Bulkiness and Weight of Materials

Two of the major hazards involved in handling and storing materials include:

- Bulkiness
- Weight of Materials

Often, handling heavy and bulky objects results in back and spinal injuries. Workers that lift these objects may suffer from acute and chronic back pains.

Body Movement

This is a common factor related to back injuries. Bending, twisting, and turning are some of the common body movements that lead to back and spinal injuries.

Another common factor that can potentially cause severe injuries is falling objects. Materials that have been improperly stacked can present a great danger.

When workers move materials they must be aware of the following:

- Improper lifting may cause strains and sprains.
- Falling materials may cause bruises, fractures, or even death.

It is very important that efforts be made by both the employer and worker to ensure that dangers from improper material handling are minimized, if not eliminated, from the workplace. Inspections of the workplace must be carried out on a periodical basis to ensure that they are free from any related hazards.

Methods of Prevention

If the worker has to manually handle an object, he or she must ask for assistance when a load is:

- Bulky to the extent that it cannot be grasped or lifted properly.
- Bulky to the extent that it cannot be seen around or over.
- One that cannot be handled safely.

Blocks

When placing blocks under raised loads, workers must make sure that the raised loads are kept in a raised position until their hands have been removed from beneath them. The blocks must be large and sturdy enough to be able to support the load. Block materials with cracks, splintered pieces, and rot must not be used.

Handles, Holders, and Protective Equipment

All loads ideally should be moved via mechanical means when possible. When loads are to be moved manually, with the use of handles and holders may minimize chances of injuries to the fingers and hands. In the case of loads with sharp and rough edges, workers must wear gloves. It also may be advisable for a worker to be fitted with steel-toed shoes when carrying heavy or bulky loads, so as to minimize the risk of foot injuries in the case of accidentally dropping the load.

Load Weight and Mechanical Moving Equipment

Workers must never overload mechanical moving equipment. All types of material handling equipment have maximum weight specifications which must be adhered to. As such, the type of equipment used to move a load from one point to another must be dictated by the specifications of the load itself.

Stored Materials

Workers must ensure that stored materials do not create hazards. For example, workers must ensure that storage spaces are not left to accumulate flammable materials, cause explosions or tripping hazards, or easily harbor rats and other pests. Additionally, storage containers must have adequate capacity to handle the height and weight of stored items, as well as being accessible and in good condition.

Bound Material

All materials stored in tiers shall be stacked, racked, blocked, interlocked, or otherwise secured to prevent sliding, falling, or collapse.

Furthermore, maximum safe load limits that have been specified by building inspectors must not be exceeded or otherwise violated, and signs displaying load limits must be posted in all storage areas except for slab on grade.

Height Limitations

Always adhere to height limitations when stacking materials.

Lumber that is manually handled must not be stacked at a height of more than 16 feet; 20 feet if a forklift is being used. Painting stripes on poles and walls is a good way to indicate the maximum height allowed.

Stacking Lumber, Bricks, and Masonry Blocks

If used lumber is being stacked, workers must ensure that all nails have been removed before stacking lumber. Furthermore, workers must ensure that the lumber stacks are on level and solidly supported bracing. Lumber must be stacked such that it is stable and self-supporting.

Loose bricks must not be stacked to heights of more than seven feet. When a stack of loose bricks exceeds four feet, they must be tapered back two inches for every foot of height over and above the four-foot level.

When masonry blocks are stacked to a height of six feet or higher, the stacks must be tapered back one-half block for each tier over the six-foot level.

Bags and Bundles

It is advisable that when bags and bundles are stacked, interlocking rows are used. Bagged materials must be stacked by stepping back the layers and cross-keying the bags at least every ten bags high. When workers remove bags from the stack, they must start with the topmost layer working their way down.

Non-compatible materials shall be segregated in storage. Baled paper and rags must be kept at a minimum of 18 inches from walls, sprinklers, and partitions. Finally, it is advised that boxed materials be banded, or at least held in place using cross-ties or shrink plastic fiber.

Drums, Barrels, and Kegs

- Drums, barrels, and kegs must be stored symmetrically.
- However, if they are stored on their sides, the bottom tiers must be blocked accordingly to prevent them from rolling.
- When barrels are stacked on end, planks must be placed between each tier to make a firm, flat stacking surface.
- If the stack reaches two or more tiers, the lowest tier must be secured on either side to prevent the barrels from shifting.

Availability for the Material

When employees stack materials, they must consider the need for availability of the material. Some materials cannot be stacked due to shape, size, or fragility constraints. In most cases these can be safely stored on shelves or in bins.

Poles, structural steel, and other cylindrical materials can be stored in racks. If they are stacked, they must be blocked to prevent them from spreading and/or tilting. Pipes and bars must not be stored in racks that face the main aisle, as this could be hazardous to passers-by, especially while moving materials.

Lesson Summary

Some materials cannot be stacked due to shape, size, or fragility constraints. In most cases, these can be safely stored on shelves or in bins. All materials stored in tiers must be stacked, racked, blocked, interlocked, or otherwise secured to prevent sliding, falling, or collapse. Storage containers must also have adequate capacity to handle the height and weight of stored items, as well as be accessible and in good condition. Fitting loads with handles and holders may minimize the chances of injuries to the fingers and hands.

Bending, twisting, and turning are some of the common body movements that can lead to back and spinal injuries. Frequent handling of heavy and bulky objects often results in such injuries. Workers that lift these types of objects may suffer from acute and chronic back pains.

Lesson 2: Materials Handling Equipment

Lesson Focus

This lesson focuses on the following topics:

- Conveyors
- Cranes
- Slings
- Powered Industrial Trucks

Conveyors

Risks

The following risks are associated with using conveyors:

- Workers' hands can get caught at points where the conveyor runs over support members.
- If the conveyor passes over a work area, workers can be struck by falling materials.
- A worker can become caught and drawn into the conveyor.

Safety Measures

There are a number of methods an employer can use to reduce the frequency and severity of conveyor-related injuries.

- Emergency buttons or pull cords designed to stop the conveyor must be installed, preferably near worker stations.
- Conveyor belts that are continuously accessible (such as those used in assembly lines) must have emergency stop cables that run along the entire length of the belt.
- Emergency stop systems must be designed in such a manner that they have to be reset before the conveyor can start again. This ensures that the conveyor can run only after an employee has been removed from danger.
- Employees are strictly prohibited from riding on the conveyor.
- When a conveyor passes over a work area, guards must be fitted along the sides of the belt to ensure that materials do not fall on employees.
- In cases where the crossover is low, a warning sign must be displayed or the area must be painted in a bright color that is easily noticeable.

Cranes

Operators

It is very important to note that only qualified, competent persons must be allowed to operate cranes. Operators must know the specifications of all loads they lift, such as what is actually being lifted and its weight. Each crane has a rated capacity that is determined by the length of its boom and the boom radius.

> **Note:** Cranes that have telescopic booms may be capable of lifting a heavier load when the boom length and radius are small. If the boom is extended, the weight of the object can overload the crane.

Movable Cranes

When using movable cranes, the operator must ensure that a boom angle indicator has been fitted. In cases where the crane has a telescopic boom, a means of determining the boom's length also must be present. Load rating charts that are specific to the crane must be placed in the operator's cabin.

Outriggers

Mobile that requires the use of outriggers must be placed on firm, level ground. The outrigger must be placed on timbers or cribbed so as to spread the weight of the crane and the load over a large enough area. This helps to ensure that the crane remains stable and does not tip while in operation.

Loads

Operators must ensure that hoisting chains and ropes are properly attached in reference to the load. This can be achieved by ensuring that loads are connected to the load hooks by slings or fixtures. All sharp edges of loads must be padded to prevent them from cutting into slings.

Safety Inspections

Cranes must be inspected as directed by the manufacturer and OSHA standards by competent persons who are familiar with them. Critical parts such as the operating mechanisms, hooks, and load-carrying components must be checked on at least a daily basis to ensure that no deterioration, damage, or maladjustments have occurred.

Slings

Employers must ensure that slings are visually inspected before and during all operations. A damaged or defective sling must be removed from service immediately.

- Slings must not be shortened with knots, bolts, or by any other means unless they are specifically designed by the manufacturer to do so. The rated capacity of a sling must be noted and strictly adhered to.
- Slings must not be loaded beyond their rated capacity.
- Shock loading is strictly prohibited.
- Jerking the load, rather than slowly picking it up causes the force to be multiplied and can exceed the rated capacity of the sling or chain even though the load weight is a fraction of the capacity.
- Hands or fingers should not be placed between the sling and its load while the sling is being tightened around the load.
- A sling should not be pulled from under a load when the load is resting on the sling.

Powered Industrial Trucks

New powered industrial trucks (e.g. tow motors, forklifts, fork trucks, cherry-pickers, etc.) must meet the design and construction requirements of the American National Standard for Powered Industrial Trucks, Part II, ANSI b56.1-1969. Powered industrial trucks (P.I.T.s) manufactured since 1969 must have identifying marks indicating that they have been inspected and accepted by a nationally accepted testing laboratory.

P.I.T. owners and operators must not make any modifications or additions to the truck without the approval of the manufacturer. If any modifications are made, capacity, operation, and maintenance instruction tags, and signs must be changed to reflect the new requirements.

There are 11 different types of industrial trucks or tractors, each having varying safety levels, constraints, and load capabilities. They all operate under different conditions and environments. In some cases, certain trucks cannot be used, and in other cases they can be used only if approved by a nationally accepted testing laboratory.

Under normal circumstances, P.I.T.s must not be used in atmospheres containing high concentrations of metal dust, carbon black, coal, or coke dust.

In cases of existing high concentrations of magnesium, aluminum, or aluminum bronze dust, the circuit breakers, fuses, switches, and motor controllers of P.I.T.s must be protected or enclosed.

More Information:

- **Metal Dust:** Trucks must not be used in atmospheres containing **Metal Dust.**
- **Carbon Black:** Trucks must not be used in atmospheres containing **Carbon Black.**
- **Coal or Coke Dust:** Trucks must not be used in atmospheres containing **Coal or Coke Dust.**

Some powered industrial trucks have been constructed specifically for use in areas that contain flammable vapors or dusts. Additions, such as safeguards to the exhaust, fuel, and electrical systems, have to be made to the trucks in such cases. Due to the flammability and volatility of the atmosphere, such trucks will have to be equipped with non-electrical ignitions, temperature limitation features, and electrical engines, and many other safety devices.

There are some safety precautions that must be followed when operating and maintaining a powered industrial truck. These include:

- High lift trucks must be fitted with overhead guards.
- Forklifts must be equipped with vertical load backrest extensions that comply with the manufacturer's specifications.
- Battery charging installations must be placed only in areas that have been specified for that purpose.
- A conveyor, overhead hoist or equivalent handling equipment must be used when handling batteries.
- Trucks that have a general lighting of less than two lumens per square foot must be provided with auxiliary directional lighting.
- Arms and legs must not be placed between uprights of the mast or outside the running lines of the truck.
- Overhead installations such as lights, pipes, and sprinkler systems must be adequately protected.
- Personnel working on a properly designed loading platform must have means to shut off power to the truck if needed.
- All trucks that are to undergo repairs to their electrical systems must have their batteries disconnected prior to the repairs.
- Any replacement part for the trucks must have the equivalent safety levels as the original parts.
- Only stable and safely arranged loads are to be handled. Caution must be exercised at all times when handling loads.
- When using trucks to load or unload materials onto train boxcars, trucks, trailers, or railroad cars, the trucks must be secured using brakes and wheel blocks to prevent their movement.

Lesson Summary

Employers must ensure that slings are visually inspected before and during all operations. A damaged or defective sling must be removed from service immediately.

There are a number of methods an employer can use to reduce the severity of crane-, industrial truck-, and conveyor-related injuries. For example, determining the rated capacity of a crane by the length of its boom and the boom radius will aid in preventing potential injuries.

Lesson 3: Ergonomics, Training and Education

Lesson Focus

This lesson focuses on the following topics:

- Ergonomic Safety and Health Principles
- Fire Safety Precautions
- Aisles and Passageways
- Training and Education
- Safety and Health Program Management Guidelines

Ergonomics Safety and Health Principles

Ergonomics is a principle that states that jobs should be adapted to fit the person, rather than the person being forced to fit the job. As such, the study of ergonomics attempts to provide the most conducive environment possible to fit the employee's needs and lead to the greatest possible productivity.

Ergonomics includes changing workplace conditions to make the job as least physically demanding as possible and to reduce the stressors that can lead to trauma or injuries from repetitive actions. In the case of material storage and handling, this may include reducing the size or weight of objects lifted, making use of mechanical lifting aids, or changing the height of pallets and shelves to make them more accessible.

There are numerous methods by which lifting injuries can be prevented, including the implementation of ergonomically designed systems and the proper training and supervision of employees.

In addition to the use of ergonomic principles, there are a number of basic safety precautions that can be employed to reduce the incidence and severity of lifting injuries. These include the use of general fire safety precaution techniques and keeping aisles and passages clear.

Fire Safety Precautions

Employees must always keep in mind that flammable and combustible materials must be stored in accordance to their fire characteristics. For example, when storing flammable liquids, employees must ensure that they are separated from other materials by using fire walls or other appropriate storage facilities and equipment.

Combustibles must be stored in areas where smoking, open flames, and sparks are prohibited. Some materials are only dangerous when they come together. Employees must be aware of the reactive qualities of different materials and keep potentially reactive materials properly separated from each other.

Aisles and Passageways

Sufficient clearance must be allowed in passageways and aisles for the movement of materials mechanically, particularly at loading docks, through doorways, and wherever turns must be made. Providing sufficient clearance will minimize the possibility that workers will get pinned down. Also, sufficient clearance will reduce the risk that a load will strike an obstruction and fall on an employee. As such, all passageways and aisles must be kept clear of obstructions and tripping hazards. Materials should never be stored in aisles.

Training and Education

OSHA requires that all employees participate in training programs related to handling and storage hazards. These programs must contain material that will be helpful to employees in reducing material handling and storage hazards. The training program must include the following:

- Informing employees about the dangers of handling heavy and bulky materials without proper training.
- Illustrating how to avoid unnecessary physical stress and strain.
- Teaching employees to determine what they are able to comfortably handle without having to undergo physical strain.
- Instructing employees about the proper use of equipment.
- Teaching employees how to recognize potential hazards and how to prevent or correct them.

Due to the high incidence of back and spinal injuries that results from manual lifting, safe lifting techniques must be demonstrated to all employees. As such, a training program that is designed to instruct on proper lifting techniques must include:

- The health risks of improper lifting.
- Knowledge of the basic anatomy of the spine, muscles, and joints.
- Awareness of individual body weaknesses and strengths.
- Recognizing the physical factors that may lead to an accident.
- Use of safe lifting postures and timings and how to minimize load—moment effects.
- Use of handling aids such as steps, platforms, handles, etc.

- The warning signals the body may send if you lift something you should not.

Safety and Health Program Management Guidelines

It is imperative that your company's management play an active role in the effective implementation of a safety and health program designed for handling and storage. When management is closely involved with such a program, line supervisors and (by extension) employees can be persuaded of its importance and motivated to take it seriously.

Material Storage

Material stored inside buildings under construction shall neither be placed within 6 feet of any hoist way or inside floor openings, nor within 10 feet of an exterior wall which does not extend above the top of the material stored.

Each employee required to work on stored material in silos, hoppers, tanks, and similar storage areas shall be equipped with personal fall arrest equipment meeting the requirements of Subpart M of this part.

Non-compatible materials shall be segregated in storage.

Materials Stored on Tiers

All materials stored in tiers shall be stacked, racked, blocked, interlocked, or otherwise secured to prevent sliding, falling, or collapse.

Maximum safe load limits of floors within buildings and structures, in pounds per square foot, shall be conspicuously posted in all storage areas, except for floor or slab on grade. Maximum safe loads shall not be exceeded.

Aisles and passageways shall be kept clear to provide for the free and safe movement of material handling equipment or employees. Such areas shall be kept in good repair.

When a difference in road or working levels exists, means such as ramps, blocking, or grading shall be used to ensure the safe movement of vehicles between the two levels.

OSHA's recommended *Safety and Health Program Management Guidelines,* issued in 1989, can provide a blueprint for employers who are seeking guidance about how to effectively manage and protect worker safety and health. The four main elements of an effective occupational safety and health program are:

- Management commitment and employee involvement

- Worksite analysis
- Hazard prevention and control
- Safety and health training

More Information: These elements encompass steps such as:

- Establishing and communicating clear safety and health management program goals.
- Conducting worksite audits to identify existing hazards and eliminate them. Effectively designing the job site or job to prevent hazards.
- Providing essential training to address the safety and health responsibilities of both management and employees.

Dock boards (Bridge Plates)

- Portable and powered dock boards shall be strong enough to carry the load imposed on them.
- Portable dock boards shall be secured in position, either by being anchored or equipped with devices that will prevent their slipping.
- Handholds, or other effective means, shall be provided on portable dock boards to permit safe handling.
- Positive protection shall be provided to prevent railroad cars from being moved while dock boards or bridge plates are in position.

Lesson Summary

It is imperative that your company's management play an active role in the effective implementation of a safety and health program designed for handling materials and their storage. When management is closely involved with such programs, it can persuade supervisors and employees alike of its importance, and motivate them to take the program seriously.

Employees must also be aware of the reactive qualities of different materials and keep them properly segregated. All passage ways must be maintained clear of obstructions. By implementing ergonomically designed systems and training employees, employers can greatly reduce the number of personnel injuries.

Module 14: Motor Vehicles, Mechanized Equipment and Marine Operations; Rollover Protective Structures and Overhead Protection; and Signs, Signals and Barricades

Module Description

This module is intended for workers who need to know about motor vehicles, mechanized equipment, marine operations, rollover protective structures, overhead protection, signs, signals, and barricades.

We will be discussing motor vehicles, mechanized equipment, marine operations, rollover protective structures, overhead protection, signs, signals, and barricades in detail. This course will also cover the topics included in OSHA 29 CFR 1926 Subparts O-Motor Vehicles; W-Rollover Protection; and G-Signs, Signals, and Barricades.

Module Learning Objectives

At the conclusion of this module, you should be able to:

- Identify OSHA standards for Motor Vehicle Safety.
- Demonstrate machine and equipment handling according to OSHA standards.
- Describe how industrial tractors are regulated by OSHA.
- Discuss the purpose of signs and barricades.

Lesson 1: Subpart O-Motor Vehicles

Lesson Focus

This lesson focuses on the following topics:

- General Requirements
- Material Handling Equipment
- Access Roadways and Grades
- Brakes
- Audible Alarms

General Requirements

Introduction

Motor vehicles covered by Subpart O of the OSHA regulations are those vehicles that operate within an off-highway jobsite which is not open to public traffic.

Braking Systems

All vehicles must have a service brake system, an emergency brake system, and a parking brake system. These systems can utilize common components, and they always must be maintained in operable condition.

Headlights and Taillights

Whenever visibility conditions warrant additional light, all vehicles or combinations of vehicles in use, must be equipped with at least two operable headlights and taillights.

Brake Lights

All vehicles, or combinations of vehicles, must have brake lights in operable condition regardless of light conditions.

Audible Warning Devices

All vehicles must be equipped with adequate audible warning devices at the operator's station. These devices must be kept operational.

Obstructed View to the Rear

No employer shall use any motor vehicle equipment having an obstructed view to the rear unless:

- The vehicle has a reverse signal alarm audible above the surrounding noise levels.
- The vehicle is backed up only when an observer signals that it is safe to do so.

Windshields

- All vehicles with cabs must be equipped with windshields and powered wipers.
- Cracked and broken glass must be replaced.
- Vehicles operating in areas, or under conditions, that cause windshields to fog or frost must be equipped with operable defogging and defrosting devices.

Cab Shield

All haulage vehicles with pay loads loaded by cranes, power shovels, loaders, or similar equipment, must have a cab shield and/or canopy adequate to protect the operator from shifting or falling materials.

Transporting Tools and Materials

Tools and materials must be secured to prevent movement when transported in the same compartment with employees.

Transporting Employees

Vehicles used to transport employees must have seats firmly secured and adequate for the number of employees to be carried.

Trucks with Dump Bodies

Trucks with dump bodies must be equipped with positive means of support. The supports must be permanently attached and capable of being locked into position to prevent accidentally lowering a worker during maintenance or inspection work.

Operating Levers

Operating levers controlling hoisting or dumping devices on haulage units must be equipped with latches or other devices that will prevent accidental startup or tripping of the mechanism.

Dump Truck Trip Handles

Trip handles for dump truck tailgates must be installed so the operator can stay clear during dumping.

Mud Flaps

Mud flaps may be used in lieu of fenders whenever motor vehicle equipment is not designed for fenders.

Vehicle Inspection

All vehicles must be checked at the start of each shift to ensure that parts, equipment, and accessories are in safe operating condition and are free of apparent damage that could cause failure while in use. These components include:

- Service brakes-including trailer brake connections.
- Parking system (hand brakes).
- Emergency stopping system (brakes).
- Tires.
- Horn.
- Steering mechanism.
- Coupling devices.
- Seat belts.
- Operating controls.
- Safety devices.

All defects must be corrected before the vehicles are placed in service.

> **Note:** These requirements also apply to equipment such as the following, where the equipment is necessary:
>
> - Lights
> - Reflectors
> - Windshield wipers
> - Defrosters
> - Fire extinguishers

Material Handling Equipment

Seat Belts

Scrapers, loaders, crawler or wheel tractors, bulldozers, off-highway trucks, graders, agricultural and industrial tractors, and similar equipment must be equipped with seat belts.

- Seat belts need not be provided for equipment which is designed only for standup operation.

- Seat belts need not be provided for equipment which does not have rollover protective structure (ROPS) or adequate canopy protection.

Access Roadways and Grades

No employer must move or cause construction equipment or vehicles to be moved on any access roadway or grade, unless the access roadway or grade is constructed and maintained to safely accommodate such movement.
Every emergency access ramp and beam used by an employer must be constructed to restrain and control runaway vehicles.

Brakes

All earth-moving equipment must have a service braking system capable of stopping and holding the fully loaded equipment.

Audible Alarms

- All bidirectional machines, such as rollers, compacters, front-end loaders, bulldozers, and similar equipment, must be equipped with horns, distinguishable from the surrounding noise levels.
- These horns must be operated as needed when machines are moved in either direction. They always must be kept operational.
- No employer shall permit earthmoving or compacting equipment which is limited by an obstructed rear view to be used in reverse gear, unless the equipment has a reverse signal alarm in operation that is distinguishable from the surrounding noise levels, or an employee signals that it is safe to do so.

Lesson Summary

All vehicles must be checked at the start of each shift to ensure that parts, equipment, and accessories are in safe operating condition and are free of apparent damage that could cause failure while in use. All defects must be corrected before the vehicles are placed in service.

Vehicles used to transport employees must have seats firmly secured and adequate for the number of employees to be carried. Tools and materials must also be secured to prevent movement when transported in the same compartment with employees.

All haulage vehicles with pay loads loaded by cranes, power shovels, loaders, or similar equipment, must have a cab shield and/or canopy adequate to protect the operator from shifting or falling materials. No employer shall use any motor vehicle equipment having an obstructed view to the rear unless:

- The vehicle has a reverse signal alarm audible above the surrounding noise levels.
- The vehicle is backed up only when the observer signals that it is safe to do so.

All vehicles must be equipped with adequate audible warning devices at the operator's station. These devices must be kept operational, and whenever visibility conditions warrant additional light, all vehicles or combinations of vehicles in use, must be equipped with at least two operable headlights and taillights.

All vehicles must have a service brake system, an emergency brake system, and a parking brake system. These systems can utilize common components, and they always must be maintained in operable condition.

Lesson 2: Subpart W-Rollover Protective Structures for Material Handling (ROPS)

Lesson Focus

This lesson focuses on the following topics:

- Introduction
- Design of ROPS
- Labeling

Introduction

All rubber-tired, self-propelled scrapers; rubber-tired front-end loaders; rubber-tired dozers; wheel-type agricultural and industrial tractors; crawler tractors; crawler type loaders; and motor graders, with or without attachment that are used in construction work, must have rollover protective structures (ROPS).

More Information: This requirement does not apply to side boom pipe laying tractors.

Design of ROPS

Strength

Rollover protective structures and supporting attachments must be designed, fabricated, and installed in a manner that supports, based on the ultimate strength of the metal, at least two times the weight of the prime mover applied at the point of impact.

Overturn

The design objective must be to minimize the likelihood of a complete overturn and, thereby, minimize the possibility of the operator being crushed as a result of a rollover or upset.

The design must provide a vertical clearance of at least 52 inches from the work deck to the ROPS, at the point of ingress or egress.

Labeling

Each ROPS must have the following information permanently affixed to the structure:

- Manufacturer's or fabricator's name and address.
- ROPS model number, if any.
- Machine make, model, or series number that the structure is designed to fit.

Lesson Summary

The design objective of scrapers, loaders, dozers, tractors, crawlers, and graders discussed, must be to minimize the likelihood of a complete overturn and, thereby, minimize the possibility of the operator being crushed as a result of a rollover or upset. For this reason, rollover protective structures and supporting attachments must be designed, fabricated, and installed in a manner that supports, based on the ultimate strength of the metal, and at least two times the weight of the prime mover applied at the point of impact.

Lesson 3: Subpart G-Signs, Signals, and Barricades

Lesson Focus

This lesson focuses on the following topics:

- Accident Prevention Signs and Tags
- Danger Signs
- Caution Signs
- Exit Signs
- Safety Instruction Signs
- Directional Signs
- Accident Prevention Tags

Accident Prevention Signs and Tags

Signs and symbols shall be visible at all times when work is being performed and must be removed or covered promptly when the hazards no longer exist.

Danger Signs

A danger sign must be used only where an immediate hazard exists.

Each danger sign must have red as the dominant color for the upper panel, black outline on the borders, and a white lower panel for additional sign wording.

Caution Signs

Caution signs must be used only to warn against potential hazards or to caution against unsafe practices.

Every caution sign must have yellow as the dominant color, a black upper panel and borders with yellow lettering of the word "caution" on the black panel, and a lower yellow panel for additional sign wording. Black lettering must be used for additional wording.

The standard color of the background shall be yellow and the panel must be black with yellow letters. Any additional wording must be in black letters on a yellow background.

Exit Signs

Exit signs, when required, must be lettered in legible red letters, not less than six inches high, on white fields with principal letter strokes of at least three-fourths of an inch in width.

Safety Instruction Signs

Safety instruction signs, when used, must be white with green upper panels, using white letters to convey principal messages. Any additional wording on the signs must be in black letters on white backgrounds.

Directional Signs

Directional signs, other than automotive traffic signs, shall be white with a black panel and a white directional symbol. Any additional wording on the sign must be in black letters on the white background.

Traffic Signs

Construction areas must be posted with legible traffic signs at points of hazard.

Accident Prevention Tags

Accident prevention tags must be used as a temporary means of warning employees of an existing hazard, such as defective tools, equipment, etc. They must not be used in place of, or as a substitute for, accident prevention signs.

Lesson Summary

Signs and symbols must be visible at all times when work is being performed and must be removed or promptly covered when the hazards no longer exist. For instance, directional signs, other than automotive traffic signs, are white with a black panel and a white directional symbol. Any additional wording on the sign must be in black letters on the white background.

Module 15: Safety and Health Programs

Module Description

Have you ever been injured on the job? Do you know what steps to take in the event of sickness, injury, or death due to your workplace environment? More importantly, do you know how to protect yourself, as well as others, and help promote healthy working conditions? Every year, more than 50,000 workers die from exposure to various hazards in the workplace. The Occupational Safety and Health Administration (OSHA) is committed to saving lives, preventing injuries, and protecting the health of workers all across America. This module will show you how to identify workplace hazards and become involved with ensuring healthy and safe working environments.

Module Learning Objectives

At the completion of this module, you should be able to:

- Describe the importance of effective safety and health programs.
- Summarize the common characteristics of exemplary workplaces.
- Explain the General Guidelines of an effective safety and health program.
- Discuss the major elements of an effective safety and health program.
- Name the state programs.
- List consultation services.
- Describe the Voluntary Protection Program (VPP).
- Discuss the Safety Health Achievement Recognition Program (SHARP).
- Describe the Strategic Partnership Program.
- Apply training and education.
- Utilize electronic information.

Lesson 1: Effective Program Elements

Lesson Focus

This lesson focuses on the following topics:

- Importance of Effective Safety and Health Programs
- Common Characteristics of Exemplary Workplaces
- The Guidelines—General
- Major Elements

Importance of Effective Safety and Health Programs

It has been found that effective management of worker safety and health programs:

- Reduces the extent and severity of work-related injuries and illnesses.
- Improves employee morale and productivity.
- Reduces workers' compensation costs.

Common Characteristics of Exemplary Workplaces

Organized and systematic methods are used to:

- Assign responsibility to managers, supervisors, and employees.
- Regularly inspect for hazards and control the hazards.
- Regularly re-evaluate the effectiveness of existing programs.
- Orient and train all employees to eliminate or avoid hazards.

The Guidelines—General

An effective program:

- Includes provisions for systematic identification, evaluation, and prevention or control of hazards.
- Goes beyond specific requirements of the law to address all hazards.

Written program:

- As the size and complexity of the worksite or process increases, so does the need for written guidance.

- Some individual OSHA standards require a written program be created. Taken in whole, these individual written programs will often form the basis of the facility safety program.

Major Elements

An effective occupational safety and health program will include the following four elements:

1. Management commitment and employee involvement
2. Worksite hazard analysis
3. Hazard prevention and control programs
4. Safety and health training

1. Management commitment and employee involvement

- Management commitment and employee involvement are complementary.
- Management commitment provides the motivating force and resources for organizing and controlling activities within an organization.
- Employee involvement provides the means through which workers develop and express their own commitment to safety and health protection.

Recommended Actions

- Clearly state a worksite safety and health policy.
- Establish and communicate a clear goal and objective for the safety and health program.
- Provide visible top management involvement when implementing the program.
- Encourage employee involvement in the program and in decisions that affect safety and health (e.g., inspection or hazard analysis teams; developing or revising safe work rules; training new hires or co-workers; assisting in accident investigations).
- Assign and communicate responsibility for all aspects of the program.
- Provide adequate authority and resources to responsible parties.
- Hold managers, supervisors, and employees accountable for meeting their responsibilities.
- Review program operations at least annually to evaluate, identify deficiencies, and revise as needed.

2. Worksite Analysis

- Worksite hazard analysis involves a variety of worksite examinations to identify not only existing hazards, but also conditions and operations where changes might occur to create hazards, anticipating hazards before they become obvious.
- Effective management actively analyzes the work and the worksite to anticipate and prevent harmful occurrences.

Recommended Actions

In order to identify all the hazards:

- Conduct comprehensive baseline and periodic surveys for safety and health.
- Analyze planned and new facilities, processes, materials, and equipment.
- Perform routine job hazard analyses supported by checklists, Job Safety Analysis, or Job Hazard Analysis forms.
- Provide for regular site safety and health inspections.
- Involve the facility's Safety Committee in periodic, but regular, site inspections.
- Provide a reliable system for employees, without fear of reprisal, to notify management about apparent hazardous conditions and to receive timely and appropriate responses.
- Provide for investigation of accidents and "near miss" incidents, so that their causes and means for prevention are identified.
- Analyze injury and illness trends over time, so that patterns with common causes can be identified and addressed with an eye towards prevention.

3. Hazard Prevention and Control

- Where feasible, prevent hazards through effective design of the job or job site, which are referred to as Engineering Controls.
- Where elimination of the hazard is not feasible, control hazards to prevent unsafe and unhealthful exposure.
- Elimination or control must be accomplished in a timely manner.

Recommended Actions

Establish procedures for timely prevention, correction, or control of hazards, including:

- Engineering controls, where feasible and appropriate.

- Administrative controls such as procedures for safe work practices, which are understood and followed as a result of training, positive reinforcement, correction of unsafe performance, and enforcement.
- Provision for personal protective equipment.
- Provide for facility and equipment maintenance.
- Plan and prepare for emergencies by conducting training and drills, not less than annually.
- Establish a medical program consisting of first aid on site and the structure to access nearby physician and emergency medical care.

4. Safety and Health Training

- Safety and health training must address the safety and health responsibilities of all personnel, whether salaried or hourly.
- Safety and health training is most effective when incorporated into other training about performance requirements and job practices. After all, safety is everyone's responsibility and part of everyone's job.
- Complexity of training depends on size, complexity of the worksite, and the nature of hazards.

Recommended Actions

Conduct safety and health orientations before employees or contractors start work to ensure that all employees understand the hazards to which they may be exposed and how to prevent harm to themselves and others because of exposure to these hazards.

Ensure that supervisors carry out their safety and health responsibilities, including:

- Analyzing the work under their supervision to identify previously unrecognized potential hazards.
- Maintaining physical protections in work areas.
- Reinforcing employee training through continual performance feedback and enforcement of safe work practices.
- Ensure that managers understand their safety and health responsibilities, as described under the management commitment and employee involvement element of the guidelines.

Lesson Summary

As the size and complexity of the worksite or process increases, so does a need for written guidance. Individual written programs often form the basis of a facility safety program.

An effective program includes provisions for systematic identification, evaluation, and prevention or control of hazards and goes beyond specific requirements of the law to address all hazards. It has been found that effective management of worker safety and health programs reduces the extent and severity of work-related injuries and illnesses, improves employee morale and productivity, and reduces workers' compensation costs.

Lesson 2: OSHA Safety and Health Programs

Lesson Focus

This lesson focuses on the following topics:

- State Programs
- Consultation Services
- Voluntary Protection Programs (VPPs)
- Strategic Partnership Program
- Training and Education
- Electronic Information

State Programs

The Occupational Safety and Health Act of 1970 (OSH Act) encourages states to develop and operate their own job safety and health plans, which OSHA then approves and monitors. There are currently 28 state/territory plans: 22 cover both private and public (state and local government) employment; 4 states/territories—Connecticut, Illinois, Maine, New Jersey, New York, and the Virgin Islands—cover the public sector only.

More Information: Full details and a current map of state/territory plans.

States and territories with their own OSHA-approved occupational safety and health plans must adopt and enforce standards identical to, or at least as effective as, the federal standards, and provide extensive programs of voluntary compliance and technical assistance, including consultation services.

Consultation Services

Consultation assistance is available upon request to employers who want help in establishing and maintaining a safe and healthful workplace. Funded equally by OSHA and each state, the service is provided at no cost to the employer. Each state, whether a federal plan state, or a state plan state, operates the consultation program for the state. Primarily developed for smaller employers with more hazardous operations, the consultation service is delivered by state governments employing professional safety and health consultants.

Comprehensive assistance includes a hazard survey of the worksite and appraisal of all aspects of the employer's existing safety and health management system. In addition, the service offers assistance to employers in developing and implementing an effective safety and health management system. No penalties are proposed or citations issued for hazards identified by the consultant.

The employer's only obligation is to correct all serious hazards identified by the consultant within the agreed upon correction timeframe. OSHA provides consultation assistance to the employer with the assurance that his or her name, firm, and any information about the workplace will not be reported to OSHA enforcement staff.

Under the consultation program, certain exemplary employers may request participation in OSHA's Safety and Health Achievement Recognition Program (SHARP). Eligibility for participation in SHARP includes, but is not limited to, receiving a full-service, comprehensive consultation visit, correcting all identified hazards, and developing an effective safety and health program management system.

Employers accepted into SHARP may receive an exemption from programmed inspections (not complaint or accident investigation inspections) for a period of two years initially, or up to three years upon renewal.

Voluntary Protection Programs (VPPs)

The Voluntary Protection Program and onsite consultation services, when coupled with an effective enforcement program, expand worker protection to help meet the goals of the OSH Act. The three levels of VPP—Star, Merit, and Demonstration—are designed to recognize outstanding achievements by companies that have developed and implemented effective safety and health management systems.

The VPPs motivate others to achieve excellent safety and health results in the same outstanding way as they establish a cooperative relationship between employers, employees, and OSHA.

Strategic Partnership Program

OSHA's Strategic Partnership Program, the newest member of OSHA's cooperative programs, helps encourage, assist, and recognize the efforts of partners to eliminate serious workplace hazards and achieve a high level of worker safety and health. Whereas OSHA's Consultation Program and VPP entail one-on-one relationships between OSHA and individual worksites, most strategic partnerships seek to have a broader impact by building cooperative relationships with groups of employers and employees.

These partnerships are voluntary, cooperative relationships between OSHA, employers, employee representatives, and others such as trade unions, trade and professional associations, universities, and other government agencies.

Training and Education

OSHA's area offices offer a variety of information services, such as compliance assistance, technical advice, publications, audiovisual aids, and speakers for special engagements. OSHA's Training Institute in Arlington Heights, IL, provides basic and advanced courses in safety and health for federal and state compliance officers, state consultants, federal agency personnel, and private sector employers, employees, and their representatives.

The OSHA Training Institute also has established OSHA Training Institute Education Centers to address the increased demand for its courses from the private sector and from other federal agencies. These centers are nonprofit colleges, universities, and other organizations that have been selected after a competition for participation in the program. There is a Federal Education Center in each of the 10 Federal Regions.

OSHA awards grants to nonprofit organizations through its Susan Harwood Training Grant Program in order to provide safety and health training and education to employers and workers in the workplace.

The grants focus on programs that will educate workers and employers in small businesses (fewer than 250 employees) about new OSHA standards or about high-risk activities or hazards. Grants are awarded for one year and may be renewed for an additional 12 to 24 month period, depending on whether or not the grantee has performed satisfactorily. Emergency drills and training should occur at least every 12 months.

OSHA expects each organization awarded a grant to develop a training and/or education program that addresses a safety and health topic named by OSHA, to recruit workers and employers for the training, and to conduct the training. Grantees are also expected to follow up with people who have been trained to find out what changes were made in order to reduce the hazards in their workplaces as a result of the training.

Electronic Information

OSHA has a variety of materials and tools available on its Website. These include e-Tools, Expert Advisors, Electronic Compliance Assistance Tools (e-CATs), Technical Links, regulations, directives, publications, videos, and other information for employers and employees. OSHA's software programs and compliance assistance tools walk you through challenging safety and health issues and common problems to find the best solutions for your workplace.

Lesson Summary

OSHA awards grants to nonprofit organizations to provide safety and health training and education to employers and workers in the workplace. It expects each organization awarded a grant to develop a training and/or education program that addresses a safety and health topic, to recruit workers and employers for the training, and to conduct the training. Grantees are also expected to follow up with people who have been trained to find out what changes were made to reduce hazards in their workplaces as a result of the training.

Module 16: Scaffolds

Module Description

This module provides a general overview of the safety measures that are required when working on a scaffold. The module begins with an introduction into the various types of scaffolds and goes on to outline the OSHA safety requirements and safety measures that can be taken to ensure that employees working on scaffolds are safe.

Module Learning Objectives

At the conclusion of this module, you should be able to:

- Identify the various classifications of scaffolds.
- Discuss the basic OSHA safety requirements.
- Describe the measures that can be taken to ensure safe working conditions on a scaffold.

Lesson 1: Introduction to Scaffolds

Lesson Focus

This lesson focuses on the following topics:

- What is a Scaffold?
- Types of Scaffolds

What is a Scaffold?

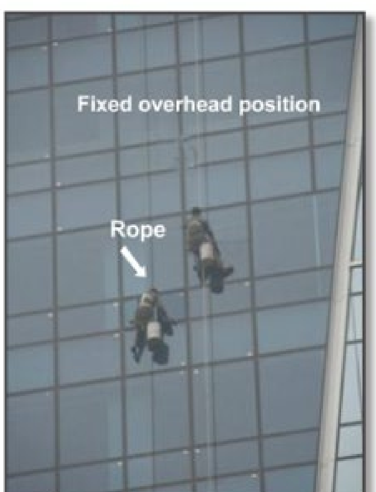
A scaffold is a term used to describe any sort of temporary elevated platform that is used to support either workers, materials, or both. They are commonly used in the construction field (usually in the construction of buildings); however, they are also used in other fields such as ship construction and by cleaning services (to clean the outer windows of high rises).

The main purpose behind the use of scaffolds is to provide support and balance to an employee and his or her materials as the employee conducts tasks in otherwise inaccessible or difficult-to-reach areas.

Types of Scaffolds

Suspended Scaffolds

These are types of scaffolds that are suspended from a fixed overhead position (often placed at the top of a building, but it can be any fixed elevated structure). The various types of suspended scaffolds are discussed next.



Two-Point (Swing Stage)

These are one of the most common types of suspended scaffolds. You see them frequently on construction sites and on skyscrapers and other high-rises where they are used by window washers and exterior building workers. The scaffold is hung from the top of a building by two ropes that are secured at either end of the platform, usually with stirrups to provide for vertical movement.

Single-Point Adjustable (Spider Scaffolds)

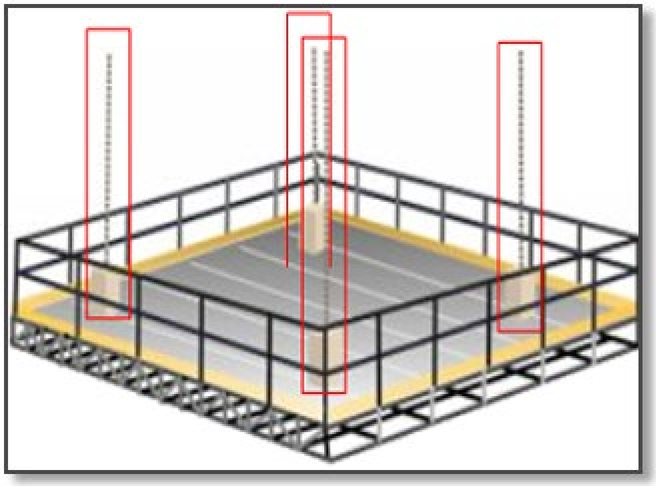
This scaffold is smaller than the two-point, as it usually accommodates only one person at a time. It is secured to the top of the building using one rope from a fixed overhead support. As with the two-point, it has a mechanism to allow for vertical movement (up and down). Again, it is often used by window washers.

Suspended Platform

This scaffold consists of horizontal and parallel ropes that are used to support a platform on which personnel and/or materials are placed. This is hung from vertical ropes suspended from a structure. These are often used in buildings still under construction.

Suspended Scaffold Platform

These consist of at least one platform (they may be more, but they rarely exceed a single platform) that is supported by more than two ropes (usually four ropes are used, one secured at each corner of the platform) from an overhead structure and fitted with a mechanism to allow for vertical movement. They are commonly used as chimney hoists in the cleaning and repair of chimney and/or other ventilation shafts.

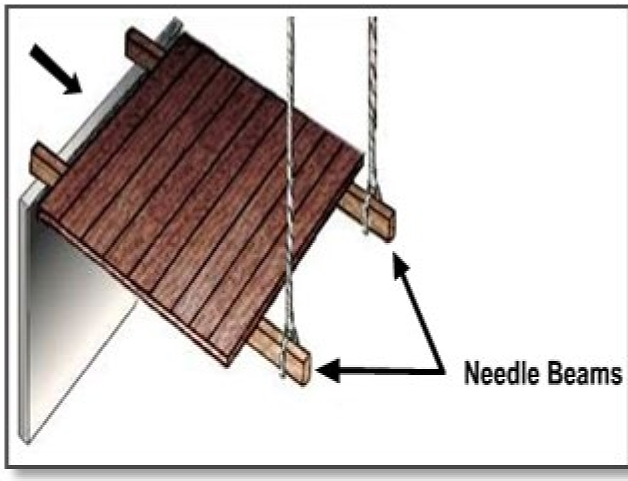


Interior Hung

This scaffold consists of two parallel, horizontal beams upon which a board or plank is placed. It is then suspended by ropes (sometimes up to four, one at each corner of the platform) from a roof or ceiling. This is primarily used indoors, hence the name, because it must be hung from roof structures.

Needle Beam

In this case, the platform (usually a simple wooden board) is supported by two needle beams. The beams are hung from ropes. Usually one end of the platform is supported on the edge of a permanent structure.



Multi-Level

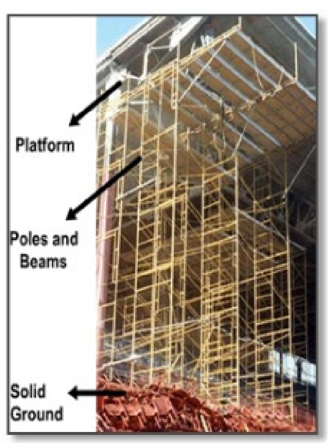
A multi-level scaffold is a series of platforms that are arranged vertically, one on top of the other. Visually it looks like two or more two-point scaffolds (or multi-point scaffolds) on top of one another. The platforms are placed within the same framework, secured by a single stirrup from the same fixed overhead.

Float (Ship)

The float (or ship) scaffold consists of a platform supported by two bearers and is hung from a fixed overhead support with ropes.

Supported Scaffolds

These are scaffolds that consist of one or more platforms elevated on poles and beams, which are placed upon a solid ground. The various types of supported scaffolds are discussed next.



Frame or Fabricated

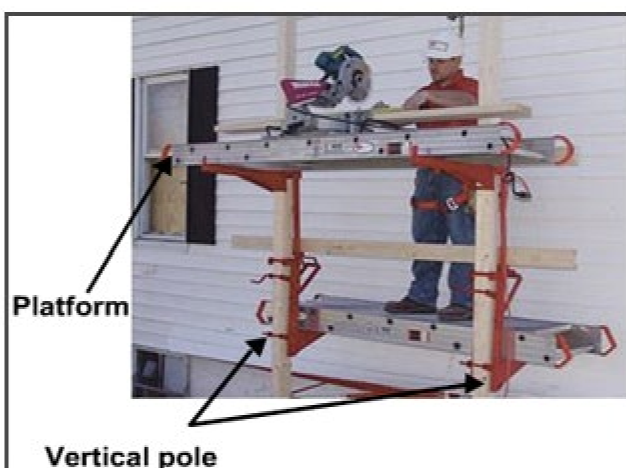
This is one of the most common types of scaffolds used. They are easy to build, economical, and practical. They range in size from small set-ups used for one or two story residential houses to large set-ups used on commercial projects; however, it is possible to make them stand several stories high if the need arises. They consist of a single or multiple platforms elevated on tubes.

Mobile

Mobile scaffolds are visually similar to frame scaffolds, but with one main difference: they are mounted on wheels or casters. They are commonly used by painters, plasterers, electricians, plumbers, and others who need to change position frequently, hence the wheels.

Pump Jack Scaffold

This scaffold consists of a platform that is elevated on a pair of vertical poles and fitted with moveable brackets. The brackets allow the platform to be moved up and down using a jack (similar to those used to change a car tire). They are attractive because of their ability to be raised and lowered somewhat quickly and easily and because they are relatively inexpensive.

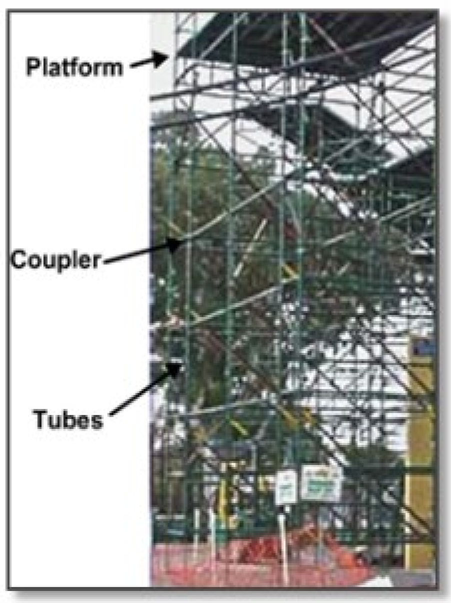


Ladder Jack

This is a very simple scaffold. In this case, the platform is placed in brackets that are attached to a pair of ladders. They are mostly used for light applications. They are popular mostly due to their practicality, ease, and economy.

Tube and Coupler

In this case, tubes (which look like pipes) are placed together in a lattice-like framework using couplers (joints) to hold them together. The lattice-like pattern into which they are arranged adds balance and strength to the framework. Platforms can be placed at the top of the framework and at multiple levels. Tube and coupler scaffolds are often used to carry heavy weights, and they can be built to a height of multiple stories while being able to be erected to conform to the shape of a building. A prime advantage lies in that they can be built in several directions and combinations that cater to any structure.



Poles

This type of scaffold is also known as Wood Pole, because every part of the scaffold, from the platform on down, is built using wooden poles and boards. There are two types: single pole, which are supported on one side (the interior side) by a fixed structure, such as a building; and two-pole, which are supported by two sets of wooden poles on either side of the platform. They are not commonly used due to the fact that they must be built from scratch, cannot be reused, and are difficult to erect and use in a safe and compliant manner.

Specialty

There are a large number of scaffolds that are not widely used but are employed only in specific jobs. Some of the more common ones include the following:

- Plasterers', Decorators', and Large-Area Scaffolds
- Bricklayers' Square Scaffolds
- Horse Scaffolds
- Form Scaffolds and Carpenters' Bracket Scaffolds
- Roof Bracket Scaffolds
- Outrigger Scaffolds
- Window Jack Scaffolds
- Crawling Boards (Chicken Ladders)
- Step, Platform, and Trestle Ladder Scaffolds

Lesson Summary

A scaffold refers to a temporary, elevated platform that is used to support workers and/or materials. There are several types of scaffolds:

1. **Suspended scaffolds:** the type that are suspended by a wire rope from a fixed overhead position (usually placed at the top of a building). They can be broken down further into the subcategories that include: Two-point (or swing stage) scaffolds; single-point adjustable (spider) scaffolds; catenary (using horizontal and parallel wire ropes); multi-point adjustable; interior-hung; float (ship); and more.
2. **Supported scaffolds:** the type that consist of one or more platforms elevated on poles and beams, which are placed upon a solid ground. They can be broken down into the following subcategories: Frame or fabricated; mobile; pump jack; and more.
3. **Specialty scaffolds**: includes decorators', plasterers', and large-area scaffolds, among others.

Lesson 2: Overview of OSHA Directives for the Construction of Scaffolds

Lesson Focus

This lesson focuses on the following topics:

- Suspension Scaffolds
- Supported Scaffolds

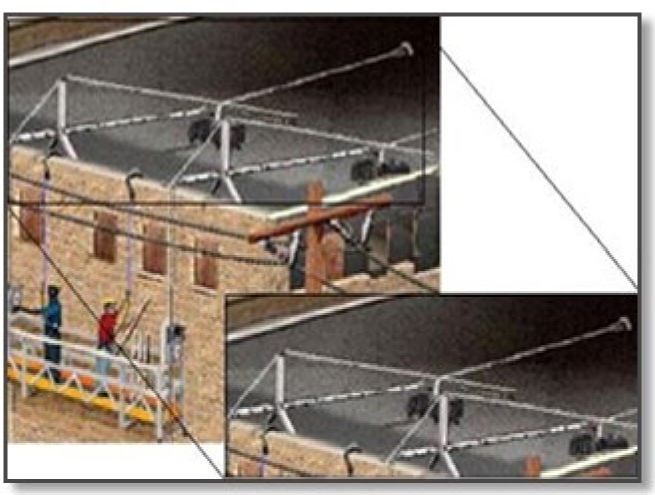
Suspension Scaffolds

The regulations presented for the two-point scaffold are applicable to all other types of suspension scaffolds, unless stated otherwise.

Two-Point (Swing Stage)

Anchorage

When taking into account the safety of a suspension scaffold, a primary factor that must be considered is the anchorage. Because a suspension scaffold is, in effect, hanging from a structure, its weight must be sufficiently supported and balanced to ensure that it doesn't plummet to the ground. The anchorage that the tieback is secured to must be capable of withstanding four times the intended load of the scaffold.
As such, the tieback should not be secured to objects such as vents or piping but to structural members (foundation beams, for example).



Support

Suspension scaffolds are designed for vertical motion (that is up and down); as such, the scaffold must be capable of supporting its own weight as well as that of the personnel and materials on it while it is either stationary or in motion. The scaffold and its anchorage must be capable of handling up to four times the maximum intended load, and the support ropes must be capable of handling up to six times the intended maximum weight of the scaffold and its load. Scaffold components that have been manufactured by different manufacturers should not be mixed, unless specified. In addition, no modifications should be made to the scaffold components for any reason without approval from the manufacturer.

Access

Though it is possible for suspension scaffolds to be accessed using ladders, it is a preferred practice to access the scaffold from the roof. Safe access methods are discussed in more detail in the next lesson.

Fall Protection

Personnel working from suspension scaffolds may be a great distance above the ground; as such, a common accident is falls by workers from elevated positions. Both fall arrest systems and guardrails should be provided on any scaffold that is expected to be elevated to more than ten feet above the ground. This will be discussed in more detail in the next lesson.

Platform

The platform is the part of the scaffold where the personnel work from and the materials are placed. It is clearly an important component of the scaffold and must be checked regularly to ensure that it meets the applicable safety standards. Each scaffold platform must be at least 18 inches wide. Also, a platform should be able to support its own weight in addition to four times the maximum allowed weight.

Note: The platform for a two-point scaffold should be no more than 36 inches wide unless designed by a qualified person to prevent unstable conditions.

Stability

The scaffold must be designed in such a manner that it does not sway while it is being raised or lowered. In addition to the engineering methods that are employed to minimize horizontal movement of the scaffold, the employees working on the scaffold must exercise caution at all times.

Electrical Hazards

Due to the fact that scaffolds are typically constructed primarily of metal, it is important that they remain clear of any electrical power sources, as this would increase the risk of electrocution. A minimum clearance to maintain from all electrical lines up to 50 kV is 10 feet. Unless the line is insulated and carrying less than 300 volts, in which case the minimum clearance to maintain is 3 feet. Lines carrying more than 50 kV require greater clearance distances as determined by 1926.451(f)(6).

Personnel Training

One of the most important OSHA requirements is proper training, by competent persons, of the scaffold builders and those who are expected to work on the scaffold.

Single-Point Adjustable

General Requirements

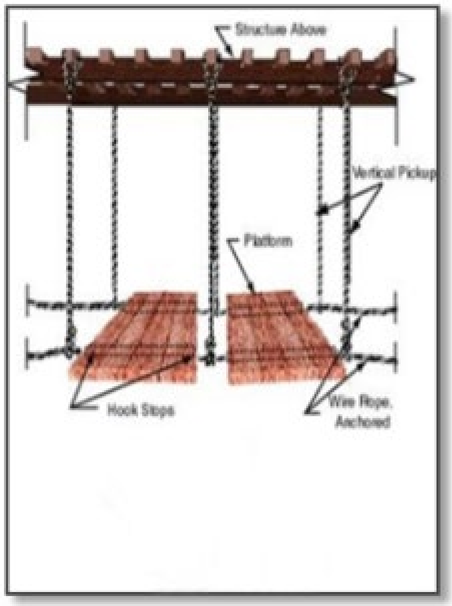
The support rope (the rope that is between the scaffold and the suspension device) must be maintained in a vertical position unless all of the following conditions are met:

- The rigging has been designed by a qualified person.
- The scaffold is accessible to rescuers.
- The supporting rope is protected to ensure that it will not chafe at any point where a change in direction occurs.
- The scaffold is positioned so that swinging cannot bring the scaffold into contact with another surface.

Catenary

General Requirements

Catenary scaffolds should not have more than two interconnected platforms at any one time. Furthermore, because catenary scaffolds do not usually have guardrails, all employees on a scaffold must be protected with personal fall arrest systems if operated at a height in excess of ten feet.



Multi-Point Adjustable

General Requirements

Passage from one platform to another is only allowed when the platforms abut and are at the same height if bridges are not used.

These scaffolds shall be suspended from metal outriggers, brackets, wire rope slings, hooks, or other means that meet the equivalent criteria for strength and durability.

Furthermore, multiple multi-point scaffolds must not be bridged together unless the design of the scaffolds allows them to, the bridge connections are articulated, and the hoists are properly sized.

Interior Hung

General Requirements

Because interior hung scaffolds can only be suspended from the roof structure or other structural members, these structures must be inspected to ensure that they possess sufficient strength.

Needle Beam

General Requirements

Ropes or hangers must be used to support one end of the scaffold. The other end may be supported by ropes, hangers, or a permanent structural member. Needle beams need to be properly secured to ensure that they do not roll or are displaced. In addition, the platform needs to be securely attached to the needle beams with bolts or equivalent means.

Float (Ship)

General Requirements

Platforms must be secured to a minimum of two bearers (such as wooden beams) that extend to at least six inches beyond the platform on each side. Rope connections must be secure so that the platform does not shift or slip. Each employee on a float scaffold must be protected by a personal fall arrest system if working at an elevation above ten feet.

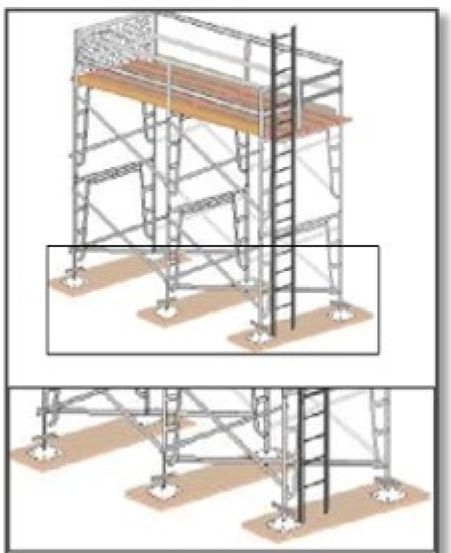
Supported Scaffolds

The regulations presented for the frame or fabricated scaffold are applicable to all other types of supported scaffolds, unless stated otherwise.

Fabricated Frame or Tubular Welded Frame

Base Section

- Firm Foundation: Supported scaffolds must be set on base plates or mud sills to ensure the stability of the structure. As such, the footings of the scaffold must be capable of withstanding the load weight that is set upon it without movement or displacement.
- Frames and panels shall be braced by cross, horizontal, or diagonal braces, or combination of these. These frames and panels secure vertical members together laterally. The cross braces shall be of the proper length to ensure that vertical members are square and aligned. With this system properly used, the completed scaffold is always plumb, level, and square. All brace connections shall be secured.



Base plates or Mud sills

Support Structure

Two important factors in ensuring that the scaffold is stable and is not prone to swaying are the strength and structural integrity of the supports. The supports of the scaffold must be capable of withstanding up to four times their intended maximum weight load as well as the weight of the structure.

Access

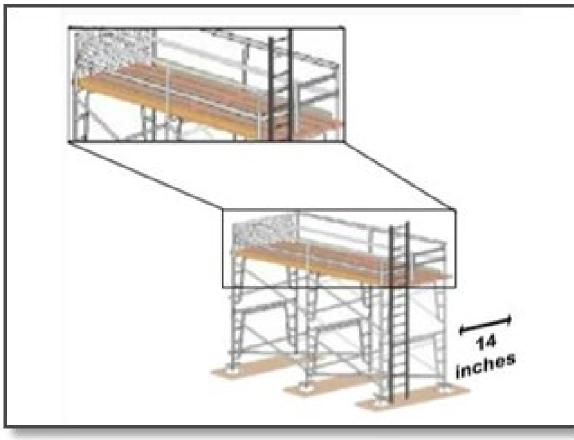
Personnel are subject to accidents while they are climbing on or off a scaffold. The mode of accessing the scaffold must be designed in a manner that ensures that employees are not needlessly being endangered, either by accessing the scaffold or putting undue pressure on the structure. Employees are prohibited from climbing the cross-braces as a means of accessing the scaffold. This is extremely dangerous and may undermine the structural integrity of the structure.

Fall Protection

A common hazard to the employees on scaffolds are falls. The installation of proper fall protection minimizes the risk of such an occurrence. This may include the installation of guardrails on the platform or the use of personal fall arrest systems. Employees on scaffold platforms that are higher than 10 feet above the next level must be adequately protected from falling through the use of proper protective systems and practices.

Platform

The platform is the work area of the scaffold. It supports both the employees and the equipment and materials that they use. It is essential that the platform conform to safety measures to ensure that the employees are not endangered in the course of their work. The platform should be fully planked, and the gaps between the planks should not exceed 1 inch. The platform should not be more than 14 inches from the structure being worked on unless guardrail systems are erected along the front edge and/or personal fall arrest systems are in use for all exposed employees. The maximum distance from the structure for plastering and lathing operations is 18 inches.



Keeping Upright

Scaffolds that exceed a height four times their minimum base dimension must be restrained from tipping with ties, braces, guys, or equivalent means. Unless they have been designed for the specific purpose, scaffolds should not be moved horizontally while employees are on them.

Electrical Hazards

As with suspension scaffolds, the height of supported scaffolds often means that they may be built within close proximity of power lines. In addition, the fact that scaffolds are often built using metal parts makes the risk of electrocution particularly high. As a result, specific measures must be taken to minimize the risk to employees.

Personnel Training

One of the most important OSHA requirements is the proper training by qualified experts of both the scaffold builders and those that are expected to work on the scaffold.

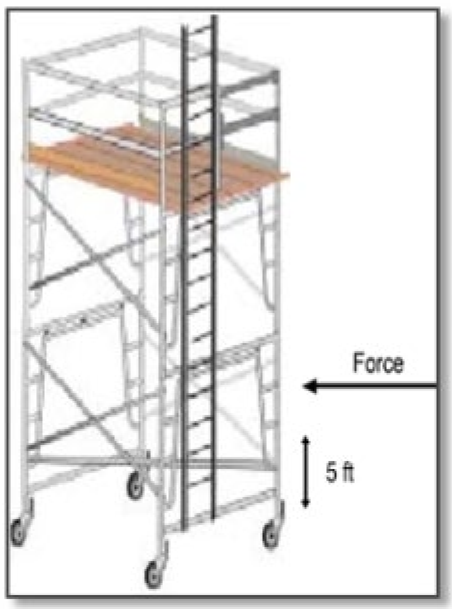
Mobile

Moving

Scaffolds must be stabilized to prevent tipping over while in motion. When the scaffold is being moved manually, the force must be applied to an area that is as close to the base as possible, and in an area that is not more than five feet above the ground. If the scaffold is moved using a powered system, the system must be designed for that purpose.

Scaffolds shall not be moved horizontally while employees are on them, unless all of the following conditions are met:

- The surface on which the scaffold is being moved is within 3 degrees of level and free of pits, holes, and obstructions;
- The height to base width ratio of the scaffold is two to one or less, unless the scaffold is designed and constructed to meet or exceed nationally recognized stability test requirements;
- Required outrigger frames are installed on both sides of the scaffold;
- When power systems are used, the force is applied directly to the wheels and a speed in excess of 1 foot per second is not generated; and
- No employee is present on any part of the scaffold that extends outward beyond the wheels, casters, or other supports.



Pump Jack

General Requirements

The bracket and braces of the pump jack must be made from metal plates and angles to ensure strength. Each bracket must be fitted with two positive gripping mechanisms to prevent slippage.

Poles must be secured to the structure by rigid triangular bracing at the bottom, top, and other points as needed.

If the pump jack has to pass bracing that is already installed, an additional brace must be installed approximately four feet above the brace to be passed and must be left in place until the pump jack has been moved and the original brace reinstalled.

If wood is used for poles, it must be straight-grained and free of shakes, dead knots, and other defects.

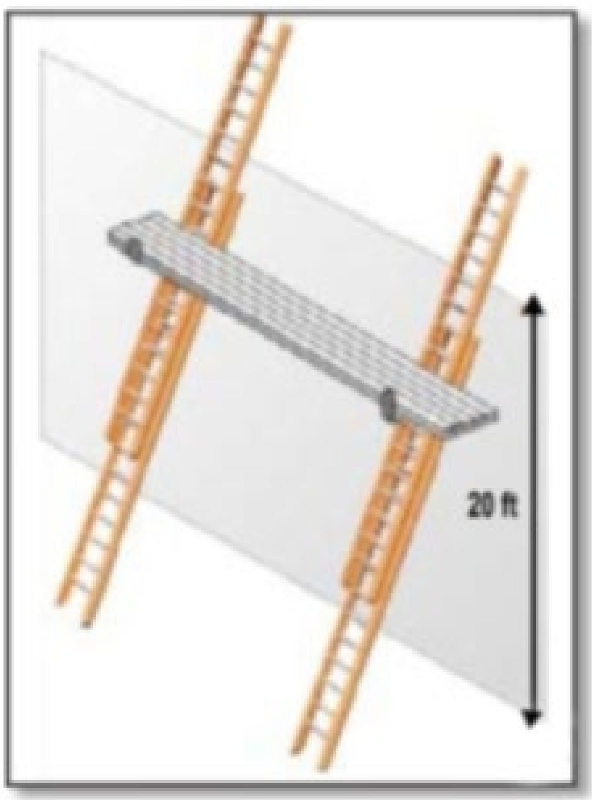
Ladder Jack

Support

Ladders that are used to support ladder jack scaffolds must be placed, fastened, or otherwise equipped with devices in such a manner so as to prevent the scaffold from slipping. They should also be appropriately fastened to ensure overall stability.

Platforms

The maximum height at which a platform can be placed is 20 feet.



Lesson Summary

There are safety requirements applicable to all scaffolds and additional standards applicable to specific types of scaffolds Unless otherwise stated, the safety regulations for the two-point scaffold apply to all other types of suspension scaffolds. With suspended scaffolding, a primary factor to consider in terms of safety is the anchorage of the scaffold from the building (or other structure). Additional requirements focus on how the scaffold is supported, how it can be accessed (preferably from the roof, rather than a ladder); fall protections, such as arrest systems and guardrails, which are required for any scaffold higher than ten feet in the air; and the platform, which must be at least 18" wide and able to support at least its own weight plus four times the maximum allowed weight. Many of these (not suspension-specific) requirements apply to supported scaffolds, as well.

Further safety requirements (which apply to both supported and suspended scaffolds) address stability (so the scaffold does not sway during its raising or lowering); control of electrical hazards (meeting the minimum 10-foot clearance from all electrical lines up to 50 kV, and other controls); and of vital importance to OSHA and worker safety, proper training to those building and working on scaffolds.

Lesson 3: Scaffold Safety Measures

Lesson Focus

This lesson focuses on the following topics:

- Introduction
- How Do You Minimize Risks?
- Guardrails
- Personal Fall Arrest Systems

Introduction

One out of every three deaths in construction results from fatal falls. This high fatality rate indicates the importance of ensuring that scaffold workers must be well protected against accidental falls. Generally, precautions must be taken for employees expected to work at heights above six feet. Fall protection is not required (but may be an excellent practice) for employees working on scaffolding at a height of ten feet or less.

Working on scaffolds may be more hazardous due to the fact that there is often very little space for a person to maneuver, especially when space is also taken up by the various materials that the employee needs to complete his or her job.

How Do You Minimize the Risks?

There are various ways that employers can minimize the risk to their employees to a sufficiently acceptable level.

Uniformity

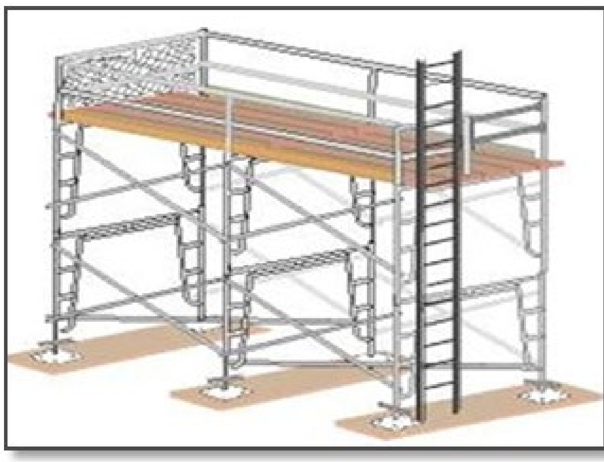
- Ensure that the scaffold has been erected in accordance with the instructions of the manufacturer.
- Do not alter or modify any of the components of the scaffold. If you are faced with a problem, contact the manufacturer.
- If you have scaffolding components from two or more manufacturers, do not under any circumstances mix the components.
- Do not use incompatible metals for the components of the scaffold.

Guardrails

All open and exposed sides of the scaffold at levels above ten feet should be fitted with guardrails to prevent falls or all exposed employees shall be provided with proper fall arrest systems. The guardrails should consist of a least a top-rail, a mid-rail, and when necessary, a toe-board.

Prohibit Climbing

Prohibit climbing on the cross-braces of the scaffold because it is extremely dangerous and against OSHA regulations to use the cross-braces as a means of accessing the scaffold. Climbing the cross-brace can destabilize the scaffold and cause it to tip over. In addition, employees climbing up or down will not be protected by a personal fall arrest system and would be at an increased risk of falling.



Provide safe ways to access the scaffold.

Provide the employees with personal fall arrest systems when appropriate (this will be discussed in more detail later in the lesson).

Guardrails

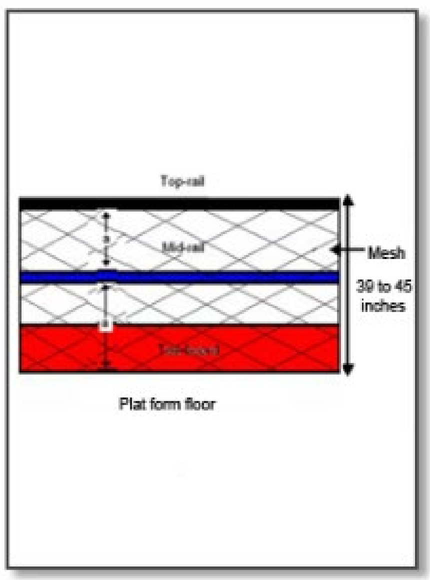
If an employee is expected to work at heights that exceed ten feet, the employer must ensure that the scaffold is fitted with guardrails or that proper personal fall arrest systems are in use. The following provisions must be met when installing guardrails.

Top- and Mid-Rails

The top-rail (that is the topmost part of the guardrail) must be between 39 and 45 inches above the platform or walking level of the scaffold.

A mid-rail is the portion that exists below between the top-rail and the work platform. The mid-rail must be halfway between the top-rail and the surface of the platform. In case there is the need for other structural panels to be installed (such as additional mid-rails), they should be installed so as not to leave openings that are wider than 19 inches.

Toe-boards or mesh screening may also be installed, especially if there is any concern of accidentally falling objects striking workers below.



Strength of Guardrails

Guardrails must be manufactured in such a manner that they would be capable of withstanding up to 200 pounds of force applied at any point and from any direction upon the top-rail. Mid-rails must be capable of withstanding up to 150 pounds of force applied at any point and from any direction.

Smoothness

The guardrails must not have any jagged or protruding surfaces that could cause punctures (either in clothing or in skin). In addition, the top-rail and mid-rails must be constructed in such a manner so as not to overhang the scaffold, thereby causing a projection hazard.

Personal Fall Arrest Systems

Personal fall arrest systems are one of the options that can be used to minimize the risks of injuries related to falls from an elevation. They should be used in the absence of, or instead of, a guardrail system if the employee is expected to work at heights exceeding ten feet.

Types and Components of Personal Fall Arrest Systems

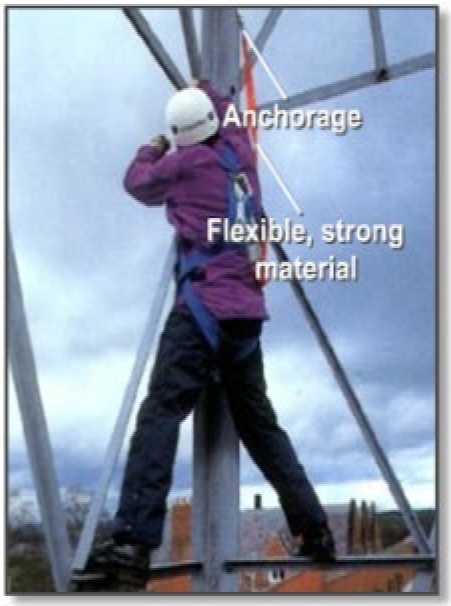
Body Harness

Full body harnesses are designed to minimize the stress on the body that is induced by a fall. Employees must be trained by a competent person in fall protection systems prior to using a full body harness. Harnesses should be inspected prior to each use for mildew, wear, damage, and other deterioration. Defective harnesses shall be removed from service.

> **More Information:** Body harnesses are designed to minimize the stresses on the body that is induced by a fall. Due to high incidences of internal injuries suffered during falls, OSHA has deemed the body belts used for fall protection present a danger to workers and are no longer allowed.

Lanyards/Vertical Lifelines

Vertical lifelines consist of a line, made of a strong material, which is attached to an appropriate anchorage at one end and attached to the full body harness at the other end. Advances in synthetic materials have led to the creation of shock-absorbing lanyards with increased strength.



Self-Retracting Lifelines (SRLs)

SRLs are commonly used as an attractive alternative to fixed-length lanyards. The line is encased in a protective housing that extends and retracts automatically, which increases mobility and may reduce the risk of tripping. SRLs can be anchored to an appropriate anchorage point above an employee's head for increased safety and mobility. These devices are also commonly called "yo-yos."

Horizontal Lifelines

Horizontal lifelines may be practical in areas where the possible anchorage points are otherwise limited or difficult to access. They are easy to transport and relatively quick to set up. The idea is pretty simple: Two anchorage points are connected at two points and an extended cable is then run between the two anchorages.

PFAS Use Requirements

Requirements for using personal fall arrest systems include:

- When stopping a fall, personal fall arrest systems should limit the maximum arresting force to no more than 900 pounds.
- The line should be rigged to ensure that a worker does not freefall for more than 6 feet and does not come into contact with any surface.
- The fall arrest system must have sufficient strength to withstand twice the potential impact energy of a worker freefalling for six feet.
- Any systems that have been involved in a fall impact (that is, have been involved in arresting a falling worker) should be removed immediately and not used again until they have been inspected by a competent person to ensure that they are undamaged.
- Workers who have been involved in a fall must be assisted immediately, or at least be in a position to rescue themselves—otherwise suspension trauma or other harm may result. This is a condition where pooling of the blood in the extremities may cause loss of consciousness or even death. To avoid this, when suspended, the worker must limit restriction points and move their arms and legs to maintain circulation. If the worker is unconscious when rescued, proper treatment and medical attention should be provided immediately.
- Ensure that regular checks are conducted on the systems for wear and tear and that any defective items are immediately replaced.
- Do not, under any circumstances, attach a fall arrest system to guardrails. They are not designed for that purpose and are unlikely to withstand a fall impact.

Case Study

There are numerous cases of severe injuries and death when personnel working on scaffolds did not take, or were not equipped with, the necessary safety measures. Here are some examples:

- An employee was taking measurements from a scaffold not fitted with guardrails. He tripped and fell 14 feet to the ground. He died instantly.

- A worker was working on a snow and ice covered scaffold with no guardrails or a fall arrest system. He slipped and fell approximately 20 feet. He died instantly.
- An employee was working on a scaffold during stormy weather. It is suspected he lost balance due to a strong gust of wind. He was not wearing a personal fall arrest system and fell 15 feet to his death.

Lesson Summary

A scaffold must not just be anchored properly and be strong and stable; the workers themselves must be trained in how to safely use and maneuver (themselves and their equipment) in the often small space.

Employers can minimize the risk to employees by making sure all scaffolding construction, materials, and other elements are compatible. Scaffolds must contain safe, well-constructed guardrails that consist of three rails: top, mid, and, when necessary, a toe board or employees must be provided with appropriate personal fall arrest systems; guardrails must be sufficiently strong and smooth according to OSHA guidelines. Employers must also prohibit climbing on a scaffold's cross braces, and if there are no guardrails, provide personal fall arrest systems for workers. These systems may include body harnesses, vertical lifelines, self-retracting lifelines and horizontal lifelines, and must meet other OSHA requirements.

Module 17: Tools - Hand and Power

Module Description

This module gives you a basic understanding about OSHA's role in the prevention and elimination of work-related illnesses and injuries. Hand and power tools are a part of our everyday lives and help us to perform tasks that otherwise would be difficult or impossible. However, these simple tools can be hazardous and have the potential for causing severe injuries when used or maintained improperly. Special attention to hand and power tool safety is necessary to reduce or eliminate these hazards.

Module Learning Objectives

At the conclusion of this module, you should be able to:

- Discuss OSHA standards and rules associated with hand and power tools
- Explore guarding techniques or principles that apply to hand and power tools
- Identify the precautions that are essential for safe use of hand and power tools

Lesson 1: Safe Use of Hand and Power Tools

Lesson Focus

This lesson focuses on the following topics:

- Introduction
- General Requirements
- Hazards of Hand and Power Tools
- Switches

Introduction

Hand and power tools are a part of our everyday lives. These tools help us in performing tasks that otherwise would be difficult or impossible. However, even simple tools can be hazardous and have the potential for causing severe injuries when used or maintained improperly. Special attention to hand and power tool safety is necessary to reduce or eliminate these hazards.

General Requirements

Hazards

Workers using hand and power tools may be exposed to these hazards:

- Falling or flying objects which can be abrasive, or may splash
- Harmful dusts, fumes, mists, vapors, and gases
- Frayed or damaged electrical cords, hazardous connections, and improper grounding

Basic Tool Safety Rules

Basic tool safety rules include the following:

- Perform maintenance regularly
- Use the right tool for the job
- Inspect tools before use
- Operate according to manufacturers' instructions
- Use the proper personal protective equipment (PPE)
- Use required and provided guards

Hazards of Hand and Power Tools

Hand Tool Hazards

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.

Hand tool hazards are often caused by misuse and improper maintenance.

Do not use:

- Wrenches when jaws are sprung.
- Impact tools (chisels and wedges) when heads have mushroomed.
- Tools with loose, cracked or splintered handles.
- A screwdriver as a chisel.
- Tools with taped handles—(They may be hiding cracks.)

Hand Tools—Protection

When using saw blades, knives, or other sharp tools, employees should direct the tool 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.

- Use PPE, such as safety goggles and gloves as necessary
- Keep the floor surface where working free from debris and tripping or slipping hazards
- Keep cutting tools sharp

Power Tools

Power tools must be fitted with appropriate guards and safety switches. They are extremely hazardous when used improperly.

Different types of power tools are determined by their power source:

- Electric
- Pneumatic
- Liquid fuel
- Hydraulic
- Powder-actuated

Switches

Hand-held power tools must be equipped with one of the following:

- Constant Pressure Switch
- Positive On/Off Switch
- Momentary On/Off Switch

Constant Pressure Switch

Circular saws, chainsaws, and percussion tools without positive accessory holding means must be equipped with a constant pressure switch that will shut off when the pressure is released.

Positive On/Off Switch

This switch is used with many hand-held tools, including powered platen sanders, grinders with wheels two inches in diameter or less, routers, laminate trimmers, nibblers, shears, scroll saws, and jigsaws with blade shanks one-fourth of an inch wide or less.

Momentary On/Off Switch

Hand-held powered drills, tappers, fastener drivers, horizontal, vertical, and angle grinders with wheels greater than two inches in diameter, disc sanders, belt sanders, reciprocating saws, and saber saws must be equipped with a momentary contact "off" switch and may have a lock-on provided that they can be turned off by a single motion of the same finger that turned them on.

Power Tools—Precautions

- Disconnect tools when not in use, before servicing and cleaning, and when changing accessories
- Keep people not involved with the work away from the tools
- Secure work with clamps or a vice, freeing both hands to operate the tool
- Don't— hold the switch button while carrying a tool
- Keep tools sharp and clean
- Consider what you wear, as loose clothing and jewelry can get caught in moving parts
- Remove damaged electric tools and tag them: “Do Not Use”

Electric Cords

- Don’t carry portable tools by the cord
- Don’t use electric cords to hoist or lower tools
- Don’t yank cord or hose to disconnect it
- Keep cords and hoses away from heat, oil, and sharp edges

Lesson Summary

We regularly use hand and power tools as part of our everyday lives. They help us in performing tasks that otherwise might be difficult or impossible to accomplish. However, even simple tools can be hazardous and have the potential for causing severe injuries when used or maintained improperly. So, paying special attention to power tool safety is necessary to help reduce or eliminate hazards.

Lesson 2: Classification of Tools

Lesson Focus

This lesson focuses on the following topics:

- Types of Tools
- General Safety Precautions

Types of Tools

Electric Power Tools

To protect a worker from shock, these tools must:

- Have a three-wire cord plugged into a grounded receptacle.
- Be double insulated.

Electric Tools—Good Practices

Good practices for the use of electric tools include:

- Operate within design limits.
- Use gloves and safety shoes. (Care must be exercised when using gloves with rotating power tools. In some cases, using gloves can become more dangerous as they may possibly come into contact with the rotating parts, thereby drawing the hand into the tool.)
- Store in a dry place.
- Don’t use in wet locations unless approved for those conditions.
- Keep work areas well lit.
- Ensure that cords don’t present a tripping hazard.

Abrasive Wheels and Tools

Abrasive wheels and tools may throw off flying fragments.

Abrasive wheels must be equipped with guards that:

- Cover the spindle end, nut, and flange projections.
- Maintain proper alignment with the wheel.
- Do not exceed the strength of the fastening.
- Guard so that a minimal amount of the wheel is exposed.

Inspecting Abrasive Wheels

Before mounting:

- Inspect closely for damage.
- Perform sound or ring test to ensure that the wheel is free from cracks and/or defects.

To test:

- Tap wheel gently with a light, non-metallic instrument.
- If the wheel sounds cracked or dead, do not use it because it could fly apart. Keep in mind that this test is most accurate if the abrasive wheel is suspended and not held. By holding the wheel you could possibly alter the sound and giving off a false indicator of defects.

Abrasive Wheel Use

To prevent cracking:

- Fit the wheel on the spindle freely.
- Tighten the spindle nut enough to hold the wheel in place without distorting the flange.
- Let the tool come up to speed prior to grinding or cutting.
- Don't stand in front of the wheel as it comes up to full speed.
- Use eye and/or face protection while operating wheel.

Abrasive Wheel Work Rests

The following information applies to abrasive wheel work rests:

- Keep work rests not more than 1/8th inch from wheel surface, and tongue guards at the top of the wheel not more than 1/4 inch from wheel surface.
- This minimizes the chance of jamming the work between the wheel and the rest, which may cause the wheel to break.
- Don't adjust the wheel while it is rotating.

Guarding

Never remove guards or use a power tool without proper guarding in place. The removal of guards on moving parts may cause severe injury or even death to an employee or other persons near them.

The following information applies to guarding:

- Guard exposed moving parts of power tools

- Guard belts, gears, shafts, pulleys, sprockets, spindles, flywheels, chains, and other moving parts
- Never remove a guard when a tool is in use

Guarding—Point of Operation

The point of operation is where the work is actually performed on the materials. The point of operation must be guarded or otherwise protected.

Guarding—Protection

Machine guards must protect the operator and others from:

- Point of operation
- In-running nip points
- Rotating parts
- Flying chips and sparks

Radial Arm Saw Guarding

The lower blade guard on a radial arm saw is designed to prevent the operator from coming into contact with the rotating blade. This guard must automatically return to the covering position when withdrawn from the work.

Guarding Portable Circular Saws

Guard these saws above and below the base plate or shoe. The upper and lower guards must cover the saw to the depth of the teeth. When withdrawn from the work, the lower guard must automatically return to the covering position.

Table Saw Guarding

Use a hood for guarding against contact with the upper blade.

Pneumatic Tools

The following information applies to the use of pneumatic tools:

- Pneumatic tools are powered by compressed air.
- They include nail guns, staplers, chippers, drills, and sanders.
- Hazards include getting hit by a tool attachment or by a fastener that worker is using with the tool.
- Take the same precautions with an air hose that you would take with electric cords.

Pneumatic Tools—Fastening

Ensure tool is fastened securely to the air hose to prevent a disconnection. Use a proper wire or positive locking device that attaches the air hose to the tool.

Pneumatic Tool Safety

- All pneumatic driven nail guns, staplers, and other similar equipment with automatic fastener feeds, shall have a safety device on the muzzle to prevent the tool from ejecting fasteners, unless the muzzle is in contact with the work surface.
- The manufacturer's safe operating pressure for hoses, pipes, valves, filters, and other fittings shall not be exceeded. Eye protection must be worn while operating pneumatic tools.
- Hearing protection is typically required while operating jackhammers due to the high noise levels generated.
- Compressed air hoses with an inside diameter (ID) greater than one half (1/2) inch must have a safety device in place to reduce pressure in case of hose failure.

Compressed Air Cleaning

The following information applies to compressed air cleaning:

- Do not use compressed air for cleaning.
- Exception: compressed air may be used for cleaning where it is reduced to less than 30 P.S.I. with effective chip guarding and PPE and appropriate controls are in place to prevent injuries and damage.

Liquid Fuel Tools

The following information applies to Liquid Fuel tools:

- Usually gas powered.
- Main hazards are fuel vapors and exhaust; therefore they should not be used in enclosed and confined spaces.
- Use only approved flammable liquid containers.
- Before refilling a fuel-powered tool tank, shut down the engine and allow it to cool.

Powder-Actuated Tools

The following information applies to powder-actuated tools:

- User must be trained to operate.

- Tools must be tested each day before loading to ensure the safety devices are working properly.
- Wear suitable ear, eye, and face protection.
- Select a powder level that will do the work without excessive force.

Easily Penetrated Material

Avoid driving into materials easily penetrated unless materials are backed by a substance that will prevent the pin or fastener from passing through. Also, don't drive fasteners into very hard or brittle material that might chip or splatter, or make the fasteners ricochet.

Powder-Actuated Tool Safety Tips

The following safety tips apply to the use of powder-actuated tools:

- Do not use powder-actuated tools in explosive or flammable environments.
- Inspect powder-actuated tools before use to ensure:
    - The tool is clean
    - That moving parts of the tool operate freely
    - The barrel of the tool is free from obstructions and has the proper shield, guard, and attachments
- Do not load the tool unless it will be immediately used.
- Do not leave a loaded tool unattended.
- Keep hands clear of the barrel end of the tool.
- Never point the tool at anyone.
- Store unloaded tools in a secured box.

Jacks

To set up a jack, ensure that:

- The base of the jack is on a firm, level surface.
- The jack is centered.
- The jack head is placed against a level surface.
- You apply the lift force evenly to the jack.
- The jack is lubricated and inspected regularly.

Jacks—Capacity

The following information applies to the capacity of a jack:

- The manufacturer's rated capacity must be marked on all jacks and must not be exceeded.
- All jacks must have a stop indicator that must not be exceeded.

Jacks—Blocking

Immediately block the load after it is lifted. 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.

General Safety Precautions

Employees who use hand and power tools and are exposed to the hazards of falling, flying, abrasive, and/or splashing objects or harmful dusts, fumes, mists, vapors, and/or gases must be provided with the PPE necessary to protect them from those hazards.

All hazards involved in the use of power tools can be prevented by following five basic safety rules:

1. Keep all tools in good condition with regular maintenance
2. Use the right tool for the job
3. Examine each tool for damage before use
4. Operate the tool according to the manufacturer's instructions
5. Provide and use the appropriate PPE.

More Information: Employees and employers have a responsibility to work together to establish safe working procedures. If a hazardous situation is encountered, it should be brought to the attention of the proper individual(s) immediately.

Case Study

What Happened?

An employee was killed when he was struck in the head by a nail fired from a powder actuated tool. The tool operator was attempting to anchor a plywood form in preparation for pouring a concrete wall.

Description of the incident:
A 22-year-old carpenter's apprentice was killed when he was struck in the head by a nail fired from a powder-actuated nail gun. The nail gun operator fired the gun while attempting to anchor a plywood concrete form causing the nail to pass through the hollow form. The nail traveled 27 feet before striking the victim. The nail gun operator had never received training on how to use the tool, and none of the employees in the area were wearing PPE.

In another situation, two workers were building a wall while remodeling a house. One of the workers was killed when he was struck by a nail fired from a powder-actuated nail gun. The tool operator who fired the nail was trying to attach a piece of plywood to a wooden stud. But, the nail shot through the plywood and stud, striking the victim.

Below are some OSHA regulations that should have been followed.

- Powder-actuated nail guns should not be used to drive nails into easily penetrated materials unless the material is backed by a substance that will prevent the nail from passing through.
- Employees who operate powder or pressure-actuated tools must be trained to avoid firing into easily penetrated materials (like plywood).
- In areas where workers could be exposed to flying nails, appropriate PPE must be used.

Lesson Summary

In this lesson, we discussed the various types of tools and their general safety precautions. Electric power tools must be double insulated and have a three-wire cord plugged into a grounded receptacle. When using power tools, you should use gloves and safety shoes, keep work areas well lit, and ensure that cords don't present a tripping. Don't use power tools in wet locations unless approved for those conditions.

Abrasive wheels and tools may throw off flying fragments and should have guards and be inspected before use. Never remove guards or use a power tool without proper guarding in place. The point of operation must be guarded or otherwise protected.

The lower blade guard on a radial arm saw is designed to prevent the operator from coming into contact with the rotating blade. This guard must automatically return to the covering position when withdrawn from the work.

Pneumatic tools are powered by compressed air and they include nail guns, staplers, chippers, drills, and sanders. Hazards include getting hit by a tool attachment or by a fastener that worker is using with the tool. They should have a safety device on the muzzle to prevent the tool from ejecting fasteners, unless the muzzle is in contact with the work surface.

Avoid driving into materials easily penetrated unless materials are backed by a substance that will prevent the pin or fastener from passing through. Do not use powder-actuated tools in explosive or flammable environments.

Lesson 3: Mechanical Power-Transmission Apparatus

Lesson Focus

This lesson focuses on the following topics:

- Introduction
- Prime mover guards—flywheels
- Cranks and connecting Rods
- Shafting
- Pulleys
- Belt, Rope, and Chain Drivers
- Gears, Sprockets, and Chains
- Guarding Friction Drives
- Keys, Setscrews and Other Projections
- Collar and Couplings
- Guarding of Clutches, Cutoff Couplings, and Clutch Pulleys
- Belt Shifters, Clutches, Shippers, Poles, Perches and Fasteners

Introduction

Mechanical Power-Transmission Apparatus

Mechanical power-transmission apparatus includes all the parts that make up a mechanical system used to transmit energy from a main power source to the component that performs the work. These components include flywheels, pulleys, belts, connecting rods, shafting, couplings, cams, spindles, chains, cranks, and gears. OSHA has established basic guidelines for all employers to ensure that their employees do not get injured by getting caught in rotating parts, in-running nip points, pulleys, or other such components.

Prime-Mover Guards

Never remove guards while in operation. Always use proper lockout/tagout procedures when performing maintenance.

Flywheels that are located within 7 feet or 2.128 meters or less above a platform must be enclosed with a perforated sheet or with an enclosure of woven wire. Guard rails must be placed within 15 inches, or 38.1 centimeters and 20 inches, or 50.8 centimeters from the outer rim of the flywheel. A standard toeboard must be in place if the flywheel extends into a pit or is within 12 inches or 30.48 centimeters of the floor.

Any part of the flywheel that extends through the working floor must be completely enclosed or surrounded by a guardrail and toeboard.

A flywheel having a smooth rim five feet in diameter or less, where a guardrail and toe board cannot be installed, must have a disk attached to it in such a way that it covers the spokes of the wheel on the exposed side and present a smooth surface and edge. It must also provide means for periodic inspection. To allow the wheel to be turned over, an open space of more than 4 inches or 10.16 centimeters in width may be left between the outside edge of the disk and rim of the wheel. If the disk cannot cover any dangerous projections, such as the key, they must be cut off or covered.

Flywheels that are located above working areas must be guarded by installing guards that have sufficient strength to hold the weight of the flywheel in the event of a shaft or wheel mounting failure.

Flywheels

Cranks and Connecting Rods

Never place your hands past protective guards or try to remove them. Doing so may result in one or multiple body parts being injured.

When exposed to contact, cranks and connecting rods must be guarded with proper materials by securely fastening it to the frame. Approved materials include expanded metal, perforated or solid sheet metal, wire mesh on a frame of angle iron, or iron pipe securely fastened to the floor or frame of a machine. You must ensure that all metal is free from burrs and sharp edges at all times.

Alternatively, a guardrail can also be used to guard cranks and connecting rods. The guardrail used must be 42 inches or 106.68 centimeters in height, with mid-rail between top rail and the floor. Posts cannot be more than 8 feet or 2.432 meters apart; they must be fixed permanently and should be strong, smooth, and free from protruding nails, bolts, and splinters.

Tail Rods or Extension Piston Rods

Tail rods or extension piston rods must be guarded in a similar way as cranks and connection rods. If a guardrail is used on sides and end, it must have a clearance between 15 inches or 38.1 centimeters and 20 inches or 50.8 centimeters when the rod is fully extended.

Shafting

Each continuous line of shafting must be secured in position against excessive endwise movement. Inclined and vertical shafts, particularly inclined idler shafts, have to be securely held in position against endwise thrust.

Guarding Horizontal Shafting

Any exposed parts of horizontal shafting that are 7 feet or 2.128 meters or less from the floor or the working platform must be protected by enclosing the shafting completely with a stationary casing or by a trough enclosing sides and top or sides and bottom of shafting as location requires. This enclosing is not required for runways used exclusively for oiling, or running adjustments.

Shafting under bench machines has to be enclosed by a stationary casing, or by a trough at sides and top or sides and bottom, as location requires. The sides of the trough must come within at least 6 inches or 15.24 centimeters of the underside of the table, or if shafting is located near floor within 6 inches or 15.24 centimeters of the floor. In every case, the sides of the trough must extend at least 2 inches or 5.08 centimeters beyond the shafting or protuberance.

Guarding Vertical and Inclined Shafting

Vertical and inclined shafting 7 feet or 2.128 meters or less from the floor or working platform, except maintenance runways, must be enclosed with a stationary casing made of expanded metal, perforated or solid sheet metal, wire mesh on a frame of angle iron, or iron pipe securely fastened to the floor or frame of the machine.

Projecting Shaft Ends

All projecting shaft ends and edges must be smooth and not project more than one-half the diameter of the shaft, unless guarded by non-rotating caps or safety sleeves. Unused keyways have to be filled up or covered.

Pulleys

Any part of a pulley which is 7 feet or 2.128 meters or less from the floor or working platform, must be guarded with a sheet made of expanded metal, perforated or solid sheet metal, wire mesh on a frame of angle iron, or iron pipe securely fastened to the floor or frame.

Pulleys serving as balance wheels, (e.g., punch presses), on which the point of contact between belt and pulley is more than 6 feet, 6 inches or 1.976 meters from the floor or the platform, can be guarded with a disk covering the spokes.

Pulleys that have cracks or pieces broken out of rims, must never be used. Pulleys should never be operated at a speed in excess of the manufacturer's recommendations.

Location of Pulleys

A guide must be provided to prevent the belt from leaving the pulley on the side where there is insufficient clearance, unless the distance to the nearest fixed pulley, clutch, or hanger exceeds the width of the belt used.

Approved Guarding Materials

Belt, Rope, and Chain Drives
Horizontal Belts and Ropes

The belt must be fully enclosed where both runs of the horizontal belt are 42 inches, 106.68 centimeters or less from the floor. If both runs of horizontal belts are 7 feet or 2.128 meters or less from the floor level, the guard should extend to at least 15 inches or 38.1 centimeters above the belt.

Overhead Horizontal Belts

Overhead horizontal belts, with lower parts 7 feet or 2.128 meters or less from the floor or platform, must be guarded on the sides and the bottom. Guards must run the entire length of the belt and follow the line of the pulley to the ceiling or be carried to the nearest wall, thus enclosing the belt effectively. Where belts are so located as to make it impractical to carry the guard to a wall or ceiling, construction of those guards should be such as to completely enclose the top and bottom runs of the belt and face of the pulleys.

Horizontal overhead belts more than 7 feet or 2.128 meters above the floor or platform must be guarded for their entire length if located over passageways or work places and traveling 1,800 feet or more per minute. They also have to be guarded for the entire length if center to center distance between pulleys is 10 feet or 3.04 meters or more or if the belt is 8 inches or 20.32 centimeters or more in width.

Overhead Horizontal Belts

If the upper and lower runs of horizontal belts are located in such a way that passage of persons between them would be possible, the passage must be completely barred by a guardrail or other barrier. Alternatively, a platform can be provided over the lower run guarded on either side by a railing completely filled in with wire mesh or other filler, or by a solid barrier. The upper run must be guarded in a way as to prevent contact with either the worker or by objects carried by him. In power plants, only the lower run of the belt needs to be guarded.

Overhead chain and link belt drives follow the same rules as overhead horizontal belts and should be guarded in the same manner.

Vertical and Inclined Belts

Vertical and inclined belts must be enclosed by a guard made of expanded metal, perforated or solid sheet metal, wire mesh on a frame of angle iron, or iron pipe securely fastened.

Alternatively, a guardrail can also be used to guard vertical and inclined belts. The guardrail used must be 42 inches or 106.68 centimeters in height, with mid-rail between top rail and floor. Posts cannot be more than 8 feet or 2.432 meters apart; they must be fixed permanently and should be strong, smooth, and free from protruding nails, bolts, and splinters.

All guards for inclined belts have to be arranged in such a manner that a minimum clearance of 7 feet or 2.128 meters is maintained between belt and floor at any point outside of guard.

Vertical Belts

Vertical belts running over a lower pulley more than 7 feet or 2.128 meters above floor or platform must be guarded at the bottom in the same manner as horizontal overhead belts.

Cone-Pulley Belts

To properly guard the nip point of the belt and pulley, the cone belt and pulley must be equipped with a belt shifter. If the belt shifter does not have a frame that completely guards the nip point of the belt and pulley, the nip point must be protected by placing a vertical guard in front of the pulley that extends to at least the top of the largest step of the cone.

Belt Tighteners

All suspended counterbalanced tighteners and their parts must be strong enough and fastened securely. All bearings must be securely capped. Some means must be present that prevents the tightener from falling if the belt breaks. All suspended counterweights that are not guarded by location, must be encased in such a way as to prevent any accidents.

Belts and Guarding

Gears, Sprockets, and Chains

Gears

All gears used must be guarded by completely enclosing them with guardrails at least 7 feet or 2.128 meters high extending 6 inches or 15.24 centimeters above the mesh point of the gears. A gear can also be guarded by a band guard covering the face of the gear and having flanges extended inward beyond the root of the teeth on the exposed side or sides. When any portion of the train of gears guarded by a band guard is less than 6 feet or 1.824 meters from the floor, a disk guard or a complete enclosure to the height of 6 feet or 1.824 meters must be used.

Hand-Operated Gears

Although not required, it is highly recommended to guard hand-operated gears that are used only to adjust machine parts and which do not continue to move after hand power is removed.

Sprockets and Chains

All sprocket wheels and chains have to be enclosed unless they are more than 7 feet or 2.128 meters above the floor or platform. Protection against falling must be provided in any area where the drive extends over other machines or working areas. However, this does not apply to manually operated sprockets.

Openings for Oiling

Openings with hinged or sliding, self-closing covers must be present if frequent oiling has to be done. Oil feed tubes must be attached to all points that are not easily accessible to add lubricant while machinery is in motion.

Sprocket and Chain

Guarding Friction Drives

All driving points of all friction drives that come in contact must be guarded. It is important to completely cover all arm- or spoke-friction drives and all web-friction drives with holes in the web. The projecting belts on friction drives that are exposed to contact must also be guarded.

Keys, Setscrews, and Other Projections

It is important to remove or guard with metal covers all projecting keys, setscrews, and other projections in revolving parts. However, this does not apply to keys or setscrews within gear or sprocket casings, other enclosures, or keys, setscrews, or oil-cups in hubs of pulleys less than 20 inches (or 50.8 centimeters) in diameter where they are within the plane of the rim of the pulley. It is recommended that no projecting setscrews or oil-cups be used in any revolving pulley or part of machinery.

Collars and Couplings
Collars

All revolving collars, including split collars, must be cylindrical. All screws or bolts used in collars should not project beyond the largest periphery of the collar.

Couplings

Shaft couplings must be constructed in a way that they prevent hazards from bolts, nuts, setscrews, or revolving surfaces. However, bolts, nuts, and setscrews can be used where they are covered with safety sleeves, used parallel with the shafting and are countersunk or else do not extend beyond the flange of the coupling.

Guarding of Clutches, Cutoff Couplings, and Clutch Pulleys

Guards

Clutches, cutoff couplings, or clutch pulleys that have any projecting parts and which are located 7 feet or 2.128 meters or less above the floor or working platform must be enclosed by a stationary guard. A "U" type guard can be used.

Belt Shifters, Clutches, Shippers, Poles, Perches, and Fasteners

Belt Shifters

Tight and loose pulleys on all new installations made on or after August 31, 1971 must be equipped with a permanent belt shifter. The belt shifter must be equipped with mechanical means to prevent it from creeping from loose to tight pulley. Old installations should be changed so that they conform to this rule.

Belt shifters and clutch handles should be rounded. They must be located as far as possible from danger of accidental contact but within easy reach of the operator. Where belt shifters are not directly located over a machine or bench, the handles should be cut off 6 feet 6 inches or 1.976 meters above floor level.

Belt Shippers and Shipper Poles

It is not recommended to use belt poles instead of mechanical shifters.

Belt perches

Belt perches, in the form of brackets, rollers etc., can be used where loose pulleys or idlers are not practical to keep idle belts away from the shafts.

Belts Fasteners

Belts that have to be shifted by hand and belts within 7 feet (2.128 meters) of the floor or working platform which are not guarded must not be fastened with metal in any case.

Belts, Couplings, and Collars

Lesson Summary

If the upper and lower runs of horizontal belts are located in such a way that passage of persons between them would be possible, the passage must be completely barred by a guardrail or other barrier. Alternatively, a platform can be provided over the lower run and guarded on either side by a railing completely filled in with wire mesh or other filler, or by a solid barrier. The upper run must be guarded in a way so as to prevent contact with either the worker or with objects carried by him. In power plants, only the lower run of the belt needs to be guarded.

Any part of the flywheel that extends through the working floor must be completely enclosed or surrounded by a guardrail and toe board. If a belt breaks, all suspended counterweights that are not guarded by location, must be encased in such a way so as to prevent any accidents. OSHA has established some basic guidelines for all employers to ensure that their employees do not get injured by getting caught in rotating parts, in in-running nip points, in pulleys, or other such components.

Module 18: Welding and Cutting

Module Description

This module is intended to provide an overview of the hazards associated with welding, cutting, and brazing and the protective measures necessary to assure the work is performed safely. The module is specifically designed to help workers meet OSHA compliance regarding welding, cutting, and brazing.

Module Learning Objectives

At the conclusion of this module, you should be able to:

- Discuss OSHA's general requirements concerning welding, cutting, and brazing.
- Identify the general safety requirements for all types of welding.
- Describe the general characteristics for various types of welding.
- Name the specific safety requirements for oxygen-fuel gas welding and cutting, arc welding and cutting, and resistance welding.

Lesson 1: General Requirements

Lesson Focus

This lesson focuses on the following topics:

- Introduction
- Fire Prevention and Protection
- Personnel Protection
- Health Protection and Ventilation

Introduction

Welding, cutting, and brazing are some of the most common industrial processes. However, if proper preventive measures are not taken, these processes can be extremely hazardous. Burns to the skin, flash burns to the eyes and fire are some of the more immediate and serious hazards associated with welding, cutting, and brazing.

The use of compressed gases to create extremely hot flames can expose workers to highly dangerous conditions. There are many welding techniques that have different types of hazards associated with them, including the risk of fire, explosion, gas, and fume hazards.

The OSHA standard mandates all employers adopt and follow good work practices in all welding, cutting, and brazing techniques to prevent injuries, fires, and explosions.

Supervisor's Responsibility

Supervisor's duties include:

- Safe handling of the cutting or welding equipment, and the safe use of the cutting or welding process.
- Determining the combustible materials and hazardous areas present or likely to be present in the work location

Protecting combustibles from ignition by implementing the following measures:

- Have the work moved to a location free from dangerous combustibles.
- If the work cannot be moved, have the combustibles moved to a safe distance from the work or have the combustibles properly shielded against ignition.

- See that cutting and welding are so scheduled that plant operations that might expose combustibles to ignition are not started during cutting or welding.
- Secure authorization for the cutting or welding operations from the designated management representative.
- Determine that the cutter or welder secures approval that conditions are safe before going ahead.
- Determine that fire protection and extinguishing equipment are properly located at the site.

Fire Prevention and Protection

In order to protect workers from fire-related hazards, OSHA has specified basic preventive measures along with certain special preventive measures for exceptionally dangerous tasks, like welding and cutting containers and welding in confined spaces.

The OSHA standard's basic preventive measures for fire in welding, cutting, and brazing focus on eliminating fire hazards. These include:

- Before an object is welded or cut, it must be moved to a safe place.
- If the object to be welded or cut cannot be moved, then the area must be cleared of all moveable fire hazards.
- If certain fire hazards cannot be removed from the area, then workers are required to use guards to protect the immovable fire hazards from heat, sparks, and slag.
- If, however, the requirements mentioned above cannot be met, then employees must not perform any welding and cutting tasks.

Apart from these basic preventive measures for fires in welding and cutting, OSHA requires all workers to take certain special precautions. The OSHA standard requires workers to have proper fire extinguishing equipment available. All fire extinguishing equipment must be in proper working condition and must be kept close by for instant use. Preventive equipment may consist of buckets of sand, pails of water, fire extinguishers, or hoses. However, these may vary according to the nature of the work and the quantity of combustible material present in the vicinity.

Where there is a considerable amount of combustible material present closer than 35 feet from the work location, OSHA requires employers to station fire watchers whenever welding or cutting is performed. OSHA also requires employers to station fire watchers if considerable amounts of combustible materials are present that can be easily ignited by sparks, even if they are more than 35 feet away. The OSHA standard requires the fire watch to be maintained for at least a half hour after the welding or cutting task has been completed, and for a longer period of time if necessary.

Case Study

Welding Hazard

In a product refinery, two newly recruited workers were required to weld pipes near some storage tanks. These tanks contained highly flammable hydrocarbons. Some time after work commenced, the combustible material caught fire and resulted in a big explosion. Three workers who were working in the area died on the spot and seven were seriously wounded. Three of those workers died later as a result of their injuries.

This accident occurred because no preventive measures were taken before welding operations were started. No one made sure that there were no hazardous materials present in the vicinity of the work area, as required by the OSHA standard. Also, the workers were new and had not received any safety training and education regarding hazards associated with tasks like welding, cutting and brazing.

When Welding is Prohibited

The OSHA standard has specified certain situations in which welding, cutting, or brazing is not allowed. Cutting or welding is not allowed in:

- Buildings that have damaged sprinkler systems.
- Areas that are not authorized by management.
- Locations that have explosive atmospheres due to the presence of mixtures of flammable gases, liquids or dusts in the air.
- Areas where there is a risk of explosive atmospheres. These include areas inside unclean or improperly prepared tanks and areas with an accumulation of flammable gasses, vapors, liquids, or combustible dusts.

There are many containers that require additional safety precautions apart from the basic preventive measures. The OSHA standard specifies that welding, cutting, or other hot work should not be performed on barrels, used drums, tanks, or other containers until they are properly cleaned. Cleaning should remove all materials or substances like tars, acids, greases, or other flammable or toxic materials. It is also important to remove or blank any pipeline or connections to the container being welded or cut.

Welding in Confined Spaces

Personnel who are required to work in confined spaces must follow additional safety guidelines. OSHA defines a confined space as a relatively restricted space that has limited means of entry or exit. Examples of confined spaces include tanks, boilers, and pressure vessels. Before working in a confined space, all appropriate safety measures must be in place. The space must be ventilated thoroughly to be rid of any flammable or toxic gasses.

It is important for all employees who are assigned the task of welding or cutting inside a confined space to leave their gas cylinders and welding machines outside the space. If arc welding is suspended for a long period of time, such as during lunch or overnight, all electrodes must be removed from the holders. The holders must be placed carefully so that accidental contact does not occur. Also, the machine must be disconnected from the power source when not in use.

When an operation is suspended, all torch valves must be closed so that no gas escapes through the nozzle. Whenever the torch is not to be used for a long period of time, the gas supply to the torch must be properly shut off at a point outside the confined area. If possible, the hose and torch must also be removed from the confined space.

If a welder is to enter a confined space, employers must station an attendant outside the space to monitor the welder at all times. The attendant must be capable of putting rescue operations into effect.

Personnel Protection

OSHA has specified guidelines for personnel involved in welding and cutting operations to take protective measures against various other hazards apart from fire hazards. These measures provide guidelines to personnel for fall protection, eye protection, and protective clothing. If welders are required to work at a height, for example on a platform, a runway, or a scaffold, OSHA mandates the use of railings, lifelines, or some equally effective safeguards.

Performing operations like welding, cutting or brazing without proper eye protection may cause serious eye injuries. OSHA requires all personnel to wear helmets and hand shields during all arc welding or arc cutting operations in order to protect themselves from direct radiant energy from the arc. However, OSHA does not require personnel to wear helmets and hand shields while involved in submerged arc welding. OSHA also mandates all helpers and attendants to have proper eye protection.

The material that is used to make the helmets and hand shields must be an insulator for heat and electricity. It is very important to ensure that the helmets, goggles, and shields are not readily flammable, and they must be strong enough to withstand sterilization. If the work permitted, welding should be performed behind a non-combustible screen with a low reflectivity surface, such as zinc oxide.

This helps in absorbing ultra-violet radiation that may harm a welder; however, all booths and screens used must allow circulation of air at floor level. People in the vicinity of the area where welding or cutting operations are being carried out must be provided with non-combustible screens, shields, or goggles if necessary.

All personnel involved in welding, cutting, or brazing operations must be provided with personal protective equipment to protect themselves from burns and fires.

The type of protective clothing may vary according to the nature of the welding operation and the location where work has to be performed. Employers must provide personal protective equipment materials that are designed to provide maximum protection from hot metal and sparks.

Health Protection and Ventilation

Some materials that are used in welding operations can be extremely hazardous even if precautionary measures have been taken. These materials must be removed by proper ventilation. The materials that are considered extremely hazardous include fluorine compounds, zinc, lead, beryllium, cadmium, mercury, certain cleaning compounds, and stainless steel.

Nitrogen dioxide is a harmful gas released from the processing of stainless steel. When working with the materials states above, workers must protect themselves with proper PPE, such as a respirator, to protect themselves.

Lesson Summary

All fire extinguishing equipment must be in proper working condition and must be kept close by for instant use. However, these devices may vary according to the nature of the work and the quantity of combustible material present in the vicinity. OSHA requires employers to station fire watchers if considerable amounts of combustible materials are present that can be easily ignited by sparks and requires the fire watch to be maintained for at least a half hour after the welding or cutting task has been completed or longer if necessary.

OSHA additionally requires all personnel to wear helmets and hand shields during all arc welding or arc cutting operations in order to protect themselves from direct radiant energy from the arc. It mandates all helpers and attendants to have proper eye protection. Also, if a welder is to enter a confined space, employers must station an attendant outside the space to monitor the welder at all times, and this attendant must be capable of putting rescue operations into effect.

Lesson 2: Oxygen-fuel Gas Welding and Cutting

Lesson Focus

This lesson focuses on the following topics:

- Introduction
- Cylinders and Containers
- Manifolding of Cylinders
- Service Piping Systems
- Protection of Service Pipe Systems

Introduction

In this lesson, we will discuss the preventive and protective measures that focus on hazards associated with oxygen-fuel gas welding and cutting. Welders must guard against mixtures of fuel gasses and air or oxygen, as such mixtures may be explosive. No devices are to be used that mix air or oxygen with flammable gasses before they have to be consumed, unless they have been approved by an authorized person.

The OSHA standard requires all welders to take special care when dealing with acetylene. Acetylene should never be generated or stored except in approved cylinders. It should not be utilized at a pressure exceeding 15 pounds per square inch gauge (psig) or 30 pounds per square inch absolute (psia). Using acetylene at pressures exceeding 15 psig (30 psia) can be extremely hazardous.

Gaseous acetylene is highly unstable at pressures above 15 psig and it may decompose with an explosion. The decomposition of acetylene must be avoided by storing it in cylinders that have been specially designed for storing such gasses.

Cylinders and Containers

The OSHA standard requires all portable cylinders that are used for storage and shipment of compressed gasses to be constructed and maintained according to the regulations set forth by the U.S. Department of Transportation, 49 CFR Parts 171-179.

OSHA has provided specific guidelines for using and handling cylinders and containers containing compressed gasses. All personnel must know about marking of cylinders, storage of cylinders, and their operating procedures.

Approval and Marking

OSHA mandates that all compressed gas distributors clearly mark all compressed gas cylinders. Markings must include either the chemical or trade name of the gas stored in the cylinder. It is very important to ensure that all stamping, stenciling, or labeling used for marking the cylinder is not easily removable. The cylinder must be marked on the shoulder where it does not come into contact with other surfaces. Marking cylinders not only ensures proper use but also helps personnel to store them properly. An employer or employee must not attempt to use the contents of an unmarked cylinder.

Storage of Cylinders

Proper storage of cylinders is also stressed by the OSHA standard. All cylinders must be stored away from radiators and other devices that produce heat. If cylinders are stored inside buildings, steps must be taken to protect and ventilate the location thoroughly. It also must be ensured that the storage area is dry and at least 20 feet (6.1 m) away from highly combustible materials. It is additionally important to store cylinders away from stairs, elevators, exit routes, or other areas where they can be toppled or damaged by passing people or falling objects, or where they could otherwise be tampered with.

Personnel responsible for storing cylinders must make sure to close valves of all empty cylinders. Some cylinders are designed with valve protection caps. When the cylinders are not in use, these protection caps must be placed on the valves and appropriately tightened. The purpose of the valve protection cap is to protect the valve and to buffer the shock received if the cylinder falls.

Fuel Gas Cylinders

All fuel gas cylinders stored inside a building must be limited to a total gas capacity of 2,000 cubic feet (56 m3) or 300 pounds (135.9 kg) of liquefied petroleum gas. All fuel gas cylinders with a gas capacity greater than 2,000 cubic feet (56 m3) or 300 pounds of liquefied petroleum gas must be stored in a separate room or a special building. These buildings or rooms must not have any heating or lighting and should be kept properly ventilated at all times. However, this limitation is not applicable for cylinders that are being used or are ready to be used.

Acetylene cylinders are required to be stored with the valve end up. If these cylinders are stored on their side, acetone may leak out and create a hazardous condition.

Oxygen Cylinders

Oxygen cylinders must be stored away from fuel-gas cylinders or other combustible materials, such as oil or grease. These cylinders must be stored at a minimum distance of 20 feet (6.1 m) from highly combustible material.

Oxygen cylinders outside generator houses are required to be separated from the generator by using a partition that has a fire-resistance rating of at least one hour. The partition must not have any openings and must not allow any gasses to accumulate. OSHA has specified this preventive measure in order to protect personnel from fire hazards.

Operating Procedures

Due to the potential hazards associated with cylinders containing compressed gasses, OSHA requires all personnel to store and operate these cylinders properly. Care must be taken to eliminate all traces of oil and grease from cylinders, cylinder valves, regulators, couplings, hoses, and other apparatus when welding operations are being carried out. Welders must not operate or handle cylinders with oily hands or gloves. Also, it must be ensured that no oily surface or greasy clothing is exposed to a jet of oxygen.

Compressed gas cylinders have two critical components that must be handled carefully: valve outlet and the regulator. Valve protection caps are used to protect valves from getting damaged and from coming into contact with oil or grease. The OSHA regulation specifies that workers should never use valve protection caps for lifting the cylinders as the caps may accidentally come loose and fall, possibly causing a sudden release of pressure.

Apart from protecting the valve outlet, measures must be taken to protect the regulator. Regulators must be removed and valve-protection caps placed properly before cylinders are moved.

Cylinders that are not equipped with fixed hand wheels must have keys, handles, or non-adjustable wrenches on valve stems while they are being used.

A regulator must always be attached to a compressed gas cylinder before it is used, except when connected to a manifold. It is important to ensure that the regulator being used is compatible with the gas in the cylinder and its service pressure. The regulator must be cleaned with a clean filter installed. All manifolds and headers should be capped when not in use to prevent injuries.

Before a regulator is attached, the protective cap must be removed from the cylinder and the valve opened slightly for an instant, and then closed immediately.

This practice ensures that the cylinder valve is cleared of any dust or dirt that may have accumulated during storage. Dirt can damage vital parts of a regulator and may cause a fire or an explosion.

The valve of a cylinder containing acetylene should not be opened more than one and a half turns of the spindle and preferably no more than three-fourths of a turn. This allows adequate flow of the gas and permits the welder to close the valve quickly in an emergency situation.

While the welding or cutting operations are being carried out, all cylinders must be kept far away from the work location so that no sparks, hot slag, or flame can reach them. If they cannot be removed, they must be protected with fire-resistant shields. The OSHA standard also specifies that cylinders must not be placed in an area where they can become a part of an electric circuit.

Manifolding of Cylinders

Advantages of using manifolds:

- Because gas cylinders have not been scattered throughout the work area but have been kept centrally:
  - The possibility of accidents is reduced.
  - More space is available at each workplace.
- In case of fire, one can easily reach the cylinders.
- There is more effective use of gases.
- Cylinders are transported by less distance.
- There is no replacement of cylinders inside the workshop.

Welders do not always use portable cylinders as a source of gas. Sometimes a service pipe system is used to provide a manifolding effect. Manifolding is the process of using multiple-line fluid inputs into a single intake chamber for the purpose of combining gasses when they are needed for welding.

Portable outlet headers are used in order to control the flow of a particular gas. Each portable outlet header consists of a nozzle and a hose that can be connected to a portable cylinder or a service pipe. The OSHA standard specifies that, except for temporary service where conditions preclude a direct supply, portable outlet headers must never be used indoors.

All service piping outlets used to withdraw and supply oxygen or fuel gas to a portable outlet header must consist of a shut-off valve that is easily accessible. The service outlet on the portable outlet header must be equipped with a valve assembly that must consist of a detachable outlet seal cap attached to the body of the valve.

The use of a seal cap ensures that the outlet pipe thread will remain free from oil or grease and not be damaged. Damaged pipe threads can result in leaky connections.

Service Piping Systems

All service piping systems being utilized must be designed and installed according to the safety requirements specified by OSHA. The pipes to be used should be at least Schedule 40, and all fittings must be of standard weight in sizes up to and including 6-inch nominal. Schedule 40 pipe has a working pressure of up to 125 psi, and it should always be tested before use.

A close inspection is also required because problems may arise if line extensions are made with pipe type other than Schedule 40. OSHA has specified some special requirements when personnel are using service pipe systems with oxygen or acetylene.

The piping system is required to have a minimum pressure of 250 psig if oxygen is supplied to a service piping system from a low-pressure oxygen manifold without any pressure-regulating device. When the connected equipment is used at pressures less than 250 psig, a pressure-regulating device must be used for each station outlet.

For acetylene or acetylenic compounds, the piping must be made of steel or wrought iron. Under certain conditions, acetylene forms explosive compounds with copper, silver, and mercury; therefore, employers must ensure that unalloyed copper is not used for acetylene or acetylenic compounds except when using certain listed equipment.

All piping must be installed in a way that it runs as directly as possible. Some space should be allowed for expansion, contraction, jarring, and vibration. This will help protect the pipes from damage. Pipes that have to be laid underground must be located below the frost line, and protective measures must be taken to prevent or protect against corrosion.

After installation, the piping has to be blown out with air, nitrogen, or carbon dioxide to remove any foreign materials. For oxygen piping, the air, nitrogen, or carbon dioxide that is used must be completely oil-free. When air or gas is released from combustible gas lines, care must be taken to ensure that no source of ignition is allowed near uncapped openings.

Underground piping must be protected against corrosion by covering or painting it with a suitable material that would allow maximum protection against corrosion.

After installing the piping systems, they must be tested to ensure that they are gas-tight at 1.5 times the maximum operating pressure. Oxygen must be tested by only using oil-free and non-combustible materials. Under no circumstances are personnel allowed to use flames to detect leaks.

Protection of Service Pipe Systems

The OSHA standard requires employers to ensure that the service pipe system is always protected against the build-up of excessive pressure and leaks. Protection may be provided using pressure relief devices, protective equipment, regulators, and hoses.

Pressure Relief Devices

Pressure relief devices are used to protect service piping from excessive pressure build-up. Pressure relief devices must be set to function at not more than the pressure specified for the system. The pressure relief device must be made to discharge upwards to a safe location. OSHA mandates the use of pressure relief valves for preventing excessive build-up in fuel-gas piping systems.

Piping Protective Equipment

The OSHA standard mandates the use of approved protective equipment for fuel-gas piping in order to prevent:

- The backflow of oxygen into the fuel-gas system.
- The passage of a flash-back into the fuel-gas supply system.
- Excessive back-pressure of oxygen in the fuel-gas supply system.

Personnel can use one device that performs all three functions of the protective equipment or separate devices to achieve each task separately. In a fuel-gas piping system, the protective equipment is required either at the main supply line, at the head of each branch line, or at each location where fuel-gas is withdrawn. However, it is preferable to place the protective equipment at the main supply as this would provide the best protection.

Regulators

Pressure-reducing regulators can be used to control pressure in piping systems. OSHA has specified that pressure-reducing regulators shall only be used for the gas and pressures for which they are made.

If any part of these regulators is out of order and needs repair, only skilled mechanics that have had proper training should fix it. The regulators for oxygen piping systems must be labeled with a warning advising the user to: "USE NO OIL."

Hoses

Apart from using release devices, the piping system must be designed using proper hoses to protect against leaks. The OSHA standard specifies that the hose and hose connections must be clamped or securely fastened so that they can withstand twice the pressure to which they are normally subjected. This pressure cannot be less than 300 psi. To test the hoses, oil-free air or oil-free inert gas must be used.

The oxygen hose is green and has a right-hand threaded nut for connecting to the torch. The acetylene fuel-gas hose is usually red (sometimes black) and has a left-hand threaded nut for connecting to the torch.

Hoses that are burnt, worn, or have other defects must be replaced or repaired before any operations are performed. OSHA also prohibits personnel from using leaky hoses.

When inspecting hoses, look for charred sections close to the torch. These may have been caused by flash-back. Also check that hoses are not taped up to cover leaks.

Lesson Summary

All personnel who weld or supervise those individuals who do must know about marking of cylinders, storage of cylinders, and their operating procedures. OSHA mandates that all compressed gas distributors, for example, clearly mark all compressed gas cylinders. Markings must include either the chemical or trade name of the gas stored in the cylinder.

It is additionally important to store cylinders away from stairs, elevators, exit routes, or other areas where they can be toppled or damaged by passing people or falling objects, or where they could otherwise be tampered with. Due to the potential hazards associated with cylinders containing compressed gases, OSHA requires all personnel to store and operate these cylinders properly.

The OSHA standard requires employers to ensure that the service pipe system is always protected against the build-up of excessive pressure and leaks. Protection may be provided using pressure relief devices, protective equipment, regulators, and hoses. OSHA mandates the use of pressure relief valves for preventing excessive build-up in fuel-gas piping systems.

Lesson 3: ARC Welding and Resistance Welding

Lesson Focus

This lesson focuses on the following topics:

- Arc Welding and Cutting
- Resistance Welding

ARC Welding and Cutting

The information presented in this lesson will focus on preventing accidents and promoting work safety when performing arc welding or cutting operations. In the arc welding process, an electric current is passed through the welding rod and is forced to jump or arc across a gap. The heat produced through this process is intense enough to perform welding and cutting operations. Most of the precautions and safe practices specified by OSHA are common to oxy-fuel gas welding, but there are certain requirements that are unique to arc welding.

One of the unique requirements of arc welding is shielding. It has been noticed that if air is kept away from the weld puddle, the welds produced have better physical and chemical properties. Some gasses like oxygen, hydrogen, and nitrogen, when mixed with moisture, can reduce the quality of the weld. Therefore, shielding is used to preserve the integrity of the weld joint.

Application

The OSHA standard requires construction of standard machines for arc welding service. These must be designed to carry their rated load with rated temperature rises. The maximum temperature of the cooling air should be 40 degrees Celsius (104 degrees Fahrenheit), and the maximum altitude is 3,300 feet (1,005.8 m). The machines should be suitable for operation in atmospheres containing gases, dust, and light rays produced by the welding arc.

To carry out the arc welding process, a welder can either use an alternating current (AC) or a direct current (DC). For alternating current machines, the voltage should not exceed the limit of 80 volts for manual and 100 volts for automatic arc welding and cutting. For direct current machines, the voltage must not exceed the limit of 100 volts for both manual and automatic arc welding and cutting.

If certain special welding and cutting processes are carried out that require values of the voltages higher than the specified limits, OSHA mandates employers provide all personnel with adequate insulation or other means that would ensure their safety.

If arc welding and cutting operations are being carried out at a location where the surroundings are warm and humid, or where perspiration is a factor, OSHA recommends the use of reliable automatic controls for reducing no-load voltage to reduce the shock hazard. Some of the older AC machines do not have an automatic control and are on load all the time.

Design

The OSHA standard requires all types of arc welding machines and control apparatus to be enclosed except for the operating wheels, levers or handles. It is also very important to enclose input power terminals, tap change devices, and live metal parts so that they can only be accessed by means of tools.

While carrying out welding operations, all personnel are required to protect the terminals for welding leads from accidental contact by workers or by metal objects such as hooks, vehicles, cranes, etc. To achieve this, OSHA specifies the use of:

- Dead-front receptacles for plug connections.
- Recessed openings with non-removable hinged covers.
- Heavy insulating sleeving or taping.

The connections for portable control devices must never be connected to an AC circuit of higher than 120 volts. On circuits above 50 volts, all exposed metal parts of portable control devices should be grounded by a grounding conductor in the control cable.

Personnel must never use AC reactors or auto transformers to obtain welding current directly from an AC power source with a voltage exceeding 80 volts.

Installation

Proper installation of equipment is very important to ensure safety during arc welding and cutting operations. One of the most critical requirements is proper grounding. OSHA requires personnel to ensure that the frame or case of the welding machine (except with engine-driven machines) is properly grounded before it is used.

The OSHA standard specifies that conduits that contain electrical conductors must never be used for completing a work-lead circuit. Pipelines must not be used as a permanent part of a work-lead circuit. However, they may be used during extension, construction, or repair, but only when current is not being carried through threaded joints, flanged bolted joints, or caulked joints. Special precautions must be taken to avoid sparking at the connection of the work-lead cable.

Supply Connections and Conductors

If a welding machine does not have a disconnecting switch or a controller as an integral part, one must be provided at or near the machine. A disconnect switch with overload protection is required for each outlet that has to be connected to a portable welding machine.

The rated current-carrying capacity of the supply conductors for individual welding machines must not be less than the rated primary current of the welding machines.

Operations that involve many welders working on one structure may require both polarities in the DC welding process. Supply circuit limitations for AC welding may require allocation of machines among the phases of the supply circuit. In a situation like that, no-load voltages between electrode holders should be twice as normal in DC or 1, 1.41, 1.73, or twice as normal on AC machines.

Operation and Maintenance

OSHA requires personnel to check all connections of the machines before initiating the operations to ensure that all requirements have been fulfilled. Work clamps that are magnetic must be cleared of all metal particles that might be sticking to them. Welders must spread out all coiled welding cables before use to prevent overheating and damage to insulation.

While the welding operations are being carried out, cables with splices within 10 feet (3 meters) of the holder must not be used. It is important that the welding electrode cables are never coiled around parts of the welders' bodies.

OSHA mandates the replacement of all cables that have damaged insulation or exposed bare conductors. Work and electrode cables must only be joined by using means that are particularly designed for that purpose.

Resistance Welding

The third type of welding process is resistance welding. Resistance welding utilizes pressure and heat that is generated in the pieces to be welded by resistance to an electric current.

When conducting resistance welding, all equipment should be installed by a qualified electrician. It must be ensured that all machines have disconnecting switches or circuit breakers that are located at or near the machine. Also, thermal protection switches must be provided for all ignitron tubes used in resistance welding equipment.

All personnel who are required to perform resistance welding must be properly trained and judged to be competent before they perform any tasks.

For all non-portable spot and seam welding machines, all external circuits must not operate on a voltage higher than 120 volts. All resistance welding equipment and control panels that involve voltages of over 550 volts must be properly insulated and shielded. OSHA requires all doors and access panels for the resistance welding machines and control panels to be kept locked and interlocked in order to prevent unauthorized persons from coming in contact with the live portions of the equipment.

Where there is a possibility of the operator's fingers being under the point of operation, all press welding machine operations shall be effectively guarded by the use of a device such as an electronic eye safety circuit, two hand controls, or protection similar to that prescribed for punch press operation. In all press welding operations, if the operator is required to have his or her fingers under the point of operation, he or she must be provided with effective protective equipment.

Wherever practical, a shield guard of safety glass or suitable fire-resistant plastic must be installed at the point of operation to avoid the hazard of flying sparks. Also, protective shields should be installed to prevent flying sparks from harming passing persons.

All foot switches that may be present on the machine must be guarded so that the machine does not get started accidentally. On special multi-spot welding machines, including 2-post and 4-post weld presses, there must be at least two safety emergency stop buttons.

OSHA requires all portable welding guns, transformers, and related equipment suspended from overhead structures to be outfitted with safety chains or cables. In case of failure of any component of the supporting system, these safety chains and cables must be capable of enduring the shock load.

All initiating switches, including retraction and dual schedule switches, located on the portable welding gun shall be equipped with suitable guards capable of preventing accidental initiation.

The outer casing of all portable welding transformers must be grounded. The OSHA standard requires all flash welding machines to comprise a protective hood to control flying flash.

Lesson Summary

For direct current machines, the voltage must not exceed the limit of 100 volts for both manual and automatic arc welding and cutting. OSHA requires all doors and access panels for the resistance welding machines and control panels to be kept locked and interlocked in order to prevent unauthorized persons from coming in contact with the live portions of the equipment.

Wherever practical, a shield guard of safety glass or suitable fire-resistant plastic must be installed at the point of operation to avoid the hazard of flying sparks. Also, protective shields should be installed to prevent flying sparks from harming passing persons.

Module 19: Silica Exposure

Module Description

OSHA estimates 2.3 million American workers are exposed to respirable crystalline silica within their job site or manufacturing plant. Over 80% of the workers that are exposed to silica dust are in the construction industry. Crystalline Silica has been linked to several medical conditions and even death to workers exposed to the deadly dust. Exposure to respirable crystalline silica is a health concern for exposed workers. The Occupational Safety and Health Administration (OSHA) recently updated the silica standard to increase the protection of workers through:

- Exposure identification sampling
- Medical evaluations
- Continued medical surveillance
- Lower Permissible Exposure Limit (PEL)
- Specific guideline for common construction tasks
- Requiring a silica exposure control program
- Addressing appropriate hazard exposure control

Module Learning Objectives

At the conclusion of this module, you should be able to:

- Identify materials which contain silica
- Understand the health hazards of respirable crystalline silica
- Explain the OSHA regulation on respirable crystalline silica for construction
- Be informed of the key provisions of the OSHA Construction standard 29 CFR 1926.1153
- Describe the federal guidance for medical surveillance
- Analyze exposure control techniques to protecting general industry workers from silica exposure
- Recognize the health hazards related to over exposure to respirable crystalline silica
- Identify the cause of lung tissue damage
- Understand the three major development stages of silicosis
- Explain the basic symptoms of silicosis

Lesson 1: The Issue

Lesson Focus

This lesson focuses on the following topics:

- Silica
- Over Exposure of Silica
- Silica Exposure Limits
- Exposure Assessment Options
- Exposure Control Options
- Requirements
- Hazard Communication
- Housekeeping

Silica

Silica molecule is made up of two of the most abundant elements on the earth, oxygen and silicon. The structure of a silica molecule is two Oxygen atoms to one Silicon atom. The bonded molecules when lined up in a repeatable pattern is referred to as "crystalline silica". There are 3 identified forms of silica in the OSHA standard:

- Quartz
- Cristobalite
- Tridymite

Respirable crystalline silica dust is a very small particle of hazardous dust that is linked to lung cancer, silicosis, chronic obstructive pulmonary disease and kidney disease if breathed into the body. It is defined as Quartz, Cristobalite, and/or Tridymite material that is entrapped in airborne particles as defined by the sampling specifications of the International Organization for Standardization (ISO) 7708: 1995 Air Quality-Particle Size Fraction Definitions for Health-Related Sampling.

The source of the silica dust is from drilling, crushing, cutting, or grinding rocks such as quartz (the most common surface material by volume to make up the earth's crust). However, silica can be found in brick, mortar, concrete, slate, granite, tile, sand-blasting sand, and filter media.

Silicosis is a lung disease that is related to silica exposure for workers that have chronic exposure or even acute exposures at a very high level of silica. Workers that develop silicosis have such lung damage that they experience shortness of breath, occasional bluish skin at the ear lobes or lips, chronic fatigue, and loss of appetite.

Over Exposure of Silica

Over-exposure to respirable crystalline silica has been linked to several health diseases and conditions, such as, but not limited to:

- Lung Cancer
- Chronic Obstructive Pulmonary Disease (COPD)
- Chronic Kidney Disease (CKD)
- Silicosis

Lung Cancer is the leading cause of cancer death in America among, both men and women. When silica is inhaled along with smoking, there is a higher risk for workers to get lung cancer than either factor alone. The American Cancer Society reports, over 100 studies conducted have shown there is "strong consistent evidence that silica exposure increases lung cancer risks (American Cancer Society, 2013).

Chronic Obstructive Pulmonary Disease is a progressive and mostly irreversible airflow obstruction condition which afflicts mostly cigarette smoker. However a report done in the United Kingdom identifies the relationship of increased cases of COPD in non-smoking individuals that are exposed to silica at work (British Medical Bulletin, 2012).

Chronic Kidney Disease (CKD) is liked to workers that have occupational exposure to silica. Though the sample size is small, the US National Library of Medicine National Institutes of Health noted in a 2011 report that there is "a positive relationship between occupational silica exposure and CKD" (NCBI, 2011). Additionally, the report states exposure to silica may also be associated with earlier stages of kidney disease.

Silicosis is caused due to Silica exposure. It is a pulmonary disease that causes chronic inflammatory reaction. This disease is known to kill lung tissue due to the process where the body's immune response cells, the Macrophage, try to dissolve the silica dust. Instead, the macrophage become weighted down with the respirable crystalline silica and sink into the lung tissue where they die. The alveoli (air sacs) in the lungs are damaged as scarred because of the activity that caused the macrophage to die. Eventually, the worker will have difficulty breathing and die from the exposure to silica.

There are 3 major development stages for the development of silicosis:

1. **Chronic** (> 10 years of mild over-exposure of respirable crystalline silica)
2. **Accelerated** (5-10 years of moderate over-exposure of respirable crystalline silica)
3. **Acute** (weeks-3 years of heavy over-exposure of respirable crystalline silica)

Basic symptoms of silicosis are as follows:

- Fever
- Loss of appetite
- Fatigue
- Occasional blue hues skin at ear lobes or lips
- Shortness of breath while exercising
- Persistent coughing

Workers that have silica exposure and exhibit signs for silicosis should seek medical attention.

Silica Exposure Limits

Exposure Limits and Specific Construction Task Identified in Task 1 of the Standard

The Occupational Safety and Health Administration (OSHA) has revised its Silica standard to reflect the current research which showed the previous standard wasn't protective enough for workers. The new regulation is expressed in the amount of silica that a worker can be exposed over an 8-hour time weighted average (TWA). This limit is called the Permissible Exposure Limit (PEL) and it has been lowered to 50 micrograms of respirable crystalline silica per cubic meter of air (µg/m3). At the 25 µg/m3 averaged over an 8-hour day level the employer must act to reduce the exposure to the worker.

The employer must prove that a workplace that is presumed or known to have over 25 µg/m3 (Action Level) over a Time Weighted Average (TWA) of a course of an 8-hour work shift, has been assessed. OSHA's Permissible Exposure Limit (PEL) for silica exposure is 50 µg/m3 over a TWA of an 8-hour period.

To calculate the TWA for exposure the employer must use the following calculation:

TWA= (Ca Ta + Cb Tb……Cn Tn)/8

TWA is the exposure for the work shift

C is the concentration during any period of Time (T) where the concentration of the silica is constant; and the Time duration is expressed in hours at the noted concentration.

Example:

- 3 hours at 100 µg/m3
- 2 hours at 10 µg/m3
- 5 hours at 50 µg/m3

TWA= (3 x 100 + 2 x 10 + 5 x 50)/8= 71.25 µg/m3

This is above the action level and above the PEL; the employer must comply with the 29 CFR 190.1053 rules.

If construction workers do certain tasks as identified on the 29 CFR 1926.1153 Table 1 jobs, then the controls must be fully and properly implemented. The conditions for compliance of the specific controls under Table 1 are as follows:

- Using equipment as intended with engineering controls
- Maintaining equipment properly
- Teaching workers how to use equipment as instructed by the manufacturer
- Changing vacuum bags when needed
- Meant to help the construction employers to meet the regulations easily

Workers that are actively operating the listed equipment or have some responsibility for completing the task on Table 1 are called the “Engaged Employee”. However, non-engaged employees are the workers that are in the area of the regulated task. Additionally, worksites must have provisions to keep all workers and the general public from being exposed to silica dust exposure.

The list of tasks which uses equipment to create respirable crystalline are as follows (OSHA, 2018):

1. **Stationary masonry saws**
    a. Use a saw that is equipped with integrated water delivery system with constant feed
    b. Operate per the Operations and Maintenance (O & M) manual to minimize dust emissions
    c. No respiratory protection needed
2. **Handheld power saw (any diameter)**
    a. Use a saw that is equipped with integrated water delivery system with constant feed
    b. Operate per the Operations and Maintenance (O & M) manual to minimize dust emissions.
    c. When used outdoors for:
        i. Less than 4 hours/shift no respirator is needed
        ii. More than 4 hours/shift respirator with a minimum assigned protection factor (APF) of 10
    d. When used indoors or enclosed areas
        i. Less than 4 hours/shift Respirator with APF 10
        ii. More than 4 hours/shift Respirator with APF 10
3. **Handheld power saws for cutting fiber-cement board (with blade diameter of 8" or less**
    a. Use saw equipped with commercially available dust collection system
    b. Use as outlined in O & M
    c. 99% or greater dust collection efficiency
    d. No respiratory protection needed
4. **Walk-behind saws**
    a. Use a saw that is equipped with integrated water delivery system with constant feed
    b. Operate per the Operations and Maintenance (O & M) manual to minimize dust emissions
    c. No respiratory protection needed
    d. When used outdoors for:
        i. Less than 4 hours/shift no respirator is needed
        ii. More than 4 hours/shift respirator no respirator is needed
    e. When used indoors or enclosed areas
        i. Less than 4 hours/shift Respirator with APF 10
        ii. More than 4 hours/shift Respirator with APF 10

5. **Drivable saws**
    a. Use a saw that is equipped with integrated water delivery system with constant feed
    b. Operate per the Operations and Maintenance (O & M) manual to minimize dust emissions
    c. No respiratory protection needed
6. **Rig-mounted core saws or drills**
    a. Use a saw that is equipped with integrated water delivery system with constant feed
    b. Operate per the Operations and Maintenance (O & M) manual to minimize dust emissions
    c. No respiratory protection needed
7. **Handheld and stand-mounted drills (including impact and rotary hammer drills**
    a. Use a saw that is equipped with shroud or cowling with dust collection
    b. Operate per the Operations and Maintenance (O & M) manual to minimize dust emissions
    c. Use a Hepa-filtered vacuum when cleaning holes
    d. Dust collector must be provided with a filter with 99% or greater efficiency and a filter-cleaning mechanism
    e. No protection needed
8. **Dowel drilling for concrete**
    a. Use shroud around drill bit with a dust collection system
    b. Dust collector must have a filter with 99% or greater efficiency and a filter-cleaning mechanism
    c. Use a HEPA-filtered vacuum when cleaning holes
    d. Work under 4 hours/shift use a respirator with an APF 10
    e. Work over 4 hours/shift use a respirator with an APF 10
9. **Vehicle-mounted drilling rigs for rock and concrete**
    a. Use dust collection system with close capture hood or shroud around drill bit with a low-flow water spray to wet the dust at the discharge point form the dust collector or,
    b. Operate from within an enclosed cab and use water for dust suppression on drill bit
    c. No respiratory protection needed
10. **Jackhammers and handheld powered chipping tools**
    a. Use tool with continuous stream or spray of water at point of impact or,
    b. Use tool with commercially available shroud and dust collection system
    c. Operate per the Operations and Maintenance (O & M) manual to minimize dust emissions

d. Dust collector must be provided with a filter with 99% or greater efficiency and a filter-cleaning mechanism
e. When used outdoors for:
    i. Less than 4 hours/shift no respirator is needed
    ii. More than 4 hours/shift respirator with a minimum assigned protection factor (APF) of 10
f. When used indoors or enclosed areas
    i. Less than 4 hours/shift Respirator with APF 10
    ii. More than 4 hours/shift Respirator with APF 10

11. Handheld grinders for mortar removal (i.e., tuckpointing)

a. Use grinder equipped with commercially available shroud and dust collection system
b. Operate per the Operations and Maintenance (O & M) manual to minimize dust emissions
c. Dust collector must provide 25 cubic feet per minute (cfm) or greater of airflow per inch of wheel diameter
d. Filter with 99% or greater efficiency and a cyclonic pre-separator or filter-cleaning mechanism
e. Work less than 4 hours/shift use respirator with an APF 10
f. Work more than 4 hours/shift use respirator with an APF 25

12. Handheld grinders for uses other than mortar removal

a. Use a saw that is equipped with integrated water delivery system with constant feed to the grinding surface
b. Operate per the Operations and Maintenance (O & M) manual to minimize dust emissions
c. No respiratory protection needed or,
d. Use grinder equipped with commercially available shroud and dust collection system
e. Dust collector must provide 25 cubic feet per minute (cfm) or greater of airflow per inch of wheel diameter
f. Filter with 99% or greater efficiency and a cyclonic pre-separator or filter-cleaning mechanism
g. When used outdoors for:
    i. Less than 4 hours/shift no respirator is needed
    ii. More than 4 hours/shift no respirator is needed
h. When used indoors or enclosed areas
    i. Less than 4 hours/shift no respirator is needed
    ii. More than 4 hours/shift Respirator with APF 10

13. **Walk-behind milling machines and floor grinders**
    a. Use a saw that is equipped with integrated water delivery system with constant feed to the cutting surface
    b. Operate per the Operations and Maintenance (O & M) manual to minimize dust emissions
    c. No respiratory protection needed or,
    d. Use a Hepa-filtered vacuum when used indoors or enclosed areas to remove loose dust in between passes
    e. Dust collector must be provided with a filter with 99% or greater efficiency and a filter-cleaning mechanism
    f. No respiratory protection needed
14. **Small drivable milling machines (less than half-lane)**
    a. Operate per the Operations and Maintenance (O & M) manual to minimize dust emissions
    b. Use a machine equipped with supplemental water sprays designed to suppress dust. Water must be combined with a surfactant
    c. No respiratory protection needed
15. **Large drivable milling machine (half-lane and lager)**
    a. <u>Asphalt Only at any depth</u>
    b. Use machine with exhaust ventilation on drum enclosure and supplemental water sprays designed to suppress dust
    c. <u>Cuts 4” in depth or less on any substrate</u>
    d. Use machine with exhaust ventilation on drum enclosure and supplemental water sprays designed to suppress dust
    e. Operate and maintain machine to minimize dust emissions or,
    f. Use a machine with supplemental water spray designed to suppress dust. Water must be combined with a surfactant
16. **Crushing machines**
    a. Use equipment that is designed to spray or mist for dust suppression at crusher and other points where dust is generated
    b. Operate per the Operations and Maintenance (O & M) manual to minimize dust emissions
    c. Use a ventilated booth that provides fresh, climate-controlled air to the operator, or a remote-control station
    d. No respiratory protection needed
17. **Heavy equipment and utility vehicles used to abrade or fracture silica-containing materials**
    a. Operate equipment in an enclosed cab
    b. When employees outside of the cab are engaged in the task, apply water and/or dust suppressants as necessary to minimize dust emissions

18. **Heavy equipment and utility vehicles for tasks such as grading and excavating**
    a. Apply water and/or dust suppression as necessary to minimize dust emissions
    b. When the equipment operator is the only employee engaged in the task, operate equipment from within an enclosed cab

Exposure Assessment Options

Employers that either do not perform Table 1 tasks or choose to use another form of exposure control must evaluate the worksite for silica exposure. For the employer to know the actual employee exposure level to respirable crystalline silica, they will have to do worksite assessment. There are two options of assessments allowed under the silica standard:

- Performance option, or
- Scheduled monitoring option

Performance Option

Performance Option is the most flexible of the two accepted assessment methods. *Objective data* and/or *air monitoring data*, in any combination, is utilized to profile the work environment. *Air monitoring* must be done in accordance to the Appendix A of the standard. Appendix A lists laboratory procedures for measuring the quality of air. The statement of the approved laboratory as to the level of silica at the most representative location of the worker's environment is acceptable to OSHA.

Objective Data is information that is taken from sources such as, but not limited to,

- an employer,
- manufacturer,
- industry-wide surveys, or
- associations

This data must be an accurate depiction of the working conditions of the worksite in concentration, duration, types of materials, environmental conditions, etc. OSHA give examples of acceptable sources for objective data (OSHA, 2018):

- Calculations based on substance composition
- Area sampling exposure mapping based on results
- Historical data for air monitoring by the employer

- Air monitoring data that reflects the workplace from industry-wide surveys

If the employer chooses to use the performance option, then the following must occur:

- Exposure assessment must be done prior to the commencement or assignment of work
- Reassessment of exposure must be done if there is a change in the process, product, or hazard control equipment that is expected to increase the exposure
- The employer must prove that the assessment was accurate
- The employer must ensure that the exposure assessment reflects the exposure for each job classification and every shift.

Scheduling Monitoring Option

Scheduling monitoring option is an assessment method is performed as soon as work is set to begin. The exposed employee is given an air sampling device to wear at their breathing zone for a full shift. Another technique for conducting a scheduling monitoring is using a stationary air sampling meter which is positioned in a place that represents the highest concentrations of silica exposure for several employees in a regulated area.

The employer can discontinue monitoring if the initial employee monitoring is below the action level. If the most recent sampling event is at or above the action level, but below the PEL, then the sampling must be repeated within a 6-month period. However, if the most recent monitoring sampling reveals exposure above the PEL, then it must be repeated within 3 months.

Where the most recent, non-initial, exposure monitoring reveals that the sampling results are below the action level, then the employer needs 2 consecutive samples below the action level. The samples must be taken 7 or more days apart from each other. If one of the 2 follow up samples exceed the action level, then the employer must follow the procedures as outlined in the Reassessment of exposures section of the standard.

Employees must be notified, in writing or by a posting in a location where everyone can see, of the results of the silica exposure test results within 5 working days after the completion of either exposure assessment. The 5-day notification begins when:

- An employer receives the laboratory results of the scheduling monitoring test, or
- Following the completion of the performance option exposure assessment

Employees or the designated representative must be allowed to observe the air monitoring if requested. Anyone observing a scheduled monitoring assessment must be protected from silica exposure by engineering controls or personal protective equipment.

Exposure Control Options

Engineering controls are the most effective way to protect a worker from any hazard that cannot be eliminated. An engineering control is a physical device that will mitigate the hazard from encountering the worker. The second-best way to protect a worker from a hazard is to define administrative controls (work rules). Finally, Personal Protective Equipment (PPE) is utilized as the other two controls are being developed or the hazard is still present in some form after the other two controls.

Here are some examples of each type of control.

1. **Engineering Controls**
    a. Ventilation systems in cabs of vehicles
    b. Wet cutting methods
    c. Vacuums equipped with a 0.3-micron Hepa filter
2. **Administrative Controls**
    a. Policies and Procedures
    b. Following Operations and Maintenance (O & M) manuals
    c. Conducting Job Hazard Analysis (JHA)
    d. Exposure Control Plan
3. **Personal Protective Equipment (PPE)**
    a. Hand protection
    b. Eye and face protection
    c. Respiratory protection
    d. Gloves

Abrasive Blasting

Abrasive Blasting with substrates containing silica is regulated as an extremely high hazard task. The employer must comply with the Ventilation standard 1926.57. Additionally, it is encouraged to use alternative substrates to replace silica as an engineering control. The use of a respirator is mandatory when doing repair task where engineering and work practices aren't feasible.

Another requirement in this standard is to have a *written exposure control plan* which includes the following as a minimum:

- Description of the tasks in the workplace involving exposure to silica
- Description of engineering controls, work practices, and respiratory protection for each task
- Description of housekeeping measures
- Description of the signs that indicate the engineering or other exposure controls are not working effectively, such as increase of visible dust or no water being delivered on the blade of a handsaw
- Include manufacturer instruction for all tools and equipment that are being used per the Table 1 guidelines
- Annual review of plan for effectiveness and update the plan when necessary
- Written plan must be readily available to each employee covered by the section, their designated representative, the Assistant Secretary and the Director

Medical evaluation

Medical evaluation is another requirement for workers that are required to wear respirators under the standard for 30 or more days a year. The examinations must be offered every 3 years and must contain tests for pulmonary functions, chest x-ray, and a physical exam.

Medical surveillance is intended to:

1. Identify if there is any disease caused from exposure to respirable crystalline silica contracted by the worker and take actions to protect their health;
2. Determine if the work has any conditions that may make them or sensitive to working around silica;
3. Determine if the worker is fit to wear a respirator

After the exam the worker will get a report detailing their health and the employer will receive a medical opinion as per the limitations, if any, to the worker as a result of the exam. All medical evaluations must be free to the employees and offered at a reasonable time and place for the employee.

Additionally, medical records must be retained and available in accordance to 29 CFR 1910.1020 (must commonly regulated as the time of employment plus 30 years). The records must include:

- Air monitoring data
- Objective data
- Medical Records

Though silica sand in the respirable state can be very dangerous for the workers, it is controllable by engineering, administrative, and PPE. In some cases, the exposure to this dust can be eliminated by substitution methods. However, the employer must protect its workers from this known hazard through the methods outlined in the OSHA standard.

Hazard Communication

Employers must comply with the 29 CFR 1910.1200 Subpart Z hazard communication standard. This standard is commonly referred to as “the right to know” rule for chemical exposure. Workers must be aware of the hazards related to the handling, storage, and use of chemicals in or around their work environment. Under the silica standard employers must address:

- Cancer hazards
- Lung effects
- Immune system effects
- Kidney effects

Under the hazard communication standard each component of the facility must have:

- Labelling of primary and secondary containment of chemicals,
- A written hazard communication program
- An administer of the hazard communication program
- Training on the chemicals that the workers are exposed to the workplace
- Understanding of how to interpret the Safety Data Sheets (SDS)
- Knowledge of what task will produce over exposure to chemicals

Workers must be trained on the following topics regarding respirable silica dust exposure:

1. How the presence or release of silica is detected and analyzed
    - Objective data or Air Monitoring Sampling
2. To recognize that visible increase in dust concentration indicates that the work exposure control practice in inadequate
3. On the details of workplace-specific SDS information, signage, container labels, emergency procedures, written exposure control plan
4. Work practices that will reduce or increase the exposure to silica dust

5. Housekeeping techniques designed to reduce or eliminate the workplace exposure to silica

Workers must be retrained at the time that it is found that they are working in a manner that suggest that they have forgotten the initial training of the hazards of silica.

Acceptable training methods are as follows, but not limited to:

- Hands-on training
- Webinars
- Videotapes
- Slide presentations
- Classroom instruction
- Seminars
- Written material
- Any combination of training delivery systems

Housekeeping

Housekeeping is a term that refers to the condition of the work environment as a measure of cleanliness. Employees must avoid dry sweeping, brushing, or using compressed air to blow dust off of themselves or any surface. This practice will increase the exposure of silica to the worker and the surrounding workstations.

Alternatively, the employer must instruct workers to use:

- Wet cutting methods
- Collect dust in a 0.3-micron High Efficiency Particulate Arrestance (HEPA)Filter
- Compressed air cleaning only when used with a ventilation system that effectively captures the dust cloud

Lesson Summary

Exposure to silica has been linked to lung cancer, silicosis, chronic obstructive pulmonary disease, and kidney disease in workers. OSHA's silica standard aims to reduce this hazard through a detailed standard, training, and enforcement. Through the use of engineering controls, administrative controls, and PPE, the exposed worker can be protected from the harmful respirable crystalline silica dust.

Module 20: Lead Exposure

Module Description

Lead is a very toxic substance. People who are exposed to lead or lead compounds may become ill or even die due to lead poisoning. Our bodies remove lead from our systems at a slow rate, so inhaling even small doses of lead for a prolonged period of time can result in lead poisoning. Workers who are required to work at or near sites that are contaminated with lead are at a greater risk of lead poisoning.

This module is designed for workers who work in areas where the hazard of lead exposure exists. The module focuses on the health risks associated with exposure to lead and how workers can protect themselves against lead.

Module Learning Objectives

At the conclusion of this module, you should be able to:

- Identify the health effects and risks of exposure to lead
- Identify the ways in which lead can enter the body
- Identify the signs and symptoms of exposure to lead
- Describe the medical monitoring program
- Discuss the medical tests that are required before an employee begins work
- Control lead exposure
- Identify common control measures

Lesson 1: Lead in the Workplace

Lesson Focus

This lesson focuses on the following topics:

- Introduction
- Lead in the Construction Industry
- Routes of Exposure to Lead
- Activities That Can Cause Lead Exposure
- Health Hazards of Lead Exposure
- Signs and Symptoms of Lead poisoning
- Medical Monitoring
- Exposure Assessment

Introduction

At room temperature and pressure, pure lead is a heavy metal. It is mixed with many substances to form lead compounds that are used for a multitude of purposes. However, despite its usefulness, lead can be toxic if it is absorbed by the body in sufficient quantities through inhalation or ingestion.

When lead enters the body it circulates in the bloodstream and accumulates in various organs, possibly causing irreversible harm to body tissues. Although the body routinely rids itself of absorbed lead, some may still remain in the blood and tissues. With increased exposure, the stored amount of lead may continue to increase and eventually leads to lead poisoning which can cause serious illness or death.

Lead in the Construction Industry

Lead is abundantly used in the construction industry due to properties that render it useful for the manufacture of many materials. Some of these properties include:

- Low melting point.
- High molecular weight.
- High density.
- Very easy to shape (ductile).
- Readily available.

Lead compounds were often applied to steel and iron structures in the form of paint primer. Lead was also commonly used for making different metal alloys found in lead shielding in walls, and in lead pipes.

Workers in the construction industry are at an increased risk of exposure to lead and lead compounds. Continuous exposure can be catastrophic if specific control measures are not taken.

Routes of Exposure to Lead

Lead most commonly enters the body through inhalation or ingestion. Lead is usually not absorbed through the skin.

Inhalation

In the construction industry, inhalation is the most common route of lead absorption into the body. It occurs when there are airborne lead particles in the work area and workers take them in by breathing. Inhalation can also occur when a worker smokes in a contaminated area.

Ingestion

Workers can accidentally consume lead particles while eating or drinking contaminated food or beverages, or by eating, drinking, or smoking with contaminated hands. If workers do not follow specific work guidelines and hygiene practices they may take contaminants home, causing harm to the whole family.

Activities That Can Cause Lead Exposure

Construction workers may be exposed to lead while performing the following tasks:

- Removing and applying lead-based paints
- Melting and casting lead and babbitt metal
- Soldering
- Reclaiming lead-acid batteries
- Grinding or sanding lead-containing materials
- Machining lead
- Cutting or heating lead-containing materials

Health Hazards of Lead Exposure

Lead is a toxic substance and can cause severe adverse health effects if there is long-term or acute overexposure. Lead can severely damage your nervous, urinary, blood-forming, and reproductive systems.

Lead can cause anemia as it hinders the formation of hemoglobin in the blood. It can also cause damage to the cells in the kidneys, leading to kidney failure. Lead has also been found to reduce sperm count in men and decrease their fertility.

If a pregnant woman is exposed to lead, the lead particles can pass from the mother to the infant through the placenta.

Signs and Symptoms of Lead Poisoning

Exposure to lead may affect each person differently. Lead can cause severe damage to the body even before the symptoms appear.

Early Signs

Early signs of lead poisoning can be overlooked as everyday medical complaints. These include:

- Loss of appetite.
- Metallic taste.
- Irritability.
- Moodiness.
- Joint and muscle aches.
- Trouble sleeping.
- Lack of concentration.
- Fatigue.
- Decreased sex drive.
- Headaches.

Later Signs

Brief intense exposure or prolonged overexposure can result in severe damage to your blood-forming, nervous, urinary, and reproductive systems. Some noticeable medical problems include:

- Anemia.
- Kidney failure.
- Stomach pains.
- High blood pressure.
- Convulsions or seizures.
- Constipation or diarrhea.
- Tremors.
- Nausea.
- Wrist or foot drop.

- Reduced fertility.

Medical Monitoring

Lead has an action level of 30 micrograms per cubic meter (30 ug/m3). If you work in the construction industry and are exposed to lead at or above the action level, initial medical surveillance is required.

Your employer may be required to perform medical monitoring every six months. If you have a blood lead level of 40 ug/100g, you must be tested at least every other month until your blood lead level goes below 40 ug/100g for two consecutive blood tests. Your employer is required to notify you in writing within 5 days of the test if your blood lead level exceeds 40 ug/100g.

If your blood lead level is at or above 50 ug/100g, you must not enter any lead contaminated areas until two consecutive tests confirm that your blood lead level has been reduced to 40 ug/100g or less. Your employer is required to provide annual medical examinations to all employees whose blood lead levels have been at or above 40 ug/100g during the previous year.

Exposure Assessment

Your employer is responsible for assessing each employee's exposure level. If the initial exposure is assessed to be at or above the action level (30 ug/m3), your employer must obtain samples that indicate the level of exposure for each work shift and for each task in each work area. The degree of daily exposure to lead for each monitored employee can be assessed through these samples.

The results of all assessments that indicate the exposure level of employees to lead must include the following information:

- All observations, information, and calculations that show an employee's exposure to lead
- Measurements of any previous airborne lead
- Any complaints made by an employee of symptoms that indicate lead exposure
- Objective information about the materials that are used or the processes that have to be carried out

If two consecutive readings that have been taken a week apart are below the action level, your employer can discontinue lead monitoring and choose to only monitor those employees who are at a greater risk of lead exposure. Your employer can also use the information related to lead exposure for the same task that was taken in the previous 12 months. However, your employer must maintain an accurate account of the nature and the pertinence, of any preceding exposure data.

If initial assessment is not performed by your employer, the company must assume that all employees carrying out lead-related tasks are exposed at levels above the permissible exposure level (PEL) of 50 ug/m3 and must provide them with the appropriate respirators, protective clothing and equipment, enclosed changing areas, washing facilities, and proper training.

If initial assessment indicates that the level of exposure is below the action level (30 ug/m3), your employer must document these findings, including the date, exact work location, and the names and social security numbers of all the employees that were monitored.

Monitoring and Observing

If initial assessment indicates that the exposure is below the action level, your employer is not required to assess the workplace unless the processes or controls are changed. However, the company is required to perform monitoring at least every six months if the exposure level is at or above the action level, but at or below the PEL. Monitoring must be continued until at least two consecutive measurements, that have been taken at least seven days apart, are below the action level.

Monitoring must be performed quarterly if the employee exposure is above the PEL. When at least two consecutive measurements that have been taken at least seven days apart are at or below the PEL, but at or above the action level, monitoring should be continued every six months until the exposure is below the action level.

Your employer is required to perform additional monitoring if there is a change in the equipment, control, process, or personnel. Additional monitoring is also required when a new task has been started that can increase the risk of exposure to lead. Your employer is required to inform all employees about the assessment results within five working days after they have been received.

If the exposure level is determined to be at or above the PEL, your employer is required to issue a written notice to you informing you about the exposure level and the preventive measures they must take in order to reduce exposure.

If you are required to perform lead-related tasks you have the right to observe the monitoring of your lead exposure. Furthermore, you are entitled to receive respirators, protective clothing, and any other equipment that is required for performing the task.

Lesson Summary

Lead can be very toxic—even deadly—if it is absorbed by the body in sufficient quantities, most commonly by either unintentional inhalation or ingestion. Because our bodies are slow to remove lead from our systems, someone who inhales small doses of lead—over a long period of time—can end up with lead poisoning. When lead enters the body it circulates in the bloodstream and accumulates in various organs, possibly causing irreversible harm to body tissues.

If the amount of lead stored in the body continues to increase, the person can suffer numerous adverse health effects, including severe damage to kidneys, nervous, urinary, blood-forming, and reproductive systems; anemia; decreased fertility; and danger to the unborn babies of pregnant workers, since lead particles can pass through the placenta. Workers must learn to recognize the early and later symptoms of lead poisoning, which range from headaches and fatigue to seizures and tremors.

Workers in the construction industry are at an increased risk of lead exposure, because lead is used in everything from steel and iron structures to walls and lead pipes. Specific measures must be taken to protect workers from the deadly hazards posed by lead. Such measures include medical monitoring, medical surveillance where indicated, exposure assessments, regular monitoring of exposure levels, and additional monitoring where indicated.

Lesson 2: Exposure Reduction & Employee Protection

Lesson Focus

This lesson focuses on the following topics:

- Lead Control Measures
- Personal Hygiene and Housekeeping Practices
- Protective Clothing
- Respiratory Protection
- Recordkeeping

Lead Control Measures

In order to minimize employee exposure to lead, your employer must make sure that lead control measures and good work practices are used when workers are performing lead-related tasks. The permissible exposure level of lead is 50ug/m3. If exposure beyond this level exists, additional controls are required.

Some control measures that can be adopted to reduce your exposure to lead include exhaust ventilation, encapsulation, substitution, process modification, and isolation.

Exhaust Ventilation

All equipment and tools used to remove lead-based paint must have a high-efficiency particulate air (HEPA) vacuum system attached, to collect lead dust particles. Your employer must provide local exhaust ventilation for tasks such as welding, cutting, burning, or heating. To clean up the work area, you must only use HEPA vacuums in order to prevent lead particles from becoming airborne.

Some operations, such as abrasive blasting, may require full containment or enclosure. The structure of the enclosure must allow the flow of ventilation air past you. This reduces the concentration of airborne lead and increases visibility.

The enclosure must be equipped with dust collection and air-cleaning devices so that the emission of lead particles can be controlled. Your employer is required to maintain a negative pressure inside the enclosure in order to prevent lead particles from contaminating areas outside the enclosure.

Encapsulation

Your employer is required to follow similar precautions if they are making all lead-based paint inaccessible by encapsulating it with a material that adheres to the surface, such as epoxy coating, acrylic, or flexible wall coverings. In addition to painting or coating, lead can also be enclosed by using systems such as plywood paneling, gypsum wallboard, aluminum, or vinyl. Vinyl tiles or linoleum flooring can be used to cover floors that are coated with lead-based paint.

Your employer is also responsible for supervising the workers and contractors who are required to carry out activities that involve encapsulated lead-based paint, and ensuring that a minimum amount of lead is released in the air during maintenance or demolition.

A Substitution

You can avoid using lead-containing materials by selecting other materials. Epoxy-covered zinc-containing primers can be used instead of lead-containing coatings. Also, you can use equipment that decreases the risk of lead emission. When cutting lead-containing materials, for example, you can use a mobile hydraulic shear instead of a torch. For some operations, you can use surface preparation equipment instead of abrasive blasting.

Hand scraping using a hand gun can be replaced by chemical strippers. This considerably reduces the amount of lead dust released in the air. However, care must be taken because these strippers can be hazardous.

Process Modification

In order to reduce the risk of lead hazard, lead-containing paints can be applied using brushes or rollers instead of spraying them. Using this method ensures that only a little amount of lead is introduced into the air. For abrasive-blasting operations, you should use a non-silica containing abrasive instead of sand when possible, as free silica in the sand can create an increased respiratory hazard for the workers.

A large amount of dust may be produced while performing abrasive blasting. Less dusty techniques should be used in order to minimize the dust being produced. These techniques can include:

- **Hydro-blasting** that involves using high-pressure water with or without abrasives to remove coatings from different substances.
- **Vacuum blasting** in which there is a vacuum system attached to the blast head that removes the blast material immediately after it is produced.

When removing lead-based paints in residential housing units workers must use a flameless electrical heat gun type softener. Furthermore, the temperature of these heat guns must be set below 700 degrees Fahrenheit.

If you are required to perform abrasive blasting on the exterior surfaces of buildings, you must ensure that the configuration of the head of the blasting nozzle is appropriate for the substrate being used, so that the vacuum can contain all the debris. You must also have HEPA vacuum cleaner attachments for different surfaces. Using the right brush and attachment for the right surface will reduce the amount of lead dust emitted into the air.

Isolation

Employers cannot completely enclose and ventilate some abrasive blasting tasks. However, they can isolate many operations in order to reduce the risk of exposure to lead. Your employer must restrict unauthorized personnel from entering the isolated work areas by posting warning signs.

Personal Hygiene and Housekeeping Practices

Exposure to lead can have adverse health effects. However, you can minimize your exposure to lead by adopting rigorous personal hygiene and housekeeping practices. Furthermore, these practices ensure that you do not take lead-contaminated dust from the worksite to your home where it can endanger your family.

Housekeeping

All accumulations of lead and lead debris must be removed every day or after every work shift. At the end of each shift you must either use a high-efficiency particulate air (HEPA) vacuum to clean lead dust, or wet it before sweeping. All workers performing clean up tasks must wear proper protective equipment and clothing, including suitable respirators, in order to prevent contact and inhalation of lead particles.

All lead debris and contaminated material that has to be disposed of must be placed in impermeable bags or containers and properly sealed. These bags and containers must be labeled as lead-containing waste. These measures ensure that no worker is exposed to lead. Your employer is responsible for disposing of lead waste according to federal, state, and local government laws.

Personal Hygiene Practices

Your personal hygiene practices must focus on minimizing your exposure to lead. The work area must have adequate washing facilities so that workers do not take contaminants into uncontaminated areas. Your employer is responsible for providing workers with clean changing areas. Furthermore, they must also provide non-contaminated eating areas that are separate from the work areas.

Changing Areas

If you are exposed to lead above the permissible exposure limit (PEL), you must be provided with a clean changing area. This changing area must be divided into two sections: one for storing clean street clothes, and the other for removing and storing contaminated clothing. This segregation ensures that your street clothes do not come in contact with contaminated work clothes.

Employees must NEVER wear contaminated clothes away from the work site. They should not be taken home for washing under any circumstances. They should only be laundered by professionals. Disposable clothing must be properly disposed of according to federal, state, and local laws.

Showers

If you get a considerable amount of contaminants on your skin, hair, and protective clothing while performing your assigned tasks you must take a shower before leaving the work site. It is the responsibility of the employer to provide you with adequate showering facilities to remove contaminants and change into clean clothing.

If you do not shower and change into clean clothing before leaving the worksite, you may contaminate your vehicle and home with lead dust. This lead contamination can harm your family members.

Eating and Drinking Practices

All employees who perform lead-related tasks must clean or remove their protective clothing and thoroughly wash their hands and face before eating, drinking, or smoking. It is the responsibility of the employer to inform all workers that they must not eat, drink, or smoke in the work area or in areas where lead-containing material is present.

Washing Facilities

Your employer is required to provide workers with adequate washing facilities that are located near the worksite. These washing facilities must be equipped with water, soap, and clean towels so that employees can thoroughly remove lead contamination from their skin.

Contaminated water from all showers and washing facilities must be disposed of according to the local, state, or federal laws.

End-of-Day Procedures

At the end of the workday you must follow certain procedures to minimize your exposure to lead. These procedures include:

- Placing disposable clothes and shoe covers into impermeable containers that are assigned for lead waste and then properly sealed off.
- Placing all lead-contaminated clothes, shoes, and personal protective equipment in a closed container to be laundered by a professional.
- Taking a shower and washing hair and skin as necessary.
- Changing into regular street clothes.

Protective Clothing

If you are required to perform lead-related tasks, your employer must provide you with clean, dry, protective clothing and equipment free of cost. Clothing that may be required at lead-containing construction sites include:

- Full-body protective work clothing.
- Gloves.
- Goggles with protective shields.
- Blasting or welding helmets.

If there are no laundering services available, your employer should provide you with disposable clothes and shoe covers. You must change into clean non-disposable coveralls every day. Before you take off your work clothes and respirator, you must clean all loose particles on your clothing by using high-efficiency particulate air (HEPA) filter vacuum equipment. Loose particles of lead can also be removed from the respirator by using a damp wipe. All protective clothes worn must fit you properly.

All contaminated clothes that have to be laundered, cleaned, or disposed of should be placed in closed containers and sealed off. These containers must be labeled with warning signs that advise workers not to remove dust by blowing or shaking.

Your employer must inform all persons who handle lead contaminated clothing or equipment, in writing, about potential lead hazards. You must be careful never to remove lead from protective clothing using means that can release lead dust into the work area, such as shaking, brushing, or blowing.

You must never wear protective clothing outside the work area, or take contaminated clothing and equipment to your homes or vehicle.

Some tasks require you to wear gloves. Underneath the protective clothing, you should wear clothes that are appropriate for the existing weather and temperature conditions.

Respiratory Protection

At some construction sites the lead content in the air may be high, or can vary widely. At such sites you may be required to use respirators in addition to the basic protective measures.

If lead levels require the additional protection, you must wear your respirator before you enter the work area and remove it only after you have left the work site. Your employer is required to initiate a respiratory protection program in order to train all employees about the usage of their respirators.
Minimum requirements of the program include:

- A written guide explaining how to select and use respirators.
- Selection of respirators according to the hazards associated with a particular task.
- Training sessions about the proper usage of respirators along with their limitations.
- Inspecting, cleaning, disinfecting, and maintaining the work site on a regular basis.

Respirator Selection

Protection from lead particles can be obtained by using different types of respirators. Usually a respirator is selected according to the nature of the work and the amount of lead present in the workplace.

Before entering the work area, you must fit test your respirator by putting it on and making sure that it fits properly and that there are no gaps where lead dust or vapors can enter.

Types of Respirators

There are two basic types of respirators that can be used to provide protection against lead: air-purifying respirators and atmosphere-supplying respirators.

Air-Purifying Respirators

A respirator with an air-purifying filter, cartridge, or canister is called an air-purifying respirator. A properly selected respirator removes lead contaminants from the air by passing air through the air-purifying component and making it acceptable to breathe normally.

Atmosphere-Supplying Respirator

An atmosphere-supplying respirator consists of a component that provides you with breathable air not taken from the ambient atmosphere. There are two types of atmosphere-supplying respirators: the supplied-air respirator (SAR) and self-contained breathing apparatus (SCBA) unit.

Supplied-air respirators use a hose called an airline to provide clean air from the air tank. There are two types of supplied-air respirators: pressure-demand respirators and continuous-flow respirators.

Pressure-demand respirators prevent the contaminated air from entering the face-piece by maintaining a positive pressure. Continuous-flow respirators also maintain a positive pressure by constantly supplying fresh air to the face-piece.

A self-contained breathing apparatus (SCBA) consists of a hose that is connected to a cylinder of compressed air.

Record Keeping

Your employer is required to maintain a record of all the findings of the employee exposure assessments. These records should be accurate and must contain the following information:

- The name, social security number, and job classification of the employee who was monitored
- Description of the sampling procedures along with the date, number, duration, location, and results of each sample taken
- Details of all sampling and analytical methods used along with the evidence of their accuracy
- The type of respirator worn
- The factors that might affect the measurement of employee exposure

Your employer is required to make these records available to you and your representatives. Furthermore, if your employer stops doing business all records and documents regarding employee monitoring and assessment must be handed over to their successor.

Lesson Summary

Employers are responsible for supervising workers to ensure compliance with all control measures, as well as necessary personal hygiene and housekeeping practices, to minimize employees' lead exposure. This may require supplying employees with protective clothing, a professional laundering service (or disposable clothes and shoe covers), and respiratory protection (including proper training) where needed. The two basic types of respirators that can provide protection against lead are air-purifying respirators and atmosphere-supplying respirators.

Good housekeeping practices include removing all lead accumulations every day or after every work shift; using HEPA vacuums to clean lead dust; sealing off impermeable bags or containers; and having all workers doing clean-up wear protective equipment (including respirators) and clothes. Personal hygiene practices include using clean changing areas, non-contaminated eating areas, adequate washing facilities, and strictly adhering to end-of-day and all other hygiene-related procedures. Employees must NEVER wear lead-contaminated work clothes away from the work site, and disposable clothes must be discarded in accordance with all laws. Your employer must inform all persons who handle lead contaminated clothing or equipment, in writing, about potential lead hazards, and must maintain records of all employee exposure assessments.

Module 21: Asbestos Exposure

Module Description

Asbestos is a substance that has been used for centuries. Its heat-resistant properties make it almost indestructible; due to this property, asbestos has been widely used in the construction industry, including pipe and boiler insulation, flooring and ceiling tiles, drywall, adhesives, and much more. Asbestos has also been widely used in products such as vehicle brakes, wire insulation, dryers, and much more. Before 1973, asbestos was sprayed onto different surfaces for fire protection purposes, but this practice was banned due to its hazardous nature. Furthermore, it is no longer legal to be used for insulating pipes and boilers in most countries, including the United States.

However, asbestos can still be found in many buildings. Those who work in construction, repair, demolition, and renovations are at a greater risk of contracting asbestos-related diseases such as asbestosis, lung cancer, and mesothelioma. Very stringent exposure guidelines have been established for asbestos.

This module introduces students to the hazards of asbestos in the workplace and provides information about the measures that must be taken in order to minimize the effects of exposure to asbestos.

Module Learning Objectives

At the conclusion of this module, you should be able to:

- Describe the hazards of asbestos in the workplace.
- Discuss the health effects of exposure to asbestos.
- Identify and assess asbestos-related work activities.
- Apply control measures for low-risk, moderate-risk, and high-risk activities.
- Relate the proper disposal of asbestos containing material.
- Select appropriate protective equipment.

Lesson 1: Asbestos in the Workplace

Lesson Topics

This lesson focuses on the following topics:

- What is Asbestos?
- Uses of Asbestos
- Health Hazards of Exposure to Asbestos
- Asbestos-related Diseases

What is Asbestos?

Asbestos is a group of naturally occurring mineral silicates whose crystals form long, thin fibers. The three types of asbestos that were commonly used in building materials are Chrysotile, Amosite, and Crocidolite.

Chrysotile

Chrysotile is the most commonly used type of asbestos. This type of asbestos is commonly called "white asbestos."

Amosite

Amosite, commonly referred to as "brown asbestos," is the second most common type of asbestos and accounts for approximately four to six percent of the asbestos used in building materials in the United States.

Crocidolite

Crocidolite is the least common type of asbestos and accounts for only about one to four percent of the asbestos materials used in the United States. Crocidolite is commonly known as "blue asbestos."

Why is Asbestos a Hazard?

Asbestos has been determined to be a hazardous substance because its fiber masses break easily into tiny particles that can easily become airborne. These fibers, when inhaled or swallowed, can cause serious health problems.

Uses of Asbestos

Asbestos has many properties that make it ideal for use in a variety of products. It is strong, fire-resistant, a poor conductor of heat and electricity, corrosion-resistant, and found in abundance. Those products that are made with asbestos are called asbestos-containing materials (ACM).

By the end of the 19^{th} century, and until around 1980, asbestos was widely used in the construction industry for the manufacture of building material. Building materials that contain asbestos are known as asbestos-containing building material (ACBM).

The most common uses of ACBM include:

- **Insulation material:** This was usually applied with spray, trowel, or manually installed on many surfaces to insulate them from heat and cold.
- **Fireproofing material:** This material was applied with a spray to steel beams that were used in construction of multi-story buildings. This helped to protect the structural members from damage caused by heat in case there was a fire.
- **Acoustical or soundproofing material:** Apart from soundproofing, this material was also used for decoration. A mixture of asbestos and some other materials was sprayed onto ceilings and walls to create a textured look.
- **Miscellaneous materials:** Asbestos has been used in the making of many products, including roofing felts, roofing shingles, floor tiles, vehicle brakes, combustion vents, exterior siding and wallboard, and flues for waste gases and heat.

The asbestos fibers in these products are tightly woven into the materials and is easily released if the material is damaged (by a mechanical process such as drilling, grinding, cutting, or sanding). The asbestos present in roofing shingles and siding that is exposed to weathering can deteriorate gradually and release asbestos fibers in the air.

General industry employees may be exposed to asbestos during the manufacture of asbestos-containing products or when performing brake and clutch repairs.

The potential for a product containing asbestos to release breathable fibers depends, in part, on its degree of friability. Friable means that the material can be crumbled or reduced to dust-size particles likely to emit fibers.

The fibrous or fluffy sprayed-on materials used for fireproofing, insulation, or sound proofing are considered to be friable, and they may readily release airborne fibers if disturbed.

Materials such as vinyl-asbestos floor tile or roofing felts are considered nonfriable and generally do not emit airborne fibers unless subjected to damage, polishing, grinding, sanding, and similar operations.

Asbestos-cement pipe or sheet can emit airborne fibers if the materials are cut or sawed, or if they are broken.

Health Hazards of Exposure to Asbestos

Many studies have proven that any prolonged or excessive exposure to asbestos is likely to have adverse health effects. Inhalation of asbestos fibers may cause several lung diseases. It has been demonstrated that the greater the exposure to asbestos fiber, the greater the risk of developing an illness.

If someone is exposed to brief bursts of asbestos fibers in addition to those present in the background, he or she is at a greater risk of contracting an asbestos-related disease. Construction workers who work on and disturb asbestos-containing materials in buildings are at a greater risk of coming in contact with additional asbestos fibers.

The Respiratory System

Exposure to asbestos fibers often adversely affects the lungs. Tvhere are several mechanisms in the human body that are used to "filter" the air it breathes. In the nose and mouth, many large particles from the air are removed. Then it is passed to the airway tubes that are covered with mucus where smaller particles may get trapped. Tiny hair-like cells present in the airway tubes then push these particles upwards into the nose or the back of the mouth. From there they can either be swallowed or expelled.

However, the effectiveness of these hair-like cells may be greatly impaired when a person smokes. This may render the body susceptible to unwanted dust or fibers that may be present in the air.

Dust particles too small or too numerous to be captured and expelled through the body's normal protective mechanisms may enter the tiny air sacs in the lungs where respiration occurs. A smoker is likely more susceptible to this than a non-smoker due to the compromised filtration system. The human immune system then releases large cells called macrophages that attempt to digest the dust particles. This is another one of the body's defense mechanisms against unwanted particles in the lungs.

Asbestos-related Diseases

The risk of developing an asbestos related disease increases greatly when the body's natural defenses are not able to control or remove asbestos fibers that enter the lungs. The three main factors that determine the likelihood of developing an asbestos related disease include smoking, the amount and duration of the exposure, and age. Asbestos-related diseases include asbestosis, lung cancer, mesothelioma, and some other cancers.

From the state of Colorado:

- Asbestosis is a lung disease that causes scarring of the lungs. Eventually, this scarring may become so severe that the lungs cannot adequately function. The latency period (meaning the time it takes for the disease to become developed) can be 15-40 years.
- Mesothelioma is a cancer of the lining of the lung and chest and/or the lining of the abdominal wall. Asbestos exposure is the leading cause of this type of cancer. The latency period for mesothelioma is often 15-50 years.
- Lung cancer can be caused by asbestos. The effects of lung cancer are often greatly increased by cigarette smoking. Cancer of the gastrointestinal tract can also be caused by asbestos. The latency period for cancer is often 15-30 years.

From EPA:

- Asbestosis is a serious, progressive, long-term non-cancer disease of the lungs. It is caused by inhaling asbestos fibers that irritate lung tissues and cause the tissues to scar. The scarring makes it hard for oxygen to get into the blood. Symptoms of asbestosis include shortness of breath and a dry, crackling sound in the lungs while inhaling. There is no effective treatment for asbestosis.
- Lung cancer causes the largest number of deaths related to asbestos exposure. People who work in the mining, milling, manufacturing of asbestos, and those who use asbestos and its products are more likely to develop lung cancer than

the general population. The most common symptoms of lung cancer are coughing and a change in breathing. Other symptoms include shortness of breath, persistent chest pains, hoarseness, and anemia.
- Mesothelioma is a rare form of cancer that is found in the thin lining (membrane) of the lung, chest, abdomen, and heart and almost all cases are linked to exposure to asbestos. This disease may not show up until many years after asbestos exposure. This is one of the reasons that great efforts are being made to prevent school children from being exposed.

Asbestosis

Asbestosis is a serious disease that causes severe scarring of the lungs and reduces lung elasticity. Due to this, breathing becomes very difficult. Workers who have been exposed to asbestos fibers for long periods of time often manifest the symptoms of this disease. This disease can lead to disability or even death.

All types of asbestos can cause asbestosis. Just like all other diseases that are associated with asbestos exposure, it may take many years for the disease to show up. Typically, asbestosis has a latency period of 15 to 40 years.

Mesothelioma

Mesothelioma is a type of cancer that affects the abdominal lining or the chest cavity lining. It causes great damage to the vital functions of the body and always results in death. Mesothelioma occurs in people who have been exposed to asbestos for a limited period of time. This type of cancer does not seem to occur due to cigarette smoking; rather, it depends on the amount of asbestos inhaled and the period of exposure. Mesothelioma has a latency period of 15 to 50 years.

Lung Cancer

Lung cancer occurs due to long periods of exposure to asbestos. The risk of contracting this disease increases if the worker smokes cigarettes. In fact, workers who are cigarette smokers are 50% more likely to develop lung cancer than those who do not smoke. Asbestos-related lung cancer has a latency period of 15 to 30 years.

Lesson Summary

If someone is exposed to brief bursts of asbestos fibers in addition to those present in the air, he or she is at a greater risk of contracting an asbestos-related disease. It has been demonstrated that the greater the exposure to asbestos fiber, the greater the risk of developing an illness.

Asbestos-related diseases include asbestosis, lung cancer, and mesothelioma. Workers who have been exposed to asbestos fibers for long periods of time often manifest the symptoms of asbestosis; this disease can lead to disability or even death. Mesothelioma, on the other hand, may occur in people who have been exposed to asbestos for a limited period of time.

Lesson 2: Protection Against Asbestos

Lesson Topics

This lesson focuses on the following topics:

- Introduction
- Engineering Controls and Safe Work Procedures
- Personal Protective Equipment

Introduction

Compliance Program

Where the Time-Weighted Average (TWA) and/or excursion limit is exceeded, the employer shall establish and implement a written program to reduce employee exposure to or below the TWA and to or below the excursion limit. This is done by means of engineering and work practice controls and by the use of respiratory protection where required or permitted. Such programs shall be reviewed and updated as necessary to reflect significant changes in the status of the employer's compliance program.

The employer shall inform all employees concerning the availability of self-help smoking cessation program material. The employer shall also institute engineering controls and work practices to reduce and maintain employee exposure to or below the TWA and/or excursion limit except to the extent that such controls are not feasible. When they are not sufficient, they will be supplemented by appropriate respiratory protection. Employers must provide respirator training and medical clearance to use respirators.

For any employee exposed to airborne concentrations of asbestos that exceed a Permissible Exposure Limit (PEL), employers must provide and require the use of protective clothing, such as coveralls or similar full-body clothing, head coverings, gloves, and foot coverings. As well, employers must provide face shields, appropriate eye and face protection, or other appropriate protective equipment wherever the possibility of eye irritation exists and require workers to wear it.

Employers must establish decontamination areas and hygiene practices for employees exposed above a PEL. In addition, employees may not smoke in work areas that might expose them to asbestos. In general industry, employers must provide medical examinations for workers who are exposed above a PEL.

Sign Specifications

The warning signs should indicate the following information:

- Danger
- Asbestos
- Cancer and Lung Disease
- Hazard
- Authorized Personnel Only

In addition, where the use of respirators and protective clothing is required in the regulated area, the warning signs shall include “Respirators and protective clothing are required in this area.”

Warning Labels

Warning labels shall be affixed to all raw materials, mixtures, scrap, waste, debris, and other products containing asbestos fibers, or to their containers.

The labels shall comply with the requirements of OSHA's Hazard Communication standard, and shall include the following information:

- Danger
- Contains Asbestos Fibers
- Avoid Creating Dust
- Cancer and Lung Disease Hazard

All hand-operated and power-operated tools that would produce or release fibers of asbestos, such as but not limited to saws, scorers, abrasive wheels, and drills shall be provided with local exhaust ventilation systems.

Local exhaust ventilation and dust collection systems shall be designed, constructed, installed, and maintained in accordance with good practices of ANSI Z9.2-1979.

Insofar as practicable, asbestos shall be handled, mixed, applied, removed, cut, scored, or otherwise worked in a wet state sufficient to prevent the emission of airborne fibers.

Engineering Controls and Safe Work Procedures

The employer shall not use employee rotation as a means of compliance with the TWA and/or excursion limit.

Permissible Exposure

Exposure to airborne asbestos fibers may not exceed 0.1 fibers per cubic centimeter of air (0.1 f/cc) averaged over the 8-hour workday.

Excursion Limit

The employer shall ensure that no employee is exposed to an airborne concentration of asbestos in excess of 1.0 fiber per cubic centimeter of air (1 f/cc) as averaged over a sampling period of thirty (30) minutes.

In general industry, employers must perform initial monitoring for workers who may be exposed above a PEL or above the excursion limit.

Employers must conduct subsequent monitoring at reasonable intervals, and in no case at intervals greater than six months for employees exposed above a PEL.

> **More Information:** In general industry, employers must establish regulated areas wherever asbestos concentrations may exceed a PEL, controlled zones known as regulated areas that are designed to protect employees where certain work with asbestos is performed and limit access to these areas to authorized persons who are wearing appropriate respiratory protection and who have been properly trained. Employers must also prohibit eating, smoking, drinking, chewing tobacco or gum, and applying cosmetics in these areas, and they must display warning signs at each regulated area.

Low-risk Work Activities

Low-risk work activities are those that do not pose a great health and safety threat to workers. Work that has to be done near friable asbestos-containing material without disturbing it is categorized as low-risk work. Moving asbestos containing material that is in clean and sealed bags is also considered a low-risk task. Workers who have to carry out such tasks must be informed about the hazards of asbestos.

Employers are required to identify and clearly label all areas where asbestos-containing materials are present. Employers must also ensure that all workers are properly trained to handle asbestos-containing materials when workers are required to perform this work.

Moderate-risk Work Activities

There are many asbestos-related work tasks that are categorized as moderate-risk activities. These tasks require workers to follow specific procedures in order to ensure safety.

Activities that carry a moderate risk of exposure to airborne asbestos fibers may include:

- Cutting, drilling, grinding, shaping, or removing non-friable manufactured products that contain asbestos with hard tools.
- Using a coarse disc to buff floors.
- Drilling non-friable asbestos-containing materials.
- Taking out mounting screws from cement products containing asbestos.
- Analyzing asbestos samples in a laboratory.
- Collecting samples of materials that might contain asbestos for laboratory analysis.
- False ceiling removal to get to a work area when there are friable asbestos-containing materials found on the surface.
- Taking apart drywall that contains asbestos in the joint-filling material.
- Carrying out a procedure that does not create any friable asbestos waste material such as removing vinyl-asbestos floor coverings.
- Destroying a block wall that contains asbestos fragments in the cavity.
- After completion of the asbestos removal process, taking apart the treated enclosure.
- Installing or removing a glove-bag apparatus in order to remove pipe insulation when the insulation is in good condition.
- Removing asbestos insulation from piping using prefabricated glove-bags.

Measures for Moderate-risk Activities

Workers who are involved in a moderate-risk task must follow specific work procedures. They must make sure that all those present at or near the work area are not exposed to the asbestos fibers in the air. Workers must place necessary enclosures, barricades, or similar structures around the work area so that everyone knows the exact location of the designated work area. They must warn unauthorized people from entering the work area by placing signs around it.

Workers are required to put on suitable protective equipment and clothing. The material of the clothing must not allow penetration of asbestos fibers. Torn or defective clothing must be replaced immediately. A respirator with an appropriate filter must also be worn.

All dust and waste produced during work must be wiped; compressed air must never be used to clean clothing or work surfaces. By using polyethylene sheets, the spread of asbestos dust to other parts of the work area can be controlled by sealing doorways, windows, or any other openings. If a worker suspects the presence of friable asbestos on any surface in the work area, he or she must wipe it off with a damp cloth and take necessary steps to identify the source and correct any deficiencies that may have allowed the dust to be present.

All sealable containers or bags containing asbestos waste must be labeled properly to identify the contents, the associated hazards, and the precautionary measures required in handling the substance. These bags and containers must not be left in the work area and should be removed after each work shift. Workers must make sure to wipe the surface of each container or bag before it is removed from the work area.

After completion of the tasks, all polyethylene sheets and work area barriers should be sprinkled with water. They should then be folded carefully in order to contain any remaining dust. After that, they should be placed in bags or containers and properly sealed. The bags should be disposed of as asbestos waste.

Before leaving the work area, workers must use proper materials to clean all protective equipment and clothing before taking it outside the work area. All protective clothing must be left inside the work area for cleaning. If there is no designated storage area within the work area, the clothing must be placed in a sealable bag or container and disposed of as asbestos waste. The encapsulation of asbestos-containing materials requires covering with a sealant or glue to prevent the release of fibers.

After the work has been completed, a document must be presented to the employer stating that the work area is safe to enter by unprotected personnel.

High-risk Work Activities

Those activities that are categorized as high-risk work activities must be carried out very carefully, following certain specific procedures in order to protect workers and other personnel who may be otherwise affected by them.

Some of the tasks that may pose a high risk of exposure to asbestos fibers in the air include:

- Maintaining, cleaning, or removing air-handling equipment in structures and buildings where sprayed asbestos-containing fireproofing material is used.
- Encapsulating, removing, or enclosing friable asbestos-containing materials while repairing, altering, maintaining, or demolishing a building or a structure.
- Repairing, dismantling, demolishing, or altering any structure, building, or device that has asbestos-containing material.
- Any task where large amounts of friable asbestos fibers can become airborne.

Measures for High-risk Activities

High-risk activities require special measures for specific tasks including isolating the work area, decontaminating workers, controlling airborne asbestos fibers, disposing of asbestos containing material, and collecting samples of materials that may contain asbestos.

Isolating the Work Area

All designated work areas must be isolated in order to prevent unauthorized personnel from entering. In order to isolate a work area, signs should be placed around it to warn unauthorized people against entering. The work area must be enclosed with proper polyethylene sheets in order to contain the asbestos fibers. If the work area cannot be enclosed, a notice must be provided to all workers, specifying alternative work procedures that can control the risk of asbestos exposure.

In order for the contaminated air to remain in the enclosed area or filtered prior to release, it must be ensured that the air pressure in the work area is lower than the surrounding area. This low pressure should be maintained until all work has been completed. Stairways and elevators must be sealed off using polyethylene sheets and tape. The air heating and ventilation system in the work area must be shut down and all ducts should be sealed off with polyethylene sheets.

All devices and fixtures that can be removed should be wiped with damp cloths and removed from the contaminated area. All non-removable devices and fixtures should be covered with polyethylene sheets. The floor of the work area must be covered with polyethylene sheets and extended at least 12 inches up the wall. All enclosures must be inspected on a regular basis in order to ensure that there are no breaks, tears, or leaks.

Decontaminating Workers

In order to ensure that workers do not carry any contaminants outside the work area, they must be decontaminated in a designated space inside the work area. Before entering the contaminated work area, workers should remove their street clothing in a clean room and put on clean work clothes. They must make sure that their respirator fits properly. Workers are required to enter the personnel transfer room and put on the required personal protective equipment. They can then proceed towards the contaminated work area to carry out the assigned tasks.

After leaving the contaminated work area, workers should remove the asbestos fibers from personal protective equipment using a proper system. They must remove all protective clothing and equipment in the personnel transfer room. Any disposable clothing must be placed in polyethylene bags and disposed of properly.

When the respirator and its harness are free from all contaminants, these should then be removed. The workers can then enter the clean room to put on their street clothes. The respirator should be cleaned and disinfected and stored in the clean room until it is required again. All tools and equipment must be stored in the equipment holding room.

Controlling Airborne Asbestos Fibers

In order to properly control the asbestos fibers in the air, certain rules must be followed. Materials containing asbestos should only be removed after getting an approval from authorized personnel. Workers must never use dry clothes or compressed air to clean asbestos-containing materials.

After all the asbestos-containing materials have been removed, all exposed surfaces in the work area must be properly cleaned.

Employers must identify all asbestos material that is encapsulated and must ensure that it is firmly bound by the encapsulating material so that there are no loose fibers. Workers must ensure that encapsulating material does not disturb the bond between asbestos-containing material and its supporting surface.

Workers must make sure that they disturb or displace the least amount of asbestos-containing material possible while repairing it. After performing this task, they should seal the exposed asbestos and then remove the work enclosure. All surfaces that are exposed must be washed thoroughly and properly protected.

Disposing of Asbestos Waste Materials

To ensure that asbestos waste is properly disposed of, all waste materials should be placed in leak-proof containers while remaining inside the enclosed area. These containers should then be sealed and labeled. The outside surface of all containers must be decontaminated before they are removed from the storage room and the waste transfer room.

In order to prevent the containers from getting damaged or torn while being transported to the disposal site, they must be properly packaged using double polyethylene bags.

Employers must ensure that the asbestos-containing waste material is disposed of immediately or after each work shift. All arrangements must be made in advance with the concerned authorities to transport the waste to assigned dumpsters. It is very important to inform the transport drivers about the hazards of asbestos and the appropriate measures they must take. Signs must be placed on the transport vehicles displaying the nature of the materials being transported.

By washing and vacuuming, one must then decontaminate the enclosure and all the equipment. Finally, the air inside the enclosure must be decontaminated before taking apart the enclosure.

Collecting Samples of Materials that May Contain Asbestos

Only a qualified person may collect samples of materials that may contain asbestos. These samples must then be sent immediately to a laboratory where their contents can be determined.

In order to collect samples, a qualified person must take measures recommended for moderate-risk activities. Before starting work, it must be ensured that there are no unprotected workers present in the work area. The materials should be prepared to ensure that no asbestos fibers will be released during the collection process, and the workers must disturb the least amount of material possible.

A sample should be taken by deep penetration into a material to ensure that the sample is valid. The sample collector must observe the color and the texture of the various materials present in the work location in order to collect samples of all those present. These should then be placed in leak-proof containers and properly sealed. Labels must also be placed on the containers to identify the contents as laboratory samples.

To collect any loose material that may break off while sampling, the floor of the work area should be covered with polyethylene sheets when necessary. After completion of the work, these sheets must be placed in leak-proof containers and disposed of properly.

All workers present near the sampling area must be equipped with a respirator as sampling can create airborne asbestos fibers that could be injurious to health.

Personal Protective Equipment

Protective Clothing

Personal protective equipment includes all asbestos protective clothing such as coveralls or any other full-body clothing, hard hats, gloves, rubber boots without laces, and eye protection.

All workers who are required to perform asbestos-related tasks must wear the appropriate protective equipment. Protective clothing should be made with a material that does not allow asbestos fibers to penetrate. The protective clothing should cover the whole body, and it should fit comfortably at the neck, wrists, and ankles. Headgear and proper boots that can resist the penetration of asbestos fibers must be worn. If protective clothing gets damaged or torn, it must be replaced immediately.

It must be ensured that workers do not exit the work area while wearing their protective clothing. All contaminated clothing and equipment must be taken off and kept in the equipment room or work area so that the contaminants do not enter the clean area.

Respiratory Protection

Many types of respirators provide protection from asbestos dust and fibers. Usually a respirator is selected according to the nature of the work and the amount of asbestos that may be produced.

Before entering the work area, workers must put on their respirators, make sure that they fit properly, and check that there are no gaps from which asbestos fibers may enter.

Types of Respirators

Respiratory protection against asbestos can be obtained through two basic types of respirators: air-purifying respirators and atmosphere-supplying respirators.

Air-purifying Respirator

A respirator with an air-purifying filter, cartridge, or canister is called an air-purifying respirator. This respirator removes asbestos contaminants from the air by passing it through an air-purifying component, making it acceptable to breathe normally.

Atmosphere-supplying Respirator

An atmosphere-supplying respirator consists of a component that provides the user with breathable air that is not taken from the ambient atmosphere. There are two types of atmosphere-supplying respirators: supplied-air respirators (SARs) and self-contained breathing apparatus (SCBA) units.

- **Supplied-air respirators (SAR):** It uses a hose called an airline to provide clean air from an air tank. There are two types of supplied-air respirators: pressure demand respirators and continuous-flow respirators.

  Pressure-demand respirators prevent the contaminated air from entering the face-piece by maintaining positive pressure. Continuous-flow respirators also maintain positive pressure by constantly supplying fresh air to the face-piece.

- **Self-contained Breathing Apparatus (SCBA) Unit:** It consists of a hose that is connected to a cylinder of compressed air. Activities that carry a risk of exposure to asbestos do not usually require the use of SCBAs. However, in some cases, pressure-demand SCBAs are used, which supply air to the face-piece if the inside pressure reduces due to inhalation or leakage.

Employee Notification of Monitoring Results

The employer must, within 15 working days after the receipt of the results of any monitoring performed, notify each affected employee of these results either individually in writing or by posting the results in an appropriate location that is accessible to affected employees.

The written notification shall contain the corrective action being taken by the employer to reduce employee exposure to or below the TWA and/or excursion limit, wherever monitoring results indicated that the TWA and/or excursion limit had been exceeded.

You must keep accurate records of the following:

- All measurements taken to monitor employee exposure to asbestos—30 years.
- Medical records, including physician's written opinions—duration of the employee's employment plus 30 years.
- Training records—1 year beyond the last date of employment.

Lesson Summary

All workers who are required to perform asbestos-related tasks must wear the appropriate protective equipment. Protective clothing should be made with a material that does not allow asbestos fibers to penetrate. The protective clothing should cover the whole body, and should fit comfortably at the neck, wrists, and ankles. Headgear and boots that resist the penetration of asbestos fibers must also be worn, and if protective clothing gets damaged or torn, it must be replaced immediately.

To collect any loose material that may break off while sampling, the floor of the work area may need to be covered with polyethylene sheets. After completion of the work, these sheets must be placed in leak-proof containers and disposed of properly. Only a qualified person may collect samples of materials that may contain asbestos. These samples must then be sent immediately to a laboratory where their contents can be determined.

Workers must disturb the least amount of material possible. By washing and vacuuming, one must then decontaminate the enclosure and all of the equipment. Next, all exposed surfaces from which asbestos has been removed should be sealed or protected. Finally, the air inside the enclosure must be decontaminated before taking apart the enclosure.

In order to prevent the containers from getting damaged or torn while being transported to the disposal site, they must be properly packaged using double polyethylene bags. All permanent enclosures around asbestos-containing materials must be airtight, and warning signs must be put up inside enclosures to warn workers about the dangers of asbestos and any protective measures that must be taken.

Workers must never use dry clothes or compressed air to clean asbestos-containing materials. Also, in order for the contaminated air to remain in the enclosed area or filtered prior to release, it must be ensured that the air pressure in the work area is lower than the surrounding area. This low pressure should be maintained until all work has been completed. All designated work areas must be isolated in order to prevent unauthorized personnel from entering. In order to isolate a work area, signs should be placed around it to warn unauthorized persons against entering.

Course Summary

This course gave students the information needed to recognize hazards for the construction industry. Our focus throughout the course was on hazard identification, control and avoidance for the protection of the workers. In this course we discusses the following topics:

- Introduction to OSHA
- Managing Safety and Health
- OSHA Focus Four Hazards
    - Falls
    - Electrocution
    - Struck-by
    - Caught-In
- Personal Protective Equipment
- Health Hazards in Construction
- Stairways and Ladders
- Confined Space Entry
- Cranes and Rigging
- Ergonomics
- Excavations
- Fire Protection and Prevention
- Material Handling, Use and Disposal
- Motor Vehicle, Mechanized Equipment, and Marine Operations: Rollover Protection
- Signs, Signals, and Barricades
- Powered Industrial Vehicles
- Scaffolds
- Tools hand and power
- Welding and Cutting
- Silica Exposure
- Asbestos Exposure