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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:

- **Vertical:** hangs vertically (5000 pound minimum breaking strength).
- **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.

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