Module 3: OSHA Focus Four Hazards

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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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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.

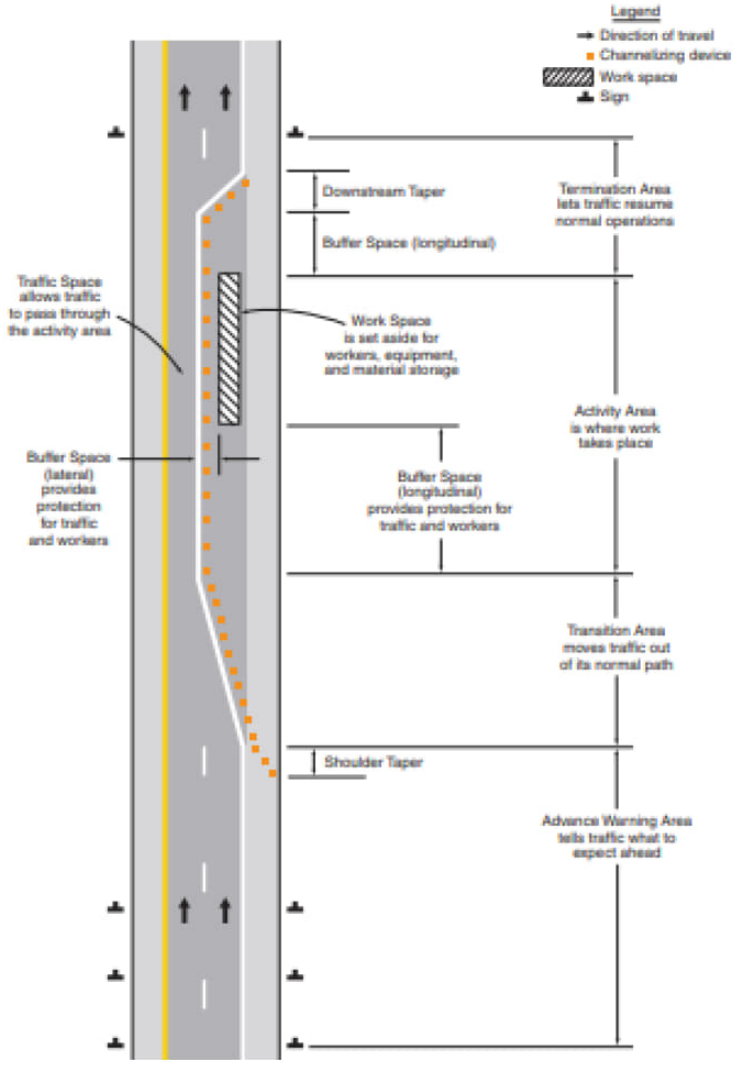
The channeling devices are placed in a pattern that begins in the advanced warning area so that when the cones are parallel to the work area they have been angled back. This angling of the channeling devices is referred to as the taper.

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.

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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.