Construction Worksite Safety

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OSHAcademy Course 813 Study Guide

Construction Worksite Safety

This study guide is designed to be reviewed off-line as a tool for preparation to successfully complete OSHAcademy Course 813.

Read each module, answer the quiz questions, and submit the quiz questions online through the course webpage. You can print the post-quiz response screen which will contain the correct answers to the questions.

The final exam will consist of questions developed from the course content and module quizzes.

We hope you enjoy the course and if you have any questions, feel free to email or call:

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Disclaimer

Revised: January 8, 2018

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Course Introduction

Nearly 6.5 million people work at approximately 252,000 construction sites across the nation on any given day. The fatal injury rate for the construction industry is higher than the national average in this category for all industries.

For any part of the contract work, contractors or subcontractors cannot require any laborer or mechanic employed in the performance of the contract to work in surroundings or under working conditions that are unsanitary, hazardous, or dangerous to their health or safety.

Potential Hazards for workers in construction include the following:

- falls (from heights)
- trench collapse
- scaffold collapse
- electric shock and arc flash/arc blast
- failure to use proper personal protective equipment
- repetitive motion injuries

For construction, the 10 OSHA standards most frequently included in the agency's citations in FY 2014 were:

1. 1926.501 - Fall Protection
2. 1910.1200 - Hazard Communication
3. 1926.451 - Scaffolding
4. 1910.134 - Respiratory Protection
5. 1910.178 - Powered Industrial Trucks
6. 1910.147 - Lockout/Tagout
7. 1926.1053 - Ladders
8. 1910.305 - Electrical, Wiring Methods

9. 1910.212 - Machine Guarding
10. 1910.303 - Electrical, General Requirements

Module 1: Scaffolds and Aerial Lifts

Introduction

When scaffolds and aerial lifts are not erected or used properly, fall hazards can occur. About 2.3 million construction workers frequently work on scaffolds. Protecting workers from scaffold-related accidents would prevent an estimated 4,500 injuries and 50 fatalities each year.

Unsafe scaffolding procedures can cause accidents, serious injuries and even death. Accidents involving scaffolding mainly involve:

- workers falling
- incorrect operating procedures
- environmental conditions
- falling materials

Training and Retraining

Training in scaffold safety should be provided for both supported and suspended scaffolding in addition to general requirements for capacity and platform construction, safe access, fall protection, falling object protection, safe use, and training.

Workers should be retrained if any of the following conditions occur:

- An accident occurs during scaffold or aerial lift use.
- Workplace hazards involving scaffolds or aerial lifts are discovered.
- A different type of scaffold or aerial lift is used.

Employers are also required to retrain workers who they observe working improperly on scaffolds or operating aerial lifts.

Supported Scaffolds

Supported scaffolds consist of one or more platforms supported by outrigger beams, brackets, poles, legs, uprights, posts, frames, or similar rigid support.

Frame Scaffold or Fabricated Frame: Platform(s) supported on fabricated end frames with integral posts, horizontal bearers, and intermediate members.

Manually Propelled/Mobile: Unpowered, portable, caster- or wheel-mounted supported scaffold.

Pump Jack: Platform supported by vertical poles and movable support brackets.

Ladder Jack: Platform resting on brackets attached to ladders.

Tube and Coupler: Platform(s) supported by tubing, erected with coupling devices connecting uprights, braces, bearers, and runners.

Pole: Posts with fixed connection points that accept runners, bearers, and diagonals, also made of wood, that can be interconnected at predetermined levels.

Specialty: Scaffold types designed for a narrow and very specific range of applications. Includes plasterers', decorators', and other large-area scaffolds; bricklayers' square scaffolds; horse scaffolds; outrigger scaffolds; step, platform, and trestle ladder scaffolds; form and carpenter's bracket scaffolds; window jack scaffolds; crawling boards and chicken ladders; and roof bracket scaffolds.

Check out this OSHA video describing the hazards of working on supported scaffolds.

Suspension Scaffolds

Suspended scaffolds are platforms suspended by ropes, or other non-rigid means, from an overhead structure.

- **Two-point** (swing stage): Platform supported by hangers (stirrups) suspended by two ropes from overhead supports and equipped with a means to permit the platform to be raised and lowered.

- **Single-point Adjustable**: Platform suspended by one rope from an overhead support and equipped with a means to permit the platform to be moved to desired working levels.
- **Catenary**: Platform supported by two essentially horizontal and parallel ropes attached to structural members of a building. Additional vertical pickups may also provide support.
- **Multi-point Adjustable**: Platform(s) suspended by more than two ropes from overhead supports and equipped with a means to permit the platform to be raised and lowered. Includes chimney hoists.
- **Interior Hung**: Platform suspended from the ceiling or roof structure by fixed-length supports.
- **Needle Beam**: A platform suspended from needle beams.
- **Multi-level**: Two-point or multi-point adjustable suspension scaffold with a series of platforms at various levels resting on common stirrups.
- **Float** (ship): Braced platform resting on two parallel bearers and hung from overhead supports by ropes of fixed length.

Recommended Precautions: Supported and Suspended Scaffolds

Recommended precautions to take while working with scaffolds include:

- Make sure employees are instructed about the hazards of using diagonal braces as fall protection. Scaffolds should be accessed by using ladders and stairwells. Crossbracing should not be used.
- Make sure scaffolds are sound, rigid and sufficient to carry its own weight plus four times the maximum intended load without settling or displacement.
- Ensure scaffolds are erected on solid footing.
- Do not support scaffolds or planks with unstable objects, such as barrels, boxes, loose bricks or concrete blocks. Ladders, boxes, barrels, buckets or other makeshift platforms should not be used to raise work height. Extra material should not be used to build up on scaffold platforms.

- Ensure scaffolds are erected, moved, dismantled or altered under the supervision of a competent person.
- Never use scaffold accessories such as braces, brackets, trusses, screw legs or ladders that are damaged or weakened from any cause. Make sure they are immediately repaired or replaced.
- Tightly plank scaffold platforms with scaffold plank grade material or equivalent. All scaffolds should be fully planked.
- Make sure a competent person inspects the scaffolding and, at designated intervals, repeat the inspection.
- Ensure a competent person inspects rigging on suspension scaffolds before each shift and after any occurrence that could affect structural integrity to ensure that all connections are tight and that no damage to the rigging has occurred since its last use.
- Check that synthetic and natural rope used in suspension scaffolding is protected from heat-producing sources.
- Always check to make sure scaffolds are at least 10 feet from electric power lines at all times.
- Equip scaffolds with guardrails, midrails and toeboards, as required.
- Ensure damaged parts that affect the strength of the scaffold are taken out of service.
- Make sure scaffolds are not moved horizontally while workers are on them unless they are designed to be mobile and workers have been trained in the proper procedures.
- Do not allow employees to work on scaffolds when covered with snow, ice, or other slippery materials. Employees are not permitted to work on scaffolds in bad weather or high winds unless a competent person has determined it is safe to do so.
- Scaffolds should not be loaded with more weight than they were designed to support.

For a complete course on scaffold safety, take OSHAcademy Course 803, Scaffold Safety Program Management and Course 804, Safe Scaffold Erection and Inspection.

You may also want to visit OSHA's Safety and Health Topics: Scaffolding web page.

Aerial Lifts

Aerial lifts are vehicle-mounted, boom-supported aerial platforms, such as cherry pickers or bucket trucks, used to access utility lines and other aboveground job sites. The major causes of fatalities are falls, electrocutions, and collapses or tip overs.

Aerial lifts have replaced ladders and scaffolding on many job sites due to their mobility and flexibility. They may be made of metal, fiberglass-reinforced plastic, or other materials. They may be powered or manually operated, and are considered to be aerial lifts whether or not they can rotate around a primarily vertical axis.

Employers must take measures to ensure the safe use of aerial lifts by their workers if they are required to use this equipment in the course of their employment.

Aerial Lift Training

Only trained and authorized persons are allowed to operate an aerial lift. Training should include the following:

- explanations of electrical, fall, and falling object hazards
- procedures for dealing with hazards
- recognizing and avoiding unsafe conditions in the work setting
- instructions for correct operation of the lift (including maximum intended load and load capacity)
- demonstrations of the skills and knowledge needed to operate an aerial lift before operating it on the job
- when and how to perform inspections
- manufacturer's requirements

Type of Aerial Lifts

Manually-propelled elevating aerial platforms: When employees use manually propelled elevating aerial platforms as covered by ANSI/SIA A92.3-1990, the manufacturer's operating manual must be with the equipment. You must follow all operating and maintenance instructions and recommendations of the manufacturer.

Boom-supported elevating work platforms: When employees use boom supported elevating work platforms as covered by ANSI/SIA A92.5-1992, the manufacturer's operating manual must be with the equipment. Follow all operating and maintenance instructions and recommendations of the manufacturer.

Vehicle-mounted elevating and rotating lifts [ANSI A92.2 devices]: Platforms other than buckets or baskets must include guardrail systems with guardrails, midrails, and toeboards. *Each person who works on a boom-supported platform must use a personal fall-protection system* that includes a body harness and a lanyard attached to the boom or basket.

Scissor lifts: When employees use self-propelled elevating aerial platforms (scissor lifts), as covered by ANSI/SIA A92.6-1990, the manufacturer's operating manual must be with the equipment. Follow all operating and maintenance instructions and recommendations of the manufacturer.

Aerial Lift Safe Work Practices

To make sure you are not injured while operating an aerial lift, follow these safe work practices:

- Make sure that workers who operate aerial lifts are properly trained in the safe use of the equipment.
- Maintain and operate elevating work platforms according to the manufacturer's instructions.
- Never override hydraulic, mechanical, or electrical safety devices.
- Never move the equipment with workers in an elevated platform unless this is permitted by the manufacturer.
- Do not allow workers to position themselves between overhead hazards, such as joists and beams, and the rails of the basket. Movement of the lift could crush the worker(s).

- Maintain a minimum clearance of at least 10 feet, or 3 meters, away from the nearest energized overhead lines.
- Always treat power lines, wires and other conductors as energized, even if they are down or appear to be insulated.
- Use a body harness or restraining belt with a lanyard attached to the boom or basket to prevent the worker(s) from being ejected or pulled from the basket.
- Set the brakes and use wheel chocks when on an incline.
- Use outriggers, if provided.
- Do not exceed the load limits of the equipment. Allow for the combined weight of the worker, tools and materials.

You may also want to visit OSHA's Fact Sheet for Aerial Lifts and 29 CFR 1926.453, Aerial lifts.

Module #1 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **Employers should _____ workers who they observe working on scaffolds or aerial lifts improperly.**

   a. retrain
   b. send home
   c. ignore
   d. terminate

2. **Scaffolds should be accessed by using _____ and not _____.**

   a. crossbracing or stairwells, ladders
   b. ladders or stairwells, crossbracing
   c. ladders or crossbracing, stairwells
   d. endbracing or crossbracing, ladders

3. **You notice workers on a supported scaffold while it is snowing. What do you tell the workers?**

   a. Tell them nothing, because the job has to get done on time
   b. Be careful during access and egress
   c. They are not allowed to work on slippery scaffold surfaces
   d. Be sure to wear their winder safety boots

4. **You notice workers on an aerial lift are working within 10 ft. of a high voltage line. What do you tell the workers?**

   a. Tell them nothing, because the job has to get done on time
   b. The workers should maintain a clearance of 10 ft. or more from the high voltage line
   c. Tell the workers to be careful they do not come within 3 ft. of the high voltage line
   d. Tell the workers to use poles to move the HV lines out of the way

5. **Use a _____ to the aerial lift boom or basket to prevent the worker(s) from being ejected or pulled from the basket.**

    a. fall arrest system
    b. an articulating lifeline
    c. a 3/8 in manila rope around the waste
    d. a body harness or restraining belt with a lanyard attached

Module 2: Slips, Trips, and Falls

Introduction

Each year, falls consistently account for the greatest number of fatalities in the construction industry. Slippery surfaces and poor housekeeping also result in serious injuries due to slips, trips, and falls.

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

Threshold Height

Where workers on a construction site are exposed to vertical drops of 6 feet or more, OSHA requires that employers provide fall protection in one of three ways before work begins:

- guardrail systems,
- safety net systems, or
- personal fall arrest systems.

Again, employers must protect employees from fall hazards whenever an employee is working 6 feet or more above a lower level. However, if an employee is working on a scaffold, the height requirement for fall protection is 10 feet. Don't let these different threshold heights confuse you.

Recommended Precautions: Slips, Trips, and Falls

Take these precautions to help prevent injuries due to slips, trips, and falls on the worksite:

- Use fall arrest/restraint systems, as appropriate, when working at elevation.
- Consider using aerial lifts or elevated platforms to provide safer elevated working surfaces.
- Erect guardrail systems with toeboards and warning lines or install control line systems to protect workers near the edges of floors and roofs.

- Cover floor holes.
- Use safety net systems or personal fall arrest systems (body harnesses).

Check out this OSHA video describing the importance of fall-restraint systems while roofing.

Recommended Precautions: Elevated Surfaces

Take these precautions to help prevent injuries while working on elevated surfaces on the worksite:

- Post signs, when appropriate, showing the elevated surface load capacity.
- Install standard guardrails on surfaces elevated more than 48 inches above the floor or ground.
- Ensure standard 4-inch toeboards are installed on all elevated surfaces that expose people or machinery to falling objects.
- Install a permanent means of entry and exit with handrails to elevated storage and work surfaces.
- Pile, stack or rack material in a way that prevents it from tipping, falling, collapsing, rolling or spreading.

Skylights, Floor Holes, and Wall Openings

Employees on a construction site are exposed to floor holes and wall openings that can result in serious or fatal falls. Generally, in residential construction, when employees are exposed to a hazard of falling 6 feet or more to a lower level, the employer must ensure that fall protection systems are provided, installed, and implemented.

To protect employees, follow these safe work practices:

- **Skylights:** Install guarding in the form of standard railing around skylight openings, or install a cover capable of supporting the maximum intended load. Covers over skylight openings should be installed so as to prevent accidental displacement.

Check out this short OSHA video on the dangers of falling through skylights.

- **Holes:** To protect employees on walking/working surfaces from falling through holes (including skylights) more than six feet above lower levels, install guardrails or place covers over the holes.

- Guard floor openings that are 2 inches or more with a secured cover, a guardrail, or equivalent on all sides (except at entrances to stairways).

Check out this short OSHA video on the dangers of floor openings.

- **Falling objects:** To protect employees on a walking/working surface from objects falling through holes (including skylights), cover the holes and install toeboards around the edges of permanent floor openings.

- **Wall openings:** Use a guardrail system to protect employees working on, at, above, or near wall openings (including those with chutes attached) where:

  - the outside bottom edge of the wall opening is six feet or more above lower levels, and/or

  - the inside bottom edge of the wall opening is less than 39 inches above the walking/working surface from falling.

- **Established floors, mezzanines, balconies, and walkways:** Use guardrails or fall arrest/restraint systems to protect employees working on established floors, mezzanines, balconies, and walkways with an unprotected side or edge six feet or more above a lower level from falling.

- **Dangerous equipment:** Protect employees from falls into or onto dangerous equipment, regardless of the fall distance. To protect employees use guardrails or fall arrest/restrain systems.

- **Excavations:** Each employee at the edge of an excavation six feet or more in depth must be protected from falling when the excavations are not readily seen because of plant growth or other visual barriers. Use guardrail systems to protect each employee at the edge of a well, pit, shaft, and similar excavation six feet or more in depth from falling.

For more information on fall protection, take OSHAcademy Course 805, Fall Protection in Construction.

Housekeeping

Cleaning and housekeeping on construction sites may not be the highest priority. To some, it may even seem like a waste of time or unnecessary. Nevertheless, good housekeeping practices can help prevent serious injuries and regulatory fines. Follow these best housekeeping practices:

- Keep aisles and passageways clear to provide for the free and safe movement of material handling equipment or employees. Such areas must be kept in good repair.
- During the construction, alteration, or repair work, clear forms and scrap lumber with protruding nails and all other debris from work areas, passageways, and stairs in and around buildings or other structures.
- Remove combustible scrap and debris at regular intervals during the course of construction. Be sure the means of removal process keeps employees safe.
- Provide containers for the collection and separation of waste, trash, oily and used rags, and other refuse.
- Equip containers used for garbage and other oily, flammable, or hazardous wastes (such as caustics, acids, harmful dusts, etc.) with covers. Dispose of garbage and other waste at frequent, regular intervals.

Module #2 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **Where workers on a construction site are exposed to vertical drops of _____, OSHA requires that employers provide fall protection.**

   a. 6 feet or more
   b. 4 feet or more
   c. 10 feet or more
   d. 9 feet or more

2. **Guardrail toeboards should be _____ in height.**

   a. 8 inches or greater
   b. 6 inches or greater
   c. 3 inches or greater
   d. 4 inches or greater

3. **Guard floor openings of _____ with a secured cover, a guardrail or equivalent on all sides (except at entrances to stairways).**

   a. 3 inches or more
   b. 4 inches or more
   c. 6 inches or more
   d. 12 inches or more

4. **What should you do to protect employees from a 7-foot trench that is not readily seen?**

   a. Place spoils around the trench
   b. Install a guardrail around the trench
   c. Plant foliage
   d. Post warning signs

5. **Use guardrail systems to protect each employee at the edge of a well, pit, shaft, and similar excavation _____ in depth from falling.**

    a. 10 feet or more
    b. 4 feet or more
    c. 6 feet or more
    d. 8 feet or more

Module 3: Ladders and Stairways

Introduction

Ladders and stairways are common sources of injuries and fatalities among construction workers. OSHA estimates there are more than 24,000 injuries and as many as 36 fatalities per year due to falls on stairways and ladders used in construction. Nearly half of these injuries were serious enough to require time off the job.

Training

Employers must train each employee exposed to hazards while using ladders or stairways. The training program must train each employee how to recognize ladder and stairway hazards and minimize the hazards. Employees should be trained by a competent person in the following areas:

- nature of fall hazards in the work area
- correct procedures for erecting, maintaining, and disassembling the fall protection systems to be used
- proper construction, use, placement, and care in handling of all stairways and ladders
- maximum intended load-carrying capacities of ladders

Employers must retrain each employee as necessary to maintain their understanding and knowledge on the safe use and construction of ladders and stairs.

Ladder Hazards

Falls from portable ladders are one of the leading causes of occupational fatalities and injuries. According to the Bureau of Labor and Statistics (2012), 14 percent of all work-related deaths are due to falls, with 20 percent of these deaths being related to the use of ladders.

Ladders need to be inspected by a qualified person for visible defects before each use. While in use, a ladder may go through conditions that may impact its integrity. A ladder with compromised integrity will not be safe for use.

Recommended Precautions

Recommended precautions to protect employees from falls from ladders include:

- Use the Quarter Length Rule: Place the ladder's base a distance away from the wall or upper support equal to one-quarter the effective working length of the ladder. This represents about a 4:1 height to base ratio. That will approximate the optimum resistance to sliding, strength of the ladder, and balance of the climber. The angle of the ladder will be about 75 degrees.

- Before using a ladder, be sure to read and follow all the labels and markings on the ladder.

- Avoid electrical hazards. Look for overhead power lines before handling a ladder. Avoid using a metal ladder near power lines or exposed energized electrical equipment.

- Always inspect the ladder prior to using it. If the ladder is damaged, it must be removed from service and tagged until repaired or discarded.

- Always maintain a 3-point (two hands and a foot, or two feet and a hand) contact on the ladder when climbing. Keep your body near the middle of the step and always face the ladder while climbing.

- Only use ladders and appropriate accessories (ladder levelers, jacks or hooks) for their designed purposes.

- Ladders must be free of any slippery material on the rungs, steps or feet.

- Do not use a self-supporting ladder (e.g., step ladder) as a single ladder or in a partially closed position.

- Do not use the next-to-the-top or top step/rung of a ladder as a step/rung unless it was designed for that purpose. Check out this video of an actual accident that happened when a worker failed to follow this practice.

- Use a ladder only on a stable and level surface, unless it has been secured (top or bottom) to prevent displacement.

- Do not place a ladder on boxes, barrels or other unstable bases to obtain additional height.

- Do not move or shift a ladder while a person or equipment is on the ladder.

- An extension or straight ladder used to access an elevated surface must extend at least 3 feet above the point of support. Do not stand on the three top rungs of a straight, single or extension ladder.

- A ladder placed in any location where it can be displaced by other work activities must be secured to prevent displacement or a barricade must be erected to keep traffic away from the ladder.

- Be sure that all locks on an extension ladder are properly engaged.

- Do not exceed the maximum load rating of the ladder. Be aware of the ladder's load rating and of the weight it is supporting, including the weight of any tools or equipment. Never load ladders beyond the maximum intended load or beyond the manufacturer's rated capacity.

- Be sure the load rating can support the weight of the user, including materials and tools.

- Avoid using ladders with metallic components near electrical work and overhead power lines.

For a complete course on ladder safety, take OSHAcademy Course 603.

Take a short online course from Oregon OSHA: See How to Select and Use a Portable Ladder.

For more information on ladder safety see OSHA's Falling Off Ladders Can Kill: Use Them Safely, Reducing Falls in Construction: Safe Use of Extension Ladders, and Reducing Falls in Construction: Safe Use of Stepladders.

Stairway Hazards

Slips, trips and falls on stairways are a major source of injuries and fatalities among construction workers. The rules covering stairways and their components generally depend on how and when stairs are used.

Specifically, there are rules for stairs used during construction and stairs used temporarily during construction, as well as rules governing stair rails and handrails.

Requirements

The following requirements apply to all stairways used during construction:

- Make sure there is a stairway at points of access where there is an elevation break of 19 inches or more.
- Stairways with four or more risers, or higher than 30 inches, must be equipped with at least one handrail.
- For stairways that will not be a permanent part of the building under construction make sure landings are at least 30 inches deep and 22 inches wide (76 x 56 cm) at every 12 feet (3.7 m) or less of vertical rise.
- Install stairways at 30 to 50 degrees from the horizontal.
- Do not exceed variations in riser height or stair tread depth more than 1/4 inch in any stairway system, including any foundation structure used as one or more treads of the stairs.
- The platform for doors and gates opening directly onto a stairway must extend at least 20 inches (51 cm) beyond the swing of the door or gate.
- Secure metal pan landings and metal pan treads in place before filling.
- Make sure stairway parts are free of dangerous projections such as protruding nails.

- Correct slippery conditions on stairways.
- Do not use spiral stairways that will not be a permanent part of the structure.

For a complete course on stairway safety, take OSHAcademy Course 603.

Module #3 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **Which of the following ladder and stairway training topics should be taught to all construction workers?**

a. Duties and responsibilities
b. Training procedures
c. Proper construction, use, placement and care
d. Proper LOTO techniques

2. **Ladders should be placed at about a _____ angle to achieve a 4:1 height to base ratio.**

a. 45 degree
b. 75 degree
c. 90 degree
d. 60 degree

3. **You notice a worker using a self-supporting ladder (e.g., step ladder) as single ladder. What do you tell the worker?**

a. It's fine to use the ladder as a single ladder
b. Be sure to partially fold the ladder when using it
c. Be careful when using the ladder in that manner
d. Do not use the ladder in that manner

4. **During construction, ensure stairways are installed at _____ from the horizontal.**

a. 30 to 50 degrees
b. 15 to 30 degrees
c. 39 to 43 degrees
d. 22 to 30 degrees

5. In construction, variation in riser height or stair tread should not exceed _____.

a. 1/4 inch
b. 1/2 inch
c. 1/16 inch
d. 3/8 inch

Module 4: Working with Electricity

Introduction

Electricity has long been recognized as a serious workplace hazard. OSHA's electrical standards are designed to protect employees exposed to dangers such as electric shock, electrocution, fires, and explosions.

The following hazards are the most frequent causes of electrical injuries in construction:

- contact with power lines
- lack of ground-fault protection
- missing or discontinuous path to ground
- equipment not used in manner prescribed
- improper use of extension and flexible cords

Control of Hazardous Energy (Lockout/Tagout)

The employer must establish a program consisting of energy control procedures, employee training, and periodic inspections. The purpose is to ensure that equipment is isolated from the energy source and made inoperative before any employee performs any service or maintenance where the unexpected energizing, start up, or release of stored energy could occur.

Sequence of a Lockout/Tagout Procedure

The following are the steps to lockout/tagout equipment.

1. Notify all affected employees that service or maintenance is required on a piece of equipment. An affected employee is one who normally works on the machine that is being locked or tagged for service. This action also applies to employees who are working in the area of the locked/tagged piece of equipment.

2. Authorized employees should refer to the company procedure to identify the type and magnitude of the energy that the machine uses, understand the hazards of the energy and know the methods to control the energy.

3. If the equipment is operating, the authorized employee will shut it down by the normal stopping procedure (depress stop button, open switch, close valve, etc.).

4. De-activate the energy-isolating device(s) so the equipment is isolated from the energy source(s).

5. Lockout/tagout the energy-isolating device(s) with assigned individual lock(s).

6. Dissipate or restrain stored or residual energy (such as springs; elevated or suspended equipment parts; hydraulic systems; air, gas, steam or water pressure; electricity in capacitors; etc.) by methods such as grounding, repositioning, blocking or bleeding down.

7. Remove all other employees from the area before the equipment is disconnected from the energy source(s).

8. Verify the isolation of the equipment by attempting to restart the equipment under its normal operations. Remember to return operating control(s) to the neutral or “off” position after attempting to restart the equipment.

9. At this point the equipment should be in locked-out condition.

Restoring Equipment to Service

The following are procedures for restoring equipment to service:

1. Check the equipment and immediate area around the equipment to ensure nonessential items such as tools have been removed and equipment components are operationally intact.

2. Check the work area to ensure all employees have been safely positioned or removed from the area.

3. Verify the controls are in neutral.

4. Remove the lockout device(s) and start the equipment. The removal of some forms of blocking may require starting the equipment before safe removal.

5. Notify affected employees that the service or maintenance is completed and the equipment is ready for use.

Group Lockout/Tagout

In the steps outlined in the previous section, one person should place his or her lock on each piece of an energy-isolating device. There may be occasions when more than one person needs to work on a piece of equipment. When this occurs, each person involved in the service or maintenance will be required to place his or her own lock on the energy- isolating device.

- A single authorized employee must assume the overall responsibility for the control of hazardous energy for all members of the group while the servicing or maintenance work is in progress.

- A multi-hasp lock is required if the energy-isolating device does not have enough places for each employee to place his or her own lock.

- Each employee must affix his/her personal lockout or tagout device to the group lockout device, group lockbox, or comparable mechanism, before engaging in the servicing and maintenance operation.

- When the activities involving group lockout or tagout extend into another workshift, or there is a change of authorized employees, the provisions for shift or personnel changes must also be followed.

Ground Fault Circuit Interrupters (GFCI)

- All 125-volt, single-phase, 15-, 20-, and 30-ampere receptacles on construction sites that are for temporary power and are available for use by employees, must have approved ground-fault circuit interrupters (GFCIs).

- GFCI protection must be located at the outlet end of the circuit. Extension cords or other devices with listed ground-fault circuit interrupter protection are acceptable.

- Receptacles more than 125-volt, single phase, 30-amperes must have protection that complies with GFCI protection above, or an assured equipment grounding conductor program.

Working Near Overhead High-voltage Lines and Equipment

Overhead and buried power lines at your site are especially hazardous because they carry extremely high voltage. Fatal electrocution is the main risk, but burns and falls from elevations are also hazards. Using tools and equipment that can contact power lines increases the risk.

Examples of Equipment That Can Contact Power Lines

- aluminum paint rollers
- backhoes
- concrete pumpers
- cranes
- long-handled cement finishing floats
- metal building materials
- metal ladders
- raised dump truck beds
- scaffolds

Restricted Space Precautions

Important general electrical safety precautions when working around high voltage power lines in construction include:

- No person is allowed to perform any construction activity within the restricted space surrounding an overhead high-voltage line or equipment unless:
  - that person is the owner, an authorized employee, or authorized (in writing) agent of the overhead high voltage system,

- proper notification is provided and the line and/or equipment is de-energized and visibly grounded by the owner of the high-voltage system or authorized agent, or accidental contact is prevented by use of insulating barriers or guards,
- insulated power lines (not tree wire) and equipment designed and engineered to allow only incidental contact are installed by the owner of the high-voltage system or authorized agent.

- For high voltage power lines rated more than 600 Volts (V) and up to 50 kilovolts (kV), restricted space extends 10 feet in all directions from the surface of the line or equipment.
- For high voltage power lines rated over 50 kV, restricted space extends 10 feet plus 0.4 inch for each one kV over 50 kV, or twice the length of the insulator (but never less than 10 feet) in all directions from the surface of the line or equipment.
- For equipment or structures in transit, on level surfaces, restricted space extends:
  - four feet in all directions from lines or equipment rated 50 kV or less,
  - 10 feet in all directions for lines or equipment rated more than 50 kV, and
  - 16 feet in all directions for lines or equipment rated more than 345 kV up to and including 750 kV.

General Precautions

Follow these general electrical safety precautions on construction sites:

- Secure electric equipment firmly to the surface on which it is mounted. Wooden plugs driven into holes in masonry, concrete, plaster, or similar materials must not be used.
- Do not work on new and existing energized (hot) electrical circuits until all power is shut off and grounds are attached.
- Make sure an effective Lockout/Tagout system is in place.
- Promptly replace frayed, damaged or worn electrical cords or cables.

- Ensure all extension cords have grounding prongs.
- Protect flexible cords and cables from damage. Sharp corners and projections should be avoided.
- Use extension cord sets used with portable electric tools and appliances that are the three-wire type and designed for hard or extra-hard service. (Look for some of the following letters imprinted on the casing: S, ST, SO, STO.)
- Maintain all electrical tools and equipment in safe condition and regularly check for defects and take the tools out of service if defects are found.
- Do not bypass any protective system or device designed to protect employees from contact with electrical energy.
- Locate and identify overhead electrical power lines.
- Ensure that ladders, scaffolds, equipment or materials never come within 10 feet of electrical power lines.
- Properly ground all electrical tools unless they are of the double insulated type.
- Do not allow multiple plug adapters.

Real World Accident

Scaffold Too Close to Power Line

Seven employees of a masonry company were erecting a brick wall from a tubular, welded-frame scaffold approximately 24 feet high. The scaffold had been constructed only 21 horizontal inches across from a 7,620-volt power line. A laborer carried a piece of wire reinforcement (10 feet long by 8 inches wide) along the top section of the scaffold and contacted the power line with it. The laborer, who was wearing leather gloves, received an electric shock and dropped the wire reinforcement, which fell across the power line and simultaneously contacted the metal rail of the scaffold, energizing the entire scaffold. A 20-year-old bricklayer standing on the work platform in contact with the main scaffold was electrocuted.

Module #4 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **Which of the following programs helps prevent the unexpected energizing, startup or release of stored energy?**

   a. Stored Energy Program
   b. Job Safety Analysis Program
   c. Lockout/Tagout Program
   d. Pre-Job Hazard Assessment Program

2. **Authorized employees should lockout/tagout the energy-isolating device(s) with _____.**

   a. personal plastic ties
   b. assigned individual locks
   c. combination locks
   d. tagged ratchet locks

3. **During group lockout/tagout, _____ to the group lockout device, group lockbox, or comparable mechanism.**

   a. each employee must affix his/her personal lockout/tagout device
   b. one employee will affix his/her personal lockout/tagout device
   c. only the authorized employee needs to affix a lockout/tagout device
   d. at least two employees must affix lockout/tagout devices

4. **Ground fault circuit interruption (GFCI) protection on construction sites must be located at the _____ of the circuit.**

   a. middle or center
   b. inlet side
   c. either inlet or outlet end
   d. outlet end

5. **On construction sites, ensure that ladders, scaffolds, equipment or materials never come within _____ of electrical power lines.**

   a. 3 feet
   b. 10 feet
   c. 4 feet
   d. 12 feet

Module 5: Excavation and Trenching

Introduction

Two workers are killed every month in trench collapses. An excavation is any man-made cut, cavity, trench, or depression in an earth surface formed by earth removal.

Trench (Trench excavation) means a narrow excavation (in relation to its length) made below the surface of the ground. In general, the depth is greater than the width, but the width of a trench (measured at the bottom) is not greater than 15 feet (4.6 meters).

Dangers of Trenching and Excavation

Cave-ins pose the greatest risk and are much more likely than other excavation-related accidents to result in worker fatalities. Other potential hazards include falls, falling loads, hazardous atmospheres, and incidents involving mobile equipment. One cubic yard of soil can weigh as much as a car. An unprotected trench is an early grave. Do not enter an unprotected trench.

Check out this actual Oregon OSHA video in which a worker is almost buried in a trench cave in. It's likely the Oregon OSHA inspector cited the employer.

Competent Person

Employers should inspect trenches daily, before each shift, and as conditions change by a competent person before worker entry to ensure elimination of excavation hazards. The designated competent person should have and be able to demonstrate the following:

- Training, experience, and knowledge of:
  - soil analysis
  - use of protective systems
  - requirements of 29 CFR Part 1926 Subpart P
- Ability to detect:
  - conditions that could result in cave-ins

- failures in protective systems
- hazardous atmospheres; and
- other hazards including those associated with confined spaces

- Authority to take prompt corrective measures to eliminate existing and predictable hazards and to stop work when required.

How to dig your own grave. Refer to the photos below. The question is, where was the competent person for this worksite? (Source OR-OSHA)

An Oregon OSHA compliance officer stopped by an excavation where two workers were partially buried. They were unable to move until co-workers (also in danger) dug them out.

Access and Egress

To avoid fall injuries during normal entry and exit of a trench or excavation at your job site, ladders, stairways, or ramps are required. In some circumstances, when conditions in a trench or excavation become hazardous, survival may even depend on how quickly you can climb out. Use the following guidelines and safe practices to avoid excavation access-egress hazards:

- Provide stairways, ladders, ramps, or other safe means of egress in all trenches that are 4 feet deep or more.

- Position means of egress within 25 lateral feet of workers.

- Structural ramps that are used solely for access or egress from excavations must be designed by a competent person.
- When two or more components form a ramp or runway, they must be connected to prevent displacement, and be of uniform thickness.
- Cleats or other means of connecting runway components must be attached in a way that would not cause tripping (e.g., to the bottom of the structure).
- Structural ramps used in place of steps must have a non-slip surface.
- Use earthen ramps as a means of egress only if a worker can walk them in an upright position, and only if they have been evaluated and approved by a competent person.

Inspections

A competent person should inspect and document an area. The following components specify the frequency and conditions requiring inspections.

- daily and before the start of each shift
- as dictated by the work being done in the trench
- after every rainstorm
- after other events that could increase hazards, e.g. snowstorm, windstorm, thaw, earthquake, etc.
- when fissures, tension cracks, sloughing, undercutting, water seepage, bulging at the bottom, or other similar conditions occur
- when there is a change in the size, location, or placement of the spoil pile
- when there is any indication of change or movement in adjacent structures

Trench Safety Measures

Trenches 5 feet (1.5 meters) deep or greater require a protective system unless the excavation is made entirely in stable rock. If less than 5 feet deep, a competent person may determine that a protective system is not required.

Trenches 20 feet (6.1 meters) deep or greater require that the protective system be designed by a registered professional engineer or be based on tabulated data prepared and/or approved by a registered professional engineer in accordance with 1926.652(b) and (c).

General Safety Practices

Follow these general safety practices below when working in and around excavations:

- Keep heavy equipment away from trench edges.
- Identify other sources that might affect trench stability.
- Keep excavated soil (spoils) and other materials at least 2 feet (0.6 meters) from trench edges.
- Know where underground utilities are located before digging.
- Test for atmospheric hazards such as low oxygen, hazardous fumes and toxic gases when greater than 4 feet deep.
- Do not work under suspended or raised loads and materials.
- Ensure that personnel wear high visibility or other suitable clothing when exposed to vehicular traffic.
- Do not cross over an excavation unless approved walkways or bridges are provided. Do not use ladders to cross over excavations.
- Check for the possibility of hazardous atmospheres such as a lack of oxygen or the accumulation of combustible gas concentrations.
- Do not let standing water accumulate in or around the trench.

Protective Systems

The basic methods for protection from cave-ins are sloping, benching, shoring, and shielding. The method you should use depends on factors such as soil type and water content, excavation depth and width, the nature of the work, and nearby activities that could increase the risk of a cave-in.

The competent person has the responsibility for considering these factors and for determining the appropriate protective system. A registered professional engineer must design protective systems for all excavations that are more than 20 feet deep.

Benching is a method of protecting workers from cave-ins by excavating the sides of an excavation to form one or a series of horizontal levels or steps, usually with vertical or near-vertical surfaces between levels. There are two basic types of benching, simple and multiple. Benching cannot be done in Type C soil.

Sloping to protect workers can be done by cutting back the trench wall at an angle inclined away from the excavation not steeper than a height/depth ratio of 1.5 :1, according to the sloping requirements for the type of soil.

- Always provide a way to exit a trench—such as a ladder, stairway or ramp—no more than 25 feet of lateral travel for employees in the trench.
- Keep spoils at least two feet back from the edge of a trench.
- Make sure that trenches are inspected by a competent person prior to entry and after any hazard-increasing event such as a rainstorm, vibrations or excessive surcharge loads.

Maximum allowable slopes for excavations less than 20 ft. (6.09 m) based on soil type and angle to the horizontal are as follows:

TABLE V:2-1. ALLOWABLE SLOPES

Soil type	Height/Depth ratio	Slope angle
Stable Rock (granite or sandstone)	Vertical	90°
Type A (clay)	¾:1	53°
Type B (gravel, silt)	1:1	45°
Type C (sand)	1½:1	34°
Type A (short-term)	½:1	63°
(For a maximum excavation depth of 12 ft.)		

Source: OSHA Technical Manual, Section V, Chap. 2, Excavations: Hazard Recognition in Trenching and Shoring (Jan. 1999).

Shoring is the provision of a support system for trench faces used to prevent movement of soil, underground utilities, roadways, and foundations. Shoring or shielding is used when the location or depth of the cut makes sloping back to the maximum allowable slope impractical. Shoring systems consist of posts, wales, struts, and sheeting. There are two basic types of shoring, timber and aluminum.

Shielding protects workers by using trench boxes or other types of supports to prevent soil cave-ins. Designing a protective system can be complex because you must consider many factors: soil classification, depth of cut, water content of soil, changes caused by weather or climate, surcharge loads (e.g., spoil, other materials to be used in the trench) and other operations in the vicinity.

Training

Employees working in excavations should receive training on the following topics:

- surface encumbrances
- underground installations

- access and egress
- exposure to vehicular traffic
- exposure to falling loads
- warning system for mobile equipment
- hazardous atmospheres
- water accumulation
- stability of adjacent structures
- loose rock and soil
- daily inspections
- fall protection

Competent person training should also include the following:

- protection of employees in excavations
- design of sloping and benching systems
- design of support systems, shield systems, and other protective systems
- materials and equipment
- installation and removal of support
- sloping and benching systems
- shield systems

Real World Accident

A 24-year-old worker died when he was buried under a wall of the trench he was working in. The excavation wall and part of the sidewalk next to the concrete garage floor collapsed onto him while he was attempting to attach the new PVC pipe he had installed to the main sewer. One of the decedent's coworkers was also caught in the collapse. Firefighters who arrived on the scene were able to extricate the decedent's coworker from the excavation. He was transported to a hospital and recovered. The decedent's body was recovered from the excavation approximately 8 hours after the wall collapsed.

For more information on excavation safety be sure to take OSHAcademy Course 802, Trench and Excavation Safety, and refer to DHHS (NIOSH) Publication 2011-208, Preventing Worker Deaths from Trench Cave-ins and the OSHA Technical Manual (OTM).

Module #5 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **Construction workers should provide stairways, ladders, ramps, or other safe means of egress in all trenches that are _____.**

   a. 10 feet deep or more
   b. 8 feet deep or more
   c. 4 feet deep or more
   d. 6 feet deep or more

2. **Trenches _____ require a protective system unless the excavation is made entirely in stable rock.**

   a. 5 feet (1.5 meters) deep or greater
   b. 4 feet (1.2 meters) deep or greater
   c. 3 feet (1 meters) deep or greater
   d. 8 feet (2,5 meters) deep or greater

3. **Construction workers should keep excavated soil (spoils) and other materials _____ from trench edges.**

   a. at least 2 feet (0.6 meters)
   b. at least 3 feet (1 meter)
   c. at least 1 foot (0.3 meters)
   d. at least 2 feet (0.6 meters)

4. **_____ protects workers by excavating the sides of an excavation to form one or a series of horizontal levels or steps.**

   a. sloping
   b. shoring
   c. benching
   d. shielding

5. _____ protects workers by using trench boxes or other types of supports to prevent trench cave-in.

a. sloping
b. shoring
c. benching
d. shielding

Module 6: Cranes and Rigging

Introduction

Moving large, heavy loads is crucial to today's manufacturing and construction industries. Much technology has been developed for these operations, including careful training and extensive workplace precautions. There are significant safety issues to be considered, both for the operators of the diverse "lifting" devices, and for workers in proximity to them.

Hazards in Crane Operations and Rigging

Significant and serious injuries may occur if cranes are not inspected before use and if they are not used properly. Often these injuries occur when a worker is struck by an overhead load or caught within the crane's swing radius. Many crane fatalities occur when the boom of a crane or its load line contact an overhead power line.

Safety Precautions and Best Practices

Recommended safety precautions and best practices to protect employees from the hazards associated with operating cranes and derricks include:

Before operation

- Check all crane controls to insure proper operation before use.
- Inspect wire rope, chains and hook for any damage.
- Know the weight of the load that the crane is to lift.
- Ensure that the load does not exceed the crane's rated capacity.
- Fully extend outriggers.
- Barricade accessible areas within the crane's swing radius.
- Check all rigging prior to use.
- Do not wrap hoist ropes or chains around the load.

- A competent person must inspect slings and all fastenings and attachments for damage or defects.
- Verify cranes and derricks will not be operating within 10 feet of any electrical power line.
- Post illustrations of hand signals to crane and derrick operators on the job site.
- Test and correctly set overload limits.
- Perform and maintain initial and annual inspections of all hoisting and rigging equipment.

During operation

Raise the load a few inches to verify balance and the effectiveness of the brake system.

- Do not move a load over workers.
- Watch for overhead electrical distribution and transmission lines and maintain a safe working clearance of at least 10 feet from energized electrical lines.
- Provide an electrical ground to the upper rotating structure supporting the boom and materials being handled while working near energized transmitter towers.
- Barricade accessible areas within the crane's swing radius.
- Use tag lines to prevent dangerous swing or spin of materials when raised or lowered by a crane or derrick.
- Make load testing reports/certifications available.

Operator and Signal Person

The employer should make sure only properly trained and qualified operators and signal persons work with hoisting and rigging equipment. Operators and signal persons must understand and use appropriate load charts and follow manufacturers' procedures for operating cranes. Operators must be able to correctly determine the angle and length of the

crane boom at all times. Signal persons must be able to use correct signals for the crane operator to follow. Operators and signal persons should do the following:

- Keep the operator's manual and all procedures for operating the crane (such as load charts, recommended operating speeds, and hazard warnings) in the cab and readily available.
- Make sure the operator can determine the angle and length of the crane boom at all times.
- Ensure the signal person uses correct signals for the crane operator to follow.
- Don't do anything distracting, such as texting or talking on a mobile phone, while operating the crane.
- Don't leave the controls while the load is suspended.
- Before starting the engine, verify that all controls are in the proper position and workers are in the clear.
- If crane adjustments or repairs are necessary, inform, in writing, the person responsible for receiving the information and the operator on the next shift.
- Don't operate a crane beyond its rated capacity.
- Don't use a crane to drag or pull loads sideways.
- Don't let the boom and any other parts of a crane contact an obstruction.
- Don't lift loads over the front area of wheel-mounted cranes unless the manufacturer permits it.
- When handling a load that is 90 percent or more of the maximum line pull, test the brakes by lifting the load a few inches and applying the brakes; repetitive lifts of such loads need to be tested only the first time.
- Don't lower the load or the boom below the point where fewer than two full wraps of rope remain on their respective drums.

- Control the crane's rotational speed so that the load doesn't swing out beyond the radius.

Refusing to handle loads. A crane operator concerned about hazards involving a crane can refuse to handle loads until a qualified person determines there isn't a hazard or the hazard has been corrected.

Stopping multiple-crane lifts. The crane operator and the lift director have the authority to stop a multiple-crane lift if either determines the lift can't be done according to the lift plan.

Equipment

- Make sure cranes are equipped with a load chart.
- Inspect crane machinery and other rigging equipment daily prior to use to make sure that it is in good condition.
- Extend crane outriggers when required.
- Ensure crane platforms and walkways have anti-skid surfaces.
- Remove all broken, worn or damaged wire rope from service.
- Provide guardrails, hand holds and steps for safe and easy access to and from all areas of the crane.
- Properly torque tower crane mast bolts to the manufacturer's specifications.
- Post the maximum acceptable load and the last test results on the crane.
- Inspect rigging equipment for material handling before use on each shift and whenever necessary during its use to ensure that it is safe.
- Remove defective rigging equipment from service.
- Do not load rigging equipment in excess of its recommended safe working load.
- Remove rigging equipment, when not in use, from the immediate work area so as not to present a hazard to employees.

- Mark custom-designed grabs, hooks, clamps, or other lifting accessories, for units such as modular panels, prefabricated structures, and similar materials, to indicate the safe working loads.

- Proof-test grabs, hooks, clamps, or other lifting accessories prior to use to 125 percent of their rated load. Included are alloy steel chain, wire rope, metal mesh, natural or synthetic fiber rope (conventional three strand construction), and synthetic web (nylon, polyester, and polypropylene).

Program and Training

- Ensure written safety procedures are required and provided for the safe operation of all cranes used in construction.

- Ensure employees who operate cranes are properly trained, have sufficient practical experience, and follow operating procedures for the safe operation of the crane.

- Document the level of operator training and experience in writing.

- Provide additional training and experience for all employees engaged in construction work who operate cranes of five-ton capacity or greater, and make sure they possess a valid crane operator’s safety training card issued by a training provider or employer.

Crane Operator Certification

OSHA requires employers to ensure that their crane operators are certified under at least one of four options listed below.

The third-party certification option is the only certification option that is "portable," meaning that any employer who employs an operator may rely on that operator's certification as evidence of compliance with the cranes standard's operator certification requirement.

The four options are:

1. certification by an independent testing organization accredited by a nationally recognized accrediting organization

2. qualification by an employer's independently audited program

3. qualification by the U.S. military

4. compliance with qualifying state or local licensing requirements

For more information on crane safety be sure to take OSHAcademy Course 820, Crane and Derrick Safety I, and Course 821, Crane and Derrick Safety II.

Module #6 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **When hoisting a load, make sure you do NOT _____.**

    a. move hoist ropes or chains to the bottom of the load
    b. sling hoist ropes over the load
    c. wrap hoist ropes or chains around the load
    d. position chains under the load

2. **What should be used to prevent dangerous swing or spin of materials when raised or lowered by a crane or derrick?**

    a. Positioning poles
    b. Tag lines
    c. Swing hooks
    d. Movement sensors

3. **The crane operator must be able to _____ at all times.**

    a. determine the angle and length of the crane boom
    b. interpret the positioning diagram
    c. determine and approve swing radii
    d. understand crane boom movement policies

4. **Prior to hoisting operations, be sure to proof-test grabs, hooks, clamps, or other lifting accessories to _____.**

    a. twice their rated load
    b. four times of their rated load
    c. 110% of their rated load
    d. 125% of their rated load

5. _____ is the only crane operator certification option that is considered "portable".

a. OSHA certification
b. Third-party certification
c. Employer certification
d. Online certification

Module 7: Powered Industrial Trucks and Vehicle Safety

Introduction

Powered industrial trucks, commonly called forklifts or lift trucks, are used in many industries, primarily to move materials. They can also be used to raise, lower, or remove large objects or a number of smaller objects on pallets or in boxes, crates, or other containers. Powered industrial trucks can either be ridden by the operator or controlled by a walking operator.

Note: Over-the-road haulage trucks and earth-moving equipment that has been modified to accept forks are not considered powered industrial trucks.

Hazards

Approximately 100 employees are fatally injured and approximately 95,000 employees are injured every year while operating powered industrial trucks. Forklift turn-over accident accounts for the most significant number of these fatalities.

There are many types of powered industrial trucks. Each type presents different operating hazards. For example, a sit-down, counterbalanced high-lift rider truck is more likely than a motorized hand truck to be involved in a falling load accident because the sit-down rider truck can lift a load much higher than a hand truck.

Accident Factors

Workplace type and conditions are also factors in hazards commonly associated with powered industrial trucks. For example, retail establishments often face greater challenges than other worksites in maintaining pedestrian safety. Beyond that, many workers and others can also be injured in any of the following scenarios:

- Lift trucks are inadvertently driven off loading docks.
- Lifts fall between docks and an unsecured trailer.
- Workers are struck by a lift truck.
- Workers fall while on elevated pallets and tines.
- Workers have not been properly educated and trained in the principles of physics that allow a forklift to lift heavy loads.

- Workers are not familiar with how a particular forklift operates.
- Workers operate the forklift carelessly.
- Workers use defective or malfunctioning forklifts.

Forklift Stability

Forklift stability consists of four things:

1. the fulcrum point
2. the center of gravity
3. the stability triangle
4. load center

On a forklift, the fulcrum point is the location at which front axle and the load is balanced by the weight of the forklift's counterweight and battery (if electric).

A forklift's center of gravity is the point at which all the weight of the forklift is concentrated and a new center of gravity is created with every load. Imagine you're riding a tricycle—think of it as a triangle on wheels. If you peddle around a corner and shift your center of gravity forward over the front wheel, you'll tip over. If you shift your center of gravity over the rear wheels, you are less likely to tip over.

Factors that cause a forklift to tip forward are:

- sloping surfaces
- overloading
- inappropriate use of attachments
- traveling down ramps with the load forward
- heavy braking

- moving with an elevated mast
- forward-tilting elevated mast
- shifting or off-center loads

If the combined center of gravity moves outside of the stability triangle, the forklift tends to tip sideways.

Factors that cause a forklift to tip sideways are:

- excessive speed while turning
- turning with an elevated mast
- sloping surfaces
- slick surfaces
- uneven terrain
- tight turns
- shifting or off-center loads
- turning sideways on ramps

Forklift Safety Precautions and Best Practices

o prevent forklift accidents, be sure to follow the guidelines and best practices below:

- Always use seatbelts when operating a forklift.
- Do not allow employees to drive or ride in unsafe vehicles.
- Require employees to report any vehicle-related safety problems.
- Secure equipment and tools to prevent them from moving in a vehicle or make sure a barrier is in place to protect the passengers.

- Ensure that vehicles have working horns that can be heard above any surrounding noise.
- Make sure there is a backup alarm on any vehicle that has an obstructed view to the rear.
- Make sure the backup alarm can be heard above surrounding noise unless there's a spotter or it's certain that no one can enter the danger area.
- Train and certify all operators to ensure that they operate forklifts safely.
- Do not allow any employee under 18 years old to operate a forklift.
- Properly maintain haulage equipment, including tires.
- Do not modify or make attachments that affect the capacity and safe operation of the forklift without written approval from the forklift's manufacturer.
- Conduct corrective and preventive maintenance in a timely manner.
- Follow safe operating procedures for picking up, moving, putting down and stacking loads.
- Do not exceed the 5-mph speed limit, and slowdown in congested or slippery surface areas.
- Prohibit operator speeding, stunt driving and horseplay. Retrain or discipline as appropriate, and document.
- Do not handle loads that are heavier than the capacity of the industrial truck.
- Remove unsafe or defective forklift trucks from service.
- Do not travel with elevated loads.
- Assure that a rollover protective structure is in place.
- Make certain that the reverse signal alarm is operational and audible above the surrounding noise level.

- Forklift truck operators demonstrate competence by successful completion of training and evaluation of driving skills.
- Inspect forklifts before each use for proper condition of brakes, horns, steering, forks and tires.
- Make sure powered industrial trucks (forklifts) meet American National Standards Institute (ANSI) standards.
- Make sure battery charging is conducted in areas specifically designated for that purpose.
- Material handling equipment is provided for handling batteries, including conveyors, overhead hoists or equivalent devices.
- Reinstall and properly position, and secure batteries in the forklift.
- Do not permit smoking in the battery charging areas.
- Prevent open flames, sparks or electric arcs in battery charging areas.
- Provide training as necessary when an operator is assigned to drive a different type of truck.
- When leaving a forklift unattended, fully lower the load and forks, place controls in neutral position, turn the power off and set the brakes.
- Make sure there is sufficient headroom for the forklift and operator under overhead installations, lights, pipes, sprinkler systems, etc.
- Ensure overhead guards are in place to protect the operator against falling objects.

Forklift Training

An untrained operator of a forklift can be as dangerous as an unlicensed operator of a motor vehicle. It is a violation of Federal law for anyone under 18 years of age to operate a forklift or for anyone 18 years of age or older who is not properly trained and certified to do so.

OSHA regulations require that the employer ensures that a forklift operator is competent to operate the forklift he or she is assigned to use. The employer must document operator training and an evaluation of the operator's performance while using the forklift.

Training has three parts:

1. formal instruction such as a lecture, discussion, interactive computer learning, videotape and/or written material (can be taken anywhere);
2. hands-on practical training which includes demonstrations by the trainer and exercises by the trainee (on the model of forklift the worker will use); and
3. an evaluation of the operator skills by observing the operator's performance while doing actual work using the forklift. This evaluation must be repeated at least once every three years (must be at workplace).

Refresher may be required if the operator has been involved in an accident, near miss or unsafe operations. Also, if an operator is assigned to a new type of forklift or if workplace conditions change that could affect safety, then refresher training is required.

The topics listed in the table below should be covered when training a forklift operator. If a specific topic does not apply to the forklift in the employer's workplace, covering it is optional.

Topics related to powered industrial trucks	Topics related to your workplace
Operating instructions	Surface conditions where the PIT will be operated
Warnings and precautions for the types of PIT the operator will be authorized to operate	Composition of loads to be carried and load stability
Differences between the PIT and the automobile	Load manipulation, stacking, and un-stacking
PIT controls and instrumentation: Where they are located, what they do, and how they work	Pedestrian traffic in areas where the PIT will be operated
Engine or motor operation	Narrow aisles and other restricted places where the PIT will be operated
Steering and maneuvering	Use of door opening and closing devices

Visibility (including restrictions due to loading)	Hazardous (classified) locations where the PIT will be operated
Fork and attachment adaptation, operation, and use limitations	Ramps and other sloped surfaces that could affect the PITs stability
PIT capacity	Closed environments and other areas where insufficient ventilation or poor PIT maintenance could cause a buildup of carbon monoxide or diesel exhaust
PIT stability	Other unique or potentially hazardous environmental conditions in the workplace that could affect safe operation
Any PIT inspection and maintenance that the operator will be required to perform	
Refueling	
Charging and recharging of batteries	
Operating limitations	
Any other operating instructions, warnings, or precautions listed in the operator's manual for the types of PIT that the employee is being trained to operate	

Heavy Vehicle Safety

Using and working around heavy equipment and machinery construction sites can lead to serious injury or death. Construction workers and vehicle operators should not be allowed to handle heavy machinery without proper training. Failing to follow proper safety precautions, hurrying, and a lack of attention are major causes of construction equipment accidents.

Follow the precautions and best practices below to make sure operators and others working around heavy equipment do not get injured or killed.

Make sure all vehicles are equipped with:

- a service brake system
- an emergency brake system
- a parking brake system
- working headlights, tail lights, and brake lights
- an audible warning device (horn)
- intact windshield with working windshield wipers

Here are some other things to keep in mind:

- Ensure all operators have been trained on the equipment they will use.
- Check vehicles at the beginning of each shift to ensure that the parts, equipment, and accessories are in safe operating condition. Repair or replace any defective parts or equipment prior to use.
- Do not operate a vehicle in reverse with an obstructed rear view unless it has a reverse signal alarm capable of being heard above ambient noise levels or a signal observer indicates that it is safe to move.
- Keep all workers at a safe distance during heavy equipment operations.

- Vehicles loaded from the top (e.g., dump trucks) must have cab shields or canopies to protect the operator while loading.
- Ensure that vehicles used to transport workers have seats, with operable seat belts, firmly secured and adequate for the number of workers to be carried.
- Equipment should have roll-over protection and protection from falling debris hazards as needed.
- Prior to permitting construction equipment or vehicles onto an access roadway or grade, verify that the roadway or grade is constructed and maintained to safely accommodate the equipment and vehicles involved.
- Do not modify the equipment's capacity or safety features without the manufacturer's written approval.
- Where possible, do not allow debris collection work or other operations involving heavy equipment under overhead lines.

Traffic Control

Traffic controls should conform to the Federal Highway Administration (FHWA) Manual of Uniform Traffic Control Devices (MUTCD). The MUTCD contains the national standards governing all traffic control devices. All public agencies and owners of private roads open to public travel across the nation rely on the MUTCD to bring uniformity to the roadway.

Safety precautions for traffic control workers include all the following:

- Provide adequate and appropriate traffic controls for all construction projects on or adjacent to a highway, street, or roadway.
- Provide signaling by trained and qualified flaggers.
- Provide barricades for protection of employees.
- Ensure employees set up appropriate traffic controls when they stop on or are adjacent to a highway, street, or road in a way that creates a hazard and when traffic cannot adjust safely on its own.

Traffic Control Devices

To be effective, a traffic control device should meet five basic requirements:

1. fulfill a need
2. command attention
3. convey a clear, simple meaning
4. command respect from road users
5. give adequate time for proper response

High-Visibility Garments

Employees exposed to hazards caused by on-highway type moving vehicles in construction zones and highway traffic should wear highly visible upper body garments.

- The colors should contrast with other colors in the area to make the worker stand out.
- Colors should be equivalent to strong red, strong orange, strong yellow, strong yellow-green, or fluorescent versions of these colors.
- During hours of darkness, the garments must also have reflective material visible from all sides for 1,000 feet.

Real World Accident

A foreman's 15 year-old step-son was tragically killed while the youth was operating a forklift at the warehouse. The victim was being shown how to operate the forklift and was practicing picking up and moving empty pallets. He had just unloaded a pallet in the warehouse and had picked the empty pallet off the floor when he lost control of the forklift. The police investigator stated that the forklift suddenly went backward, crashed open a closed loading bay door and dropped four feet to the ground. The victim fell off and the forklift landed on top of him. The victim was pinned to the ground and sustained massive chest injuries.

Module #7 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **Which of the following accounts for the most significant number of forklift fatalities?**

    a. Turn-over accidents
    b. Struck-by accidents
    c. Jump-to-below accidents
    d. Contact-with accidents

2. **On a forklift, which of the following is the point at which all the weight of the forklift is concentrated?**

    a. The fulcrum point
    b. Stability triangle
    c. Center of gravity
    d. Load center

3. **You're the worksite supervisor and notice an experienced and trained forklift driver speeding through the worksite, clearly driving too fast. What should you do?**

    a. Tell the driver to slow down and schedule for retraining
    b. Tell the driver to slow down to 5 mph and evaluate the incident for possible discipline
    c. Report the behavior to the safety committee
    d. Don't do anything: just keep on doing your job

4. **It is a violation of Federal law for anyone _____ to operate a forklift who is not properly trained and certified.**

    a. less than 18 years old
    b. not assigned
    c. at any age
    d. 18 years of age or older

5. **During hours of darkness, the garments for work in construction zones and highway traffic should have reflective material visible _____.**

   a. from all sides for 1,000 feet
   b. from front and back for 1,000 feet
   c. from all sides for 500 feet
   d. from front and back for 500 feet

Module 8: Chemical Hazards

Introduction

Construction workers are exposed daily to various health hazards on the construction site. Covering all the health hazards in construction is outside the scope of our training in this course, but we will cover some of the hazards to which workers will be exposed.

Hazard Communication Program

One program that helps to prevent illness due to exposure to health hazards is the Hazard Communication Program. The purpose of OSHA's hazard communication standard (HCS) is to ensure that all hazardous chemicals are evaluated and the information is transmitted to employees via a hazard communication program.

The HCS applies to all hazardous chemicals to which employees may be exposed under normal conditions of use, or in a foreseeable emergency. A "hazardous chemical" is any chemical that presents a physical or health hazard.

Contractors' employees must also be informed about the hazardous chemicals they may be exposed to. The employer's written hazard communication program must include all the following:

1. the methods the employer will use to provide contractors' employees on-site access to safety data sheets (SDS)

2. the methods to inform them of any precautionary measures

3. the methods to inform other employees of the labeling system used in the workplace

The employer must ensure that each container of hazardous chemicals in the workplace is labeled, tagged, or marked to identify the hazardous chemicals and appropriate hazard warnings.

The employer must maintain copies of the required SDS for each hazardous chemical, and must ensure that they are readily accessible during each work shift by employees when they are in their work areas.

If employees must travel between workplaces during a work shift, the SDS may be kept at the primary workplace facility; however, the employer must ensure that employees can immediately obtain the required information in an emergency.

Hazards

Failure to recognize the hazards associated with chemicals can cause chemical burns, respiratory problems, fires and explosions on construction sites.

Health hazards: Hazardous chemicals can produce acute and/or chronic (short-term and/or long-term) illness and other health issues. Some examples of hazardous substances that can cause illness include:

- carcinogens
- toxic agents
- irritants
- corrosives
- sensitizers

Physical hazards: Hazardous chemical physical hazards produce injuries. Some examples include:

- combustible liquids
- compressed gases
- explosives
- flammables
- organic peroxides
- oxidizers
- unstable (reactive) agents

General Precautions and Safe Work Practices

Recommended precautions and safe work practices to protect employees from exposure to hazardous chemicals include the following:

- Maintain a Safety Data Sheet (SDS) for each chemical used in the facility.
- Make this information accessible to employees at all times in a language and format that are clearly understood by all affected personnel.
- Train employees on all requirements of the hazard communication program, including how to read and use the SDS.
- Follow manufacturer's SDS instructions for handling hazardous chemicals.
- Train employees about the risks of each hazardous chemical being used.
- Provide spill clean-up kits in areas where chemicals are stored.
- Have a written spill control plan.
- Train employees to clean up spills, protect themselves and properly dispose of used materials.
- Provide proper personal protective equipment and enforce its use.
- Store chemicals safely and securely.
- Develop and maintain a written hazard communication program addressing Safety Data Sheets (SDS), labeling and employee training.
- Label each container of a hazardous substance (vats, bottles, storage tanks) with standardized Globally Harmonized System (GHS) labeling.

Exposure to Lead

Employers need to determine whether their workers will be exposed to lead on the construction worksite. This initial determination is done by sampling the air they breathe with

special equipment. This is called air monitoring (also, exposure monitoring). It's important to know the following to help protect workers:

- **Action level:** The exposure level at which you must act to protect your employees. Thirty micrograms per cubic meter of air (30 µg/m3) averaged over an eight-hour period is the action level for lead exposure.

- **Permissible exposure limit:** The permissible exposure limit (PEL or OSHA PEL) is the legal limit for exposure to a chemical substance or physical agent. The employer must make sure that no employee is exposed to lead at concentrations greater than fifty micrograms per cubic meter of air (50 ug/m3) averaged over an 8-hour period.

- **Trigger tasks for Lead:** Tasks that expose workers to extreme amounts of lead and trigger a set of interim measures employers must take to protect those workers. If employees do any of these tasks, assume they're exposed to lead at levels above the PEL until you've done an initial determination.

The following tasks can expose workers to extreme amounts of lead:

- cutting with a torch
- heat gun work
- manual sanding
- manual scraping of dry materials
- sanding with a dust collection system
- spray painting
- manual demolition of structures such as dry wall, windows, and siding
- sanding without dust collection systems
- abrasive blasting
- lead burning

- torch burning
- welding

Protective Measures for Lead

If your employees do trigger tasks, you must provide them with all the following until you can show they are exposed below the action level:

- Make sure workers wear appropriate respirators.
- Provide adequate protective clothing.
- Clean areas for changing and storing clothing.
- Ensure workers have access to hand washing facilities.
- If necessary, provide blood sampling for lead.
- Conduct training that covers lead health hazards and protective measures.

Exposure to Methylene Chloride (MC)

About 9,505 construction companies use products that contain the hazardous chemical, methylene chloride. Exposure often happens when workers are stripping paint or other coatings, applying foam, painting with epoxy paint, cleaning equipment with solvents, and spraying adhesives.

Workers are more likely to be exposed to high levels of MC when working in small, enclosed spaces that are not well ventilated.

Exposure may occur through inhalation, by absorption through the skin, or through contact with the skin. OSHA considers methylene chloride to be a potential occupational carcinogen.

The following describes some engineering controls and work practices you may find helpful in reducing worker exposures to MC at your site.

- Keep MC Vapors contained. Store and transport MC products only in approved safety containers.

- Instruct and train employees to be aware of hazards, personal hygiene, and how to use personal protective equipment.
- Instruct employees handling or using flammable liquids, gases, or toxic materials in the safe handling and use of these materials.
- Avoid breathing the air directly above areas covered with MC.
- Avoid direct skin contact with MC. Wear two pairs of gloves when using stripping solution. The inner glove should be made of polyethylene (PE)/ethylene vinyl alcohol (EVOH), PE, or laminate to prevent MC penetration. The outer glove should be made of nitrile or neoprene to protect against puncture or rips. Wear a face shield or goggles to protect your face and eyes.
- Use the washing facilities in your work area to wash off any MC from your hands and face. Use lots of soap or mild detergent and water to clean grease, oil, dirt, or anything else off your skin. Do not use MC or other organic solvents to clean your skin.
- Minimize the chance of spills and leaks. Develop and follow procedures for containing MC spills or leaks.
- Take extra precautions in low and confined spaces. MC vapors are heavier than air, so they tend to move to low, unventilated spaces.

Check out more detailed information on Methylene Chloride from the EPA.

Exposure to Chromium

Chromium is a steel gray, lustrous, hard metal extracted from chromite ores. Chromium VI (hexavalent chromium) is of principal concern because of its extreme toxicity and designation as a human carcinogen.

In 2011, it is estimated 558,000 workers are potentially exposed to Cr(VI) in the United States. US production of chromium was estimated at 160,000 metric tons, coming almost entirely from recycling stainless steel scraps.

Some major industrial sources of hexavalent chromium are:

- chromate pigments in dyes, paints, inks, and plastics

- chromates added as anti-corrosive agents to paints, primers and other surface coatings
- chrome plating by depositing chromium metal onto an item's surface using a solution of chromic acid
- particles released during smelting of ferrochromium ore
- fume from welding stainless steel or non-ferrous chromium alloys
- impurity present in Portland cement

Workers performing the following tasks are potentially exposed to Cr(VI). Workplace exposures occur mainly in the following task areas:

- welding and other types of hot work on stainless steel and other metals that contain chromium
- use of pigments, spray paints and coatings
- operating chrome plating baths

Workplace exposure to hexavalent chromium may cause the following health effects:

- lung cancer in workers who breathe airborne hexavalent chromium
- irritation or damage to the nose, throat, and lung (respiratory tract) if hexavalent chromium is breathed at high levels
- irritation or damage to the eyes and skin if hexavalent chromium contacts these organs in high concentrations

Safety Precautions

To protect employees from the hazards associated with Hexavalent Chromium, employers should do the following:

- Limit the eight-hour time-weighted average exposure to chromium VI (hexavalent chromium) to five micrograms per cubic meter of air (5 ug/m3).

- Perform periodic monitoring at least every 6 months if initial monitoring shows employee exposure at or above the action level (2.5 micrograms per cubic meter of air calculated as an 8-hour time-weighted average).

- Provide appropriate personal protective clothing and equipment when there is likely to be a hazard present from skin or eye contact.

- Implement good personal hygiene and housekeeping practices to prevent hexavalent chromium exposure.

- Prohibit employee rotation as a method to achieve compliance with the exposure limit (PEL).

- Provide respiratory protection as specified in the standard.

- Make available medical examinations to employees within 30 days of initial assignment, annually, to those exposed in an emergency situation, to those who experience signs or symptoms of adverse health effects associated with hexavalent chromium exposure, to those who are or may be exposed at or above the action level for 30 or more days a year, and at termination of employment.

For more information, take OSHAcademy Course 705, Hazard Communication Program, and check out this short video: Introduction to the Globally Harmonized System of Hazard Communication produced by the Haskell Corporation.

Module 8 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **A hazardous chemical is any chemical that _____.**

    a. has been listed on the GHS hazardous chemical list
    b. can cause harm through absorption, inhalation, or ingestion
    c. is caustic and used on a construction worksite
    d. presents a physical or health hazard

2. **What is the term used to describe the legal limit for exposure to a chemical substance or physical agent?**

    a. Lower Exposure Limit (LEL)
    b. Permissible Exposure Limit (PEL)
    c. Higher Exposure Limit (HEL)
    d. Optimal Exposure Limit (OEL)

3. **The Action Level for exposure to lead is _____ averaged over an 8-hour period.**

    a. ten micrograms per cubic meter of air (10 ug/m3)
    b. twenty micrograms per cubic meter of air (20 ug/m3)
    c. thirty micrograms per cubic meter of air (30 ug/m3)
    d. fifty micrograms per cubic meter of air (50 ug/m3)

4. **What is a helpful method to reduce exposure to methylene chloride (MC)?**

    a. Wear two pairs of gloves when using stripping solution
    b. Use air purifying respirators when in a confined space
    c. Always use the buddy system when working with MC
    d. Use organic solvents to remove MC from the skin

5. **Which of the following tasks may expose workers to Chromium VI (hexavalent chromium) in the workplace?**

   a. repairing and replacing vehicle brake systems
   b. use of latex paint and coatings
   c. welding and other types of hot work on stainless steel
   d. operating aluminum plating baths

Module 9: Health Hazards (Continued)

This module will continue the discussion about the various health hazards to which construction workers are exposed. These topics will help you better understand and be able to react to occupational health hazards in construction. The topics we will discuss in this module include:

- excessive noise
- ionizing and non-ionizing radiation
- exposure to asbestos

Excessive Noise

Every year, approximately 30 million people in the United States are occupationally exposed to hazardous noise. Employers must have a hearing conservation program whenever employee noise exposures equal or exceed an eight-hour time-weighted average sound level (TWA) of 85 A-weighted decibels (dBA). A decibel is an expression of the relative loudness of sound in air as perceived by the human ear.

When employees are exposed to sound levels exceeding those listed in the table to the right, administrative or engineering controls must be used. For instance, if employees are exposed to an average of 90 dBA over an 8-hour workday, then hearing protection controls must be used.

To reduce exposure to excessive noise in the construction industry, take the following precautions:

- Reduce the time workers spend in noisy areas.
- Rotate two or more workers so that each is exposed to noise less than 85 dBA, averaged over an eight-hour day.
- Shut down noisy equipment when it's not needed.
- Maintain equipment so it runs smoothly and quietly.
- Ensure workers know how to perform their tasks and operate equipment at safe noise levels.

- Use earplugs and earmuffs. To be effective, they must totally block the ear canal with an airtight seal. An improperly fitted, dirty, or worn-out plug will not seal and can irritate the ear canal.

Radiation: Ionizing and Non-Ionizing

Radiation sources are found in a wide range of occupational settings. If radiation is not properly controlled it can be potentially hazardous to the health of workers.

- All forms of ionizing radiation have sufficient energy to ionize atoms that may destabilize molecules within cells and lead to tissue damage.

- Non-ionizing radiation is essential to life, but excessive exposures will cause tissue damage.

Ionizing Radiation

Ionizing radiation is energy in the form of waves or particles that has enough force to remove electrons from atoms and emit particles and high-energy waves (radioactive decay).

Ionizing radiation sources may be found during demolition and construction activities such as tunneling, highway and road construction. These radiation sources can pose a considerable health risk to affected workers if not properly controlled.

Workers in construction are primarily exposed to natural radiation from the sun, cosmic rays, and naturally-occurring radioactive elements, primarily uranium, thorium, and potassium, and their radioactive decay products, found in the earth's crust. These elements emit alpha particles, beta particles, and gamma rays which are discussed below:

Alpha Particles: Alpha particles, positively charge particles emitted in the radioactive decay of the heaviest radioactive elements.

The primary source of exposure for construction workers is radon, which naturally occurs in rock and soil. Radon can accumulate in crawlspaces, mines, tunnels, basements, and other poorly ventilated areas.

Beta Particles: Beta particles are fast moving electrons emitted from the nucleus during radioactive decay. They travel considerable distances in air but can be reduced or stopped by a layer of clothing, but some beta particles are capable of penetrating the skin and causing radiation damage, such as skin burns.

Gamma Rays and X-Rays: Gamma rays are photons that can pass through several feet of concrete or a few inches of lead. Gamma rays can pass through the entire body. X-rays are high-energy photons produced by the interaction of charged particles with matter, and a few millimeters of lead can stop x-rays. Because of their many uses, x-rays are the single largest source of man-made radiation exposure.

Non-ionizing Radiation

Non-ionizing radiation is composed of oscillating electric and magnetic found in a wide range of occupational settings. These fields can pose a considerable health risk to exposed workers if not properly controlled. Non-ionizing radiation includes each of the following:

- **Extremely Low Frequency Radiation (ELF):** Extremely Low Frequency (ELF) radiation at 60 HZ is produced by power lines, electrical wiring, and electrical equipment.

- **Radiofrequency (RF) and Microwave Radiation (MW):** Microwave radiation is absorbed near the skin, while RF radiation may be absorbed throughout the body. At high enough intensities, both will damage tissue through heating.

- **Infrared Radiation (IR):** The skin and eyes absorb infrared radiation (IR) as heat. Workers normally notice excessive exposure through heat sensation and pain. Sources of IR radiation include furnaces, heat lamps, and IR lasers.

- **Visible Light Radiation:** The different visible frequencies of the electromagnetic (EM) spectrum are "seen" by our eyes as different colors. Good lighting is conducive to increased production and may help prevent incidents related to poor lighting conditions. Excessive visible radiation can damage the eyes and skin.

- **Ultraviolet Radiation (UV):** Ultraviolet radiation (UV) has a high photon energy range and is particularly hazardous because there are usually no immediate symptoms of excessive exposure. Sources of UV radiation include the sun, black lights, welding arcs, and UV lasers.

- **Laser Hazards:** Lasers typically emit optical (UV, visible light, IR) radiations and are primarily an eye and skin hazard. Common lasers include CO2 IR laser, helium-neon, neodymium YAG, and ruby visible lasers, and the Nitrogen UV laser.

General safety precautions while using lasers include:

- Wear appropriate protective eyewear.
- Use minimum power/energy required for the project.
- Reduce laser output with shutters/attenuators.
- Terminate laser beam with beam trap.
- Use diffuse reflective screens, remote viewing systems, etc., during alignments.
- Remove unnecessary objects from the vicinity of the laser.
- Keep the beam path away from eye level (sitting or standing).
- Don't put your body parts (especially the eyes) in the beam.

Protection Strategies

The following three strategies are effective in reducing excessive exposure to ionizing and non-ionizing radiation:

1. Time: The amount of radiation exposure increases and decreases with the time workers spend near the source of radiation.
2. Distance: The further workers are from a radiation source, the less their exposure.
3. Shielding: The greater the shielding around the radiation source, the smaller the exposure.

Exposure to Asbestos

Asbestos is the generic term for a group of naturally occurring fibrous minerals with high tensile strength, flexibility, and resistance to thermal, chemical, and electrical conditions.

Asbestos is well recognized as a health hazard and its use is now highly regulated by both OSHA and EPA. Asbestos fibers associated with these health risks are too small to be seen with the naked eye. Health risks commonly associated with exposure to asbestos include:

- Asbestosis – a condition in which the lungs become scarred with fibrous tissue, making breathing more and more difficult, often requiring the victim to use oxygen.

- Cancer – cancer of the lungs is the most common cancer associated with exposure. Other areas may become cancerous including the throat, gastrointestinal tract, and kidneys.

- Mesothelioma - a rare, often fatal cancer, usually occurring in the chest cavity.

Some examples of products that contain asbestos include:

- floor covering and adhesives

- exterior siding

- boilers

- ceiling tiles

- pipe insulation

- floor tiles

- roof flashing

- plaster walls

- roof shingles

- wallboard joint compound

Workers in construction may be exposed to asbestos during the following activities:

- demolishing or salvaging structures where asbestos is present

- removing or encapsulating asbestos-containing materials

- constructing, altering, repairing, maintaining, or renovating asbestos-containing structures or substrates

- installing asbestos-containing products

- cleaning up asbestos spills/emergencies
- transporting, disposing of, storing, containing, and housekeeping involving asbestos or asbestos-containing products on a construction site

Work Classification

OSHA has established a classification system for asbestos construction work that spells out mandatory, simple, technological work practices that employers must follow to reduce worker exposures. Under this system, the following four classes of construction work are matched with increasingly stringent control requirements:

Class I asbestos work is the most potentially hazardous class of asbestos jobs. This work involves the removal of asbestos-containing thermal system insulation and sprayed-on or troweled-on surfacing materials.

Class II work includes the removal of other types of ACM that are not thermal system insulation, such as resilient flooring and roofing materials. Examples of Class II work include removal of asbestos-containing floor or ceiling tiles, siding, roofing, or transite panels.

Class III asbestos work includes repair and maintenance operations where ACM or presumed ACM (PACM) are disturbed.

Class IV work includes custodial activities where employees clean up asbestos-containing waste and debris produced by construction, maintenance, or repair activities. This work involves cleaning dust-contaminated surfaces, vacuuming contaminated carpets, mopping floors, and cleaning up ACM or PACM from thermal system insulation or surfacing material.

Regulated Areas

All Class I, II, and III asbestos work must be done within regulated areas. The following are required for all regulated areas:

- Only authorized personnel may enter.
- The designated competent person supervises all asbestos work performed in the area. Employers must mark the regulated area in any manner that minimizes the number of persons within the area and protects persons outside the area from exposure to airborne asbestos.

- Critical barriers or negative-pressure enclosures may mark the regulated area.
- Posted warning signs marking the area must be easily readable and understandable. The signs must bear the following information:
    - Employers must supply a respirator to each person entering regulated areas.
    - Employees must not eat, drink, smoke, chew tobacco or gum, or apply cosmetics in regulated areas.
- The employer performing work in a regulated area must inform other employers on site of the following:
    - the nature of the work
    - regulated area requirements
    - measures taken to protect on-site employees

Control Measures

For all covered work, use the following control methods to comply with the PEL, STEL, and DEQ/LRAPA rules:

- Ensure local exhaust ventilation is equipped with HEPA-filter dust collection systems.
- Enclose or isolate processes producing asbestos dust.
- Ventilate regulated areas to move contaminated air away from the employees' breathing zone and toward a filtration or collection device equipped with a HEPA filter.
- Use engineering and work practice controls to reduce exposure to the lowest possible levels, supplemented by respirators to reach the PEL or STEL or lower.
- File a notification with DEQ/LRAPA.
- Use waste shipment form for waste transport.

For all work operations, use the following engineering controls and work practices for all operations, regardless of exposure levels:

- Use vacuum cleaners equipped with HEPA filters to collect all asbestos-containing or presumed asbestos-containing debris and dust.
- Use wet methods or wetting agents to control employee exposures, except when wetting methods would cause electrical hazards, equipment malfunction, slipping hazards, or other hazards.
- Deactivate electrical circuits, if not provided with ground-fault circuit interrupters (GFCI).
- Promptly clean up and dispose of asbestos-contaminated waste and debris in leak-tight containers.

Prohibited work practices and engineering controls. Comply with these work practices and engineering control prohibitions for all asbestos-related work or work that disturbs asbestos or presumed asbestos-containing materials, regardless of measured exposure levels or the results of initial exposure assessments:

- Do not use high-speed abrasive disc saws unless they are equipped with a point-of-cut ventilator or enclosed with HEPA-filtered exhaust air.
- Do not use compressed air to remove asbestos or asbestos-containing materials unless the compressed air is used with an enclosed ventilation system.
- Do not dry sweep, shovel, or conduct any other dry cleanup of dust and debris.
- Do not rotate employees to reduce exposure.
- Do not allow the accumulation of friable asbestos materials or asbestos containing waste.
- Do not dispose materials at an unauthorized site.

Confined Spaces

OSHA will soon publish the new Confined Spaces in Construction Standard, CFR 29 1926 Subpart AA, 1926.1200. This section is a brief overview to familiarize you with some of the requirements of this new standard.

A confined space that is subject to a hazard on a construction site must be classified. The classification determines what accident-prevention and -protection requirements apply to that space.

There are four classifications of confined spaces on a construction site:

- Isolated-Hazard Confined Space (IHCS)
- Controlled-Atmosphere Confined Space (CACS)
- Permit-Required Confined Space (PRCS)
- Continuous System-Permit-Required Confined Space (CS-PRCS)

The employer has the option of selecting any of these classifications, as long as the employer meets the applicable requirements for the classification selected. The one exception is that a space with the characteristics of a CS-PRCS cannot be given a different classification.

Contractors must follow step-by-step entry of a Construction Site Permit-Required Confined Space (CS-PRCS) because, with the hazards as yet undetermined, taking these precautions will ensure the safety of the employees.

Confined Space Hazards

Below are typical confined space hazards to which construction workers may be exposed:

- biological hazards
- boilers
- pits (condenser, elevator)
- containment cavities
- electrical shock

- electrical transformers
- enclosed beams
- explosive or toxic atmospheres
- heat sinks
- materials falling into the space
- manholes (sewer, electrical, etc.)
- pipe assemblies
- purging agents
- oxygen deficiency
- septic tanks
- shafts
- sumps
- tanks (fuel, chemical, water)
- ventilation ducts
- wind turbines, towers, blades

Precautions and Best Practices

Prior to entering a potentially dangerous confined space, the following procedures should be followed:

- The controlling contractor should determine if there are any atmospheric hazards in the confined space using standard atmospheric testing and monitoring equipment. All testing of the internal atmosphere of the confined space must be done without use of mechanical ventilation or changes to the space's natural ventilation. This is to ensure that the natural atmospheric conditions within the space are assessed for hazards that may affect those employees working in the space.

- The controlling contractor should coordinate entry with all contractors who have workers entering a confined space.

- In Confined Spaces with Hazards Isolated (CSHI), the controlling contractor should isolate or eliminate all physical and atmospheric hazards in the confined space.
- In Controlled-Atmosphere Permit-Required Confined Spaces (CA-PRCS), continuously monitor the atmosphere within the confined space unless periodic monitoring is proven sufficient.
- In Permit-Required Confined Spaces (PRCS), every confined space supervisor must monitor PRCS conditions during entry.
- Maintain a written plan unless a copy of the OSHA standard is located on the worksite.
- Ensure early-warning requirements for up-stream sewer-type spaces are maintained.

OSHAcademy's partner, HSE Press, recently published an article with more specific information on the new Confined Space in Construction Standard.

Module #9 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **If employees are exposed to an average of _____, then hearing protection controls must be used.**

   a. 80 dBA over an 8-hour workday
   b. 85 dBA over an 8-hour workday
   c. 90 dBA over an 8-hour workday
   d. 95 dBA over an 8-hour workday

2. **Employers must have a hearing conservation program if their workers are exposed to an average of _____.**

   a. 80 dBA over an 8-hour workday
   b. 85 dBA over an 8-hour workday
   c. 90 dBA over an 8-hour workday
   d. 95 dBA over an 8-hour workday

3. **Workers in construction may be exposed to asbestos during which of the following activities?**

   a. Demolition or salvaging operations
   b. Roofing and paving
   c. Steel erection activities
   d. Underwater bridge construction

4. **Which of the following is NOT one of the four classifications of confined spaces on a construction site?**

   a. Isolated-Hazard Confined Space (IHCS)
   b. Controlled-Atmosphere Confined Space (CACS)
   c. Continuous System-Permit-Required Confined Space (CS-PRCS)
   d. Non-Permit-Required Confined Space (NPRCS)

5. **In Controlled-Atmosphere Permit-Required Confined Spaces (CA-PRCS) on a construction site, _____.**

   a. periodically monitor the atmosphere
   b. continuously monitor the atmosphere
   c. test initially using mechanical ventilation
   d. monitor every 14 minutes using standard equipment

Module 10: Personal Protective Equipment (PPE)

Introduction

One of the most important safe work practices for construction workers is to always use appropriate personal protective equipment (PPE) for the job being performed. Inappropriate PPE is not PPE at all, and can actually increase the likelihood of an accident or illness.

The employer is ultimately responsible for requiring employees to wear appropriate PPE in all construction activities where there is an exposure to hazards or where required by OSHA regulations.

PPE Training

PPE training should include all the following topics:

- head protection
- hearing protection
- eye and face protection
- foot protection
- respiratory protection
- working over or near water

Head Protection

Serious head injuries can result from blows to the head where there is a potential for objects falling from above, bumps to the head from fixed objects, or accidental head contact with electrical hazards.

Protective helmets must do three things:

1. resist penetration
2. absorb the shock of a blow

3. protect against electrical shock

Precautions

Employees working in areas where there is a danger of head injury from impact, falling or flying objects, or electrical shock and burns should take the following precautions to help protect the head:

- Hard hats must meet the specifications contained in American National Standards Institute, Z89.1-2014, Head Protection.
- Hard hats should be routinely inspected for dents, cracks or deterioration.
- Hard hats should be replaced after a heavy blow or electrical shock.
- Hard hats should always be maintained in good condition.
- Adjust the suspension so there's 1¼ inches between the top of your head and the shell. (If the manufacturer's directions are different, follow those.)
- Never carry anything (like tools or cigarettes) inside your hardhat while you're wearing it.

Eye and Face Protection

Thousands of people are blinded each year from work-related eye injuries that could have been prevented with the proper selection and use of eye and face protection. Eye injuries alone cost more than $300 million per year in lost production time, medical expenses, and worker compensation.

You may need eye and face protection when there's danger from:

- flying particles (from saws, drills, etc.)
- splashes
- dust
- protruding or projecting parts

- chemical vapors or fumes
- bright light or ultraviolet rays (from welding, lasers, etc.)

Electromagnetic (EM) Radiation

The most familiar form of electromagnetic (EM) radiation is sunshine, which provides light and heat. Sunshine consists primarily of radiation in infrared (IR), visible, and ultraviolet (UV) frequencies. Lasers also emit EM radiation in these “optical frequencies.”

Lasers

Laser stands for “Light Amplification by Stimulated Emission of Radiation.” The laser produces an intense, directional beam of light. The most common cause of laser-induced tissue damage is thermal in nature, where the tissue proteins are denatured due to the temperature rise following absorption of laser energy.

Because some lasers can damage eyes and skin:

- Only qualified, trained employees can install, adjust, and operate laser equipment.
- Laser equipment operators must be able to show proof that they are qualified when they are operating laser equipment.
- Employees who work in areas where potential exposure to laser light greater than five milliwatts exists must be provided with anti-laser eye protection.
- Areas in which lasers are used must have laser warning signs.
- The laser beam must not be directed at employees.
- Laser equipment must have a label that indicates maximum output.

General Precautions

- Wear safety glasses or face shields anytime work operations can cause foreign objects to get into the eye such as during welding, cutting, grinding, nailing (or when working with concrete and/or harmful chemicals or when exposed to flying particles).

- Select eye and face protectors based on anticipated hazards.
- Wear safety glasses or face shields when exposed to any electrical hazards including work on energized electrical systems.

Respiratory Protection

An estimated 5 million workers are required to wear respirators in 1.3 million workplaces throughout the United States. Compliance with the OSHA Respiratory Protection Standard could avert hundreds of deaths and thousands of illnesses annually.

Respirators protect workers against insufficient oxygen environments, harmful dusts, fogs, smokes, mists, gases, vapors, and sprays. These hazards may cause cancer, lung impairment, diseases, or death.

In order to protect your health, effective engineering and work practice controls such as ventilation, wet methods, and confinement of the task must be established. However, if these measures are not feasible, or not protective enough, appropriate respirators must be used.

When respirators are required, a written program must be implemented covering many important elements such as respirator selection procedures, fit testing for tight-fitting respirators, maintenance protocol, medical evaluations, and training. The employer must also designate a program administrator to oversee the respiratory protection program and conduct required testing and training.

Respirator Types

The appropriate respirator will depend on the contaminant(s) to which you are exposed and the protection factor (PF) required. Required respirators must be NIOSH-approved and medical evaluation and training must be provided before use.

Particulate respirators are the simplest, most common (in construction), and least expensive, but least protective of the respirator types available. These respirators only protect against particles (e.g., dust). They do not protect against chemicals, gases, or vapors, and are intended only for low hazard levels.

The commonly known "N-95" filtering face piece respirator or "dust mask" is another, more protective, type of particulate respirator, often used in hospitals to protect against infectious agents. Below are listed the two types of dust masks and four types of filtering and air-purifying respirators.

- **Single-strap dust masks:** These are usually not NIOSH-approved. They must not be used to protect from hazardous atmospheres. However, they may be useful in providing comfort from pollen or other allergens.

- **Approved filtering face pieces:** Approved filtering face pieces (dust masks) can be used for dust, mists, welding fumes, etc. They do not provide protection from gases or vapors. DO NOT USE FOR ASBESTOS OR LEAD. Instead, select from the respirators below.

- **Half-face respirators:** Half-face respirators can be used for protection against most vapors, acid gases, dust or welding fumes. Cartridges/filters must match contaminant(s) and be changed periodically.

- **Full-face respirators:** Full-face respirators are more protective than half-face respirators. They can also be used for protection against most vapors, acid gases, dust or welding fumes. The face-shield protects face and eyes from irritants and contaminants. Cartridges/filters must match contaminant(s) and be changed periodically.

- **Loose-fitting powered-air-purifying respirators:** Loose-fitting powered-air-purifying respirators (PAPR) offer breathing comfort from a battery-powered fan which pulls air through filters and circulates air throughout helmet/hood. They can be worn by most workers who have beards. Cartridges/filters must match contaminant(s) and be changed periodically.

- **Self-Contained Breathing Apparatus.** A Self-Contained Breathing Apparatus (SCBA) is used for entry and escape from atmospheres that are considered immediately dangerous to life and health (IDLH) or oxygen deficient. They use their own air tank.

Hazards to the Hands

Wearing gloves reduces hand injury risk by at least 50 percent. But it's important that the employer chooses the right glove for the job. It's not enough just to protect the hands from cuts, puncture and abrasions, gloves should be comfortable, enhance dexterity and meet job-specific needs.

Employers must select and require employees to use appropriate hand protection on construction sites when workers' hands are exposed to hazards such as:

- skin absorption of harmful substances
- severe cuts or lacerations
- severe abrasions
- punctures
- chemical burns
- thermal burns
- harmful temperature extremes

Generally, gloves fall into four categories:

1. leather, canvas or metal mesh gloves
2. fabric and coated fabric gloves
3. chemical- and liquid-resistant gloves
4. insulating rubber gloves

Leather, Canvas or Metal Mesh Gloves

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

- Leather gloves protect against sparks, moderate heat, blows, chips and rough objects.
- Aluminized gloves provide reflective and insulating protection against heat and require an insert made of synthetic materials to protect against heat and cold.
- Aramid fiber gloves protect against heat and cold, are cut- and abrasive-resistant and wear well.

- Synthetic gloves of various materials offer protection against heat and cold, are cut- and abrasive-resistant and may withstand some diluted acids. These materials do not stand up against alkalis and solvents.

Fabric and Coated Fabric Gloves

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

- Fabric gloves protect against dirt, slivers, chafing and abrasions. They do not provide sufficient protection for use with rough, sharp or heavy materials. Adding a plastic coating will strengthen some fabric gloves.

- Coated fabric gloves are normally made from cotton flannel with napping on one side. By coating the un-napped side with plastic, fabric gloves are transformed into general-purpose hand protection offering slip-resistant qualities. These gloves are used for tasks ranging from handling bricks and wire to chemical laboratory containers.

Chemical- and Liquid-Resistant Gloves

Chemical-resistant gloves are made with:

- different kinds of rubber: natural, butyl, neoprene, nitrile and fluorocarbon (viton); or

- various kinds of plastic: polyvinyl chloride (PVC), polyvinyl alcohol and polyethylene.

These materials can be blended or laminated for better performance. As a general rule, the thicker the glove material, the greater the chemical resistance. However, thick gloves may impair grip and dexterity, having a negative impact on safety.

Insulating Rubber Gloves

Insulating rubber gloves protect against certain chemicals and physical hazards. When chemical or physical hazards are present, check with the clothing manufacturer to ensure that the material selected will provide protection against the specific hazard.

Electrical Insulating Gloves and Sleeves

Insulating gloves and sleeves are critical PPE for electrical work on or near exposed energized parts.

- Insulating (rubber) gloves along with leather protectors must be worn by qualified employees within the Minimum Approach Distance to exposed energized conductors.
- Insulating (rubber) sleeves must also be worn if the upper arms or shoulders are within the Minimum Approach Distance to other exposed energized parts.

For more information on minimum approach distances, see the OSHA eTools: Electric Power website.

Protector Gloves and Storage: To ensure worker safety and the integrity of the gloves and sleeves, insulating gloves need to be worn along with protector gloves (such as leather), and both insulating gloves and sleeves need to be stored properly when not in use. Proper storage means that gloves must not be folded and need to be kept out of excessive heat, sunlight, humidity, ozone, and any chemical or substance that could damage the rubber.

Testing and Inspection: Gloves and sleeves must be electrically tested before being issued for use. They must also be visually inspected and gloves need to be air tested for any possible defects (for example, cuts, holes, tears, embedded objects, changes in texture) before each day's use and whenever there is a reason to believe they may have been damaged. It's best to inspect PPE and air test the gloves and sleeves before each use.

General Precautions

Use the following general precautions and best practices when using gloves on the construction site:

- Gloves should fit snugly.
- Workers should wear the right gloves for the job (for example, heavy-duty rubber gloves for concrete work, welding gloves for welding, insulated gloves and sleeves when exposed to electrical hazards).
- Inspect gloves before each use to ensure they are not torn, punctured or made ineffective in any way. A visual inspection will help detect cuts or tears.
- If appropriate, fill the gloves with water and tightly roll the cuff towards the fingers to help reveal any pinhole leaks. Gloves that are discolored or stiff may also indicate deficiencies caused by excessive use or degradation from chemical exposure.

- Discard and replace gloves with impaired protective ability.
- Evaluate the reuse of chemical-resistant gloves carefully, taking into consideration the absorptive qualities of the gloves. A decision to reuse chemically-exposed gloves should take into consideration the toxicity of the chemicals involved and factors such as duration of exposure, storage and temperature.

Hazards to the Legs and Feet

Construction workers who face possible foot or leg injuries from falling or rolling objects or from crushing or penetrating materials should wear protective footwear. Also, employees whose work involves exposure to hot substances or corrosive or poisonous materials must have protective gear to cover exposed body parts, including legs and feet.

If an employee's feet may be exposed to electrical hazards, non-conductive footwear should be worn. On the other hand, workplace exposure to static electricity may necessitate the use of conductive footwear.

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

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

Leg and foot protection choices include the following:

- Leggings protect the lower legs and feet from heat hazards, such as molten metal or welding sparks. Safety snaps allow leggings to be removed quickly.
- Metatarsal guards protect the instep area from impact and compression. Made of aluminum, steel, fiber or plastic, these guards may be strapped to the outside of shoes.

- Toe guards fit over the toes of regular shoes to protect the toes from impact and compression hazards. They may be made of steel, aluminum or plastic.

- Combination foot and shin guards protect the lower legs and feet, and may be used in combination with toe guards when greater protection is needed.

- Safety shoes have impact-resistant toes and heat-resistant soles that protect the feet against hot work surfaces common in roofing, paving and hot metal industries. The metal insoles of some safety shoes protect against puncture wounds. Safety shoes may also be designed to be electrically conductive to prevent the buildup of static electricity in areas with the potential for explosive atmospheres. They may also be used in non-conductive atmospheres to protect workers from workplace electrical hazards.

Module #10 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **Workers should adjust the suspension on hardhats so that there's _____.**

    a. 1 inch between the top of the head and the shell
    b. 1 1/4 inches between the top of the head and the shell
    c. 1 1/2 inches between the head and the top shell
    d. 2 inches between the head and the top of the shell

2. **Eye and face protectors should be selected based on which of the following?**

    a. Anticipated hazards
    b. Style
    c. Cost
    d. Materials

3. **Which of the following gloves should be used to protect against sparks, moderate heat, blows, chips and rough objects?**

    a. Fabric gloves
    b. Chemical resistant gloves
    c. Insulating rubber gloves
    d. Leather gloves

4. **_____ and sleeves are critical PPE for electrical work on or near exposed energized parts.**

    a. Synthetic gloves
    b. Fabric gloves
    c. Insulating gloves
    d. Leather gloves

5. What should be worn to protect the feet against hot work surfaces common in roofing, paving and hot metal industries?

a. Metatarsal guards
b. Safety shoes
c. Foot and toe guards
d. Leggings

Module 11: Confined Spaces in Construction

Introduction

The general industry confined space standard does not apply to construction employers and

does not specify the appropriate level of employee protection based on the hazards created by construction activities performed in confined spaces. Compared to general industry, the construction industry experiences higher employee turnover rates, with construction employees more often working at multiple worksites performing short-term tasks.

Unlike most general industry worksites, construction worksites are continually evolving, with the number and characteristics of confined spaces changing as work progresses. Multiple contractors and controlling contractors are found more often at construction worksites than at general industry worksites.

Also, in contrast to general industry, OSHA believes many contractors who perform construction work in sewer systems are unfamiliar with the hazards associated with these worksites. Therefore, OSHA's new construction confined space standard places more emphasis in this standard on assessing hazards at sewer worksites than it did in the general industry confined-spaces standard.

New Confined Space Standard

The new standard, Subpart AA of 29 CFR 1926 will help prevent construction workers from being hurt or killed by eliminating and isolating hazards in confined spaces at construction sites similar to the way workers in other industries are already protected.

The standard applies to both new construction within an existing sewer and alterations and/or upgrades. For example:

- installing or upgrading a manhole
- altering or upgrading sewer lines
- making nonstructural upgrades to joints, pipes, or manholes
- demolition work
- installing new or upgraded pump equipment, cables, wires, or junction boxes

The new construction rule requires employers to determine:

- what kinds of spaces their workers are in,
- what hazards could be there,
- how those hazards should be made safe,
- what training workers should receive, and
- how to rescue those workers if anything goes wrong.

If there is a confined space, the employer should determine if there are existing or potential hazards in the space. If there are such hazards, the employer should classify the space according to the physical and atmospheric hazards found in it.

The four classifications are:

- Isolated-Hazard Confined Space
- Controlled-Atmosphere Confined Space
- Permit-Required Confined Space
- Continuous System-Permit-Required Confined Space

Each type of confined space is tailored to control the different types of hazards. You can learn more about the different types of construction confined spaces in 29 CFR 1926.1203–Definitions.

Construction Employer Classifications

The **host employer** owns or manages the property on which construction is taking place.

The **controlling contractor** is the employer that has overall responsibility for construction at the worksite.

If a host employer has overall responsibility for construction at the worksite, then it is both a host employer and controlling contractor.

The **subcontractor** is the junior or secondary contractor who contracts with the controlling or "prime" contractor perform some or all of contractual-obligations under the prime contract.

The **entry employer** is usually a subcontractor who directs workers to enter a confined space for work or rescue.

Coordinating Confined Space Entry

The rule makes the controlling contractor, rather than the host employer, the primary point of contact for information about permit spaces at the work site. The host employer must provide information it has about permit spaces at the work site to the controlling contractor, who then passes it on to the employers whose employees will enter the spaces (entry employers).

Likewise, entry employers must give the controlling contractor information about their entry program and hazards they encounter in the space, and the controlling contractor passes that information on to other entry employers and back to the host. As mentioned above, the controlling contractor is also responsible for making sure employers outside a space know not to create hazards in the space, and that entry employers working in a space at the same time do not create hazards for one another's workers.

Key Requirements

There are 5 key requirements in the new construction rule, and several areas where OSHA has clarified existing requirements. The five new requirements include:

1. There are more detailed provisions that require coordinated activities when there are multiple employers at the worksite. This will ensure hazards are not introduced into a confined space by workers performing tasks outside the space. An example would be a generator running near the entrance of a confined space causing a buildup of carbon monoxide within the space.

2. It requires a competent person to evaluate the work site and identify confined spaces, including permit spaces.

3. It requires continuous atmospheric monitoring whenever possible.

4. It requires continuous monitoring of engulfment hazards. For example, when workers are performing work in a storm sewer, a storm upstream from the workers could cause flash flooding. An electronic sensor or observer posted upstream from the work site

could alert workers in the space at the first sign of the hazard, giving the workers time to evacuate the space safely.

5. It allows for the suspension of a permit, instead of cancellation, in the event of changes from the entry conditions list on the permit or an unexpected event requiring evacuation of the space. The space must be returned to the entry conditions listed on the permit before re-entry.

In addition, OSHA has added provisions to the construction rule that clarifies existing requirements in the General Industry standard. These include:

1. Requiring that employers who direct workers to enter a space without using a complete permit system prevent workers' exposure to physical hazards through elimination of the hazard or isolation methods such as lockout/tagout.

2. Requiring that employers who are relying on local emergency services for emergency services arrange for responders to give the employer advance notice if they will be unable to respond for a period of time (because they are responding to another emergency, attending department-wide training, etc.).

3. Requiring employers to provide training in a language and vocabulary that the worker understands.

Crawl Spaces and Attics

Crawl spaces and attics can be both confined spaces and permit-required confined spaces under the new standard. For instance, working in an attic and applying a large amount of spray foam (or another chemical) in a short period of time can expose a worker to low oxygen levels or a hazardous atmosphere.

In addition, changes to the entry/exit, the ease of exit, and air flow could create a confined space or cause the space to become permit-required.

Hazards in Crawl Spaces and Attics

Crawl spaces can present many confined space hazards, including:

- atmospheric hazards (e.g., flammable vapors, low oxygen levels)

- electrocution (e.g., using electrical equipment in wet conditions, unprotected energized wires)
- standing water
- poor lighting
- structural collapse
- asbestos insulation

Working in attics can also present confined space hazards, such as:

- atmospheric hazards (e.g., poor ventilation)
- heat stress
- mechanical hazards (e.g., attic ventilators, whole house fans)
- electrical hazards (e.g., damaged or frayed wires, open electrical boxes)
- slip, trip and fall hazards
- asbestos insulation

Confined Spaces in Pits

Even though a pit is typically open on top and over 4 feet deep, it can still be a confined space or permit-required confined space. Additionally, pits can be completely underground or below grade, such as a utility vault within a sewer system or a pit within a pit in a wastewater treatment plant.

Pits are found in many environments. Examples include:

- sump pits
- valve pits or vaults (e.g., wastewater treatment plants, municipal water systems)
- electrical pits/vaults

- steam pits/vaults
- vehicle service/garage pits
- elevator pits
- dock leveler pits
- industrial chemical waste pits

Many of these spaces qualify as permit-required confined spaces.

Employers must take all necessary steps to keep workers safe in confined spaces, including following the OSHA Construction Confined Spaces standard. This standard applies to both new construction in a pit and alterations and/or upgrades. Among the pit-related tasks covered by the standard are:

opening or closing valves during renovation work

installing or upgrading pump equipment, cables, or junction boxes

Construction work can create confined spaces, even if there are none at the start of a project. Changes to the entry/exit, the ease of exit, and air flow could produce a confined space or cause one to become permit-required.

Confined Spaces in Sewer Systems

Types of sewer systems include sanitary (domestic sewage), storm (runoff), and combined (domestic sewage and runoff). Sewer systems are extensive and include many different components that are considered confined spaces, including pipelines, manholes, wet wells, dry well vaults, and lift/pump stations. Therefore, employers conducting work in sewer systems will likely have workers who will encounter confined spaces.

Sewer systems also consist of wastewater treatment plants, where confined spaces include digestion and sedimentation tanks, floating covers over tanks, sodium hypochlorite tanks, and wastewater holding tanks, among others. Many of these components may also qualify as permit-required confined spaces.

Hazards Associated with Sewer Systems

Sewer systems can present a host of confined space hazards, including:

- atmospheric hazards (low oxygen, toxic or flammable gases)
- chemicals in piping and from roadway runoff (may harm lungs, skin, or eyes)
- engulfment and drowning
- electrocution (e.g., using electrical equipment in wet working conditions)
- slips, trips, and falls
- falling objects
- high noise levels, low visibility, limits to communication, and long distances to exits

For more information about hazards in the construction industry read OSHA's Anatomy of Confined Spaces in Construction.

For a more complete discussion of confined space safety, be sure to take OSHAcademy Course 713, Confined Space Program.

Module #11 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

1. **Who has overall responsibility for construction at the worksite?**

    a. Worksite supervisor
    b. Controlling contractor
    c. Host employer
    d. Entry employer

2. **Which of the following should occur in the event of changes from the entry conditions list on the permit or an unexpected event requiring evacuation of the space?**

    a. The host employer should ensure the confined space is eliminated
    b. The confined space should be re-designed
    c. The confined space should be suspended
    d. The confined space should be designated as dangerous

3. **Employers should present confined space training in _____.**

    a. language the worker understands
    b. English only
    c. the local language
    d. in English with interpreters

4. **_____ is just one hazard found in crawl spaces.**

    a. Poor lighting
    b. Standing water
    c. Heat stress
    d. Falling objects

5. High level noise is just one hazard in this type of confined space on a construction site.

a. Pits
b. Sewer systems
c. Crawl spaces
d. Vaults

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