INSTRUCTOR GUIDE FOR
10-HOUR OUTREACH TRAINING IN
THE CONSTRUCTION INDUSTRY
# Table of Contents

Introduction ............................................................................................................................................................................. v  
How to Use Topic Materials .......................................................................................................................................................... v  

**Module A: Cranes** .................................................................................................................................................................. A-1  
Lesson Plan ........................................................................................................................................................................ A-3  
Presentation Slides .................................................................................................................................................................. A-13  
Knowledge Check .................................................................................................................................................................. A-49  
OSHA Information Sheet .......................................................................................................................................................... A-51  

**Module B: Excavations** ......................................................................................................................................................... B-1  
Lesson Plan ........................................................................................................................................................................ B-3  
Presentation Slides .................................................................................................................................................................. B-11  
Knowledge Check .................................................................................................................................................................. B-53  
OSHA Information Sheet .......................................................................................................................................................... B-55  

**Module C: Health Hazards** ..................................................................................................................................................... C-1  
Lesson Plan ........................................................................................................................................................................ C-3  
Presentation Slides .................................................................................................................................................................. C-23  
Knowledge Check .................................................................................................................................................................. C-51  
OSHA Information Sheets .......................................................................................................................................................... C-53  

**Module D: Materials Handling** ............................................................................................................................................... D-1  
Lesson Plan ........................................................................................................................................................................ D-3  
Presentation Slides .................................................................................................................................................................. D-13  
Knowledge Check .................................................................................................................................................................. D-57  
OSHA Information Sheet .......................................................................................................................................................... D-59  

**Module E: PPE** ......................................................................................................................................................................... E-1  
Lesson Plan ........................................................................................................................................................................ E-3  
Presentation Slides .................................................................................................................................................................. E-11  
Knowledge Check .................................................................................................................................................................. E-55  
OSHA Information Sheet .......................................................................................................................................................... E-57
Module F: Scaffolds ................................................................. F-1
Lesson Plan ................................................................. F-3
Presentation Slides .......................................................... F-11
Knowledge Check .......................................................... F-35
OSHA Information Sheet ............................................. F-37

Module G: Stairs and Ladders .............................................. G-1
Lesson Plan ................................................................. G-3
Presentation Slides ........................................................ G-11
Knowledge Check ........................................................ G-47
OSHA Information Sheets .......................................... G-49

Module H: Hand and Power Tools ...................................... H-1
Lesson Plan ................................................................. H-3
Presentation Slides ........................................................ H-13
Knowledge Check ........................................................ H-51
OSHA Information Sheet .............................................. H-53
Introduction

This instructor guide contains a lesson plan, slide presentation, evaluation, and OSHA Fact Sheet for each of the following Construction Outreach topics:

- Cranes
- Excavation
- Health Hazards
- Materials Handling
- Personal Protective Equipment
- Scaffolds
- Stairways and Ladders
- Tools - Hand and Power

These topics and materials are intended for OSHA 10-hour Construction Outreach Training.

How to Use Topic Materials

The purpose of these materials is to provide a basic foundation for each of the topics. It is recommended that the trainer make necessary adaptations to the materials based on the needs of the trainer’s audience. It is also recommended that the trainer review the current edition of OSHA’s Outreach Training Program Construction Industry Procedures for the latest requirements on designated training topics. This information is available on the OSHA Outreach Training website at [https://www.osha.gov/dte/outreach/construction/index.html](https://www.osha.gov/dte/outreach/construction/index.html).

Instructor Guide (IG):

The IG consists of a lesson plan, slide presentation, knowledge check, and fact sheet for each of the 10-hour Construction Outreach topics listed in the introduction above. Each of these items will be further explained in the following paragraphs.

Lesson Plans (LP):

A lesson plan is provided for each topic included in the IG. It is intended that each lesson plan be used as a guide to the basic content that should be covered when teaching that topic to an outreach training class. Keep in mind that this information provides a foundation on which the trainer may build his/her topic presentation. It is up to each trainer to modify the content to best meet the needs of his/her audience. Each topic lesson plan is available in a Microsoft Word® document format to allow for modifications.
Instructions

How to Use Topic Materials

Below is a description of each part of the lesson plan:

- **IDENTIFICATION** – includes the topic title and the minimum time* required by OSHA for teaching this topic.

- **OBJECTIVES** – identify the expected student learning outcomes and how those outcomes will be achieved and measured. Objectives are written with action verbs to indicate performance to be measured.
  - **Terminal Objective (TO)** – sets forth the desired result(s); specifies what the student is able to accomplish at the end of a topic.
  - **Enabling Objectives (EO)** – identify the performance that produces a part of, leads up to, or otherwise enables the achievement of the desired result (terminal objective).

- **INSTRUCTOR MATERIALS AND RESOURCES** – provide a list of instructor materials and resources that may be helpful to the trainer as he/she prepares and presents the topic.

- **STUDENT MATERIALS** – provide a list of materials that the trainer may want to provide to each student to assist grasping the key elements of the topic.

- **TEACHING PROCEDURES** – provide content, activities, and notes for the trainer. It is not intended to be a script that is read verbatim to the students. Rather, instructors should review the entire lesson plan (including reference materials and internet links) prior to conducting the training, and use it as a resource for their planning and presentation. The teaching procedures are presented in a two-column format. The first column contains detailed information regarding the content of the lesson. The second column consists of information that the trainer may use in presenting the content, such as instructional time required to complete that portion of the training, method of instruction used, alignment with slide presentation, key points, references, links, activities, or other information that assists the trainer in presenting the content. The teaching procedures consist of the following elements:
  - **Anticipatory Set** – this portion of the lesson plan is used to capture students’ attention, gain their interest, and engage them in learning. Each lesson is provided with an activity that may be used as an anticipatory exercise or the trainer may choose to use his/her own activity that is better suited for his/her audience.
  - **Presentation** – this portion of the lesson plan is the instructional part of the presentation. It includes a detailed outline for the topic that is designed to ensure that the trainer covers key elements of the content in a manner that provides a logical flow to the presentation. Activities and references that can be used to enhance the presentation may be included where appropriate.
  - **Application** – this portion of the lesson plan provides an opportunity for students to apply what they have learned. For example, the trainer may show pictures of a worksite and have students identify unsafe conditions/actions seen in the picture, then identify best practices to prevent/control the hazards.
  - **Evaluation/Summary** – this portion of the lesson plan reviews the key points of the topic presentation. A check for understanding or evaluation of the achievement of learning objectives should be conducted at the conclusion of the lesson.
References – this portion of the lesson provides a list of OSHA resources that the trainer may use in planning and presenting the topic, including:

- OSHA Standard - provides information on standard(s) applicable to the topic.
- OSHA Publications - provides a list of OSHA publications related to the topic, including, but not limited to, fact sheets, quick cards, guidance documents, and pocket guides.
- OSHA References/Resources - provides a list of other OSHA resources that may be used in preparation and presentation of training topic, including, but not limited to, e-Tools, videos, and Safety and Health Topics.

Slide Presentations

A slide presentation with notes is provided for each topic included in the IG. It is intended that each slide presentation be used as a guide to the basic content that should be covered when teaching that topic to an outreach training class. Keep in mind that this information provides a foundation on which the trainer may build his/her topic presentation. It is up to each trainer to modify the content to best meet the needs of his/her audience. Each topic slide presentation is available in a Microsoft PowerPoint® document format to allow for modifications.

Fact Sheets

At least one OSHA Fact Sheet is provided for each of the Construction Outreach Training topics. These Fact Sheets may be used by the trainer as handouts to students. Additional Fact Sheets are available on the OSHA website.

Knowledge Check

Review questions are included in the IG as Microsoft Word® document, as well as in the slide presentation, to be used to check for understanding/achievement of learning objectives.

* The information provided is current as of publication date. It is the trainer's responsibility to stay updated on OSHA Outreach requirements and procedures.
Instructions

How to Use Topic Materials
IG  Cranes
A - 2
Lesson Plan

10-hour Construction Outreach

IDENTIFICATION

TOPIC TITLE: Cranes, Derricks, Hoists, Elevators, and Conveyors
MINIMUM TIME: 30 minutes

OBJECTIVES

Terminal Objective:
Given best practices and current OSHA and industry information regarding worksite injuries and/or fatalities, the student will be able to recognize how to protect themselves from hazards associated with construction crane operations.

Enabling Objectives:
1. Identify common causes of crane accidents.
2. Describe requirements for crane use, including pre-planning methods.
3. Describe precautions for crane use near power lines.
4. Recognize employer requirements to protect workers from crane hazards.
5. Explain training requirements related to crane operations.

INSTRUCTOR MATERIALS AND RESOURCES

• PowerPoint Presentation: Cranes, Derricks, Hoists, Elevators, and Conveyors
• Knowledge Check Answer Key: Cranes, Derricks, Hoists, Elevators, and Conveyors

STUDENT MATERIALS

• Fact Sheet
• Knowledge Check: Cranes, Derricks, Hoists, Elevators, and Conveyors
## 10-hour Construction Outreach

### TEACHING PROCEDURES --- Preparing, Presentation, Application, Evaluation

#### Anticipatory Set (Focus Attention/Gain Interest)  
**Estimated Time: ?? hours**

<table>
<thead>
<tr>
<th>Key Points</th>
<th>Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discuss case study of “Big Blue” crane collapse.</td>
<td>PPT slides #1 – #5</td>
</tr>
<tr>
<td>Case study</td>
<td></td>
</tr>
</tbody>
</table>

#### Presentation (Instruction)  
**Estimated Time: ?? hours**

<table>
<thead>
<tr>
<th>Key Points</th>
<th>Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Common Causes of Crane Accidents</td>
<td>PPT slides #6 – #15</td>
</tr>
<tr>
<td>A. Four major types of crane accidents</td>
<td></td>
</tr>
<tr>
<td>1. Contact with power lines</td>
<td></td>
</tr>
<tr>
<td>2. Overturns</td>
<td></td>
</tr>
<tr>
<td>3. Mechanical failures</td>
<td></td>
</tr>
<tr>
<td>4. Falls</td>
<td></td>
</tr>
<tr>
<td>B. Reasons accidents occur</td>
<td></td>
</tr>
<tr>
<td>1. Instability – instability of crane, instability of load, poor ground conditions, etc.</td>
<td></td>
</tr>
<tr>
<td>2. Lack of communication between operator and ground personnel</td>
<td></td>
</tr>
<tr>
<td>3. Lack of training</td>
<td></td>
</tr>
<tr>
<td>4. Inadequate maintenance or inspection of equipment</td>
<td></td>
</tr>
<tr>
<td>C. Conditions and actions that create hazardous environments for crane operations</td>
<td></td>
</tr>
<tr>
<td>1. Improper loading rating</td>
<td></td>
</tr>
<tr>
<td>2. Excessive speeds</td>
<td></td>
</tr>
</tbody>
</table>
3. No hand signals  
4. Inadequate inspection and maintenance  
5. Unguarded parts  
6. Unguarded swinging radius  
7. Working too close to power lines  
8. Improper exhaust system  
9. Shattered windows  
10. No steps or guardrails on walkways  
11. No boom angle indicator  
12. Not using outriggers

II. Crane Use  

A. Pre-planning performed before operating a crane on a job site  
   1. Know the capacities and limitations of the crane and the restrictions of the job site.  
   2. Operators, signal persons, and riggers must meet qualifications/certifications of their job.  
   3. Level the crane and ensure support surface is firm and able to support the load.  
   4. Contact power line owners and determine necessary precautions to avoid power lines.  
   5. Make sure that any workers who might be in close proximity are aware of hoisting activities.  
   6. Barricade areas within the swing radius of the crane.  
   7. Ensure that all proper maintenance and inspections of the crane have been conducted.  
   8. Determine where the safe areas on the site are to store and pick up/put down materials and place the machinery.

B. Crane Operations  
   1. Load capacity/speed of operation – make sure that the crane operator can see the rated load capacity and the proper operating speeds and is aware of any hazard warnings or instructions. Operators are not allowed to use cell phones while working on a crane, except when communicating with the signal person.

PPT slides #16 – #17
2. Weight of load – determine the weight of the load and use this information to calculate the proper way to lift and move the load. The maximum load that can be lifted can be limited by these factors:
   a. Unlevel ground or crane
   b. High winds
   c. Side loads or lifts
   d. Not using outriggers
   e. Lifting over the side
   f. Use of extensions, jibs
   g. Limits of the wire rope, slings, or lifting devices being used

3. Basic lifting principles – use these to govern a crane’s mobility and safety during lifting operations. These principles are:
   a. Center of gravity
   b. Leverage
   c. Stability
   d. Structural integrity

4. Hand signals – an illustration of signals must be posted in the vicinity of the hoisting operation. The signal person must meet OSHA’s qualification requirements. A signal person is required when any of the following conditions apply:
   a. Point of operation is not in full view of operator
   b. Operator’s view is obstructed in the direction the equipment is traveling
   c. Either the operator or the person handling the load determines a signal person is needed for safety concerns

5. Power lines – stay clear of power lines.

6. Swing radius – stay out of the swing radius of the crane and make sure that there are barricades restricting access within the swing radius area.

7. Suspended loads – keep the load as close as possible to the ground when picking up and carrying a load. All employees must stay clear of any load being lifted or suspended and shall not work any suspended load.
III. Crane Use Near Power Lines

A. Boom or crane contact with energized power lines accounts for nearly 45% of crane accidents

B. Pre-operational requirements
   1. Identify work zone
   2. Determine if any part of crane, load line, or load could get closer than 20 feet to a power line if operated at maximum working radius in the work zone. If so, must meet requirements in one of three options:
      a. De-energize and ground
      b. Ensure no part of equipment, load line, or load gets closer than 20 feet to power line
      c. Determine line’s voltage and minimum approach distance permitted under Table A.

   **TABLE A – MINIMUM CLEARANCE DISTANCES**

<table>
<thead>
<tr>
<th>Voltage (nominal, kV, alternating current)</th>
<th>Minimum Clearance Distance (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>up to 50</td>
<td>10</td>
</tr>
<tr>
<td>over 50 to 200</td>
<td>15</td>
</tr>
<tr>
<td>over 200 to 350</td>
<td>20</td>
</tr>
<tr>
<td>over 350 to 500</td>
<td>25</td>
</tr>
<tr>
<td>over 500 to 750</td>
<td>35</td>
</tr>
<tr>
<td>over 750 to 1,000</td>
<td>45</td>
</tr>
<tr>
<td>Over 1,000</td>
<td>(as established by the utility owner/operator or qualified registered professional engineer who is a qualified person with respect to electrical power transmission and distribution)</td>
</tr>
</tbody>
</table>

IV. Employer Requirements

A. Comply with all applicable employer requirements related to:
   1. Assembly/Disassembly of crane
   2. Power line safety
3. Procedures applicable to the operational functions of equipment, including attachments
4. Qualifications/certifications of:
   a. Crane operator
   b. Signal person
   c. Rigger
5. Other applicable OSHA requirements, including
   a. Training requirements
   b. Inspection requirements

B. Designate a competent person to inspect all machinery and equipment prior to each use, and during use, to make sure it is in safe operating condition

C. Comply with manufacturers’ requirements and recommendations for cranes and related equipment.

V. Training Requirements

A. Employer must provide training
   1. Overhead power lines
   2. Signal persons
   3. Operators
   4. Competent persons and qualified persons
   5. Crush/pinch points
   6. Tag-out

B. Training administration
   1. Evaluate employees’ understanding of information provided in training
   2. Provide refresher training
   3. Provide training at no cost to employee
### Application (How students apply what they learn)

<table>
<thead>
<tr>
<th>Key Points</th>
<th>Estimated Time: ?? hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Show pictures of cranes operations and have students identify hazards</td>
<td>PPT slides #23 – #27</td>
</tr>
<tr>
<td>associated with those operations.</td>
<td></td>
</tr>
</tbody>
</table>

### Evaluation/Summary

<table>
<thead>
<tr>
<th>Key Points</th>
<th>Estimated Time: ?? hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge Check: Cranes, Derricks, Hoists, Elevators, and Conveyors.</td>
<td>PPT slides #28 – #31</td>
</tr>
</tbody>
</table>

### References

**OSHA Standard:** 29 CFR 1926 Subpart CC (1926.1400 to 1926.1442)

- 1926 Subpart CC – Cranes and Derricks in Construction
  - 1926.1400 - Scope,
  - 1926.1401 - Definitions,
  - 1926.1402 - Ground conditions.
  - 1926.1403 - Assembly/Disassembly--selection of manufacturer or employer procedures.
  - 1926.1404 - Assembly/Disassembly--general requirements (applies to all assembly and disassembly operations).
  - 1926.1405 - Disassembly--additional requirements for dismantling of booms and jibs (applies to both the use of manufacturer procedures and employer procedures).
  - 1926.1406 - Assembly/Disassembly--employer procedures--general requirements.
  - 1926.1407 - Power line safety (up to 350 kV)--assembly and disassembly.
  - 1926.1408 - Power line safety (up to 350 kV)--equipment operations.
1926.1409 - Power line safety (over 350 kV).
1926.1410 - Power line safety (all voltages)--equipment operations closer than the Table A zone.
1926.1411 - Power line safety--while traveling under or near power lines with no load.
1926.1412 - Inspections.
1926.1413 - Wire rope--inspection.
1926.1414 - Wire rope--selection and installation criteria.
1926.1415 - Safety devices.
1926.1416 - Operational aids.
1926.1417 - Operation.
1926.1418 - Authority to stop operation.
1926.1419 - Signals--general requirements.
1926.1420 - Signals--radio, telephone or other electronic transmission of signals.
1926.1421 - Signals--voice signals--additional requirements.
1926.1422 - Signals--hand signal chart.
1926.1423 - Fall protection.
1926.1424 - Work area control.
1926.1425 - Keeping clear of the load.
1926.1426 - Free fall and controlled load lowering.
1926.1427 - Operator qualification and certification.
1926.1428 - Signal person qualifications.
1926.1429 - Qualifications of maintenance & repair employees.
1926.1430 - Training.
1926.1431 - Hoisting personnel.
1926.1432 - Multiple-crane/derrick lifts--supplemental requirements.
1926.1433 - Design, construction and testing.
1926.1434 - Equipment modifications.
1926.1435 - Tower cranes.
1926.1436 - Derricks.
1926.1437 - Floating cranes/derricks and land cranes/derricks on barges.
1926.1438 - Overhead & gantry cranes.
1926.1439 - Dedicated pile drivers.
1926.1440 - Sideboom cranes.
10-hour Construction Outreach

1926.1441 - Equipment with a rated hoisting/lifting capacity of 2,000 pounds or less.
1926.1442 - Severability.
1926 Subpart CC App A - Standard Hand Signals
1926 Subpart CC App B - Assembly/Disassembly--Sample Procedures for Minimizing the Risk of Unintended Dangerous Boom Movement
1926 Subpart CC App C - Operator Certification--Written Examination--Technical Knowledge Criteria

OSHA Publications


- Crane Modifications (1993, April 19) (English: HTML)
- Cranes and Derricks in Construction – Small Entity Compliance Guide for the Final Rule (OSHA 3433 - 2014) 96 pages (English: PDF)
- Cranes and Derricks in Construction: Subpart CC: Wire Rope - Inspection (OSHA FS-3635 - 2013) (English: HTML PDF)
- Cranes and Derricks in Construction: Assembly and Disassembly, Subpart CC Fact Sheet (English: HTML PDF)
- Cranes and Derricks in Construction: Operator Qualification and Certification, Subpart CC Fact Sheet (English: HTML PDF)
- Cranes and Derricks in Construction: Qualified Rigger, Subpart CC Fact Sheet (English: HTML PDF)
- Cranes and Derricks in Construction: Signal Person Qualification, Subpart CC Fact Sheet (English: HTML PDF)
- Sling Safety (OSHA 3072 - 1996) (English: HTML PDF)
- Truck Cranes (1989, May 2) (English: HTML)
- Vehicle-mounted Elevating and Rotating Devices (1990, September 14) (English: HTML)

OSHA References/Resources

Cranes

10-Hour Construction Outreach
1926 Subpart CC – Cranes and Derricks in Construction

Other standards and references used for this presentation are as follows:

1. Mobile Hydraulic Crane Standards
   - PCSA Standard NO. 2
   - Power Crane and Shovel Association

2. USA Standards
   - Safety Code for Cranes, Derricks, Hoists, Jacks and Slings
   - Crawler, locomotive and truck cranes
   - USAS B30.5-1968
Cranes

- Discuss “Big Blue” crane collapse

Case Study


Miller Park Stadium - July 1999 crane collapse caused the deaths of 3 construction workers.
Source: OSHA.gov
Moving large, heavy loads is crucial to today's construction industry. 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. (Source: OSHA.gov)

**Enabling Objectives:**
1. Identify common causes of crane accidents.
2. Describe requirements for crane use, including pre-planning methods.
3. Describe precautions for crane use near power lines.
4. Recognize employer requirements to protect workers from crane hazards.
5. Explain training requirements related to crane operations.
Four Major Types of Crane Accidents
1. Contact with power lines is a leading cause of crane accidents.
   a. Must be aware of placement of power lines surrounding worksite
   b. Maintain clearance of at least 20 feet from energized electrical lines unless other precautions have been implemented
   c. Shut off active power lines to prevent electrocution from accidental contact with live wires
2. Overturns - causes
   a. Overloads
   b. Loss of center of gravity control
   c. Outrigger failure
   d. High winds
   e. Side pull
   f. Improper maintenance
3. Mechanical Failures – Routine maintenance should be followed to prevent accidents due to mechanical failure. Components with excessive wear should be repaired and replaced as soon as possible.
4. Falls – causes
   a. Missing hand rails
   b. Improper crane operation
   c. Improper maintenance
5. Other causes of crane accidents include:
   a. Under the hook lifting device,
   b. Dropped loads,
   c. Boom collapse,
   d. Crushing by the counter weight,
   e. Outrigger use
   f. Rigging failures

Source: OSHA.gov
Cranes
Presentation Slides
IG
A - 19

Reasons Accidents Occur
1. Poor planning. Not knowing the weight of the load or the characteristics of the crane. Instability of crane, instability of load, or poor ground conditions (not level or too soft) can contribute to crane accidents.
2. Lack of communication between the crane operator and ground personnel.
3. Lack of training. Operators who do not have proper training in crane operation and safety procedures may lead to crane accidents. Everyone involved in maintaining, repairing, and assembling the crane should have training.
4. Inadequate maintenance or inspection of equipment. Timely, consistent inspections by experienced and well-trained inspectors can prevent accidents. As mentioned previous, routine maintenance should be followed and components with excessive wear should be repaired and replaced as soon as possible.
<table>
<thead>
<tr>
<th>Conditions and actions that create hazardous environments for crane operations.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Improper loading rating. Solution: Check to ensure the load does not exceed the crane's rated capacity.</td>
</tr>
<tr>
<td>2. Excessive speeds. Solution: Maintain safe speed of operation in accordance with manufacturer's recommendations.</td>
</tr>
<tr>
<td>3. No hand signals. Solution: Ensure the signal person meets OSHA's qualifications.</td>
</tr>
<tr>
<td>4. Inadequate inspections and maintenance. Solution: Check all crane equipment and controls to insure proper operation is possible before use. Plan and perform routine inspections and maintenance.</td>
</tr>
<tr>
<td>5. Unguarded parts. Solution: Ensure that all required guards are securely in place.</td>
</tr>
<tr>
<td>6. Unguarded swinging radius. Solution: Barricade accessible areas within the crane's swing radius.</td>
</tr>
<tr>
<td>7. Working too close to power lines. Solution: Watch for overhead power lines and maintain safe working clearance of at least 20 feet from energized electrical lines.</td>
</tr>
<tr>
<td>8. Improper exhaust systems. Solution: Ensure equipment exhaust is properly maintained and is in proper working condition.</td>
</tr>
<tr>
<td>9. Shattered windows. Solution: Replace damaged windows to ensure proper visibility.</td>
</tr>
<tr>
<td>10. No steps or guardrails on walkways. Solution: Ensure that all walkways are equipped with standard railings.</td>
</tr>
<tr>
<td>11. No boom angle indicator. Solution: Ensure all operational aids including boom angle indicators are working properly.</td>
</tr>
<tr>
<td>12. Not using outriggers. Solution: Fully extend outriggers in accordance with the lifting conditions and the load chart.</td>
</tr>
</tbody>
</table>
**APPLICABLE OSHA STANDARD**

**1926.1417(c)(1)** The procedures applicable to the operation of the equipment, including rated capacities (load charts), recommended operating speeds, special hazard warnings, instructions, and operator's manual, must be readily available in the cab at all times for use by the operator.
An illustration of the signals must be posted on the equipment or in the vicinity of the operations.

**APPLICABLE OSHA STANDARD**

1926.1422 Hand signal charts must be either posted on the equipment or conspicuously posted in the vicinity of the hoisting operations.
Guard moving parts such as gears or belts.

**APPLICABLE OSHA STANDARD**

1926.1433(d)(8) Belts, gears, shafts, pulleys, sprockets, spindles, drums, fly wheels, chains, and other parts or components that reciprocate, rotate or otherwise move must be guarded where contact by employees (except for maintenance and repair employees) is possible in the performance of normal duties.
OSHA determined that the preferred way to protect employees in these situations is to completely barricade the entire swing radius of the equipment and prevent employee access to the area.

1926.1424(a)(2) To prevent employees from entering these hazard areas, the employer must:

1926.1424(a)(2)(i) Train each employee assigned to work on or near the equipment ("authorized personnel") in how to recognize struck-by and pinch/crush hazard areas posed by the rotating superstructure.

1926.1424(a)(2)(ii) Erect and maintain control lines, warning lines, railings or similar barriers to mark the boundaries of the hazard areas. *Exception:* When the employer can demonstrate that it is neither feasible to erect such barriers on the ground nor on the equipment, the hazard areas must be clearly marked by a combination of warning signs (such as "Danger--Swing/Crush Zone") and high visibility markings on the equipment that identify the hazard areas. In addition, the employer must train each employee to understand what these markings signify.
**APPLICABLE OSHA STANDARD**

**1926.1433(d)(7)(iii)(C)** Windows must be of safety glass or material with similar optical and safety properties, that introduce no visible distortion or otherwise obscure visibility that interferes with the safe operation of the equipment.
**APPLICABLE OSHA STANDARDS**

**1926.1423(c)(3)** Equipment manufactured after November 8, 2011 must be equipped so as to provide safe access and egress between the ground and the operator work station(s), including the forward and rear positions, by the provision of devices such as steps, handholds, ladders, and guardrails/railings/grabrails. These devices must meet the following criteria:

1. **1926.1423(c)(3)(i)** Steps, handholds, ladders and guardrails/railings/grabrails must meet the criteria of SAE J185 (May 2003) (incorporated by reference, see § 1926.6) or ISO 11660-2:1994(E) (incorporated by reference, see § 1926.6) except where infeasible.
2. **1926.1423(c)(3)(ii)** Walking/stepping surfaces, except for crawler treads, must have slip-resistant features/properties (such as diamond plate metal, strategically placed grip tape, expanded metal, or slip-resistant paint).
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1926.1423(c)(3)(ii) Walking/stepping surfaces, except for crawler treads, must have slip-resistant features/properties (such as diamond plate metal, strategically placed grip tape, expanded metal, or slip-resistant paint).
Pre-planning performed before operating a crane on a job site.
1. Know the capacities and limitations of the crane and the restrictions of the job site.
2. Operators, signal persons, and riggers must meet qualifications/certifications of their job.
3. Level the crane and ensure support surface is firm and able to support the load.
4. Contact power line owners and determine necessary precautions to avoid power line.
5. Make sure that any workers who might be in close proximity are aware of hoisting activities. Do not move a load over workers.
6. Barricade areas within the swing radius of the crane.
7. Ensure that all proper maintenance and inspections of the crane have been conducted.
8. Determine where the safe area on the site are to store and pick up/put down materials and place the machinery.
Cranes Operations

1. Load capacity/speed of operation – make sure that the crane operator can see the rated load capacity and the proper operating speeds and is aware of any hazard warnings or instructions. Operators are not allowed to use cell phones while working on a crane, except when communicating with the signal person.

2. Weight of load – determine the weight of the load and use this information to calculate the proper way to lift and move the load. The maximum load that can be lifted can be limited by these factors:
   a. Unlevel ground or crane
   b. High winds
   c. Side loads or lifts
   d. Not using outriggers
   e. Lifting over the side
   f. Use of extensions, jibs
   g. Limits of the wire rope, slings, or lifting devices being used.

3. Basic lifting principles – use these to govern a crane’s mobility and safety during lifting operations. These principles are:
   a. Center of gravity
   b. Leverage
   c. Stability
   d. Structural integrity

4. Hand signals – an illustration of signals must be posted in the vicinity of the hoisting operation. The signal person must meet OSHA’s qualification requirements. A signal person is required when any of the following conditions apply:
   a. Point of operation is not in full view of operator.
   b. Operator’s view is obstructed in the direction of equipment is traveling
   c. Either the operator or the person handling the load determines a signal person is needed
For safety concerns
5. Power lines – stay clear of power lines.
6. Swing radius – stay out of the swing radius of the crane and make sure that there are barricades restricting access within the swing radius area.
7. Suspended loads – keep the load as close as possible to the ground when picking up and carrying a load. All employees must stay clear of any load being lifted or suspended and shall not work any suspended load.
Crane use near power lines
Workers are killed each year when cranes contact overhead power lines.
Crane Use Near Power Lines

Pre-operational requirements:
1. Identify work zone
2. Determine proximity to power lines, if closer than 20 feet, if so, must do one of the following three:
   a. De-energize and ground
   b. Ensure no part of equipment, load line, or load gets closer than 20 feet to power line
   c. Determine line's voltage and minimum approach distance permitted under Table A.
Crane use near power lines

1. Identify work zone

2. Determine if any part of crane, load line, or load could get closer than 20 feet to a power line if operated at maximum working radius in the work zone. If so, must meet requirements in one of three options:
   a. De-energize and ground
   b. Ensure no part of equipment, load line, or load gets closer than 20 feet to power line
   c. Determine line’s voltage and minimum approach distance permitted under Table A.
Employers are required to:

A. Comply with all applicable employer requirements related to:
   1. Assembly/Disassembly of crane
   2. Power line safety
   3. Procedures applicable to the operational functions of equipment, including attachments
   4. Qualifications/certifications of:
      a. Crane operator
      b. Signal person
      c. Rigger
   5. Other applicable OSHA requirements, including
      a. Training requirements
      b. Inspections requirements

B. Designate a competent person to inspect all machinery and equipment prior to each use and during use, to make sure it is in safe operating condition.

C. Comply with manufacturers’ requirements and recommendations for cranes and related equipment.
Employers must provide training:
1. Overhead power lines
2. Signal persons
3. Operators
4. Competent persons and qualified persons
5. Crush/pinch points
6. Tag-out

Training Administration
1. Evaluate employees’ understanding of information provided in training
2. Provide refresher training
3. Provide training at no cost to employee
Fall Hazards
Struck-by Hazards
Crushing Hazards
Electrical Hazards

For this particular design, the manufacturer required the use of four anchoring bars for each of the four rear legs (sixteen total anchoring bars) and two anchoring bars for each of the two telescoping front legs (four anchoring bars total). The anchoring bars in the rear were designed to be pre-stressed to 600 kilo-Newton’s per bar (approximately 135,000 pounds of force per bar) to provide resistance to the longitudinal and transversal forces primarily during the launching of the under-bridge. The front leg anchors were to be pre-stressed to resist transversal forces, such as those created by wind.

The accident investigation revealed that the employer had not designed the pier segments to accommodate each of the anchoring locations, reportedly because of congestion in the segments with other items such as stressing cables. It was further determined that the employer used only a few anchoring bars during the initial launches and as work progressed began using fewer and fewer anchoring bars. On the day of the accident, there were no anchoring bars for the four rear leg and only one anchoring bar in each of the front legs. Additionally, the front leg anchors had not been stressed to the appropriate force and were only tightened with a wrench. A few months prior to the collapse of the launching gantry, the employer had experienced a movement of about 2 centimeters at the rear legs during a launch when using a total of only two rear-leg anchoring bars. The manufacturer’s instructions provided that such movement could lead to a collapse of a launching gantry.

Two heavy equipment mechanics, an 18-year-old male and a 40-year-old male, died when electrocuted while working on a scraper. The scraper was at a construction site parked under a high voltage line. The victims were using the truck-mounted crane on one of their service trucks to assist in replacing the rear differential when the incident occurred. The crane’s boom made contact with the high voltage line. The control for the crane was a remote unit electrically wired to the truck. The 18-year-old victim was operating the crane at the time of the incident. The California Fatality Assessment and Control Evaluation (CA/FACE) investigator determined that, in order to prevent future occurrences, employers, as part of their Injury and Illness Prevention Program (IIPP), should:

Ensure heavy equipment mechanics know the safety and health hazards specific to their job assignments.

Ensure all employees perform safety and health inspections prior to starting their job assignments in order to find, eliminate, or control safety and health hazards as well as unsafe working conditions and practices, and to comply fully with the safety and health standards.

Ensure all employees are provided with mechanical and physical safeguards to the maximum extent possible in order to perform their job assignments safely.

Ensure heavy equipment mechanics are properly trained on machine operation and safety and their achievement of skills is verified through a testing program.

Source: NIOSH: Fatality Assessment and Control Evaluation (FACE) Program – California Case Report 04CA004 (http://www.cdc.gov/niosh/stateface/ca/05CA011.html)
Don’t stand under suspended loads. Keep the load as close as possible to the ground when picking and carrying a load.

1926.1425(b) While the operator is not moving a suspended load, no employee must be within the fall zone, except for employees:

1926.1425(b)(1)
Engaged in hooking, unhooking or guiding a load;

1926.1425(b)(2)
Engaged in the initial attachment of the load to a component or structure; or

1926.1425(b)(3)
Operating a concrete hopper or concrete bucket.
Improper loads or speeds can result in the tipping of the crane.

**CRANE ACCIDENT – OVERTURNED CRANE**

This crane overturned while performing loading operations on a pier. The crane was attempting to remove a metal container from a barge when it tipped and slid into the water. The wind caused the load to swing violently causing the load to go outside the swing radius, at that point the load dropped into the water and took the crane with it.

Knowledge Check

1. Nearly 45% of crane accidents are the result of the boom or crane making contact with ___.
   a. other cranes
   b. work zone barricades
   c. energized power lines
   d. workers on the ground

   c. energized power lines
Knowledge Check

2. Before beginning equipment operations, the employer must:
   a. identify the work zone and determine proximity to power lines
   b. notify utility company of lift and estimate voltage of power lines
   c. locate the fall zone and test load by lifting it at least 20 feet off the ground
   d. remove hazard area barriers and observe weather conditions

   **a. identify the work zone and determine proximity to power lines**
Knowledge Check

3. A broken window that distorts the operator’s visibility of the task is acceptable for operation.
   a. True
   b. False

b. False
Knowledge Check

4. Which of the following must be readily available to the crane operator for use at all times?
   a. Load charts and recommended operating speeds
   b. Special hazard warnings
   c. Instructions and operator’s manual
   d. All of the above

   d. All of the above
Knowledge Check

5. Who is responsible for inspecting all machinery and equipment prior to each use and during use, to make sure it is in safe operating condition?
   a. Certified person
   b. Qualified person
   c. Proficient person
   d. Competent person

   d. Competent person
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   c. locate the fall zone and test load by lifting it at least 20 feet off the ground
   d. remove hazard area barriers and observe weather conditions

3. A broken window that distorts the operator’s visibility of the task is acceptable for operation.
   a. True
   b. False – visibility cannot be distorted

4. Which of the following must be readily available to the crane operator for use at all times?
   a. Load charts and recommended operating speeds
   b. Special hazard warnings
   c. Instructions and operator’s manual
   d. **All of the above**

5. Who is responsible for inspecting all machinery and equipment prior to each use and during use, to make sure it is in safe operating condition.
   a. Certified person
   b. Qualified person
   c. Proficient person
   d. **Competent person**
Subpart CC – Cranes and Derricks in Construction: Assembly/Disassembly

This fact sheet explains the assembly and disassembly requirements of subpart CC – Cranes and Derricks in Construction, as specified in 29 CFR 1926.1403-1926.1406 and 192.1412. These provisions are effective November 8, 2010.

Procedures
Under this standard, employers must comply with all manufacturer prohibitions regarding assembly and disassembly. However, the standard generally allows employers to choose between the manufacturer’s procedures or their own (see exception below for synthetic slings procedures). Employer procedures must be developed by a “qualified person” and must satisfy a number of specified requirements, such as providing adequate support and stability for all parts of the equipment, and positioning employees involved to minimize exposure to any unintended movement or collapse.

Assembly/Disassembly responsibilities
- The rule requires the work to be directed by an A/D (Assembly/Disassembly) director. The A/D director must meet the criteria for both a “competent person” and a “qualified person,” which are defined terms in this rule, or must be a “competent person” assisted by a “qualified person.”
- The A/D director must understand the applicable procedures.
- The A/D director must review the procedures immediately prior to beginning work unless he or she understands the procedures and has used them before for that equipment type and configuration.
- The A/D director must ensure that each member of the crew understands his or her tasks, the hazards of the tasks, and any hazardous positions or locations to avoid.
- The A/D director must verify all capacities of any equipment used, including rigging, lifting lugs, etc.
- The A/D director must also address hazards associated with the operation, including 12 specified areas of concern: site and ground conditions, blocking material, proper location of blocking, verifying assist crane loads, boom & jib pick points, center of gravity, stability upon pin removal, snagging, struck by counterweights, boom hoist brake failure, loss of backward stability, and wind speed and weather.

Inspection
- Upon completion of assembly, but before use, the equipment must be inspected by a “qualified person” to ensure that it is configured in accordance with the manufacturer equipment criteria. If these criteria are unavailable, the employer’s “qualified person,” with the assistance of a registered professional engineer if necessary, must develop the appropriate configuration criteria and ensure that these criteria are met.
Assembly/Disassembly, continued.

General requirements
- A crew member who moves out of the operator’s view to a location where the crew member could be injured by movement of the equipment (or load) MUST inform the operator before going to that location. The operator must not move the equipment until that crew member informs the operator that he or she has relocated to a safe position.
- Employees must never be under the boom or jib when pins (or similar devices) are being removed, unless it is required by site constraints and the A/D director has implemented procedures that minimize the risk of unintended movement and the duration and extent of exposure under the boom.
- Component weights must be readily available for all components to be assembled.
- All rigging must be done by a “qualified rigger.”
- Pins may not be removed during disassembly when the pendants are in tension.
- Booms supported only by cantilevering must not exceed manufacturer limitations or RPE limitations, as applicable.
- Component selection and equipment configuration that affects the capacity or safe operation of the equipment must be in accordance with manufacturer requirements and limits or RPE requirements and limits, as applicable.

Synthetic slings
- The employer must follow manufacturer procedures when using synthetic slings during assembly or disassembly rigging (even when the employer has developed its own A/D procedure as an alternative to the manufacturer’s other procedures.)
- Synthetic slings must be protected from abrasive, sharp or acute edges, and configurations that might reduce the sling’s rated capacity.

Outriggers and stabilizers
When outriggers or stabilizers are used or are necessary in light of the load to be handled and the operating radius:
- Outriggers and stabilizers must be fully extended or, if permitted by manufacturer procedures, deployed as specified in the load chart.
- Outriggers must be set to remove equipment weight from the wheels, except for locomotive cranes.
- Outrigger floats, if used, must be attached to the outriggers; stabilizer floats, if used, must be attached to the stabilizers.
- Each outrigger or stabilizer must be visible to the operator or to a signal person during extension and setting.
- Outrigger and stabilizer blocking must be placed under the float/pad of the jack or, if there is no jack, under the outer bearing surface of the outrigger or stabilizer beam. Blocking must also be sufficient to sustain the loads and maintain stability and must be properly placed.

Tower cranes
- Tower cranes are subject to additional requirements for erecting, climbing and dismantling, including a pre-erection inspection (29 CFR 1926.1435).

This is one in a series of informational fact sheets highlighting OSHA programs, policies or standards. It does not impose any new compliance requirements. For a comprehensive list of compliance requirements of OSHA standards or regulations, refer to Title 29 of the Code of Federal Regulations. This information will be made available to sensory impaired individuals upon request. The voice phone is (202) 693-1999; teletypewriter (TTY) number: (877) 889-5627.

For more complete information:

U.S. Department of Labor
www.osha.gov
(800) 321-OSHA
Subpart CC – Cranes and Derricks in Construction: Wire Rope – Inspection

This fact sheet describes the inspection requirements of subpart CC – Cranes and Derricks in Construction, as specified in 29 CFR 1926.1413. These provisions are effective November 8, 2010. This document is intended to assist wire rope inspectors and supervisors.

<table>
<thead>
<tr>
<th>Inspection Trigger</th>
<th>Inspection Details</th>
<th>Performed by</th>
<th>Documentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Each shift</td>
<td>See list below, visual inspection must begin prior to each shift in which the equipment is used.</td>
<td>Competent Person</td>
<td>Not required</td>
</tr>
<tr>
<td>Monthly</td>
<td>See details below.</td>
<td>Competent Person</td>
<td>Required. Must be signed by the person who conducted the inspection and retained for a minimum of 3 months.</td>
</tr>
<tr>
<td>Annual</td>
<td>See details below.</td>
<td>Qualified Person</td>
<td>Required. Must be signed by the person who conducted the inspection and retained for a minimum of 12 months.</td>
</tr>
</tbody>
</table>

- The annual/comprehensive and monthly inspections must be documented according to 1926.1412(f)(7) and 1916.1412(e)(3), respectively.
- Rope lubricants of the type that hinder inspection must not be used.
- All documents produced under this section must be available, during the applicable document retention period, to all persons who conduct inspections under this section.

Shift Inspection

Shift inspections are visual inspections that a competent person must begin prior to each shift during which the equipment is used. Shift inspections do not require untwisting (opening) of wire ropes or booming down. The inspection must consist of observation of wire ropes (running and standing) that are likely to be in use during the shift for apparent deficiencies, including the following:

<table>
<thead>
<tr>
<th>Apparent Deficiencies – Category I</th>
<th>Removal from Service Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Significant distortion of the wire rope structure such as kinking, crushing, unstranding, birdcaging, signs of core failure, or steel core protrusion between the outer strands.</td>
<td>If a Category I deficiency is identified, the competent person must immediately determine whether it constitutes a safety hazard. If the deficiency is determined to be a safety hazard, all operations involving use of the wire rope in question must be prohibited until:</td>
</tr>
<tr>
<td>• Significant corrosion.</td>
<td>• The wire rope is replaced. (See 1926.1417), or</td>
</tr>
<tr>
<td>• Electric arc damage (from a source other than power lines) or heat damage.</td>
<td>• If the deficiency is localized, the problem is corrected by severing the wire rope in two; the undamaged portion may continue to be used. Joining lengths of wire rope by splicing is prohibited. If a rope is shortened under this paragraph, the employer must ensure that the drum will still have two wraps of wire when the load and/or boom is in its lowest position.</td>
</tr>
<tr>
<td>• Improperly applied end connections.</td>
<td></td>
</tr>
<tr>
<td>• Significantly corroded, cracked, bent, or worn end connections (such as from severe service).</td>
<td></td>
</tr>
</tbody>
</table>
### Apparent Deficiencies – Category II

If a Category II deficiency is identified, operations involving use of the wire rope in question must be prohibited until:

- Employer complies with the wire rope manufacturer’s established criterion for removal from service, or with a different criterion that the wire rope manufacturer has approved in writing for that specific wire rope. (See 1926.1417).
- The wire rope is replaced. (See 1926.1417), or
- If the deficiency is localized, the problem is corrected by severing the wire rope in two; the undamaged portion may continue to be used. Joining lengths of wire rope by splicing is prohibited. If a rope is shortened under this paragraph, the employer must ensure that the drum will still have two wraps of wire when the load and/or boom is in its lowest position.

### Apparent Deficiencies – Category III

If a Category III deficiency is identified, operations involving use of the wire rope in question must be prohibited until:

- The wire rope is replaced. (See 1926.1417), or
- If the deficiency (other than power line contact) is localized, the problem is corrected by severing the wire rope in two; the undamaged portion may continue to be used. Joining lengths of wire rope by splicing is prohibited. Repair of wire rope that contacted an energized power line is also prohibited. If a rope is shortened under this paragraph, the employer must ensure that the drum will still have two wraps of wire when the load and/or boom is in its lowest position.

Where a wire rope is required to be removed from service under this section, either the equipment (as a whole), or the hoist with that wire rope must be tagged-out, in accord with 1926.1417(f)(1), until the wire rope is repaired or replaced.

### Critical Review Items

Particular attention must be given to all of the following:

- Rotation-resistant wire rope in use.
- Wire rope being used for boom hoists and luffing hoists, particularly at reverse bends.
- Wire rope at flange points, crossover points, and repetitive pickup points on drums.
- Wire rope at or near terminal ends.
- Wire rope in contact with saddles, equalizer sheaves or other sheaves where rope travel is limited.

### Monthly Inspection

Each month an inspection must be conducted as stated under “Shift Inspection” above.

In addition to the criteria for shift inspection, monthly inspections require that:

- The inspection must include any deficiencies that the qualified person who conducts the annual inspection determines under 1926.1413(c)(3)(ii) must be monitored.
- Wire ropes on equipment must not be used until an inspection under this paragraph demonstrates that no corrective action under 1926.1413(a)(4) is required.
- The inspection must be documented according to 1926.1412(e)(3) (monthly inspection documentation).
Annual/Comprehensive Inspection
At least every 12 months, wire ropes in use on equipment must be inspected by a qualified person as stated under “Shift Inspection” above.

In addition to the criteria for shift inspection, annual inspections require that –

• The inspection must be complete and thorough, covering the surface of the entire length of the wire ropes, with particular attention given to all of the following:
  ▫ Critical review items from 1926.1413(a)(3)–(see “Critical Review Items” above).
  ▫ Those sections that are normally hidden during shift and monthly inspections.
  ▫ Wire rope subject to reverse bends.
  ▫ Wire rope passing over sheaves.

Exception
In the event an annual inspection under 1926.1413(c)(2) is not feasible due to existing set-up and configuration of the equipment (such as where an assist crane is needed) or due to site conditions (such as a dense urban setting), such inspections must be conducted as soon as it becomes feasible, but no longer than an additional 6 months for running ropes and, for standing ropes, at the time of disassembly.

• If a deficiency is determined to constitute a safety hazard, operations involving use of the wire rope in question must be prohibited until:
  ▫ The wire rope is replaced (see 1926.1417), or
  ▫ If the deficiency is localized, the problem is corrected by severing the wire rope in two; the undamaged portion may continue to be used. Joining wire rope by splicing is prohibited. If a rope is shortened under this paragraph, the employer must ensure that the drum will still have two wraps of wire when the load and/or boom is in its lowest position.
  ▫ If a deficiency is identified and the qualified person determines that, though not presently a safety hazard, the deficiency needs to be monitored, the employer must ensure that the deficiency is checked in the monthly inspections.

Additionally
• The inspection must be documented according to 1926.1412(f)(7).
• Rope lubricants of the type that hinder inspection must not be used.
• All documents produced under this section must be available, during the applicable document retention period, to all persons who conduct inspections under this section.
Section B

Excavations
IG  Excavations
B - 2
Lesson Plan

10-hour Construction Outreach

IDENTIFICATION

TOPIC TITLE: Excavations

MINIMUM TIME: 30 minutes

OBJECTIVES

Terminal Objective:
Given best practices and current OSHA and industry information regarding worksite injuries and/or fatalities, the student will be able to recognize how to protect themselves from hazards associated with excavations.

Enabling Objectives:
1. Describe the role of a competent person at an excavation site.
2. Identify hazards associated with excavations.
3. Describe the methods for protecting employees from cave-ins.
4. Apply excavation hazard protection methods.
5. Recognize employer requirements to protect workers from excavation hazards.

INSTRUCTOR MATERIALS AND RESOURCES

- PowerPoint Presentation: Excavations
- Knowledge Check Answer Key: Excavations

STUDENT MATERIALS

- OSHA Fact Sheet: Trenching and Excavation Safety
- Knowledge Check: Excavation
Excavations

Lesson Plan

**TEACHING PROCEDURES ---Preparation, Presentation, Application, Evaluation**

**Anticipatory Set (Focus Attention/Gain Interest)**  
**Estimated Time: ?? hours**

<table>
<thead>
<tr>
<th>Key Points</th>
<th>Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excavations and trenching activities are some of the most dangerous construction operations. Most accidents tend to happen in trenches between 5-15 feet deep and there's usually little or no warning before a cave-in occurs. According to OSHA, two workers are killed every month in trench collapses. The crushing weight of soil can break bones, impair circulation and breathing, and cause serious internal injuries.</td>
<td>PPT slide #1 – #3</td>
</tr>
</tbody>
</table>

**Presentation (Instruction)**  
**Estimated Time: ?? hours**

<table>
<thead>
<tr>
<th>Key Points</th>
<th>Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Role of Competent Person</td>
<td>PPT slide #4 - #5</td>
</tr>
</tbody>
</table>
| A. Required training and knowledge  
  1. Soil classification  
  2. Use of protective systems  
  3. Requirements of OSHA’s standard on excavation and trenching | |
| B. Capable of identifying hazards and have authority to eliminate hazards | |
| C. Make daily inspections of excavations, areas around them, and protective systems  
  1. Before work starts and as needed  
  2. After rainstorms, high winds, or other occurrences that may increase hazards  
  3. When it can be reasonably anticipated that an employee will be exposed to hazard(s).  
  4. Remove employees exposed to hazards | |
II. Excavation Hazards

A. Cave-ins
   1. Greatest risk
   2. Open excavation is unnatural and soil wants to flow back together to fill void

B. Other potential hazards

   1. Falls
   2. Falling loads
   3. Hazardous environment – considered a confined space; can pose potential risks of oxygen deficiency, toxic fumes, and water accumulation
   4. Mobile equipment
      a. Can contribute to cave-in potential
      b. Struck-by hazard
      c. Caught-in/-between hazard
   5. Vehicular or traffic hazards
      a. High-visibility garments needed
      b. Manual on Uniform Traffic Control Devices (MUTCD)

III. Protection from Cave-ins

A. Protection from collapse must be provided for all excavations 5 feet or deeper. Workers should never enter an unprotected trench.

B. Types of protective systems
   1. Support/shoring systems
   2. Sloping and benching
   3. Shield system

IV. Protection from Excavation Hazards

A. Instability of adjacent structures
   1. Structures become unstable when soil next to them is removed
   2. Use support system to ensure stability of structure
B. Underground structures
   1. Pipe lines, water or wastewater lines, other utility lines
   2. Before digging, contact utility or owner
   3. Support, protect, or appropriately remove underground installations in open excavations

C. Spoil pile
   1. Keep at least 2 feet from edge of excavation
   2. Place pile so that rainwater runs away from excavation and not into it

D. Mobile equipment
   1. Danger of falling into excavation
   2. Use warning system
      a. Barricades
      b. Hand or mechanical signals
      c. Stop logs
   3. Grade soil with angle away from excavation, if possible

E. Falling loads
   1. Items such as tools, equipment, or construction materials falling into trench
   2. Keep items at least 2 feet from edge or use retaining device
   3. Do not allow workers to stand or work below loads being handled by lifting or digging equipment

F. Hazardous atmospheres
   1. Test for hazardous environments before employees enter excavations that are more than 4 feet deep
   2. Proper respiratory protection or ventilation must be provided when working in hazardous atmospheres
   3. Regularly test all controls used
   4. Emergency rescue equipment must be available
      a. Breathing apparatus
      b. Safety harness and line
      c. Basket stretcher

G. Water accumulation
   1. Risk of cave-in is increased, risk of drowning, increased difficulty of exiting excavation
   2. Use water removal equipment
3. Divert surface water away from excavation and provide adequate drainage of adjacent area
4. Competent person should inspect excavations after rains

H. Access/Egress
1. Entry/exit can present fall hazards if safe means of access/egress is not in place
2. Survival may depend on quick exit
3. Stairways, ladders, ramps, or other safe means provided in all trenches 4+ feet deep; means of egress within 25 lateral feet of workers

I. Hard hats
1. Danger of head injury from impact
2. Hard hats must be worn in excavations 5+ feet deep or when competent person determines hazard exists at lesser depth

V. Employer Requirements

A. Comply with all applicable OSHA standards related to excavations, including:
   1. Training requirements
   2. Inspection requirements

B. Designate a competent person, who has the appropriate experience and training, to:
   1. Identify existing and potential hazards and immediately eliminate those hazards.
   2. Make daily inspections of excavations, areas around excavations, and protective systems as required by OSHA.
   3. Remove exposed employees from hazardous area and not allow employees to return until all necessary precautions have been taken to protect them.

PPT slide #30 – #32
### Application (How students apply what they learn) | Estimated Time: ?? hours
---|---
**Key Points** | **Methods**
Show pictures of excavation sites. Have students identify any unsafe actions or conditions and discuss related best practices. | PPT slide #33 – #36

### Evaluation/Summary | Estimated Time: ?? hours
---|---
**Key Points** | **Methods**
Knowledge Check: *Excavations* | PPT slide #37 – #41

### References

**OSHA Standard:**


- 1926 Subpart P - Excavations
  - 1926.650 - Scope, application, and definitions applicable to this subpart.
  - 1926.651 - Specific Excavation Requirements.
  - 1926.652 - Requirements for protective systems.
  - 1926 Subpart P App A - Soil Classification
  - 1926 Subpart P App B - Sloping and Benching
  - 1926 Subpart P App C - Timber Shoring for Trenches
  - 1926 Subpart P App D - Aluminum Hydraulic Shoring for Trenches
  - 1926 Subpart P App E - Alternatives to Timber Shoring
  - 1926 Subpart P App F - Selection of Protective Systems
OSHA Publications


- Earth Boring Machines (1990, June 4) (English: HTML)
- Excavations (OSHA 2226 - 2002) (English: HTML PDF)
- Hazards of Inadequately Securing Hydraulic Excavator Buckets When Using Quick Coupling Devices (2005, July 22) (English: HTML PDF)
- Trench Safety QuickCard™ (OSHA 3243 - 2011) (English: PDF)
  (OSHA 3243 - 2011) (Spanish: PDF)
- Trenching and Excavation Safety Fact Sheet (OSHA FS-3480 - 2011) (Spanish: PDF)
- Trenching and Excavation Safety Fact Sheet (OSHA FS-3476 - 2011) (English: PDF)
- Trenching Poster (OSHA 3255 - 2011) (Spanish: PDF)
- Trenching Poster (OSHA 3215 - 2011) (English: PDF)
- Underground Storage Tanks (USTs) (1990, August 31) (English: HTML)

OSHA References/Resources

- Construction Safety and Health Outreach Program, Excavations, 1996
- Safety and Health Topics, Trenching and Excavations, no date
  https://www.osha.gov/SLTC/trenchingexcavation/index.html
- OSHA Construction eTool, Trenching and Excavation, 2009
- Prevention Video (v-Tool), Excavations in Construction, no date
- Prevention Video (v-Tool), Soil Classification, no date
  https://www.osha.gov/dts/vtools/construction/soil_testing_fnl_eng_web.html
Excavations

10-Hour Construction Outreach
Excavation and trenching are among the most hazardous construction operations.
Enabling Objectives:
1. Describe the role of a competent person at an excavation site.
2. Identify hazards associated with excavations.
3. Describe the methods for protecting employees from cave-ins.
4. Apply excavation hazard protection methods.
5. Recognize employer requirements to protect workers from excavation hazards.
What a competent person needs to know...

OSHA defines soil types: Stable Rock, Type A, Type B and Type C [see 1926 Subpart P Appendix A (b)].

Competent persons must be able to determine soil type based on at least one visual and one manual test performed at the job-site.

OSHA standards require that employers inspect trenches daily and as conditions change by a competent person before worker entry to ensure elimination of excavation hazards. A competent person is an individual who is capable of identifying existing and predictable hazards or working conditions that are hazardous, unsanitary, or dangerous to workers, soil types and protective systems required, and who is authorized to take prompt corrective measures to eliminate these hazards and conditions.
Inspections must be made:

1. Before work begins.
2. After rainstorms, high winds, or other occurrences that may increase hazards.
3. When it can reasonably anticipated that a worker will be exposed to hazard(s).

It is the responsibility of the competent person to make those inspections necessary to identify situations that could result in hazardous conditions (e.g., possible cave-ins, indications of failure of protective systems, hazardous atmospheres, or other hazardous conditions), and then to insure that corrective measures are taken. It is, therefore, subject to the conditions present at each individual worksite whether or not a competent person is required to be present at the jobsite at all times.

Note: Identify hazards – soil type – sloping – materials at edge of excavation
Ask the class how many of these exist in this photo?

Have the students brainstorm on what environmental hazards might be.

Ask the students which they feel is the greatest hazard?
Cave-ins pose the greatest risk and are much more likely than other excavation related accidents to result in worker fatalities.

Two workers die every month in trench collapses!
They Both Died

- A crew was installing conduit in an 8’ deep by 2’ wide trench.
- The trench collapsed.
- Two workers were buried.
- They both died!
Protection is Required

- Never enter an unprotected trench that is 5 or more in depth
- The competent person must first choose and implement a protective system
- Even excavations less than 5 feet deep need to be deemed safe by the competent person
- Cave-ins can happen without warning
How does the competent person choose the most appropriate protective system design?

Designing a protective system can be complex because they must consider many factors: soil classification, depth of cut, water content of soil, changes due to weather and climate, or other operations in the vicinity. Employers are free to choose the most practical design approach for any particular circumstance. Once they have selected an approach, however, the system must meet the required performance criteria.

Protective systems are not required when an excavation is made entirely in stable rock or is less than 5 feet (1.52 meters) deep, if a competent person has examined the ground and found no indication of a potential cave-in.
**Shoring (Shoring system)** means a structure such as a metal hydraulic, mechanical or timber shoring system that supports the sides of an excavation and which is designed to prevent cave-ins.
Shoring Concepts

- Shoring prevents cave-ins
- Shoring, if designed and installed correctly, prevents movement of the excavated wall.
- In order for the shoring to do its job, you must stay within the protection of the shoring even when entering and exiting
Imperfect Shoring

Make-shift, improperly designed shoring does little other than provide a false sense of security.
Some contractors may choose to slope the sides to an angle not steeper than 1-1/2:1; for example, for every foot of depth, the trench must be excavated back 1-1/2 feet. A slope of this gradation or less is safe for any type of soil.

Sloping at steeper angles will require the competent person to first classify the soil and then chose a slope which will protect you from cave-ins.

The photo above is actually depicting Type C soil and is not sloped properly.
Sloping Concepts

- Sloping prevents cave-ins
- Sloping, if done correctly, removes the risk of cave-ins by sloping the soil of the trench back from the trench bottom
**SHIELD (SHIELD SYSTEM)** means a structure that is able to withstand the forces imposed on it by a cave-in and thereby protect employees within the structure. Shields can be permanent structures or can be designed to be portable and moved along as work progresses.

Trench shields and boxes, if installed correctly, are designed to protect workers from the forces of a cave-in.

In order for the shield to do its job, the worker must stay within the protection of the shield even when entering and exiting.

Use a trench box or shield designed or approved by a registered professional engineer or based on tabulated data prepared or approved by a registered professional engineer.

Timber, aluminum, or other suitable materials may also be used.

**Photo hazards:** Improper use of ladder, trench plate can not be hung from strut, box is not stabilized, fall hazard trying to get in and out of box.
Shielding Concepts

- Trench shields and boxes, if installed correctly, are designed to protect workers from the forces of a cave-in
- In order for the shield to do its job, you must stay within the protection of the shield even when entering and exiting
Class discussion

Ask the class if they have ever seen anything like the photo on the left?

Next ask them if they have ever had to cross a trench this way?

Have them come up with a conclusion of the worst possible scenario should they fall.

Explain why the photo on the right represents a safer solution.
Excavations under sidewalks and pavements are prohibited unless you provide an appropriately designed support system or another effective means of support.
Before starting work, the OSHA standard requires your employer to do the following:

- Determine the approximate location of utility installations—sewer, telephone, fuel, electric, and water lines; or any other underground installations;
- Contact the utility companies or owners involved to inform them of the proposed work within established or customary local response times; and
- Ask the utility companies or owners to find the exact location of underground installations. If they cannot respond within 24 hours (unless the period required by state or local law is longer) or cannot find the exact location of the utility installations, you may proceed with caution.

When finding the exact location of underground utilities, proceed with caution, by hand or other acceptable safe means.

Potholing is a practice used to determine the location of underground utilities by digging test holes to expose such a facility.

1926.651(b)(3) When excavation operations approach the estimated location of underground installations, the exact location of the installations shall be determined by safe and acceptable means.

The use of heavy equipment, such as a backhoe, for potholing is not a preferred method due to the riskiness of this endeavor compared to other methods of potholing. [http://www.marc.org/Government/Local-Government-Services/pdf/Potholing](http://www.marc.org/Government/Local-Government-Services/pdf/Potholing)
You must be protected from excavated or other materials or equipment that could pose a hazard by falling or rolling into excavations.

Protection shall be provided by placing and keeping such materials or equipment at least 2 feet (.61 m) from the edge of excavations, or by the use of retaining devices that are sufficient to prevent materials or equipment from falling or rolling into excavations, or by a combination of both if necessary. Possibly could be further back due to “surcharge load”
When mobile equipment is operated adjacent to an excavation, the operator must have a clear and direct view of the edge of the excavation, or... A warning system shall be utilized such as barricades, hand or mechanical signals, or stop logs. If possible, the grade should be away from the excavation.
Excavations which expose workers to vehicular traffic require specific precautions and controls.

Employees exposed to public vehicular traffic shall be provided with, and shall wear, warning vests or other suitable garments marked with or made of reflectorized or high-visibility material.

All traffic control signs or devices used for protection of construction workers shall conform to Part VI of the MUTCD, 1988 Edition, Revision 3, or Part VI of the MUTCD, Millennium Edition.
Materials too close to the excavation.

**Other Photo hazards:** Improperly constructed ladder; improper protection of type C soil.
Ask the class what the potential atmospheric hazards are depicted here?

A competent person must test any excavation deeper than 4 feet (1.22 meters) or where an oxygen deficiency or a hazardous atmosphere is present or could reasonably be expected, such as a landfill or where hazardous substances are stored nearby, before an employee enters it. If there are any hazardous conditions, your employer must provide the controls such as proper respiratory protection or ventilation.

In addition, employers are responsible for regularly testing all controls used to reduce atmospheric contaminants to acceptable levels.

If unhealthful atmospheric conditions exist or develop in an excavation, they must provide emergency rescue equipment such as a breathing apparatus, safety harness and line, and basket stretcher and ensure that it is readily available. This equipment must be attended when in use.
Water changes everything and makes soil less stable.

Efforts must be made to keep water out of excavations.

Among the additional hazards stemming from water in an excavation are undermining the sides and making it more difficult to get out of the excavation. You must have adequate protection in excavations where water has accumulated or is accumulating.

If your employer uses water removal equipment to control or prevent water accumulation, you must ensure that a competent person monitors the equipment and its operation to ensure proper use.

Diversion ditches, dikes, or other suitable means can also be used to prevent surface water from entering an excavation and to provide adequate drainage of the adjacent area.

In addition, a competent person must inspect excavations subject to runoffs from heavy rains.
You must have safe access and egress when working in excavations, including ladders, steps, ramps, or other safe means of exit for employees working in trench excavations 4 feet (1.22 meters) or deeper.

These devices must be located in the excavation within 25 feet (7.62 meters) of all workers.

Any structural ramps must be designed by a competent person if they are used for employee access or egress, or by a competent person qualified in structural design if they are used for vehicles. Also, structural members used for ramps or runways must be uniform in thickness and joined in a manner to prevent tripping or displacement.
Ladders

25 feet or less
Hard Hats

- Working below grade, overhead hazards exist
- Hard hats must be worn in excavations because of overhead hazards
Responsibilities: Employer

- Employers must:
  - preplan the work and use the one-call system to identify underground utilities
  - protect you from cave-ins and other excavation-related hazards
  - inspect the excavation at least daily and throughout the shift as needed
  - take prompt corrective action when a hazard is identified
  - respond to and correct hazards pointed out by you, the worker
Responsibilities: Employer

- Employers must:
  - make sure a ladder is within 25’ of your work area when deeper than 4’
  - keep excavated dirt, rocks and other materials back 2’ from the excavation’s edge
  - Test and monitor the air within the trench in areas suspect to atmospheric hazards
Responsibilities: You

- You must:
  - work defensively
  - Follow your company’s excavation and trenching safety rules
  - correct the hazards you are able to correct
  - report to your supervisor the hazards you are unable to correct
The victims were members of a crew installing conduit in an eight-foot-deep by two-foot-wide trench. After approximately an hour, the crew leader grounded the bucket, turned the machine off and walked to the company trailer to check blueprints. As he exited the trailer, he was informed by one of the workers that the trench had collapsed and that the two employees had been covered up.

**Ask the class for 3-4 things that may have contributed to these workers losing their lives.**

**Possible Answers:** Improper safety oversight. No protective system. No way to get out. Spoil pile too close. Any others?

**Ask the class for 3-4 recommendations for preventing a similar incident.**

**Possible Answers:** Have a competent person. Evaluate the soil and implement a protective system. Have a ladder for egress. Educate workers. Any others?
**Photo left:** Unprotected trench, undermined Unsupported pavement, spoil pile too close.

**Photo middle:** Workers leaving protection of trench box. Inadequate box – open ends – need stackable box or lay sloping angle back. Unsupported utilities

**Right photo:** Fall hazard. Improperly constructed walkway – proper access egress needed

Have students propose solution for each.
Hazard Recognition

- Identify hazards and what should be done

**Photo left:** Fall hazard. Proper support? Engineering? Surcharge load of crane.

**Photo middle:** Work zone hazard, traffic with no barricades. Class of Vest?

**Photo right:** Fall hazard, undermined pavement, unprotected excavation. Engineering of all surface encumbrances.

Have students propose solutions for each.
Photo left: Unsafe loads being placed on soil. Surcharge loads. Spoil piles.

Photo middle: Workers leaving protective system, unsupported utility pipe. Inadequate protection – sloping.

Photo right: Improperly installed protective system and potential worker exposure to traffic. Surcharge load.

Have students propose solutions
Always Remember

- Never enter a trench 5’ or greater in depth unless a protective system is in place.
- Trenches less than 5’ deep still require the competent person’s “OK”
- If a trench box or shoring is used, never leave its protection while in the trench
Knowledge Check

What is the minimum distance that excavated materials, tools, and other supplies be kept back from the excavation’s edge?

a. 1 foot
b. 2 feet
c. 7.5 feet
d. 25 feet

b. 2 feet
Knowledge Check

At what depth must a ladder, ramp, steps, or runway be present for quick worker exit:
   a. 4 feet
   b. 5 feet
   c. 10 feet
   d. It is never required

a. 4 feet
Knowledge Check

What is the greatest hazard facing a worker while working in a trench:

a. Hazardous atmospheres
b. Falls
c. Cave-ins
d. Falling Objects

c. Cave-ins
Knowledge Check

Unless made in entirely stable rock, at what depth is a protective system required for a trench:

a. Any depth if the competent person says so.

b. 5 feet deep and greater

c. Both a and b

d. A protective system is never required in trenches

**c. Both a and b**
Trenching and Excavation Safety

Two workers are killed every month in trench collapses. The employer must provide a workplace free of recognized hazards that may cause serious injury or death. The employer must comply with the trenching and excavation requirements of 29 CFR 1926.651 and 1926.652 or comparable OSHA-approved state plan requirements.

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.

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).

Competent Person
OSHA standards require that employers inspect trenches daily and as conditions change by a competent person before worker entry to ensure elimination of excavation hazards. A competent person is an individual who is capable of identifying existing and predictable hazards or working conditions that are hazardous, unsanitary, or dangerous to workers, soil types and protective systems required, and who is authorized to take prompt corrective measures to eliminate these hazards and conditions.

Access and Egress
OSHA standards require safe access and egress to all excavations, including ladders, steps, ramps, or other safe means of exit for employees working in trench excavations 4 feet (1.22 meters) or deeper. These devices must be located within 25 feet (7.6 meters) of all workers.

General Trenching and Excavation Rules
- 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 > 4 feet deep.
- Inspect trenches at the start of each shift.
- Inspect trenches following a rainstorm or other water intrusion.
- Do not work under suspended or raised loads and materials.
- Inspect trenches after any occurrence that could have changed conditions in the trench.
- Ensure that personnel wear high visibility or other suitable clothing when exposed to vehicular traffic.

Protective Systems
There are different types of protective systems.

Benching means 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. **Benching cannot be done in Type C soil.**

**Sloping** involves cutting back the trench wall at an angle inclined away from the excavation.

**Shoring** requires installing aluminum hydraulic or other types of supports to prevent soil movement and cave-ins.

**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.

**Additional Information**
Visit OSHA’s Safety and Health Topics web page on trenching and excavation at

www.osha.gov/SLTC/trenchingexcavation/index.html

www.osha.gov/dcsp/statestandard.html

This is one in a series of informational fact sheets highlighting OSHA programs, policies or standards. It does not impose any new compliance requirements. For a comprehensive list of compliance requirements of OSHA standards or regulations, refer to Title 29 of the Code of Federal Regulations. This information will be made available to sensory-impaired individuals upon request. The voice phone is (202) 693-1999; teletypewriter (TTY) number: (877) 889-5627.

For assistance, contact us. We can help. It’s confidential.
Section C

Health Hazards
Lesson Plan

10-hour Construction Outreach

IDENTIFICATION

TOPIC TITLE:  Health Hazards in Construction

MINIMUM TIME:  30 minutes

OBJECTIVES

Terminal Objective:

Given current OSHA and industry information regarding worksite illnesses, injuries, and/or fatalities, the student will be able recognize how to protect themselves from common health hazards found in construction industry workplaces.

Enabling Objectives:

1. Identify common health hazards (e.g., chemical, heat stress, noise, biological, ergonomic-related).
2. Describe types of common health hazards.
3. Apply health hazard protection methods.
4. Recognize employer requirements to protect workers from health hazards in construction, including hazards communication program.

INSTRUCTOR MATERIALS AND RESOURCES

- PowerPoint Presentation: Health Hazards in Construction
- Knowledge Check Answer Key: Health Hazards in Construction

STUDENT MATERIALS

- OSHA Fact Sheets
- Knowledge Check: Health Hazards in Construction

INSTRUCTOR NOTE:

The content in this lesson plan is provided as guidance with the understanding that not all of the content can be covered in a 30-minute presentation. Therefore, it is up to the instructor to select information for his/her presentation that is appropriate for the audience in each class. The instructor should focus on hazards faced by the employees in a particular jobsite, including, but not limited to, those discussed in this topic.
Health Hazards
Lesson Plan

10-hour Construction Outreach

TEACHING PROCEDURES ---Preparation, Presentation, Application, Evaluation

**Anticipatory Set (Focus Attention/Gain Interest)**

<table>
<thead>
<tr>
<th>Key Points</th>
<th>Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workers may potentially be exposed to chemical, physical, biological,</td>
<td>PPT slide #1 – #2</td>
</tr>
<tr>
<td>and ergonomic hazards while on the job. These health hazards may cause</td>
<td></td>
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<tr>
<td>sickness, illness, or even death. However, exposure to health hazards</td>
<td></td>
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<td>may not be limited to just the worker, but to his/her family as well.</td>
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<tr>
<td>Unlike safety hazards, some health hazards can be brought home with a</td>
<td></td>
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<tr>
<td>worker, thereby exposing the family to the potential for sickness, illness,</td>
<td></td>
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<tr>
<td>or death.</td>
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</table>

**Presentation (Instruction)**

<table>
<thead>
<tr>
<th>Key Points</th>
<th>Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Common Health Hazards</td>
<td>PPT slide #3</td>
</tr>
<tr>
<td>A. Chemical</td>
<td></td>
</tr>
<tr>
<td>B. Physical</td>
<td>PPT slides #4 – #10</td>
</tr>
<tr>
<td>C. Biological</td>
<td></td>
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<tr>
<td>D. Ergonomic</td>
<td></td>
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<tr>
<td>II. Exposure Effects of Chemical Hazards and Methods of Control</td>
<td></td>
</tr>
<tr>
<td>A. Chemical hazards exist in various forms – dusts, fumes, mists,</td>
<td></td>
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<tr>
<td>aerosols, fibers, gases, vapors</td>
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<tr>
<td>B. Common ways workers encounter chemical hazards on a construction</td>
<td></td>
</tr>
<tr>
<td>worksite</td>
<td></td>
</tr>
<tr>
<td>1. Toxic atmospheres</td>
<td></td>
</tr>
<tr>
<td>a. Confined spaces</td>
<td></td>
</tr>
<tr>
<td>b. Storage tanks, process vessels, bins, boilers, ventilation or</td>
<td></td>
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<tr>
<td>exhaust ducts, sewers, underground utility vaults, tunnels,</td>
<td></td>
</tr>
<tr>
<td>pipelines, and open-top spaces more than 4 feet in depth (pits, tubs,</td>
<td></td>
</tr>
<tr>
<td>vaults, vessels)</td>
<td></td>
</tr>
</tbody>
</table>
2. Lead exposure
   a. May occur during demolition, salvage, removal, encapsulation, renovation, and clean-up activities
   b. Used in lead-based paints, lead solder, electrical fittings and conduits, tanks linings, plumbing fixtures, and many metal alloys

3. Asbestos exposure
   a. Tends to occur in construction industry and ship repair, particularly during removal of asbestos materials during renovation, repairs, or demolition
   b. Used in products such as insulation for pipes, floor tiles, building materials, and in vehicle brakes and clutches

4. Crystalline silica
   a. Abundant in earth’s crust; most common form is quartz, which is found in many construction materials such as brick and mortar, concrete, slate, granite, sandstone, stone aggregate, tile, and sand
   b. Crystalline silica is also found in asphalt filler, roofing granules, plastic composites, soils, wallboard joint compounds, paint, plaster, caulking, and putty
   c. Exposure through inhalation of small particles in air which occurs with common operations such as cutting, sawing, and drilling

5. Welding fumes
   a. Contents of fumes depend on components of the base metal, coatings, and/or filler materials, as well as the temperatures used in the welding process
   b. Metal in fumes – aluminum, antimony, arsenic, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, molybdenum, nickel, silver, tin, titanium, vanadium, and zinc
c. Gas by-products of welding
   i. Shielding – argon, helium, nitrogen, carbon dioxide
   ii. Process – nitric oxide, nitrogen dioxide, carbon monoxide, ozone, phosgene, hydrogen fluoride, carbon dioxide

C. Effects of chemical exposures
   1. May pose risk of fire and explosion hazards
   2. May put workers at risk of developing health problems such as heart ailments, central nervous system damage, kidney damage, lung damage, sterility, cancer, burns, or rashes
   3. Entry into the body
      a. Inhalation
      b. Ingestion
      c. Absorption
      d. Injection
   4. Factors affecting exposures
      a. Physical form of chemical
      b. Means of entry into the body
      c. Amount (dose) that enters the body
      d. Toxicity level of chemical
      e. Age, sex, race, and weight of individual
   5. Acute exposure versus chronic exposures
   6. Immediate body reaction versus delayed body reaction
   7. Damage to body
      a. Permanent versus reversible
      b. Localized versus systemic
   8. Examples of chemical exposure symptoms
      a. Eye, nose, throat, upper respiratory tract, and skin irritation
      b. Flu-like symptoms
      c. Difficulty breathing
      d. Fatigue
      e. Loss of coordination
      f. Memory difficulties
      g. Sleeplessness
10-hour Construction Outreach

h. Mental confusion
i. Chronic effects – depend on extent and duration of exposure

D. Methods of protecting workers against exposure to chemical hazards
1. Control methods hierarchy
   a. Engineering controls
   b. Work practice controls
   c. Administrative controls
   d. PPE
2. Substitute with safer chemicals
3. Practice good personal hygiene – wash hands and face; launder clothes daily, using proper cleaning methods
4. Monitor/measure exposure levels
5. Establish regulated work and break areas
6. Wear PPE
7. Training

III. Exposure Effects of Physical Hazards and Methods of Control

A. Types of physical hazards on construction worksites
1. Extreme temperatures
   a. Exposure occurs in both indoor and outdoor environments due to climate or working conditions
   b. Temperatures affected by humidity level, wind speed, radiant heat, physical contact with hot or cold objects, and strenuous physical activity
2. Impact or vibrating tools
   a. Hand-held and stationary tools that transmit vibration through a workpiece
   b. Examples – chainsaws, mowers, drillers, air hammers, pile drivers, tractors, graders, excavators, earth-moving equipment, and other large machinery
3. Radiation exposure – invisible, undetectable energy that travels through space
   a. Extremely Low Frequency Radiation (ELF) – produced by power lines, electrical wiring, and electrical equipment; sources of intense exposure include ELF induction furnaces and high-voltage power lines
   b. Radiofrequency (RF) and Microwave Radiation (MW) – sources include radio emitters and cell phones
   c. Infrared Radiation (IR) – sources include furnaces, heat lamps, and IR lasers
   d. Visible Light Radiation – different visible frequencies of the electromagnetic spectrum; lighting
   e. Ultraviolet Radiation (UV) – sources include the sun, black lights, welding arcs, and UV lasers; most common form of exposure for construction workers
   f. Lasers – emit optical radiations (UV, visible light, IR)

4. Noise exposure
   a. Short-term exposure to loud noises; long-term exposure to noise
   b. Examples of noise sources on construction site – tools, equipment, and heavy machinery
   c. Permissible Exposure Limit (PEL) is 90 dBA for 8-hour Time Weighted Average (TWA); this is the legal limit set by OSHA
   d. OSHA and NIOSH recommend that worker exposure to noise be controlled below a level of 85 dBA for 8-hour TWA

B. Effects of exposure to physical hazards
   1. Exposure to cold temperatures
      a. Hypothermia
         i. Body temperature drops to or below 95°F
         ii. Impaired muscular and brain functions
iii. Symptoms – uncontrolled shivering, fumbling hands/clumsy movements, slurred speech, memory loss, erratic behavior, cool bluish/purple-colored skin

b. Frostbite
i. Freezing body tissue – exposed skin susceptible when air temperature is below 0°F or when cold temperatures are combined with high winds
ii. Leads to tissue damage, scarring, and possible amputation
iii. Symptoms – pale, waxy-white skin color that is cool to touch; tingling, stinging, or aching feeling in exposed area, followed by numbness; ears, fingers, toes, and cheeks are areas primarily affected; freezing of muscles and tendons, causing areas to become numb, painless, and hard to the touch

c. Trench foot
i. Result of prolonged exposure of lower extremities to cold (32°F to 50°F) and moisture
ii. Usually develops slowly, over a period of hours to days
iii. Symptoms – initially, reddened skin, which later becomes pale and swollen; numbness, followed by leg cramps; blister formation, followed by ulceration

2. Exposure to hot temperatures

a. Heat rash – most common problem
i. Caused by sweating
ii. Looks like red cluster of pimples or small blisters; usually appears on neck, upper chest, in the groin, under the breasts, and in elbow creases
b. Heat cramps
   i. Usually occurs after prolonged exposure to heat; heavy sweating depletes body of salt and moisture
   ii. Painful cramps in abdomen and other muscles as result of decreased salt
   iii. Signs/symptoms – muscle pains or spasms in abdomen, arms, or legs; sick feeling in the stomach

c. Heat exhaustion – serious condition
   i. Caused by loss of large amounts of fluids and sometimes excessive loss of salts due to sweating during work/exercise in hot environment
   ii. Signs/symptoms – dizziness/light-headedness; weakness; heavy sweating; pale skin color; feeling sick to stomach; vomiting; irritability; fainting; moist, clammy skin

d. Heat stroke – most serious condition
   i. Serious medical condition that requires immediate attention; occurs when body is unable to control its temperature
   ii. Body’s temperature rises rapidly, sweating is diminished or absent, and body is unable to cool down; body temperature could rise to 104 °F or higher within 10-15 minutes
   iii. Warning signs – red, hot, dry skin; rapid, strong pulse; body temperature ≥104 °F; confusion; throbbing headache; dizziness; feeling sick to stomach; unconscious

3. Impact/vibrating hazards
   a. "White fingers" or Raynaud’s Syndrome
      i. Blood vessels in fingers collapse due to repeated exposure to vibration
      ii. Skin and muscle tissues do not get enough oxygen and will eventually die
b. Hand-Arm Vibration Syndrome (HAVS)
   i. More advanced condition; entire hand or arm may be affected by exposure to vibration
   ii. Early signs – infrequent feelings of numbness and/or tingling in fingers, hands, or arms, or numbness and whiteness in the tip of the finger when exposed to cold
   iii. Disease progression – more frequent attacks of numbness, tingling, and pain; difficult to use hands; may disable worker for a long period of time

c. Fatigue
d. Strains

4. Radiation
   a. Danger from radiation increases with:
      i. Lengthening duration of exposure
      ii. Shortening distance from source
   b. Stochastic health effects – associated with long-term, low-level (chronic) exposures
      i. Cancer
      ii. DNA mutations
   c. Non-stochastic health effects – appear in cases involving exposure to radiation at high levels; short-term, high-level (acute) exposure
      i. Burns
      ii. Radiation sickness – nausea, weakness, hair loss, skin burns, or diminished organ function
      iii. Can cause premature aging or even death

5. Noise
   a. Hearing loss – temporary or permanent
   b. Tinnitus (ringing in the ears)
   c. Physical and psychological stress, reduced productivity, interference with communication and concentration

http://www.epa.gov/radiation/understand/health_effects.html
d. Signs that workplace is too noisy – ringing in ears after leaving work; having to shout to be heard by co-worker an arm’s length away; experiencing temporary hearing loss when leaving work

C. Methods of protecting workers against exposure to physical hazards
   1. Extreme temperatures
      a. Use engineering controls, such as heaters and wind shields or air-conditioning and ventilation
      b. Adjust work schedules and practices to combat effects of exceedingly cold or hot weather
      c. Wear appropriate clothing for climatic conditions
      d. Use PPE such as cold weather hoods, cooling vests, and hard hat liners
   2. Impact/vibrating tools or equipment
      a. Use tools designed to reduce vibrations
      b. Allow machine to do the work; do not grip too tightly
      c. Maintain machines in proper working order
      d. Alternate tasks using vibrating and non-vibrating tools
      e. Training
      f. PPE
   3. Noise reduction
      a. Use equipment and systems that operate quietly
      b. Enclose or shield noisy equipment; erect sound barriers
      c. Keep equipment in good repair and properly maintained
      d. Use special mounts that reduce noise from vibrations
      e. Install silencers, mufflers, or baffles
      f. Weld parts rather than rivet
      g. Use acoustical material on floors, ceilings, and walls
IV. Exposure Effects of Biological Hazards and Methods of Control

A. Types of biological hazards
   1. Contact with contaminated or disease-carrying soil, water, feces, animals (including insects, rodents, etc.), or plants
   2. Contact with human blood or bodily fluids on a construction site, which may contain bloodborne pathogens such as HIV, Hepatitis B, Hepatitis C
   3. Contact with biting or puncturing organisms
   4. Exposure can occur during demolition, renovation, sewer work, or other activities that put workers in contact with biohazards
   5. Pathogens causes diseases and illnesses, including, but not limited to:
      a. Tetanus
      b. H1N1 or Swine flu
      c. Avian flu
      d. West Nile virus
      e. Lime disease
      f. Bloodborne pathogens – HIV, Hepatitis B, Hepatitis C
   6. Exposure to poisonous or harmful plants
      a. Poison ivy, poison oak, poison sumac
      b. Thorn-bearing plants
   7. Exposure to animals
      a. Mosquitoes and other biting insects, ticks, spiders, scorpions
      b. Snakes
      c. Stray or wild animals

B. Effects of exposure to biological hazards
   1. Relatively mild, allergic reactions
   2. Serious medical conditions, even death

h. Use distance between source and receiver
i. Provide hearing protection

PPT slides #15 – #17
3. Most virulent and prevalent biological agents – anthrax, avian flu, bloodborne pathogens, botulism, floodborne disease, hantavirus, Legionnaires disease, mold, plague, ricin, SARS, smallpox, tularemia, viral hemorrhagic fevers

C. Methods of protecting workers against exposure to biological hazards
   1. Practice universal precaution with blood or other bodily fluids
   2. Personal hygiene
   3. Proper first aid attention to cuts/scratches, especially on hands and forearms
   4. Proper ventilation
   5. Proper PPE
   6. Keep current on vaccinations
   7. Use insect repellent and wear clothing to ward off pathogen-carrying insects
   8. Be alert for animals in hiding under materials or debris piles

V. Exposure Effects of Ergonomic Hazards and Methods of Control

A. Types of ergonomic hazards
   1. Associated with a range of tasks, including, but not limited to, lifting, holding, pushing, walking, and reaching
   2. Examples of ergonomic hazards
      a. Heavy, frequent, or awkward lifting
      b. Awkward grips
      c. Poorly designed tools or workstations
      d. Repetitive and intensive work

B. Effects of exposure to ergonomic hazards
   1. Musculoskeletal Disorders (MSDs)
      a. Early indications – persistent pain, restriction of joint movement, soft tissue swelling
b. MSD conditions – low back pain, sciatica, rotator cuff injuries, epicondylitis, carpal tunnel syndrome, tendinitis

c. One of the leading causes of workday injury and illnesses

C. Methods of protecting workers against exposure to ergonomic hazards
   1. Use correct work practices, such as lifting techniques
   2. Ask for help when handling heavy, bulky materials
   3. Use tools ergonomically designed for job
   4. Worksite analysis and design of workstation
   5. PPE

VI. Employer Requirements

A. OSHA sets enforceable permissible exposure limits (PEL) to protect workers against the health effects of exposure to hazardous substances. PELs are regulatory limits on the amount or concentration of a substance in the air. They may also contain a skin designation. OSHA PELs are based on an 8-hour time weighted average (TWA) exposure.

B. Employees potentially exposed to a substance with a specific standard (example lead, asbestos, etc.) must be monitored and protected in accordance with that specific standard.

C. Hazard Communication Program
   1. Worker right to know
   2. Training related to hazardous chemicals to which workers are exposed
   3. Written plan
      a. Chemical present at workplace
      b. Indication of who is responsible for various aspects of the program at the worksite
c. Indication of where written materials will be available to employees
d. Labeling and Safety Data Sheets (SDS)

4. Labeling requirements for chemicals include:
   a. Pictogram
   b. Signal word
   c. Hazard and precautionary statements
   d. Product identifier
e. Supplier identification

5. Safety data sheets
   a. Employer must have SDS for each hazardous chemical they use
   b. Uniform format
      i. Section 1, Identification
      ii. Section 2, Hazard(s) Identification
      iii. Section 3, Composition/Information on Ingredients
      iv. Section 4, First-aid Measures
      v. Section 5, Fire-fighting Measures
      vi. Section 6, Accidental Release Measures
      vii. Section 7, Handling and Storage
      viii. Section 8, Exposure Controls/Personal Protection
      ix. Section 9, Physical and Chemical Properties
      x. Section 10, Stability and Reactivity
      xi. Section 11, Toxicological Information
      xii. Section 12, Ecological Information
      xiii. Section 13, Disposal Considerations
      xiv. Section 14, Transport Information
      xv. Section 15, Regulatory Information
      xvi. Section 16, Other Information
## 10-hour Construction Outreach

**Application (How students apply what they learn)**

<table>
<thead>
<tr>
<th>Key Points</th>
<th>Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Show picture of worker on construction site. Identify multiple health hazards to which the worker is exposed.</td>
<td>PPT slide #22</td>
</tr>
</tbody>
</table>

**Evaluation/Summary**

<table>
<thead>
<tr>
<th>Key Points</th>
<th>Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge Check: <em>Health Hazards in Construction</em></td>
<td>PPT slides #23 – #26</td>
</tr>
</tbody>
</table>

**References**

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- **1926 Subpart D - Occupational Health and Environmental Controls**
  - 1926.50 - Medical services and first aid.
    - 1926.50 App A - Medical services and first aid.
  - 1926.51 - Sanitation.
  - 1926.52 - Occupational noise exposure.
  - 1926.53 - Ionizing radiation.
  - 1926.54 - Nonionizing radiation.
  - 1926.55 - Gases, vapors, fumes, dusts, and mists.
    - 1926.55 App A - Gases, vapors, fumes, dusts, and mists.
  - 1926.56 - Illumination.
  - 1926.57 - Ventilation.
  - 1926.58 - [Reserved]
  - 1926.60 - Methylenedianiline.
    - 1926.60 App A - Substance Data Sheet, for 4-4’-METHYLENEDIANILINE
    - 1926.60 App B - Substance Technical Guidelines, MDA
    - 1926.60 App C - Medical Surveillance Guidelines for MDA
10-hour Construction Outreach

- 1926.60 App D - Sampling and Analytical Methods for MDA Monitoring and Measurement Procedures
- 1926.60 App E - Qualitative and Quantitative Fit Testing Procedures.
- 1926.61 - Retention of DOT markings, placards and labels.
- 1926.62 - Lead
  - 1926.62 App A - Substance Data Sheet for Occupational Exposure to Lead
  - 1926.62 App B - Employee Standard Summary
  - 1926.62 App C - Medical Surveillance Guidelines
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- 1926.64 - Process safety management of highly hazardous chemicals.
  - 1926.64 App A - List of Highly Hazardous Chemicals, Toxics and Reactives (Mandatory)
  - 1926.64 App B - Block Flow Diagram and Simplified Process Flow Diagram (Nonmandatory)
  - 1926.64 App C - Compliance Guidelines and Recommendations for Process Safety Management (Nonmandatory)
  - 1926.64 App D - Sources of Further Information (Nonmandatory)
- 1926.65 - Hazardous waste operations and emergency response.
  - 1926.65 App A - Personal Protective Equipment Test Methods
  - 1926.65 App B - General Description and Discussion of the Levels of Protection and Protective Gear
  - 1926.65 App C - Compliance Guidelines
  - 1926.65 App D - References
  - 1926.65 App E - Training Curriculum Guidelines - Non-mandatory
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  - Asbestos: Protecting Workers from Asbestos Hazards Fact Sheet (English: HTML PDF)
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    - Hexavalent Chromium (OSHA 3373 - 2009) (English: PDF)
    - Hexavalent Chromium: Controlling Exposure to Hexavalent Chromium in Aerospace and Air Transport Painting (OSHA FS-3650 - 2013) (English: PDF)
    - Hexavalent Chromium: Controlling Hazardous Fume and Gases during Welding Fact Sheet (OSHA FS-3647 - 2013) (English: HTML PDF)
    - Hexavalent Chromium: Controlling Hexavalent Chromium Exposures during Electroplating (OSHA FS-3648 - 2013) (English: HTML PDF)
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    - OSHA’s Proposed Crystalline Silica Rule: Construction Fact Sheet (OSHA FS 3700 - 2013) (Spanish: PDF)
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    - OSHA’s Proposed Crystalline Silica Rule: Information for Small Businesses Fact Sheet (OSHA FS 3685 - 2013) (English: PDF) (OSHA FS 3704 - 2013) (Spanish: PDF)
    - OSHA’s Proposed Crystalline Silica Rule: Overview Fact Sheet (OSHA FS 3683 - 2013) (English: PDF) (OSHA FS 3702 - 2013) (Spanish: PDF)
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- **Heat Illness: Protecting Workers from the Effects of Heat Fact Sheet**
  This fact sheet provides information to employers on measures they should take to prevent worker illnesses and death caused by heat stress. 3 pages (OSHA FS -3743 - 2014) (English: HTML PDF)
- **Heat Illness: Protecting Yourself in the Sun (Spanish)**
  Protecting Yourself in the Sun (OSHA 3168 - 2000) (Spanish: HTML PDF)
- **Heat Stress QuickCard™**
  Exposure to heat can cause illness and death. Learn of precautions your employer should take any time temperatures are high and the job involves physical work. 2 pages (OSHA 3154 - 2014) (English: PDF) Spanish (OSHA 3417 - 2011) (Spanish: PDF)
  Vietnamese (OSHA 3389 - 2011) (Vietnamese: PDF)
  (Portuguese: PDF) (OSHA 3565 - 2012) (Spanish: PDF)

**OSHA References/Resources**

- *Noise and Hearing Conservation* (2005), OSHA eTool,
Construction workers are exposed to a variety of health hazards, every day, that can result in injury, illness, disability, or even death.

OSHA images taken from https://www.osha.gov/dte/grant_materials/fy09/sh-19495-09.html
Workers can be exposed to a variety of health hazards on a job site, including:

- heavy metals, such as lead dust
- concrete and silica dust
- oils, greases, solvents

If not practicing good hygiene, these hazards can be brought home and expose family members as well. Protect yourself and your family by knowing what health hazards may be present at your jobsite and take appropriate actions for exposure control.
Objectives

1. Identify common health hazards.
2. Describe types of common health hazards.
3. Apply health hazard protection methods.
4. Recognize employer requirements to protect workers from health hazards in construction, including hazards communication program.
Types of health hazards include chemical, physical, biological, and ergonomic hazards. These hazards are broken down in subsequent slides.
1.) **Welding Fumes:** Common metals include aluminum, antimony, arsenic, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, molybdenum, nickel, silver, tin, titanium, vanadium, and zinc.

2.) **Asbestos:** Removal/Repair/Demolition projects. Used in insulation for pipes, tiles, and various other building materials.

3.) **Toxic Environments:** "spray-finishing operation" as the "employment of methods wherein organic or inorganic materials are utilized in dispersed form for deposit on surfaces to be coated, treated, or cleaned." This may include such diverse activities as the application of flammable and combustible liquids, such as paint, in a spray booth or spray area, electrostatic coating operations, and automobile body lining operations.

4.) **Crystalline Silica:** Brick/mortar, concrete, slate, granite, sandstone, stone aggregate, tile, and sand

5.) **Lead:** Demolition/salvage/removal/encapsulation/clean-up/renovation activities. Also used in some paints, solder, electrical fittings/conduits, tank linings, plumbing fixtures, and many metal alloys.
1. May pose risk of fire and explosion hazards (physical hazards).
2. May put workers at risk of developing health problems such as heart ailments, central nervous system damage, kidney damage, lung damage, sterility, cancer, burns, or rashes (health hazards)
**Inhalation** is the primary route of entry for hazardous chemicals in the work environment. Nearly all materials that are airborne can be inhaled.

**Ingestion** - toxic materials can be swallowed and enter the body through the gastrointestinal tract. In the workplace, people can unknowingly ingest harmful chemicals when you eat, drink, or smoke in a contaminated work areas.

**Absorption** through the skin is another route of entry. The skin is the largest organ of your body and a common exposure site for liquid and airborne chemicals. Absorption through the skin can occur quite rapidly if the skin is cut or abraded. Intact skin is an effective barrier to many hazardous materials.

**Injection** occurs when a sharp object punctures the skin, allowing a chemical or infectious agent to enter your body. For example, injection can occur when a contaminated object such as a rusty nail punctures the skin. High-pressure hydraulic oil is a common construction injection hazard. (OSHA)
**Health Hazards**

**Acute Effect** - Having an immediate response due to a short period of exposure to a relatively high concentration.

**Chronic Effect** - The health effect exhibited by the body after long term exposure to relative low concentrations of a chemical. (OSHA)

Some chemical hazards can be acute or chronic – such as Carbon Monoxide
- **Acute Symptoms:** headache, nausea, weakness, angina, dyspnea, loss of consciousness, seizures, and coma
- **Chronic Symptoms:** lethargy, listlessness, lack of motivation, sleepiness → chronic fatigue syndrome, clinical depression, or an endocrine disorder

Sources:
Newer hierarchy of hazard control. PPE is still listed as a last line of defense. (Broken down in next slide)

1.) Eliminate the hazard (if possible)
2.) Substitute hazard with safer alternative (if possible)
3.) Engineering controls: ventilation/wetting/guarding/etc.
4.) Administrative: Giving breaks/cycling work to minimize exposures/training
5.) PPE: Respirators/hearing protectors/face shields/gloves/boots/etc.
1.) Eliminate the hazard (if possible)
2.) Substitute hazard with safer alternative (if possible)
3.) Engineering controls: ventilation/wetting/guarding/etc.
4.) Administrative: Giving breaks/cycling work to minimize exposures/training
5.) PPE: Respirators/hearing protections/face shields/gloves/boots/etc.
Physical Hazards in Construction

- Noise
- Temperature extremes
- Vibration
- Radiation

Explained in subsequent slides
1.) Temperature extremes: Exposure occurs both indoor and outdoor. Temperatures affected by humidity, wind speed, radiant heat, physical contact with hot or cold surfaces, and strenuous physical activities.

2.) Radiation: ELF produced by power lines and electrical wiring/equipment, RF and microwave radiation (cell phones and radio emitters), IR (IR lasers, furnaces, and heat lamps), UV (welding arcs, UV lasers, and sun) --- UV is the most common in construction!

3.) Vibrating/Impact: Hand-held and stationary tools that transmit vibration through work piece (i.e. chainsaws, mowers, drillers, air hammers, pile drivers, tractors, graders, excavators, earth-moving equipment, and other large machinery)

4.) Noise: Short and long-term exposure to loud noises (more on next slide)
Action limit = 85 dBA
OSHA PEL = 90 dBA (8-hr TWA)

Hearing loss:
85 dBA = Prolonged
100 dBA = 15+ minutes
120 dBA = 9 seconds
140 dBA = Immediate
1.) Eliminate the hazard (if possible)
2.) Substitute hazard with safer alternative (if possible)
3.) Engineering controls: ventilation/wetting/guarding/etc.
4.) Administrative: Giving breaks/cycling work to minimize exposures/training
5.) PPE: Respirators/hearing protections/face shields/gloves/boots/etc.

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### Protection Against Physical Hazards

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Engineering Controls</th>
<th>Administrative Controls</th>
<th>PPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>Heaters; AC; windshields; ventilation</td>
<td>Water; Rest; Shade</td>
<td>Hoods; cooling vests; hard hat liners</td>
</tr>
<tr>
<td>Vibration</td>
<td>Vibration reduction equipment</td>
<td>Train not to grip too tightly; job rotation</td>
<td>Anti-vibration gloves</td>
</tr>
<tr>
<td>Noise</td>
<td>Silencers; mufflers; enclosures; sound barriers</td>
<td>Increase distance between source and worker</td>
<td>Ear plugs; muffs</td>
</tr>
</tbody>
</table>

Eliminate or substitute hazard, whenever feasible
Types of biological hazards

1. Contact with contaminated or disease-carrying soil, water, feces, animals (including insects, rodents, etc.), or plants
2. Contact with human blood or bodily fluids on a construction site, which may contain bloodborne pathogens such as HIV, Hepatitis B, Hepatitis C
3. Contact with biting or puncturing organisms
4. Exposure can occur during demolition, renovation, sewer work, or other activities that put workers in contact with biohazards
5. Pathogens causes diseases and illnesses, including, but not limited to:
   a. Tetanus
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6. Exposure to poisonous or harmful plants
   a. Poison ivy, poison oak, poison sumac
   b. Thorn-bearing plants
7. Exposure to animals
   a. Mosquitoes and other biting insects, ticks, spiders, scorpions
   b. Snakes
   c. Stray or wild animals (OSHA)
1. Relatively mild, allergic reactions
2. Serious medical conditions, even death
3. Most virulent and prevalent biological agents – anthrax, avian flu, bloodborne pathogens, botulism, floodborne disease, hantavirus, Legionnaires disease, mold, plague, ricin, SARS, smallpox, tularemia, viral hemorrhagic fevers
In order to limit your exposure to airborne mold, wear at a minimum an N-95 respirator; for higher level of protection use a 99 or 100 (H EPA) rated filter. If oil is present in the air then make sure to use either an R or a P designated filter.

The NIOSH minimum recommendation for respiratory protection for workers remediating dusty areas contaminated with highly infectious Histoplasma capsulatum spores (from bird and bat manure) is a full-facepiece respirator (APF 50).

Get vaccinated for hepatitis B and follow the universal precautions towards bloodborne pathogens. Also, practice good hygiene; hands must be washed after using toilet facilities and before preparing food.

There is no vaccine against HIV – prevention is the only defense against the virus! (OSHA)
Types of ergonomic hazards
1. Associated with a range of tasks, including, but not limited to, lifting, holding, pushing, walking, and reaching
2. Examples of ergonomic hazards:
   a. Heavy, frequent, or awkward lifting
   b. Awkward grips
   c. Poorly designed tools or workstations
   d. Repetitive and intensive work (OSHA)
Effects of exposure to ergonomic hazards
1. Musculoskeletal Disorders (MSDs)
a. Early indications – persistent pain, restriction of joint movement, soft tissue swelling
b. MSD conditions – low back pain, sciatica, rotator cuff injuries, epicondylitis, carpal tunnel syndrome, tendinitis
c. One of the leading causes of workday injury and illnesses (OSHA)

  - Epicondylitis = soreness or pain on the outside (lateral) side of the upper arm near the elbow

  - Raynaud’s Phenomenon = a condition in which cold temperatures or strong emotions cause blood vessel spasms. This blocks blood flow to the fingers, toes, ears, and nose.

  - Thoracic Outlet Syndrome = a rare condition that involves pain in the neck and shoulder, numbness and tingling of the fingers, and a weak grip. The thoracic outlet is the area between the rib cage and collar bone.

Sources:
Health Hazards
Presentation Slides

Protection Against Ergonomic Hazards

- Use ergonomically designed tools
- Use correct work practices
  - Proper lifting techniques
  - Work station setup
- Ask for help when handling:
  - Heavy loads
  - Bulky/Awkward materials
- Proper PPE

Methods of protecting workers against exposure to ergonomic hazards
1. Use correct work practices, such as lifting techniques
2. Ask for help when handling heavy, bulky materials
3. Use tools ergonomically designed for job
4. Worksite analysis and design of workstation
5. PPE
Taken from Section VI of Health Hazards Lesson Plan -- Employer Requirements:

A. OSHA sets enforceable permissible exposure limits (PEL) to protect workers against the health effects of exposure to hazardous substances. PELs are regulatory limits on the amount or concentration of a substance in the air. They may also contain a skin designation. OSHA PELs are based on an 8-hour time weighted average (TWA) exposure.

B. Employees potentially exposed to a substance with a specific standard (example lead, asbestos, etc.) must be monitored and protected in accordance with that specific standard.

C. Hazard Communication Program
   1. Worker right to know
   2. Training related to hazardous chemicals to which workers are exposed
   3. Written plan
      a. Chemical present at workplace
      b. Indication of who is responsible for various aspects of the program at the worksite
      c. Indication of where written materials will be available to employees
      d. Labeling and Safety Data Sheets (SDS)

EMPLOYERS:
• Must furnish employees a place of employment free from recognized hazards.
• Must comply with the occupational safety and health standards issued under the OSH Act. (OSHA)
Multiple health hazards

In some cases, workers can be exposed to several health hazards at the same time or on the same worksite over time.

This worker is simultaneously exposed to noise, silica dust, vibration, and ergonomic hazards.
Knowledge Check

1. Which of the following is a common type of health hazard?
   a. Chemical hazards
   b. Economic hazards
   c. Electrical hazards
   d. Fall hazards

   a. Chemical hazards
Knowledge Check

2. Which of the following is an example of a physical health hazard?
   a. Asbestos
   b. Noise
   c. Silica
   d. Lead

   b. Noise
3. Which is an appropriate engineering control for protection against noise exposures?
   a. Earplugs
   b. Earmuffs
   c. Increasing distance between source
   d. Constructing sound barriers

   d. Constructing sound barriers
Knowledge Check

4. Which is a requirement of the employer?
   a. Determine if workers’ exposures exceed OSHA PELs
   b. Perform medical evaluations on all employees
   c. Develop silica training programs for all employees
   d. Provide all workers with safety toe protective footwear

   a. Determine if workers exposures exceed OSHA PELs
Health Hazards in Construction
Questions?
Knowledge Check: Health Hazards in Construction

Answer Key

1. Which of the following is a common type of health hazard?
   a. Chemical hazards
   b. Economic hazards
   c. Electrical hazards
   d. Fall hazards

2. Which of the following is an example of a physical health hazard?
   a. Asbestos
   b. Noise
   c. Silica
   d. Lead

3. Which is an appropriate engineering control for protection against noise exposures?
   a. Audiograms
   b. Earplugs
   c. Increasing distance between source
   d. Constructing sound barriers

4. Which is a requirement of the employer?
   a. Determine if workers exposures exceed OSHA PELs
   b. Perform medical evaluations on all employees
   c. Develop silica training programs for all employees
   d. Provide workers with steel-toed boots
Protecting Workers from Asbestos Hazards

Cleaning up after a flood requires hundreds of workers to renovate and repair, or tear down and dispose of, damaged or destroyed structures and materials. However, repair, renovation, and demolition operations often generate airborne asbestos, a mineral fiber that can cause chronic lung disease or cancer. The Occupational Safety and Health Administration (OSHA) has developed regulations designed to protect cleanup workers from asbestos hazards.

How You Can Become Exposed to Asbestos
Before it was known that inhalation of asbestos fibers causes several deadly diseases—including asbestosis, a progressive and often fatal lung disease, and lung and other cancers—asbestos was used in a large number of building materials and other products because of its strength, flame resistance, and insulating properties. Asbestos was used in asbestos-cement pipe and sheathing, floor and roofing felts, dry wall, floor tiles, spray on ceiling coatings, and packing materials. When buildings containing these materials are renovated or torn down, or when the asbestos-containing materials themselves are disturbed, minute asbestos fibers may be released into the air. The fibers are so small that they often cannot be seen with the naked eye; the fact that you can inhale these fibers without knowing it makes asbestos an even more dangerous hazard.

OSHA’s Standards for Asbestos
The work of flood cleanup personnel involves the repair, renovation, removal, demolition, or salvage of flood-damaged structures and materials. Such materials may contain or be covered with asbestos, and cleanup personnel are protected by OSHA’s construction industry asbestos standard (Title 29 Code of Federal Regulations (CFR), Part 1926.1101). This standard requires employers to follow various procedures to protect their employees from inhaling asbestos fibers. The standard contains many requirements that vary depending on the kind of work being undertaken, the amount of asbestos in the air, and other factors. You and your employer can obtain a copy of this standard and the booklet, Asbestos Standards for Construction (OSHA 3096) describing how to comply with it, from OSHA Publications, P.O. Box 37535, Washington, DC 20043-7535, (202) 693-1888(phone), or (202) 693-2498(fax); or visit OSHA’s website at www.osha.gov.

Major Elements of OSHA’s Asbestos Standard
The following include some of the major requirements of the asbestos standard. For complete information on all requirements, see 29 CFR 1926.1101.

- A permissible exposure limit (PEL) of 0.1 fiber of asbestos per cubic centimeter of air as averaged over an 8-hour period, with an excursion limit of 1.0 asbestos fibers per cubic centimeter over a 30-minute period.
- Requirements for an initial exposure assessment to ascertain expected exposures during that work operation, and periodic exposure monitoring in certain instances.
- Use of engineering controls, to the extent feasible, to meet the PEL. Where this is not possible, engineering controls must be used to reduce exposures to the lowest levels possible and then supplemented by the use of appropriate respiratory protection.
Health Hazards

OSHA Information Sheets

- Use of regulated areas to limit access to locations where asbestos concentrations may be dangerously high.
- No smoking, eating, or drinking in asbestos-regulated areas.
- Requirements for warning signs and caution labels to identify and communicate the presence of hazards and hazardous materials; recordkeeping; and medical surveillance.

Additional Information
For more information on this, and other health-related issues impacting workers, visit OSHA's Web site at www.osha.gov.

This is one in a series of informational fact sheets highlighting OSHA programs, policies or standards. It does not impose any new compliance requirements. For a comprehensive list of compliance requirements of OSHA standards or regulations, refer to Title 29 of the Code of Federal Regulations. This information will be made available to sensory impaired individuals upon request. The voice phone is (202) 693-1999; teletypewriter (TTY) number: (877) 889-5627.

For more complete information:

OSHA
Occupational Safety and Health Administration
www.osha.gov
(800) 321-OSHA

U.S. Department of Labor
DSTM 9/2005
What is crystalline silica?
Crystalline silica is a basic component of soil, sand, granite, and many other minerals. Quartz is the most common form of crystalline silica. Cristobalite and tridymite are two other forms of crystalline silica. All three forms may become respirable size particles when workers chip, cut, drill, or grind objects that contain crystalline silica.

What are the hazards of crystalline silica?
Silica exposure remains a serious threat to nearly 2 million U.S. workers, including more than 100,000 workers in high risk jobs such as abrasive blasting, foundry work, stonemasonry, rock drilling, quarry work and tunneling. The seriousness of the health hazards associated with silica exposure is demonstrated by the fatalities and disabling illnesses that continue to occur in sandblasters and rockdrillers. Crystalline silica has been classified as a human lung carcinogen. Additionally, breathing crystalline silica dust can cause silicosis, which in severe cases can be disabling, or even fatal. The respirable silica dust enters the lungs and causes the formation of scar tissue, thus reducing the lungs' ability to take in oxygen. There is no cure for silicosis. Since silicosis affects lung function, it makes one more susceptible to lung infections like tuberculosis. In addition, smoking causes lung damage and adds to the damage caused by breathing silica dust.

What are the symptoms of silicosis?
Silicosis is classified into three types: chronic/classic, accelerated, and acute.

Chronic/classic silicosis, the most common, occurs after 15–20 years of moderate to low exposures to respirable crystalline silica. Symptoms associated with chronic silicosis may or may not be obvious; therefore, workers need to have a chest x-ray to determine if there is lung damage. As the disease progresses, the worker may experience shortness of breath upon exercising and have clinical signs of poor oxygen/carbon dioxide exchange. In the later stages, the worker may experience fatigue, extreme shortness of breath, chest pain, or respiratory failure.

Accelerated silicosis can occur after 5–10 years of high exposures to respirable crystalline silica. Symptoms include severe shortness of breath, weakness, and weight loss. The onset of symptoms takes longer than in acute silicosis.

Acute silicosis occurs after a few months or as long as 2 years following exposures to extremely high concentrations of respirable crystalline silica. Symptoms of acute silicosis include severe disabling shortness of breath, weakness, and weight loss, which often leads to death.

Where are construction workers exposed to crystalline silica?
Exposure occurs during many different construction activities. The most severe exposures generally occur during abrasive blasting with sand to remove paint and rust from bridges, tanks, concrete structures, and other surfaces. Other construction activities that may result in severe exposure include: jack hammering, rock/well drilling, concrete mixing, concrete cutting, concrete block cutting and sawing, tuck pointing, tunneling operations.

Where are general industry employees exposed to crystalline silica dust?
The most severe exposures to crystalline silica result from abrasive blasting, which is done to clean and smooth irregularities from molds, jewelry, and foundry castings, finish tombstones, etch or frost glass, or remove paint, oils, rust, or dirt form objects needing to be repainted or treated. Other exposures to silica dust occur in cement and brick manufacturing, asphalt pavement manufacturing, china and ceramic manufacturing and the tool and die, steel and foundry industries. Crystalline silica is used in manufacturing, household abrasives, adhesives, paints, soaps, and glass. Additionally, crystalline silica exposures occur in the maintenance, repair and replacement of refractory brick furnace linings.

In the maritime industry, shipyard employees are exposed to silica primarily in abrasive blasting operations to remove paint and clean and prepare steel hulls, bulkheads, decks, and tanks for paints and coatings.

How is OSHA addressing exposure to crystalline silica?
OSHA has an established Permissible Exposure Limit, or PEL, which is the maximum amount of crystalline silica to which workers may be exposed during an 8-hour work shift (29 CFR 1926.55, 1910.1000). OSHA also requires hazard
How can I get more information on safety and health?

OSHA has various publications, standards, technical assistance, and compliance tools to help you, and offers extensive assistance through workplace consultation, voluntary protection programs, strategic partnerships, alliances, state plans, grants, training, and education. OSHA’s Safety and Health Program Management Guidelines (Federal Register 54:3904-3916, January 26, 1989) detail elements critical to the development of a successful safety and health management system. This and other information are available on OSHA’s website.

For one free copy of OSHA publications, send a self-addressed mailing label to OSHA Publications Office, 200 Constitution Avenue N.W., N-3101, Washington, DC 20210; or send a request to our fax at (202) 693–2498, or call us toll-free at (800) 321–OSHA.

To order OSHA publications online at www.osha.gov, go to Publications and follow the instructions for ordering.

To file a complaint by phone, report an emergency, or get OSHA advice, assistance, or products, contact your nearest OSHA office under the U.S. Department of Labor listing in your phone book, or call toll-free at (800) 321–OSHA (6742). The teletypewriter (TTY) number is (877) 889–5627.

To file a complaint online or obtain more information on OSHA federal and state programs, visit OSHA’s website.

This is one in a series of informational fact sheets highlighting OSHA programs, policies, or standards. It does not impose any new compliance requirements. For a comprehensive list of compliance requirements of OSHA standards or regulations, refer to Title 29 of the Code of Federal Regulations. This information will be made available to sensory-impaired individuals upon request. The voice phone is (202) 693–1999. See also OSHA’s website at www.osha.gov.

Replace crystalline silica materials with safer substitutes, whenever possible.

Provide engineering or administrative controls, where feasible, such as local exhaust ventilation, and blasting cabinets. Where necessary to reduce exposures below the PEL, use protective equipment or other protective measures.

Use all available work practices to control dust exposures, such as water sprays.

Wear only a N95 NIOSH certified respirator, if respirator protection is required. Do not alter the respirator. Do not wear a tight-fitting respirator with a beard or mustache that prevents a good seal between the respirator and the face.

Wear only a Type CE abrasive-blast supplied-air respirator for abrasive blasting.

Wear disposable or washable work clothes and shower if facilities are available. Vacuum the dust from your clothes or change into clean clothing before leaving the work site.

Participate in training, exposure monitoring, and health screening and surveillance programs to monitor any adverse health effects caused by crystalline silica exposures.

Be aware of the operations and job tasks creating crystalline silica exposures in your workplace environment and know how to protect yourself.

Be aware of the health hazards related to exposures to crystalline silica. Smoking adds to the lung damage caused by silica exposures.

Do not eat, drink, smoke, or apply cosmetics in areas where crystalline silica dust is present. Wash your hands and face outside of dusty areas before performing any of these activities.

Remember: If it’s silica, it’s not just dust.
Protecting Workers from Lead Hazards

Cleaning up after a flood requires hundreds of workers to renovate and repair, or tear down and dispose of, damaged or destroyed structures and materials. Repair, renovation and demolition operations often generate dangerous airborne concentrations of lead, a metal that can cause damage to the nervous system, kidneys, blood forming organs, and reproductive system if inhaled or ingested in dangerous quantities. The Occupational Safety and Health Administration (OSHA) has developed regulations designed to protect workers involved in construction activities from the hazards of lead exposure.

How You Can Become Exposed to Lead

Lead is an ingredient in thousands of products widely used throughout industry, including lead-based paints, lead solder, electrical fittings and conduits, tank linings, plumbing fixtures, and many metal alloys. Although many uses of lead have been banned, lead-based paints continue to be used on bridges, railways, ships, and other steel structures because of its rust- and corrosion-inhibiting properties. Also, many homes were painted with lead-containing paints. Significant lead exposures can also occur when paint is removed from surfaces previously covered with lead-based paint.

Operations that can generate lead dust and fumes include:

- Demolition of structures;
- Flame-torch cutting;
- Welding;
- Use of heat guns, sanders, scrapers, or grinders to remove lead paint; and
- Abrasive blasting of steel structures

OSHA has regulations governing construction worker exposure to lead. Employers of construction workers engaged in the repair, renovation, removal, demolition, and salvage of flood-damaged structures and materials are responsible for the development and implementation of a worker protection program in accordance with Title 29 Code of Federal Regulations (CFR), Part 1926.62. This program is essential to minimize worker risk of lead exposure. Construction projects vary in their scope and potential for exposing workers to lead and other hazards. Many projects involve only limited exposure, such as the removal of paint from a few interior residential surfaces, while others may involve substantial exposures. Employers must be in compliance with OSHA’s lead standard at all times. A copy of the standard and a brochure—Lead in Construction (OSHA 3142) —describing how to comply with it, are available from OSHA Publications, P.O. Box 37535, Washington, D.C. 20013-7355, (202) 693-1888(phone), or (202) 693-2498(fax); or visit OSHA’s website at www.osha.gov.

Major Elements of OSHA’s Lead Standard

- A permissible exposure limit (PEL) of 50 micrograms of lead per cubic meter of air, as averaged over an 8-hour period.
- Requirements that employers use engineering controls and work practices, where feasible, to reduce worker exposure.
- Requirements that employees observe good personal hygiene practices, such as washing hands before eating and taking a shower before leaving the worksite.
- Requirements that employees be provided with protective clothing and, where necessary, with respiratory protection according to 29 CFR 1910.134.
- A requirement that employees exposed to high levels of lead be enrolled in a medical surveillance program.

**Additional Information**
For more information on this, and other health-related issues impacting workers, visit OSHA’s Web site at www.osha.gov.

This is one in a series of informational fact sheets highlighting OSHA programs, policies or standards. It does not impose any new compliance requirements. For a comprehensive list of compliance requirements of OSHA standards or regulations, refer to Title 29 of the Code of Federal Regulations. This information will be made available to sensory impaired individuals upon request. The voice phone is (202) 693-1999; teletypewriter (TTY) number: (877) 889-5627.

For more complete information:

**OSHA**
Occupational Safety and Health Administration

U.S. Department of Labor
www.osha.gov
(800) 321-OSHA

DSTM 11/2005
Materials Handling
IDENTIFICATION

TOPIC TITLE: Materials Handling, Storage, Use, and Disposal
MINIMUM TIME: 30 minutes

OBJECTIVES

Terminal Objective:
Given best practices and current OSHA and industry information regarding worksite illnesses, injuries, and/or fatalities, the student will be able to recognize how to protect themselves from hazards associated with material handling.

Enabling Objectives:
1. Identify types of material handling equipment.
2. Describe hazards associated with material handling activities (e.g., storage, use, and disposal).
3. Identify methods to prevent hazards associated with material handling equipment.
4. Recognize employer requirements to protect workers from material handling hazards.

INSTRUCTOR MATERIALS AND RESOURCES
• PowerPoint presentation: Materials Handling, Storage, Use, and Disposal
• Knowledge Check Answer Key: Materials Handling, Storage, Use, and Disposal

STUDENT MATERIALS
• Fact Sheet
• Knowledge Check: Materials Handling, Storage, Use, and Disposal
## Anticipatory Set (Focus Attention/Gain Interest)

<table>
<thead>
<tr>
<th>Key Points</th>
<th>Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Handling and storing materials involves operations such as hoisting steel with a crane, driving a truck loaded with concrete blocks, manually carrying bags, and stacking drums, lumber or loose bricks. Improper handling and storing of materials can cause costly injuries. Workers frequently cite the weight and bulkiness of objects being lifted as causes of their injuries. Bending, twisting and turning are movements that cause back injuries. Back injuries account for over 20 percent of all occupational illnesses. The majority of over-exertion cases with lost-workdays are due to lifting, pushing/pulling, and carrying. Those cases represent 27 percent of all lost-workday cases.</td>
<td>PPT slides #1 – #3</td>
</tr>
</tbody>
</table>

## Presentation (Instruction)

<table>
<thead>
<tr>
<th>Key Points</th>
<th>Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Types of Materials Handling Equipment</td>
<td>PPT slides #4 – #5</td>
</tr>
<tr>
<td>A. Conveyors</td>
<td></td>
</tr>
<tr>
<td>B. Cranes</td>
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<td>C. Slings</td>
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<tr>
<td>D. Powered Industrial Trucks</td>
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<tr>
<td>II. Hazards Associated with Materials Handling Activities</td>
<td>PPT slides #6 – #14</td>
</tr>
<tr>
<td>A. Factors cited by workers as contributors to injuries</td>
<td></td>
</tr>
<tr>
<td>1. Major contributors – weight and bulkiness of objects</td>
<td></td>
</tr>
<tr>
<td>2. Other common contributors – bending, twisting, and turning movements.</td>
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</tr>
</tbody>
</table>
B. Hazards
1. Improper operation of equipment, such as forklifts, cranes, and work trucks
2. Accumulated materials or clutter that present tripping hazards, fire/explosion hazards, or hazards associated with the harboring of rats and other pests
3. Unsafe conditions of materials or containers, such as protruding nails, dry rot, or deteriorated containers
4. Flammability or toxicity of some materials
5. Weight of materials in excess of capabilities of lifting equipment, floors, or storage shelves
6. Improperly cutting of binding ties or other devices that secure bundles or bound materials
7. Falling objects from improper handling or storage
8. Lifting, pushing, pulling, or otherwise manually moving large, heavy items
9. Improperly stacked materials that have a potential to slide, fall, or collapse leading to struck-by or crushed-by incidents
10. Struck-by or caught-in/-between hazards related to equipment, machinery, or falling loads

C. Injuries associated with materials handling
3. Commonly reported injuries
   a. Sprains, strains, tears
   b. Soreness and pain
   c. Bruises and contusions
   d. Cuts, lacerations, and punctures
4. Events or exposures leading to injuries include, but are not limited to:
   a. Contact with objects and equipment
   b. Overexertion
   c. Falls, slips, trips, or loss of balance
   d. Transportation incidents
   e. Exposure to harmful substances or environments
   f. Repetitive motion
III. Preventing Hazards Associated with Material Handling Equipment

A. Cranes
   1. Handling and storing materials often involves operations such as hoisting tons of material, steel, and concrete with cranes. Only thoroughly trained and competent workers are permitted to operate cranes.
   2. Use the following methods to eliminate or reduce hazards of crane operations:
      a. Operators should know how much they are lifting, how much it weighs, the rated capacity of the crane, and when a load is safe to lift.
      b. Always check for crane load chart and do not exceed load limits for the operating conditions.
      c. A qualified person must inspect equipment that has been modified, repaired, or adjusted and must inspect equipment post-assembly and at least every 12 months; equipment not in regular use must be inspected if idle for 3 months or more.
      d. A competent person must begin visual inspection of equipment prior to each shift that must be completed before or during the shift. A monthly inspection must also be completed before equipment can be used.

B. Slings
   1. A sling commonly connects a crane hook to a load and is an important rigging tool.
   2. To eliminate or reduce hazards, slings need to be:
      a. Inspected every day before they are used and whenever service conditions change that could warrant another inspection;
      b. Removed from service if they are found damaged or defective in any way; and,
      c. Lubricated in the field to lengthen its useful service.
d. Selected for use based on the requirements of the job. Wire rope slings are used to hoist materials. Alloy steel chain slings are the best choice for hoisting very hot materials.
e. Do not shorten slings with knots or bolts or other makeshift devices and do not kink sling legs.

C. Forklifts
1. The four main causes of injuries involving forklifts include:
   a. Forklift overturns
   b. Forklift striking workers on foot
   c. Persons crushed by forklifts
   d. Persons falling from forklifts
2. It is illegal for anyone to operate a forklift if they are under 18 years of age or over 18 years of age and not properly trained and certified to do so.
3. Use best practices for forklift operations, including:
   a. Driving the forklift
      i. Slow down and sound the horn at locations where vision is obstructed.
      ii. Look toward the travel path and keep a clear view of it.
      iii. Don’t drive up to anyone standing in front of a bench or other fixed object.
      iv. Don’t drive with the work platform elevated.
      v. Use seatbelts with ROPS.
      vi. Don’t raise or lower the forks while the forklift is moving.
      vii. Maintain safe distance approximately three truck lengths from the truck ahead.
   b. Elevating workers
      i. Don’t use a forklift to elevate workers who are standing on the forks.
      ii. Only lift personnel with approved lift platform.
      iii. Elevate a worker on an approved lift platform only when the vehicle is directly below the work area.
iv. Whenever a truck is used to elevate personnel, secure the elevating platform to the lifting carriage or forks of the forklift.

v. Use a restraining means, such as rails, chains, or a body belt with a lanyard for the worker(s) on the platform.

c. Driving on grades/ramps
   i. Use extreme caution when driving on grades or ramps.
   ii. Do not turn on grades or ramps.
   iii. On grades, tilt the load back and raise it only as far as needed to clear the road surface.
   iv. When ascending or descending grades are greater than 10%, drive loaded trucks with the load upgrade.

d. Operating speed – operate forklift at a speed that will permit it to be stopped safely.

e. Exiting the forklift
   i. When dismounting, set the parking brake, lower the forks or lifting carriage, and neutralize the controls.
   ii. Exit from a stand-up type forklift with rear-entry access by stepping backward if a lateral tip-over occurs.

f. Riding on the forklift – do not allow passengers on forklift trucks unless a seat is provided.

g. Avoiding excess weight – do not handle loads that are heavier than the weight capacity of the forklift.

h. Avoiding struck-by or crushed-by hazards.
   i. Don’t jump from an overturning, sit-down type forklift.
   ii. Stay with the truck, hold on firmly, and lean in the opposite direction of the overturn.

i. Training – do not operate a forklift without proper training and licensing.

j. Reporting damage – any damage or problems that occur to a forklift during a shift should be reported to the supervisor.
4. When dock boards are used to bridge a loading dock and a truck so the forklift can load or unload materials, follow these requirements:
   a. Use appropriate weight-rated platform to bridge space.
   b. Secure portable dock boards so that they will not move.
   c. Ensure that dock boards have handholds or some other effective way to lift, manage, or move them safely.

D. Earth-Moving Equipment
   1. Includes heavy equipment such as cranes, scrapers, loaders, crawlers, bulldozers, off-highway trucks, graders, and tractors.
   2. Must be equipped with seatbelts. Anyone sitting in the equipment must wear the seatbelts.
   3. Any equipment with an obstructed view to the rear cannot be used in reverse gear unless that piece of equipment has a back-up signal alarm or an employee signals that it is safe to do so.
   4. Operator must be properly trained.

IV. Employer Requirements

A. Comply with OSHA standards related to materials handling, including
   1. Training requirements
   2. Inspection requirements

B. Comply with manufacturers’ requirements and recommendations for materials handling equipment.

PPT slides #35 – #36
## Application (How students apply what they learn)  
**Estimated Time:** ?? hours

<table>
<thead>
<tr>
<th>Key Points</th>
<th>Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify hazards in worksite photos and discuss possible solutions.</td>
<td>PPT slides #37 – #39</td>
</tr>
<tr>
<td>Using small items (little boxes, small blocks of wood, little bags of beans, or similar items) have students practice placing materials in tiers using an acceptable method to prevent sliding, falling, or collapse (i.e., stacked, racked, blocked, interlocked, or otherwise secured).</td>
<td></td>
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<tr>
<td>Using empty boxes, have student demonstrate proper lifting techniques.</td>
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</tbody>
</table>

## Evaluation/Summary  
**Estimated Time:** ?? hours

<table>
<thead>
<tr>
<th>Key Points</th>
<th>Methods</th>
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<tbody>
<tr>
<td>Knowledge Check: <em>Materials Handling, Storage, Use and Disposal.</em></td>
<td>PPT slides #40 – #43</td>
</tr>
</tbody>
</table>
10-hour Construction Outreach

References

OSHA Standard:


- 1926 Subpart H - Materials Handling, Storage, Use, and Disposal
  - 1926.250 - General requirements for storage.
  - 1926.251 - Rigging equipment for material handling.
  - 1926.252 - Disposal of waste materials.

OSHA Publications:

- Material Hoist Collapse (2014), OSHA Fatal Facts,
  https://www.osha.gov/Publications/OSHA3718.pdf

- Materials Handling and Storage (2002 – revised), OSHA #2236,
  https://www.osha.gov/Publications/osha2236.pdf

OSHA References/Resources:

- Powered Industrial Trucks (Forklift) (2008), OSHA eTool,

- Wood Products: Sawmills – Lumber Storage (2002), OSHA eTool,

- Materials Handling and Storage (1996), Construction Safety and Health Outreach Program,
Materials Handling

Lesson Plan
Materials Handling, Storage, Use, and Disposal
10-Hour Construction Outreach

Source of graphics: OSHA
Enabling Objectives:
1. Identify types of material handling equipment.
2. Describe hazards associated with material handling activities (e.g., storage, use, and disposal).
3. Identify methods to prevent hazards associated with material handling equipment.
4. Recognize employer requirements to protect workers from material handling hazards.

Many industries rely on efficient handling and storage of materials through diverse operations to function properly. A variety of tools/equipment is used to move, store, use, and dispose of materials. For example, in construction, the following operations may exist: “hoisting tons of steel with a crane, driving a truck loaded with concrete blocks, manually carrying bags and material, and stacking drums, barrels, kegs, lumber, or loose bricks.”

"To help reduce potential accidents associated with workplace equipment, employees need to be trained in the proper use and limitations of the equipment they operate. This includes knowing how to effectively use equipment such as conveyors, [powered industrial trucks or forklifts], cranes, and slings."
"Workers frequently cite the weight and bulkiness of objects that they lift as major contributing factors to their injuries." A study from 1999 found that 420,000 back injuries occurred from workplace accidents. Causes of the injuries included lifting heavy or bulky items and bending, twisting, or turning movements.

Hazards

• Improper operation of equipment
• Accumulated materials or clutter

• Examples of improper operation of equipment – overloads, unsafe speeds,
• Poor housekeeping presents tripping hazards, fire/explosion hazards, or hazards associated with harboring pests (rats, mice, etc.)
Hazards

- Unsafe conditions of materials or containers
- Flammability or toxicity of some materials

- Examples of unsafe conditions – protruding nails, dry rot, deteriorated containers
- Primary hazards associated with flammable materials are explosion and fire.
Exceeding load capabilities of equipment, floors, or storage shelves can cause:

- Equipment to fail or turn-over/tip-over
- Falling/dropped loads
- Floors to collapse
- Storage shelves to collapse or fall over

Binding ties or other securing devices are likely under tension, which can cause them to snap or "fly-off" when cut improperly.
• Falling objects – due to improper handling or storage, overloading capacity, etc.

• Manually moving large, heavy, and/or irregularly-shaped objects can cause injuries; back injuries are a common injury associated with manual moving of heavy, bulky items
• Improperly stacked materials have potential for sliding, falling, or collapsing, which can lead to struck-by or crushed-by incidents.

• Equipment, machinery or falling loads lead to struck-by or caught-in/-between incidents

- Back injuries – lifting or bending and then twisting and turning
- Strains and sprains – improper lifting or carrying loads too large or heavy
- Fractures and bruises from – struck by materials or caught in pinch points
- Cuts and bruises – falling materials that have been improperly stacked or had ties/securing devices incorrectly cut/removed
Injuries

- Examples of events or exposures leading to injuries
  - Contact with objects and equipment
  - Transportation incidents
  - Exposure to harmful substances or environments
Analyze job tasks and identify potential hazards associated with a task; determine/use ways to control conditions/actions of the workplace to minimize dangers.

- Attach handles or holders to loads.
- Always wear appropriate personal protective equipment. "Using the following personal protective equipment prevents needless injuries when manually moving materials:
  - Hand and forearm protection, such as gloves, for loads with sharp or rough edges.
  - Eye protection.
  - Steel-toed safety shoes or boots.
  - Metal, fiber, or plastic metatarsal guards to protect the instep area from impact or compression.
  See OSHA's booklet, Personal Protective Equipment (OSHA 3077), for additional information."

- Use proper lifting techniques.
  - Break load into parts; get help with heavy or bulky items.
  - Lift with legs, keep back straight, do not twist.
  - Use handling aids – such as steps, trestles, shoulder pads, handles, and wheels.
  - Avoid lifting above shoulder level.

- "To prevent injury from oversize loads, workers should seek help in the following:
  - When a load is so bulky that employees cannot properly grasp or lift it,
  - When employees cannot see around or over a load, or
  - When employees cannot safely handle a load."

"Employees should use blocking materials to manage loads safely. Workers should also be cautious when placing blocks under a raised load to ensure that the load is not released before removing their hands from under the load. Blocking materials and timbers should be large and strong enough to support the load safely. In addition to materials with cracks,
workers should not use materials with rounded corners, splintered pieces, or dry rot for blocking."
Preventing Hazards

- Cranes
  - Major causes of crane accidents
    - Contact with power lines
    - Overturns
    - Falls
    - Mechanical failure

Crane operators:
  • Must be qualified
  • Should know what they are lifting and what it weighs

“For example, the rated capacity of mobile cranes varies with the length of the boom and the boom radius. When a crane has a telescoping boom, a load may be safe to lift at a short boom length or a short boom radius, but may overload the crane when the boom is extended and the radius increases.”
Preventing Hazards

- Eliminate/reduce crane hazards by:
  - Knowing
    - Load
    - Capacity of the crane
    - When the load is safe to lift
  - Always checking crane load chart and never exceed load limits


"To reduce the severity of an injury, employers must take the following precautions:
- Equip all cranes that have adjustable booms with boom angle indicators.
- Provide cranes with telescoping booms with some means to determine boom lengths unless the load rating is independent of the boom length.
- Post load rating charts in the cab of cab-operated cranes. (All cranes do not have uniform capacities for the same boom length and radius in all directions around the chassis of the vehicle.)
- Require workers to always check the crane's load chart to ensure that the crane will not be overloaded by operating conditions.
- Instruct workers to plan lifts before starting them to ensure that they are safe.
- Tell workers to take additional precautions and exercise extra care when operating around power lines.
- Teach workers that outriggers on mobile cranes must rest on firm ground, on timbers, or be sufficiently cribbed to spread the weight of the crane and the load over a large enough area. (Some mobile cranes cannot operate with outriggers in the traveling position.)
- Direct workers to always keep hoisting chains and ropes free of kinks or twists and never wrapped around a load.
- Train workers to attach loads to the load hook by slings, fixtures, and other devices that have the capacity to support the load on the hook.
- Instruct workers to pad sharp edges of loads to prevent cutting slings.
- Teach workers to maintain proper sling angles so that slings are not loaded in excess of their capacity."

- "Ensure that all cranes are inspected frequently by persons thoroughly familiar with the crane, the methods of inspecting the crane, and what can make the crane unserviceable. Crane activity, the severity of use, and environmental conditions should determine inspection schedules.
- Ensure that the critical parts of a crane—such as crane operating mechanisms, hooks, air, or hydraulic system components and other load-carrying components—are inspected daily for any maladjustment, deterioration, leakage, deformation, or other damage."
• Selection of slings
  “Slings are generally one of six types: chain, wire rope, metal mesh, natural fiber rope, synthetic fiber rope, or synthetic web. In general, use and inspection procedures tend to place these slings into three groups: chain, wire rope and mesh, and fiber rope web. Each type has its own particular advantages and disadvantages. Factors that should be taken into consideration when choosing the best sling for the job include the size, weight, shape, temperature, and sensitivity of the material to be moved, as well as the environmental conditions under which the sling will be used.”

• Inspection
  “Designate a competent person to conduct inspections of slings before and during use, especially when service conditions warrant.”
  Damaged or defective slings must be removed from service.
Preventing Hazards

- Reduce sling hazards by:
  - Lubricated
  - Do not shorten with knots, bolts, or other devices, or kink legs
  - Keep clear of loads
  - Avoid sudden movement


"Ensure that workers observe the following precautions when working with slings:
  • Remove immediately damaged or defective slings from service.
  • Do not shorten slings with knots or bolts or other makeshift devices.
  • Do not kink sling legs.
  • Do not load slings beyond their rated capacity.
  • Keep suspended loads clear of all obstructions.
  • Remain clear of loads about to be lifted and suspended.
  • Do not engage in shock loading.
  • Avoid sudden crane acceleration and deceleration when moving suspended loads."
Preventing Hazards

- Forklifts
  - Main causes of injuries
    - Forklift overturns
    - Forklift striking workers on foot
    - Persons crushed by forklifts
    - Persons falling from forklifts

Source: [Image]
The training provided must be applicable to the work site and working conditions. Trainees must be supervised by a competent person and may not operate trucks where they would endanger anyone.

The requirements of the standards must be taught, as well as truck-related and workplace-related topics.

Three separate aspects of powered industrial truck training must be completed:
1. Formal training – lecture, discussion, interactive computer learning, written materials
2. Practical training – demonstrations and exercises performed by the trainee
3. Evaluation – practical observance and determination of the trainees’ competence and capability


- Slow down and sound the horn at locations where vision is obstructed.
- Look toward the travel path and keep a clear view of it.
- Don’t drive up to anyone standing in front of a bench or other fixed object.
- Don’t drive with the work platform elevated.
- Use seatbelts with ROPS.
- Don’t raise or lower the forks while the forklift is moving.
- Maintain safe distance approximately three truck lengths from the truck ahead.

- Don’t use a forklift to elevate workers who are standing on the forks.
- Only lift personnel with approved lift platform; elevate a worker on an approved lift platform only when the vehicle is directly below the work area.
- Whenever a truck is used to elevate personnel, secure the elevating platform to the lifting carriage or forks of the forklift.
- Use a restraining means, such as rails, chains, or a body belt with a lanyard for the worker(s) on the platform.
- Use extreme caution when driving on grades or ramps.
- Do not turn on grades or ramps.
- On grades, tilt the load back and raise it only as far as needed to clear the road surface.
- When ascending or descending grades are greater than 10%, drive loaded trucks with the load upgrade

OSHA n.d.,
“When traveling with a load, the load should point up the incline, regardless of direction of travel.
- Going up the incline:
  • Drive forward.
  • Forks pointed upgrade.
  • Use a spotter if load blocks the driver's view.
- Going down the incline:
  • Drive in reverse.
  • Turn head and face downgrade.
  • Forks pointed up the grade.

NOTE: When walking with a pallet truck with or without a load, the forks should be pointed downgrade, regardless of direction of travel.”
Preventing Hazards

- Forklift operating speed
  - Tip-overs
  - Turning
  - Avoiding collisions
  - Wet and slippery floors
  - Ascending/descending
  - Obstructed vision

OSHA n.d.,
https://www.osha.gov/SLTC/etools/operations/maneuvering.html#operating

- Driving too fast can cause tip-overs. Slow down when turning.
- Forklifts cannot stop quickly; avoid collisions with pedestrians and obstacles by controlling speed so that forklift can be stopped in time.
- Slow down on wet and slippery floors, and when ascending or descending grades.
- Where vision is obstructed, such as cross aisles or around corners, slow down and sound horn.
• Do not exceed weight capacity of forklift.
• Center loads and secure to keep from shifting to maintain balance of weight

OSHA n.d.,
https://www.osha.gov/SLTC/etools/pit/operations/loadhandling.html

• Center load and secure.
• Heaviest part of load should be placed nearest the front wheels.
• "Do not overload. Know the stated capacity of your forklift and do not exceed it. Only by keeping within the weight limit can you operate the forklift safely."
• "A forklift’s capacity is rated for a specified load center. If the load is off-center, improperly distributed, or oversized, it may exceed capacity and unbalance the forklift."
• Use appropriate weight-rated platform to bridge space.
• Secure portable dock boards so that they will not move.
• Ensure that dock boards have handholds or some other effective way to lift, manage, or move them safely.
Exiting the forklift:
- Hands need to be clean and dry to prevent slipping when grabbing handhold.
- Get a good grip on handhold; do not grab steering wheel.
- Be careful with footing when mounting or dismounting forklift to avoid slipping; wear appropriate footwear and keep shoes clean and free from grease.
- When getting into or out of cab, pull/lower your body; do not jump out of forklift.

Riding the forklift:
- "The OSHA standard [29 CFR 1910.178(m)] states that unauthorized personnel are prohibited from riding on a forklift. If riders are authorized, a safe place must be provided.
- Unless authorized, never carry passengers -- NO RIDERS.
- Use only specialized equipment designed to raise personnel.
- Never transport employees on a platform. Employees can only be hoisted up and down.
- Never transport employees on the forks."
"For tip-overs on sit-down counterbalanced trucks:
• Don't jump. Stay in the forklift.
• Hold tight to the steering wheel.
• Brace feet.
• Lean AWAY from the impact.
• Lean forward.

Note: Tip-over procedures for other types of forklifts may vary. For example operators of stand-up forklifts with rear-entry access should step backwards off the forklift if a tip-over occurs."

OSHA n.d.,
Preventing Hazards

- Forklift Training – do not operate a forklift without proper training and licensing.

- Reporting Damage – any damage or problems that occur to a forklift during a shift should be reported to the supervisor.
Preventing Hazards

- Earth-Moving Equipment
  - Scrapers
  - Loaders
  - Crawlers
  - Bulldozers
  - Off-highway trucks
  - Graders
  - Tractors
Preventing Hazards

- Earth-Moving Equipment
  - Seatbelts
    - Reverse gear not used unless that piece of equipment has:
      - Back-up signal alarm or
      - Signaler
    - Operator properly trained

- Provide seatbelts; exceptions: equipment is designed for standup operation or equipment does not have ROPS or adequate canopy protection
- If equipment has an obstructed rear view, it cannot be used in reverse unless it has a signal alarm.
29 CFR 1926.602

Training requirements for operators of powered industrial trucks are located in 1910.178(l). Per 1910.178(l)(2)(ii), “training shall consist of a combination of formal instruction..., practical training..., and evaluation of the operator’s performance in the workplace.”
Employer Requirements

- Comply with manufacturers’ requirements and recommendations for materials handling equipment.
Left photo: Hazard – protruding wood screws; Solution – remove any protruding objects from wood

Right photo: Hazard – height of lumber pile; Solution – if being manually handled, should not exceed 16 feet high, and lumber piles shall not exceed 20 feet in height.
Recognizing Hazards

Identify potential hazards and possible solutions:

**Left photo:** Hazard - Unstable stacked materials; Solution – stack bricks in a manner that will keep them from falling, do not stack them more than 7 feet high, and taper back a loose brick stack after it is 4 feet high.

**Right photo:** Hazard – poor housekeeping, using work area for storage of materials; Solution – keep work areas free from accumulated materials that cause tripping, fires, or explosion hazards, or may contribute to harboring of pests.
Left photo: Hazard – lifting strap is damaged; Solution – remove damaged strap from service; replace lifting strap.

**1926.251(d)(6)** “Removal from service.” Natural and synthetic fiber rope slings shall be immediately removed from service if any of the following conditions are present:

- 1926.251(d)(6)(i) Abnormal wear.
- 1926.251(d)(6)(ii) Powdered fiber between strands.
- 1926.251(d)(6)(iii) Broken or cut fibers.
- 1926.251(d)(6)(iv) Variations in the size or roundness of strands.
- 1926.251(d)(6)(v) Discoloration or rotting.

Right photo: Hazard – concrete blocks placed vertically on scaffolds can fall and strike someone below; Solution – **1926.451(h)(2)** Where there is a danger of tools, materials, or equipment falling from a scaffold and striking employees below, the following provisions apply:

- 1926.451(h)(2)(i) The area below the scaffold to which objects can fall shall be barricaded, and employees shall not be permitted to enter the hazard area; or
- 1926.451(h)(2)(ii) A toeboard shall be erected along the edge of platforms more than 10 feet (3.1 m) above lower levels for a distance sufficient to protect employees below, except on float (ship) scaffolds where an edging of 3/4 x 1 1/2 inch (2 x 4 cm) wood or equivalent may be used in lieu of toeboards;
- 1926.451(h)(2)(iii) Where tools, materials, or equipment are piled to a height higher than the top edge of the toeboard, paneling or screening extending from the toeboard or platform to the top of the guardrail shall be erected for a distance sufficient to protect employees below; or
- 1926.451(h)(2)(iv) A guardrail system shall be installed with openings small enough to prevent passage of potential falling objects; or
- 1926.451(h)(2)(v) A canopy structure, debris net, or catch platform strong enough to withstand the impact forces of the potential falling objects shall be erected over the employees below.
Knowledge Check

1. How old do you have to be to operate a forklift, regardless of training?
   a. 16
   b. 18
   c. 21
   d. 25

b. You must be at least 18 years old to operate a forklift.
Knowledge Check

2. One good way to prevent materials handling hazards is to ____.
   a. refuse to allow personnel to ride equipment without a seat and seatbelt
   b. report all damaged equipment immediately
   c. operate within manufacturer’s specifications
   d. All of these.

   d. All of these are good ways to prevent materials handling hazards.
Knowledge Check

3. Which of the following is a method for eliminating or reducing crane operation hazards?
   a. Operators should know how much they are lifting as well as the rated capacity of the crane.
   b. A competent person should visually inspect the crane once a year.
   c. Never exceed the load limit by more than 10%.
   d. All of these.

   a. Crane operators should know how much they are lifting and the rated capacity of the crane.
Knowledge Check

4. Employers must comply with OSHA standards related to materials handling, including training and _____.
   a. equipment
   b. operations
   c. inspection
   d. All of these.

c. Employers must comply with OSHA standards for training and inspection.
Knowledge Check

10-hour Construction Outreach

Name: _____________________________    Date: _____________

Knowledge Check: Materials Handling, Storage, Use, and Disposal

Answer Key

1. How old do you have to be to operate a forklift, regardless of training?
   a. 16 years old
   b. **18 years old**
   c. 21 years old
   d. 25 years old

2. One good way to prevent materials handling hazards is to _____.
   a. refuse to allow personnel to ride equipment without a seat and seatbelt
   b. report all damaged equipment immediately
   c. operate within manufacturer’s specifications
   d. **All of these**

3. Which of the following is a method for eliminating or reducing crane operation hazards?
   a. Operators should know how much they are lifting as well as the rated capacity of the crane.
   b. A competent person should visually inspect the crane once a year.
   c. Never exceed the load limit by more than 10%.
   d. **All of these**

4. Employers must comply with OSHA standards related to materials handling, including training and _____.
   a. equipment
   b. operations
   c. **inspection**
   d. All of these
Worker Safety Series
Warehousing

Think Safety

- More than 145,000 people work in over 7,000 warehouses.
- The fatal injury rate for the warehousing industry is higher than the national average for all industries.
- Potential hazards for workers in warehousing:
  - Unsafe use of forklifts;
  - Improper stacking of products;
  - Failure to use proper personal protective equipment;
  - Failure to follow proper lockout/tagout procedures;
  - Inadequate fire safety provisions; or
  - Repetitive motion injuries.

Think Safety Checklists

The following checklists may help you take steps to avoid hazards that cause injuries, illnesses and fatalities. As always, be cautious and seek help if you are concerned about a potential hazard.

General Safety

- Exposed or open loading dock doors and other areas that employees could fall 4 feet or more or walk off should be chained off, roped off or otherwise blocked.
- Floors and aisles are clear of clutter, electrical cords, hoses, spills and other hazards that could cause employees to slip, trip or fall.
- Proper work practices are factored into determining the time requirements for an employee to perform a task.
- Employees performing physical work have adequate periodic rest breaks to avoid fatigue levels that could result in greater risk of accidents and reduced quality of work.
- Newly-hired employees receive general ergonomics training and task-specific training.
- The warehouse is well ventilated.
- Employees are instructed on how to avoid heat stress in hot, humid environments.
- Employees are instructed on how to work in cold environments.
- The facility has lockout/tagout procedures.

Materials Handling Safety

- There are appropriately marked and sufficiently safe clearances for aisles and at loading docks or passageways where mechanical handling equipment is used.
- Loose/unboxed materials which might fall from a pile are properly stacked by blocking, interlocking or limiting the height of the pile to prevent falling hazards.
• Bags, containers, bundles, etc. are stored in tiers that are stacked, blocked, interlocked and limited in height so that they are stable and secure to prevent sliding or collapse.
• Storage areas are kept free from accumulation of materials that could lead to tripping, fire, explosion or pest infestations.
• Excessive vegetation is removed from building entrances, work or traffic areas to prevent possible trip or fall hazards due to visual obstructions.
• Derail and/or bumper blocks are provided on spur railroad tracks where a rolling car could contact other cars being worked on and at entrances to buildings, work or traffic areas.
• Covers and/or guardrails are provided to protect personnel from the hazards of stair openings in floors, meter or equipment pits and similar hazards.
• Personnel use proper lifting techniques.
• Elevators and hoists for lifting materials/containers are properly used with adequate safe clearances, no obstructions, appropriate signals and directional warning signs.

**Hazard Communication Safety**

• All hazardous materials containers are properly labeled, indicating the chemical's identity, the manufacturer's name and address, and appropriate hazard warnings.
• There is an updated list of hazardous chemicals.
• The facility has a written program that covers hazard determination, including Material Safety Data Sheets (MSDSs), labeling and training.
• There is a system to check that each incoming chemical is accompanied by a MSDS.
• All employees are trained in the requirements of the hazard communication standard, the chemical hazards to which they are exposed, how to read and understand a MSDS and chemical labels, and on what precautions to take to prevent exposure.
• All employee training is documented.
• All outside contractors are given a complete list of chemical products, hazards and precautions.
• Procedures have been established to maintain and evaluate the effectiveness of the current program.
• Employees use proper personal protective equipment when handling chemicals.
• All chemicals are stored according to the manufacturer's recommendations and local or national fire codes.

**Forklift Safety**

• Powered industrial trucks (forklifts) meet the design and construction requirements established in American National Standard for Powered Industrial Trucks, Part II ANSI B56.1-1969.
• Written approval from the truck manufacturer has been obtained for any modifications or additions that affect the capacity and safe operation of the vehicle.
• Capacity, operation and maintenance instruction plates, tags or decals are changed to specify any modifications or additions to the vehicle.
• Nameplates and markings are in place and maintained in a legible condition.
• Forklifts that are used in hazardous locations are appropriately marked/approved for such use.
• Battery charging is conducted only in designated areas.
• Appropriate facilities are provided for flushing and neutralizing spilled electrolytes, for fire extinguishing, for protecting charging apparatus from damage by trucks and for adequate ventilation to disperse fumes from gassing batteries.
• Conveyors, overhead hoists or equivalent materials handling equipment are provided for handling batteries.
• Reinstalled batteries are properly positioned and secured.
• Carboy tilters or siphons are used for handling electrolytes.
• Forklifts are properly positioned and brakes applied before workers start to change or charge batteries.
• Vent caps are properly functioning.
• Precautions are taken to prevent smoking, open flames, sparks or electric arcs in battery charging areas and during storage/changing of propane fuel tanks.
• Tools and other metallic objects are kept away from the top of uncovered batteries.
• Concentrations of noxious gases and fumes are kept below acceptable levels.
• Forklift operators are competent to operate a vehicle safely as demonstrated by successful completion of training and evaluation conducted and certified by persons with the knowledge, training and experience to train operators and evaluate their performance.
• The training program content includes all truck-related topics, workplace related topics and the requirements of 29 CFR 1910.178 for safe truck operation.
• Refresher training and evaluation is conducted whenever an operator has been observed operating the vehicle in an unsafe manner or has been involved in an accident or a near-miss incident.
• Refresher training and evaluation is conducted whenever an operator is assigned to drive a different type of truck or whenever a condition in the workplace changes in a manner that could affect safe operation of the truck.
• Evaluations of each operator's performance are conducted at least once every three years.
• Load engaging means are fully lowered, with controls neutralized, power shut off and brakes set when a forklift is left unattended.
• Operators maintain a safe distance from the edge of ramps or platforms while using forklifts on any elevated dock, platform or freight car.
• There is sufficient headroom for the forklift and operator under overhead installations, lights, pipes, sprinkler systems, etc.
• Overhead guards are provided in good condition to protect forklift operators from falling objects.
• Operators observe all traffic regulations, including authorized plant speed limits.
• Drivers are required to look in the direction of and keep a clear view of the path of travel.
• Operators run their trucks at a speed that will permit the vehicle to stop in a safe manner.
• Dock boards (bridge plates) are properly secured when loading or unloading from dock to truck.
• Stunt driving and horseplay are prohibited.
• All loads are stable, safely arranged and fit within the rated capacity of the truck.
• Operators fill fuel tanks only when the engine is not running.
• Replacement parts of trucks are equivalent in terms of safety with those used in the original design.
• Trucks are examined for safety before being placed into service and unsafe or defective trucks are removed from service.

Full document available at:  https://www.osha.gov/Publications/warehousing.html
Section E

PPE
Lesson Plan

10-hour Construction Outreach

IDENTIFICATION

TOPIC TITLE: Personal Protective Equipment (PPE)
MINIMUM TIME: 30 minutes

OBJECTIVES

Terminal Objective:
Given current OSHA and industry information regarding worksite illnesses, injuries, and/or fatalities, the student will be able to select appropriate personal protective equipment for common construction industry hazards.

Enabling Objectives:
1. Describe the hierarchy of controls as it relates to personal protective equipment.
2. Identify types of personal protective equipment utilized in construction.
3. Explain personal protective equipment training requirements.
4. Explain the responsibilities of employers and employees regarding personal protective equipment.

INSTRUCTOR MATERIALS AND RESOURCES

• PowerPoint presentation: Personal Protective Equipment
• Examples of required PPE
• Knowledge Check Answer Key: Personal Protective Equipment

STUDENT MATERIALS

• OSHA Fact Sheet: Personal Protective Equipment
• Knowledge Check: Personal Protective Equipment
### TEACHING PROCEDURES ---Preparation, Presentation, Application, Evaluation

**Anticipatory Set (Focus Attention/Gain Interest)**

<table>
<thead>
<tr>
<th>Key Points</th>
<th>Methods</th>
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<tbody>
<tr>
<td>OSHA requires employees to protect their employees from workplace hazards through the use of engineering or work practice controls. When these controls are not feasible or do not provide sufficient protection, the use of personal protective equipment (PPE) is required. Employers are required to assess the workplace to determine if hazards are present, or are likely to be present, which necessitates the use of PPE. If employees use PPE, employers must establish general procedures, called a <em>PPE Program</em>, to give employees necessary protective equipment and to train them to use it properly. The program should explain when to use PPE and how to select, maintain, and evaluate it.</td>
<td>PPT slides #1 – #3</td>
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</table>

**Presentation (Instruction)**

<table>
<thead>
<tr>
<th>Key Points</th>
<th>Methods</th>
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<tbody>
<tr>
<td>1. Hierarchy of controls</td>
<td>Instructor-led discussion</td>
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<tr>
<td>A. Engineering controls</td>
<td>PPT slides #4 - #8</td>
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<tr>
<td>2. Isolation</td>
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<td>3. Ventilation</td>
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<td>4. Equipment modification</td>
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<td>5. Others</td>
<td></td>
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<tr>
<td>B. Administrative controls</td>
<td></td>
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<tr>
<td>1. Proper procedures</td>
<td></td>
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<tr>
<td>2. Inspection and maintenance</td>
<td></td>
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</tbody>
</table>
3. Housekeeping

4. Supervision

5. Regulated areas (no eating, drinking, smoking, chewing tobacco or gum, and applying cosmetics)

6. Limit exposure by time or distance

7. Others

C. PPE

II. Types of PPE

A. Head protection
   1. Classes of hard hats
   2. Selecting the right hard hat

B. Eye and face protection
   1. When must eye protection be provided?
   2. Criteria for selecting eye protection
   3. Employees who wear eyeglasses
   4. Examples of eye and face protection

C. Respiratory Protection

D. Hearing protection
   1. Average dBA for selected construction trades/activities
   2. When must hearing protection be provided?
   3. Examples of hearing protection

E. Hand and arm protection
   1. When must hand protection be provided?
   2. Examples of hand and arm protection

PPT slides #9 – #29


https://www.osha.gov/Publications/osha3151.html


https://www.osha.gov/Publications/osha3151.html
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F. Foot and leg protection
   1. When must foot protection be provided?
   2. Examples of foot and leg protection

G. Body protection – protective clothing
   1. Major causes of body injuries
   2. Criteria for selecting body protection
   3. Examples of body protection

III. Training employees who are required to use PPE
   A. Why PPE is necessary
   B. How PPE will protect employee
   C. What PPE can and cannot do
   D. When and how to wear PPE
   E. How to identify signs of wear and tear
   F. How to clean and disinfect PPE
   G. When PPE is worn out and how to properly dispose of PPE

IV. Responsibilities
   A. Employer
      1. Assess workplace for hazards
      2. Provide PPE at no cost to employee
      3. Determine when to use
      4. Provide PPE training

https://www.osha.gov/Publications/osha3151.html

PPT slide #30

https://www.osha.gov/Publications/osha3151.html

PPT slides #31 – #32

https://www.osha.gov/Publications/osha3151.html

B. Employee

1. Use PPE in accordance with training and other instructions
2. Inspection and maintenance
3. Turn in PPE for replacement when needed

Application (How students apply what they learn)  Estimated Time: ?? hours
Key Points
Methods

Show pictures of jobsite activities. Have students identify the hazards and PPE needed.
PPT slides #33 – #36

Evaluation/Summary  Estimated Time: ?? hours
Key Points
Methods

Summarize key points
PPT slide #37

Knowledge Check: Personal Protective Equipment
PPT slides #38 – #45
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References

OSHA Standard:

- 1926 Subpart C - General Safety and Health Provisions
  1926.28 - Personal protective equipment.

- 1926 Subpart E - Personal Protective and Life Saving Equipment
  1926.95 - Criteria for personal protective equipment.
  1926.96 - Occupational foot protection.
  1926.97 - Electrical protective equipment.
  1926.98 - [Reserved]
  1926.99 - [Reserved]
  1926.100 - Head protection.
  1926.101 - Hearing protection.
  1926.102 - Eye and face protection.
  1926.103 - Respiratory protection.
  1926.104 - Safety belts, lifelines, and lanyards.
  1926.105 - Safety nets.
  1926.106 - Working over or near water.
  1926.107 - Definitions applicable to this subpart.

OSHA Publications

- Construction PPE QuickCard™ (OSHA 3289 - 2005) (English: HTML PDF)
  (OSHA 3289) (Spanish: HTML PDF)
- Fall Prevention: Training Guide - A Lesson Plan for Employers
  (OSHA 3666 - 2014) (English: EPUB MOBI PDF)
  (OSHA 3727 - 2014) (Spanish: EPUB MOBI PDF)
- Personal Protective Equipment (OSHA 3151 - 2003) (English: HTML PDF)
- Personal Protective Equipment Fact Sheet (English: PDF) (OSHA FS 3603 - 2012)
  (Portuguese: PDF)
10-hour Construction Outreach

- Respirators QuickCard™ (OSHA 3280 - 2005) (English: [HTML PDF](#))
  (OSHA 3600 - 2012) (Portuguese: [PDF](#)) (OSHA 3280 - 2005) (Spanish: [HTML PDF](#))
- Silica: Controlling Silica Exposures in Construction (OSHA 3362 - 2009) (English: [PDF](#))

**OSHA References/Resources**

- Personal Protective Equipment (PPE) Safety and Health Topics –
Personal Protective Equipment

10-Hour Construction Outreach
OSHA requires employees to protect their employees from workplace hazards through the use of engineering or work practice controls. When these controls are not feasible or do not provide sufficient protection, the use of personal protective equipment (PPE) is required.
Objectives:
1. Describe the hierarchy of controls as it relates to personal protective equipment.
2. Identify types of personal protective equipment utilized in construction.
3. Explain personal protective equipment training requirements.
4. Explain the responsibilities of employers and employees regarding personal protective equipment.
Protecting Employees

Employers must protect employees:

- **Assess** workplace
- **Eliminate** and **reduce** hazards using engineering and administrative controls
- Then **use** appropriate personal protective equipment (PPE)
- Remember, PPE is the **last** level of control!
The Hierarchy of Control Methods

- Graphic illustrates the effectiveness of the systems used to prevent and control hazards.
- Elimination/substitution
  - Provides the highest level of protection against hazards.
  - The hazard is eliminated from the workplace or a safer item/substance is substituted for the more hazardous item/substance.
- Engineering controls are the second most effective means of protecting employees from hazards, followed by administrative and work practice controls.
- PPE - last resort; it is least effective
Engineering controls
• Requires a physical change to the workplace
• Based on the following principles: (OSHA 2001)
  • If feasible, design the facility, equipment, or process to remove the hazard.
  • If removal is not feasible, enclose the hazard to prevent exposure in normal operations.
  • Where complete enclosure is not feasible, establish barriers or local ventilation to reduce exposure to the hazard in normal operations.
• Examples
  • Isolation – hazard is enclosed prohibiting exposure to worker
  • Ventilation – air exchanges to reduce atmospheric hazards
  • Equipment modifications – reduce the hazard through design of the equipment or attachments (Examples: reduced vibration, dust collection system, noise reduction, etc.)

Administrative Controls

Includes work practices
Requires the worker or employer to do something
Examples
- Proper procedures – workplace rules and other operation-specific rules
- Inspection and maintenance – regularly inspect tools and equipment; keep them well maintained; remove from service any damaged or broken items
- Housekeeping
- Supervision
- Regulated areas – designate areas for lunch and break times; no eating, drinking, smoking, chewing tobacco or gum, and applying cosmetics in workplace
- Limit exposure by time and distance – shorten amount of time a worker is exposed to task involving the hazard; distance hazard from workers
Examples of administrative controls that could be used to reduce noise exposure are listed here. (Note: noise protection will be further discussed later in this presentation)
"When exposure to hazards cannot be engineered completely out of normal operations or maintenance work, and when safe work practices and other forms of administrative controls cannot provide sufficient additional protection, a supplementary method of control is the use of protective clothing or equipment. This is collectively called personal protective equipment, or PPE. PPE may also be appropriate for controlling hazards while engineering and work practice controls are being installed" (OSHA 2001).


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

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

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

(OSHA Publication 3151-12R, 2003)
“There are many types of hard hats available in the marketplace today. In addition to selecting protective headgear that meets ANSI standard requirements, employers should ensure that employees wear hard hats that provide appropriate protection against potential workplace hazards. It is important for employers to understand all potential hazards when making this selection, including electrical hazards. This can be done through a comprehensive hazard analysis and an awareness of the different types of protective headgear available.”

(OSHA Publication 3151-12R, 2003)

Class G hard hats are intended for general service use, such as building construction, shipbuilding, lumbering, and manufacturing. Class G hard hats provide good impact protection, but limited voltage protection (proof-tested at 2,200 volts).
Class E hard hats are designed for electrical/utility work. They protect against falling objects and provide protection against conductors with higher voltage levels (proof-tested at 20,000 volts).
Class C hard hats provide limited protection, mostly from bumps against fixed objects. Class C hard hats do not provide any protection against electrical hazards.
Employees can be exposed to a large number of hazards that pose danger to their eyes and face. OSHA requires employers to ensure that employees have appropriate eye or face protection if they are exposed to eye or face hazards from flying particles, molten metal, liquid chemicals, acids or caustic liquids, chemical gases or vapors, potentially infected material or potentially harmful light radiation.

(OSHA Publication 3151-12R, 2003)

1926.102(a)(2)
Eye and face protection equipment required by this Part shall meet the requirements specified in American National Standards Institute, Z87.1-1968, Practice for Occupational and Educational Eye and Face Protection.
Eye and face protection equipment required by this Part shall meet the requirements specified in American National Standards Institute, Z87.1-1968, Practice for Occupational and Educational Eye and Face Protection.

https://www.osha.gov/Publications/osha3151.html

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

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

(OSHA Publication 3151-12R, 2003)
Safety spectacles are intended to shield the wearer's eyes from impact hazards such as flying fragments, objects, large chips, and particles. Workers are required to use eye safety spectacles with side shields when there is a hazard from flying objects. Non-side shield spectacles are not acceptable eye protection for impact hazards. The frames of safety spectacles are constructed of metal and/or plastic and can be fitted with either corrective or plano impact-resistant lenses. Side shields may be incorporated into the frames of safety spectacles when needed. Consider each component of safety spectacles when selecting the appropriate device for your workplace.

(OSHA Eye and Face Protection eTool, 2002)
Googles "are tight-fitting eye protection that completely cover the eyes, eye sockets and the facial area immediately surrounding the eyes and provide protection from impact, dust and splashes. Some goggles will fit over corrective lenses."
(OSHA Publication 3151-12R, 2003)

https://www.osha.gov/SLTC/etools/eyeandface/ppe/impact.html#goggles

"Safety goggles are intended to shield the wearer's eyes from impact hazards such as flying fragments, objects, large chips, and particles. Goggles fit the face immediately surrounding the eyes and form a protective seal around the eyes. This prevents objects from entering under or around the goggles. Safety goggles may incorporate prescription lenses mounted behind protective lenses for individuals requiring vision correction. Take time to consider specific lens, frame, and ventilation options when selecting safety goggles."
(OSHA Eye and Face Protection eTool, 2002)
“Constructed of vulcanized fiber or fiberglass and fitted with a filtered lens, welding shields protect eyes from burns caused by infrared or intense radiant light; they also protect both the eyes and face from flying sparks, metal spatter and slag chips produced during welding, brazing, soldering and cutting operations. OSHA requires filter lenses to have a shade number appropriate to protect against the specific hazards of the work being performed in order to protect against harmful light radiation.”

(OSHA Publication 3151-12R, 2003)
Face Shields

- Protect face from nuisance dusts and potential splashes or sprays of hazardous liquids
- Shields do not protect from impact hazards unless so rated
- Shields are for face protection, not eye protection. To protect the eyes, wear safety glasses with side shields under the face shield.

https://www.osha.gov/SLTC/etools/eyeandface/ppe/impact.html#faceshields

"Face shields are intended to protect the entire face or portions of it from impact hazards such as flying fragments, objects, large chips, and particles. When worn alone, face shields do not protect employees from impact hazards. Use face shields in combination with safety spectacles or goggles, even in the absence of dust or potential splashes, for additional protection beyond that offered by spectacles or goggles alone."

(OSHA Eye and Face Protection eTool, 2002)
Employers must ensure that employees who wear prescription (Rx) lenses or contacts use personal protective equipment (PPE) that incorporates the prescription or use eye protection that can be worn over prescription lenses. Workers who wear prescription glasses must also wear required eye protection. Eye and face protection that fits comfortably over glasses is available. Safety goggles and spectacles may incorporate prescription lenses. Dust and chemicals present additional hazards to contacts wearers. OSHA recommends that workers have an extra pair of contacts or eyeglasses in case of contact failure or loss.”

(OSHA Eye and Face Protection eTool, 2002)

https://www.osha.gov/SLTC/etools/eyeandface/employer/requirements.html
In order to select an appropriate respirator you must:
- Conduct an exposure assessment to determine the type and amount of hazardous exposure
- Take into account the factors that can influence respirator selection such as job-site and worker characteristics
- Understand the assigned protection factors
- Know the various kinds of respirators and their relevant characteristics.

(OSHA Respiratory Protection eTool 1998)
Noise, or unwanted sound, is one of the most common health problems in American workplaces. The National Institute for Occupational Safety and Health (NIOSH) estimates that 30 million workers in the U.S. are exposed to hazardous noise. Exposure to high levels of noise may cause hearing loss, create physical and psychological stress, reduce productivity, interfere with communication, and contribute to accidents and injuries by making it difficult to hear warning signals.

OSHA requires employers to determine if workers are exposed to excessive noise in the workplace. If so, the employers must implement feasible engineering or administrative controls to eliminate or reduce hazardous levels of noise. Where controls are not sufficient, employers must implement an effective hearing conservation program.”

(OSHA Noise and Hearing Conservation eTool, 2005)
"Hearing protection devices (HPDs) are considered the last option to control exposures to noise. HPDs are generally used during the necessary time it takes to implement engineering or administrative controls, or when such controls are not feasible."

(OSHA Noise and Hearing Conservation eTool, 2005)

This slide shows some examples of hearing protection devices.


The Noise Reduction Rating of hearing protectors is required labeling on the hearing protector package; manufacturers must identify the noise reduction capability of the product through "laboratory-derived numerical estimate of the attenuation achieved by the protector" (OSHA n.d.).
"If a workplace hazard assessment reveals that employees face potential injury to hands and arms that cannot be eliminated through engineering and work practice controls, employers must ensure that employees wear appropriate protection. Potential hazards include skin absorption of harmful substances, chemical or thermal burns, electrical dangers, bruises, abrasions, cuts, punctures, fractures and amputations. Protective equipment includes gloves, finger guards and arm coverings or elbow-length gloves." (OSHA Publication 3151-12R, 2003)
"There are many types of gloves available today to protect against a wide variety of hazards. The nature of the hazard and the operation involved will affect the selection of gloves. The variety of potential occupational hand injuries makes selecting the right pair of gloves challenging. It is essential that employees use gloves specifically designed for the hazards and tasks found in their workplace because gloves designed for one function may not protect against a different function even though they may appear to be an appropriate protective device.

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

- Nature of contact (total immersion, splash, etc.).
- Duration of contact.
- Area requiring protection (hand only, forearm, arm).
- Grip requirements (dry, wet, oily).
- Thermal protection.
- Size and comfort.
- Abrasion/resistance requirements.
- Gloves made from a wide variety of materials are designed for many types of workplace hazards. In general, gloves fall into four groups:
  - Gloves made of leather, canvas or metal mesh;
  - Fabric and coated fabric gloves;
  - Chemical- and liquid-resistant gloves;
  - Insulating rubber gloves (See 29 CFR 1910.137 and the following section on electrical protective equipment for detailed requirements on the selection, use and care of insulating rubber gloves)."

(OSHA Publication 3151-12R, 2003)
https://www.osha.gov/Publications/osha3151.html

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

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

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

(OSHA Publication 3151-12R, 2003)
Safety shoes have impact-resistant toes and heat-resistant soles that protect the feet against hot work surfaces common in roofing, paving and hot metal industries. The metal insoles of some safety shoes protect against puncture wounds. Safety shoes may also be designed to be electrically conductive to prevent the buildup of static electricity in areas with the potential for explosive atmospheres or nonconductive to protect workers from workplace electrical hazards.

"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."

"Electrically conductive shoes provide protection against the buildup of static electricity... Employees exposed to electrical hazards must never wear conductive shoes."

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

(OSHA Publication 3151-12R, 2003)
Body Protection

- Causes of bodily injuries
  - Intense heat
  - Splashes of hot metals or hot liquids
  - Impacts from tools, machinery, or materials
  - Sharp objects
  - Hazardous chemicals
  - Contact with potentially infectious materials
  - Radiation

https://www.osha.gov/Publications/osha3151.html

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

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

(OSHA Publication 3151-12R, 2003)
There are many varieties of protective clothing available for specific hazards. Employers are required to ensure that their employees wear personal protective equipment only for the parts of the body exposed to possible injury. Examples of body protection include laboratory coats, coveralls, vests, jackets, aprons, surgical gowns and full body suits.

If a hazard assessment indicates a need for full body protection against toxic substances or harmful physical agents, the clothing should be carefully inspected before each use, it must fit each worker properly and it must function properly and for the purpose for which it is intended.

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

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

(OSHA Publication 3151-12R, 2003)
"Employers are required to train each employee who must use PPE. Employees must be trained to know at least the following: When PPE is necessary.
- What PPE is necessary.
- How to properly put on, take off, adjust and wear the PPE.
- The limitations of the PPE.
- Proper care, maintenance, useful life and disposal of PPE.

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

The employer must document the training of each employee required to wear or use PPE by preparing a certification containing the name of each employee trained, the date of training and a clear identification of the subject of the certification."

(OSHA Publication 3151-12R, 2003)
"To ensure the greatest possible protection for employees in the workplace, the cooperative efforts of both employers and employees will help in establishing and maintaining a safe and healthful work environment.

In general, employers are responsible for:
- Performing a "hazard assessment" of the workplace to identify and control physical and health hazards.
- Identifying and providing appropriate PPE for employees.
- Training employees in the use and care of the PPE.
- Maintaining PPE, including replacing worn or damaged PPE.
- Periodically reviewing, updating and evaluating the effectiveness of the PPE program."

(OSHA Publication 3151-12R, 2003)

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

The standard makes clear that employers cannot require workers to provide their own PPE and the worker's use of PPE they already own must be completely voluntary. Even when a worker provides his or her own PPE, the employer must ensure that the equipment is adequate to protect the worker from hazards at the workplace."
Examples of PPE that Employers Must Pay for Include:
• Metatarsal foot protection
• Rubber boots with steel toes
• Non-prescription eye protection
• Prescription eyewear inserts/lenses for full face respirators
• Goggles and face shields
• Fire fighting PPE (helmet, gloves, boots, proximity suits, full gear)
• Hard hats
• Hearing protection
• Welding PPE

Payment Exceptions under the OSHA Rule
Employers are not required to pay for some PPE in certain circumstances:
• Non-specialty safety-toe protective footwear (including steel-toe shoes or boots) and nonspecialty prescription safety eyewear provided that the employer permits such items to be worn off the job site. (OSHA based this decision on the fact that this type of equipment is very personal, is often used outside the workplace, and that it is taken by workers from jobsite to jobsite and employer to employer.)
• Everyday clothing, such as long-sleeve shirts, long pants, street shoes, and normal work boots.
• Ordinary clothing, skin creams, or other items, used solely for protection from weather, such as winter coats, jackets, gloves, parkas, rubber boots, hats, raincoats, ordinary sunglasses, and sunscreen
• Items such as hair nets and gloves worn by food workers for consumer safety.
• Lifting belts because their value in protecting the back is questionable.
• When the employee has lost or intentionally damaged the PPE and it must be replaced.”

(OSHA Handout #7 from Introduction to OSHA materials, Employers Must Provide and Pay for PPE)
In general, employees should:

- Properly wear PPE,
- Attend training sessions on PPE,
- Care for, clean and maintain PPE, and
- Inform a supervisor of the need to repair or replace PPE.

(OSHA Publication 3151-12R, 2003)

https://www.osha.gov/Publications/osha3151.html
Hazard identification and PPE needed:

- Floor opening with fall hazard; sharp edges on sheet metal; bump hazard overhead; potential confined space hazard
- PPE needed: fall protection; gloves, goggles, hard hat,
Hazard identification and PPE needed:
• Workers may be exposed to traffic hazards, noise, weather conditions (heat);
• Highly visible/reflective vests, hearing protection, heat-resistant soles on shoes, eye protection, gloves
Hazard identification and PPE needed:
- Worker may be exposed to respirable crystalline silica, flying particles, and noise hazards;
- Respiratory protection, eye protection, and hearing protection needed.
- (Note: worker may also be exposed to ergonomic hazards)
Hazard identification and PPE needed:
- Workers may be exposed to hazardous materials (including lead, asbestos, silica, and other chemicals or heavy metals), noise, struck-by hazards;
- PPE needed may include eye, face, head, hand, and foot protection, respiratory protection, hearing protection, and other protective clothing (such as for cutting and welding operations).
Always Remember

- Employers must:
  - Assess the workplace for hazards
  - Use engineering and work practice controls to eliminate or reduce hazards
  - Select and provide appropriate PPE at no cost to employees to protect them
Knowledge Check

1. Who is responsible for providing PPE?
   a. The employer
   b. The employee
   c. OSHA
   d. Workers’ Compensation

   a. The employer
Knowledge Check

2. Common causes of foot injuries include: crushing, penetration, molten metal, chemicals, slippery surfaces, and sharp objects.
   a. True
   b. False

   a. True
Knowledge Check

3. Safety controls must meet the following order of priority:
   a. Substitution, PPE, workaround, and administrative
   b. Workaround, stop work, PPE, and engineering
   c. Stop work, PPE, engineering, and substitution
   d. Substitution, engineering, administrative, and PPE

   d. Substitution, engineering, administrative, and PPE
Knowledge Check

4. Which type of hard hat would provide the most protection from electrical hazards?
   a. Class A
   b. Class C
   c. Class E
   d. Class G

   c. Class E
Knowledge Check

5. The need for hearing protection is triggered at which decibel level?
   a. When it exceeds 80 decibels
   b. When it exceeds 90 decibels
   c. When it exceeds 100 decibels
   d. When it exceeds 110 decibels

   **b. When it exceeds 90 decibels**
Knowledge Check

6. Who is responsible for providing specialized work footwear?
   a. The employer
   b. The employee
   c. OSHA
   d. Insurance companies

   a. The employer
Knowledge Check: PPE

Answer Key

1. Who is responsible for providing PPE?
   a. The employer
   b. The employee
   c. OSHA
   d. Workers’ Compensation

2. Common causes of foot injuries include: crushing, penetration, molten metal, chemicals, slippery surfaces, and sharp objects.
   a. True
   b. False

3. Safety controls must meet the following order of priority:
   a. Substitution, PPE, workaround, and administrative
   b. Workaround, stop work, PPE, and engineering
   c. Stop work, PPE, engineering, and substitution
   d. Substitution, engineering, administrative, and PPE

4. Which type of hard hat would provide the most protection from electrical hazards?
   a. Class A
   b. Class C
   c. Class E
   d. Class G

5. The need for hearing protection is triggered at which decibel level?
   a. When it exceeds 80 decibels
   b. When it exceeds 90 decibels
   c. When it exceeds 100 decibels
   d. When it exceeds 110 decibels
6. Who is responsible for providing specialized work footwear?
   a. The employer
   b. The employee
   c. OSHA
   d. Insurance companies

7. Which of the following is considered approved eye protection?
   a. Sun glasses
   b. Prescription glasses
   c. Reading glasses
   d. Glasses meeting ANSI standard Z87

8. Which of the following is not considered PPE?
   a. Rubber gloves
   b. Glasses meeting ANSI Z87
   c. Sports shoes
   d. Hearing muffs
Personal Protective Equipment

Personal protective equipment, or PPE, is designed to protect workers from serious workplace injuries or illnesses resulting from contact with chemical, radiological, physical, electrical, mechanical, or other workplace hazards. Besides face shields, safety glasses, hard hats, and safety shoes, protective equipment includes a variety of devices and garments such as goggles, coveralls, gloves, vests, earplugs, and respirators.

Employer Responsibilities

OSHA's primary personal protective equipment standards are in Title 29 of the Code of Federal Regulations (CFR), Part 1910 Subpart I, and equivalent regulations in states with OSHA-approved state plans, but you can find protective equipment requirements elsewhere in the General Industry Standards. For example, 29 CFR 1910.156, OSHA's Fire Brigades Standard, has requirements for firefighting gear. In addition, 29 CFR 1926.95-106 covers the construction industry. OSHA's general personal protective equipment requirements mandate that employers conduct a hazard assessment of their workplaces to determine what hazards are present that require the use of protective equipment, provide workers with appropriate protective equipment, and require them to use and maintain it in sanitary and reliable condition.

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

As an employer, you must assess your workplace to determine if hazards are present that require the use of personal protective equipment. If such hazards are present, you must select protective equipment and require workers to use it, communicate your protective equipment selection decisions to your workers, and select personal protective equipment that properly fits your workers.

You must also train workers who are required to wear personal protective equipment on how to do the following:

- Use protective equipment properly,
- Be aware of when personal protective equipment is necessary,
- Know what kind of protective equipment is necessary,
- Understand the limitations of personal protective equipment in protecting workers from injury,
- Put on, adjust, wear, and take off personal protective equipment, and
- Maintain protective equipment properly.

Protection from Head Injuries

Hard hats can protect your workers from head impact, penetration injuries, and electrical injuries such as those caused by falling or flying objects, fixed objects, or contact with electrical conductors. Also, OSHA regulations require employers to ensure that workers cover and protect long hair to prevent it from getting caught in machine parts such as belts and chains.

Protection from Foot and Leg Injuries

In addition to foot guards and safety shoes, leggings (e.g., leather, aluminized rayon, or other appropriate material) can help prevent injuries by protecting workers from hazards such as falling or rolling objects, sharp objects, wet and slippery surfaces, molten metals, hot surfaces, and electrical hazards.

Protection from Eye and Face Injuries

Besides spectacles and goggles, personal protective equipment such as special helmets or shields, spectacles with side shields, and face shields can protect workers from the hazards of flying fragments, large chips, hot sparks,
optical radiation, splashes from molten metals, as well as objects, particles, sand, dirt, mists, dusts, and glare.

**Protection from Hearing Loss**
Wearing earplugs or earmuffs can help prevent damage to hearing. Exposure to high noise levels can cause irreversible hearing loss or impairment as well as physical and psychological stress. Earplugs made from foam, waxed cotton, or fiberglass wool are self-forming and usually fit well. A professional should fit your workers individually for molded or preformed earplugs. Clean earplugs regularly, and replace those you cannot clean.

**Protection from Hand Injuries**
Workers exposed to harmful substances through skin absorption, severe cuts or lacerations, severe abrasions, chemical burns, thermal burns, and harmful temperature extremes will benefit from hand protection.

**Protection from Body Injury**
In some cases workers must shield most or all of their bodies against hazards in the workplace, such as exposure to heat and radiation as well as hot metals, scalding liquids, body fluids, hazardous materials or waste, and other hazards. In addition to fire-retardant wool and fire-retardant cotton, materials used in whole-body personal protective equipment include rubber, leather, synthetics, and plastic.

**When to Wear Respiratory Protection**
When engineering controls are not feasible, workers must use appropriate respirators to protect against adverse health effects caused by breathing air contaminated with harmful dusts, fogs, fumes, mists, gases, smokes, sprays, or vapors. Respirators generally cover the nose and mouth or the entire face or head and help prevent illness and injury. A proper fit is essential, however, for respirators to be effective. Required respirators must be NIOSH-approved and medical evaluation and training must be provided before use.

**Additional Information**

**Contacting OSHA**
To report an emergency, file a complaint or seek OSHA advice, assistance or products, call (800) 321-OSHA or contact your nearest OSHA regional or area office.
Scaffolds
Lesson Plan

IDENTIFICATION

TOPIC TITLE: Scaffolds
MINIMUM TIME: 30 minutes

OBJECTIVES

Terminal Objective:
Given best practices and current OSHA and industry information regarding worksite injuries and/or fatalities, the student will be able to recognize how to protect themselves from hazards associated with scaffolds.

Enabling Objectives:
1. Describe the role of a competent person related to scaffolding.
2. Identify the types of scaffolds commonly used on construction sites.
3. Describe hazards associated with scaffolds.
4. Discuss methods to prevent hazards associated with scaffolds.
5. Recognize employer requirements to protect workers from scaffold hazards.

INSTRUCTOR MATERIALS AND RESOURCES

- PowerPoint Presentation: Scaffolds
- Knowledge Check Answer Key: Scaffolds

STUDENT MATERIALS

- Knowledge Check: Scaffolds
- Fact Sheet
### Anticipatory Set (Focus Attention/Gain Interest)  
**Estimated Time: ?? hours**

<table>
<thead>
<tr>
<th>Key Points</th>
<th>Methods</th>
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<tbody>
<tr>
<td>Approximately 65% of construction workers frequently work on scaffolds. Scaffold-related accidents account for approximately 4,500 injuries and 50 fatalities every year.</td>
<td>PPT slides #1 – #3</td>
</tr>
<tr>
<td>“In a Bureau of Labor and Statistics (BLS) study, 72% of workers injured in scaffold accidents attributed the accident either to the planking or support giving way, or to the employee slipping or being struck by a falling object.” (OSHA SLTC)</td>
<td><a href="https://www.osha.gov/SLTC/scaffolding/index.html">https://www.osha.gov/SLTC/scaffolding/index.html</a></td>
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### Presentation (Instruction)  
**Estimated Time: ?? hours**

<table>
<thead>
<tr>
<th>Key Points</th>
<th>Methods</th>
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<tbody>
<tr>
<td>I. Competent person</td>
<td>PPT slides #4 – #5</td>
</tr>
<tr>
<td>A. Must oversee assembly and disassembly of scaffolds, inspection of scaffolds, and safe use of scaffolds.</td>
<td></td>
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<tr>
<td>B. Must train all employees who erect, disassemble, move, operate, repair, maintain, inspect, or work on scaffolds.</td>
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<tr>
<td>C. Process for determining and designating an employee as the competent person with regard to the type of scaffold to be used.</td>
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<tr>
<td>II. Basic types of scaffolds</td>
<td>PPT slide #6</td>
</tr>
<tr>
<td>A. Supported scaffold</td>
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</tr>
<tr>
<td>1. Rests on the ground and is supported by rigid legs, poles, frames, or outriggers</td>
<td></td>
</tr>
<tr>
<td>2. Usually made of metal poles or systems or of wood</td>
<td></td>
</tr>
</tbody>
</table>
B. Suspended scaffold
   1. Consists of platforms that are suspended from above by ropes or some other type of non-rigid support
   2. Can have a single suspension point or a double suspension point

C. Aerial lifts
   1. Includes vehicle-mounted or self-propelled elevating work platforms that are used to elevate personnel
   2. May be made of metal, wood, fiberglass reinforced plastic, or other material
   3. May be powered or manually operated

III. Hazards associated with scaffolds
   A. Falls – slips, unsafe access, lack of fall protection, or failure of scaffold platforms or planks are factors that lead to fall incidents.
   B. Falling object(s) – materials, debris, or tools may fall from a scaffold at any time and hit workers below.
   C. Electrical hazards – work on scaffolds near power lines exposes workers to electric shock or electrocution.
   D. Collapse hazards – scaffolds can collapse if not secured, level, or stable or if they are overloaded.
   E. Planking hazards – planks that are in poor condition (cracked, dry-rot, or otherwise weakened) or planks that are not placed properly are hazardous due to potential for failure or for people/objects to fall through them.
   F. Weather conditions – rain, snow, wind, lightning
   G. Collisions or struck by a construction vehicle or MV which could lead to tip-over

PPT slide #7
IV. Eliminating or reducing scaffolding hazards

A. Proper access
   1. Must be provided when platforms are more than two feet above or below a point of access
   2. Examples of permitted access include ladders, stair towers, ramps, and walkways
   3. Do not access work surface by climbing on crossbraces or using unapproved ladder like ends

B. Guardrails
   1. Must be installed on open sides and ends of scaffolds
   2. A guardrail or PFAS must be used if work platform is more than 14 inches away from work
   3. Toprails
      a. supported scaffolds manufactured or placed in service after 1/1/2000: must be between 38-45 inches above the platform surface
      b. all suspended or supported scaffolds manufactured or placed in service before 1/1/2000, where both a guardrail and PFAS are used, must be 36-45 inches
   4. Mid-rails
      a. Must be installed halfway between toprail and scaffold platform when used
      b. Cross-bracings used as mid-rails must be between 20-30 inches above platform

C. Personal Fall Arrest System (PFAS)
   1. PFAS – consists of anchorage, connectors, and body harness; may include a lanyard, deceleration device, lifeline, or combination of these
   2. Type of fall protection depends on kind of scaffold being used
   3. Inspect prior to each use
   4. Should not allow a free-fall of more than 6 feet; there should be prompt rescue after a fall
   5. Requirements for use of crossbracing as part of guardrail system

PPT slides #8 – #16
D. Protection from falling objects
   1. When there is potential for tools, materials, equipment, or other objects to fall from a scaffold and strike workers below, protection must be provided.
   2. Methods of providing protection:
      a. Barricades
      b. Toeboards
      c. Screens or paneling
      d. Canopy or mesh nets
      e. Placement of large, heavy objects
   3. Wear a hardhat when working around or below scaffolds

E. Protection from electrical hazards
   1. Scaffolds should not be erected, used, dismantled, altered, or moved such that they or any conductive material handled on them might come closer to exposed or energized power lines than as follows:
      a. Insulated lines – minimum distance based on voltage
         i. Less than 300 volts – 3 feet
         ii. 300 volts to 50 kilovolts – 10 feet
         iii. More than 50 kilovolts – 10 feet plus 0.4 inches for each 1 kV over 50 kV
      b. Uninsulated lines – minimum distance based on voltage
         i. Less than 50 kV – 10 feet
         ii. More than 50 kV – 10 feet plus 0.4 inches for each 1 kV over 50 kV
   2. Scaffolds can be closer to power lines than specified where necessary to perform work, but only after the utility company or electrical system operator is notified and do one of the following:
      a. De-energize or relocate the line.
      b. Install protective coverings to prevent contact with the lines.

F. Moving scaffolds
   1. Workers cannot be on scaffold when it is being moved unless the:
      a. ground surface is level,
b. height of the scaffold is not more than twice the width, and
c. outriggers are installed on both sides of the scaffold for additional leverage.

2. Workers cannot be on a part of the scaffold that is outside of the wheel base and a competent person has to be on site when the scaffold is being moved.

G. Safe Scaffold Construction and Disassembly

1. Use appropriate scaffold construction methods.
   a. Meet platform requirements
   b. Component pieces must match
   c. Erect on stable and level ground
   d. Lock wheels and braces
   e. Meet requirements for height of scaffold to base ratio
   f. Base plates/mudsills
   g. Requirements for a professional engineer (PE)

2. Provide proper scaffold access.
3. Use a competent person.

V. Employer Requirements

A. Comply with OSHA standards related to scaffolds, including
   1. Training requirements
   2. Inspection requirements
   3. Designating a Competent Person who is appropriately trained and experienced

B. Comply with manufacturers’ requirements and recommendations for scaffolding equipment.

C. Ensure scaffold is constructed according to plans designed by the Qualified Person
### Application (How students apply what they learn)  
**Estimated Time:** ?? hours  

<table>
<thead>
<tr>
<th>Key Points</th>
<th>Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Show pictures of jobsite activities. Have students identify hazards and corrective measures needed.</td>
<td>PPT slides #18 – #22</td>
</tr>
</tbody>
</table>

### Evaluation/Summary  
**Estimated Time:** ?? hours  

<table>
<thead>
<tr>
<th>Key Points</th>
<th>Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summarize key points</td>
<td>PPT slides #23 – #26</td>
</tr>
<tr>
<td>Knowledge Check: <em>Scaffolds</em></td>
<td></td>
</tr>
</tbody>
</table>

### References

**OSHA Standard:**


- 1926 Subpart L - Scaffolds
  - 1926.450 - Scope, application and definitions applicable to this subpart.
  - 1926.451 - General requirements.
  - 1926.452 - Additional requirements applicable to specific types of scaffolds.
  - 1926.453 - Aerial lifts.
  - 1926.454 - Training requirements.
  - 1926 Subpart L App A - Scaffold Specifications
  - 1926 Subpart L App B - Criteria for Determining the Feasibility of Providing Safe Access and Fall Protection for Scaffold Erectors and Dismantlers
  - 1926 Subpart L App C - List of National Consensus Standards.
  - 1926 Subpart L App E - Drawings and Illustrations.
10-hour Construction Outreach

OSHA Publications

- *A Guide to Scaffold Use in the Construction Industry* (OSHA 3150 – 2002 [Revised])
  (English: HTML PDF)

- Safety Standards for Scaffolds Used in the Construction Industry,

OSHA References/Resources

- *Scaffolding*, Safety and Health Topics, OSHA


- *Falls: Improper Scaffold Construction*, OSHA Construction eTool,

- *Scaffolding*, OSHA PPT, Handouts, and Speaker Notes,

- *Scaffolding Collapse, Welder Falls* (2005), OSHA video,
  [https://www.osha.gov/video/shipyard_accidents/06_scaffold_erection_accident.html](https://www.osha.gov/video/shipyard_accidents/06_scaffold_erection_accident.html)
Scaffolds

10-Hour Construction Outreach
Approximately 65% of construction workers frequently work on scaffolds. Scaffold-related accidents account for approximately 4,500 injuries and 50 fatalities every year.

"In a Bureau of Labor and Statistics (BLS) study, 72% of workers injured in scaffold accidents attributed the accident either to the planking or support giving way, or to the employee slipping or being struck by a falling object." (OSHA SLTC)
Enabling Objectives:
1. Describe the role of a competent person related to scaffolding.
2. Identify the types of scaffolds commonly used on construction sites.
3. Describe hazards associated with scaffolds.
4. Discuss methods to prevent hazards associated with scaffolds.
5. Recognize employer requirements to protect workers from scaffold hazards.
Competent Person

- Oversees assembly, disassembly, inspection, and safe use of scaffolds
- Trains all employees who erect, disassemble, move, operate, repair, maintain, inspect, or work on scaffolds

CFR 1926.450(b) Definitions. Competent person means one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.
Competent Person

- Process for designating an employee as the competent person:
  - Employer appointed
  - Capability to identify hazards
  - Executes qualified person design
  - Authority to take prompt corrective action
CFR 1926.450(b) Definitions.

**Supported scaffold** means one or more platforms supported by outrigger beams, brackets, poles, legs, uprights, posts, frames, or similar rigid support.

**Suspension scaffold** means one or more platforms suspended by ropes or other non-rigid means from an overhead structure(s).

CFR 1926.453(a)(1)(i-v)

**Aerial lifts** include the following types of vehicle-mounted aerial devices used to elevate personnel to job-sites above ground:

- Extensible boom platforms;
- Aerial ladders;
- Articulating boom platforms;
- Vertical towers;
- A combination of any such devices.

Aerial equipment may be made of metal, wood, fiberglass reinforced plastic (FRP), or other material; may be powered or manually operated; and are deemed to be aerial lifts whether or not they are capable of rotating about a substantially vertical axis.
Falls – slips, unsafe access, lack of fall protection, or failure of scaffold platforms or planks are factors that lead to fall incidents.

Falling object(s) – materials, debris, or tools may fall from a scaffold at any time and hit workers below.

Electrical hazards – work on scaffolds near power lines exposes workers to electric shock or electrocution.

Collapse hazards – scaffolds can collapse if not secured, level, or stable or if they are overloaded.

Planking hazards – planks that are in poor condition (cracked, dry-rot, or otherwise weakened) or planks that are not placed properly are hazardous due to potential for failure or for people/objects to fall through them.

Weather conditions – rain, snow, wind, lightning

Collisions or struck by a construction vehicle or MV which could lead to tip-over
Reducing and Eliminating Hazards

- Proper access
- Guardrails
- Personal Fall Arrest System (PFAS)
- Protection from falling objects
- Protection from electrical hazards
- Precautions for moving scaffolds
- Safe scaffold construction and disassembly
1926.451(e) "Access." This paragraph applies to scaffold access for all employees. Access requirements for employees erecting or dismantling supported scaffolds are specifically addressed in paragraph (e)(9) of this section.

1926.451(e)(1) When scaffold platforms are more than 2 feet (0.6 m) above or below a point of access, portable ladders, hook-on ladders, attachable ladders, stair towers (scaffold stairways/towers), stairway-type ladders (such as ladder stands), ramps, walkways, integral prefabricated scaffold access, or direct access from another scaffold, structure, personnel hoist, or similar surface shall be used. Crossbraces shall not be used as a means of access.

1926.451(e)(9)(i) The employer shall provide safe means of access for each employee erecting or dismantling a scaffold where the provision of safe access is feasible and does not create a greater hazard. The employer shall have a competent person determine whether it is feasible or would pose a greater hazard to provide, and have employees use a safe means of access. This determination shall be based on site conditions and the type of scaffold being erected or dismantled.
1926.451(b)(3) Except as provided in paragraphs (b)(3)(i) and (ii) of this section, the front edge of all platforms shall not be more than 14 inches (36 cm) from the face of the work, unless guardrail systems are erected along the front edge and/or personal fall arrest systems are used in accordance with paragraph (g) of this section to protect employees from falling.
When Used – All guardrail systems must include a midrail

1926.450.b Definitions. Guardrail system means a vertical barrier, consisting of, but not limited to, toprails, midrails, and posts, erected to prevent employees from falling off a scaffold platform or walkway to lower levels.

1926.451(g)(4)(iv) When midrails are used, they shall be installed at a height approximately midway between the top edge of the guardrail system and the platform surface.

1926.451(g)(4)(xv) Crossbracing is acceptable in place of a midrail when the crossing point of two braces is between 20 inches (0.5 m) and 30 inches (0.8 m) above the work platform or as a toprail when the crossing point of two braces is between 38 inches (0.97 m) and 48 inches (1.3 m) above the work platform. The end points at each upright shall be no more than 48 inches (1.3 m) apart.
In addition to meeting the requirements of 1926.502(d), personal fall arrest systems used on scaffolds shall be attached by lanyard to a vertical lifeline, horizontal lifeline, or scaffold structural member. Vertical lifelines shall not be used when overhead components, such as overhead protection or additional platform levels, are part of a single-point or two-point adjustable suspension scaffold.

1. PFAS – consists of anchorage, connectors, and body harness; may include a lanyard, deceleration device, lifeline, or combination of these
2. Type of fall protection depends on kind of scaffold being used: 1926.451(g)(1) Paragraphs (g)(1)(i) through (vii) of this section establish the types of fall protection to be provided to the employees on each type of scaffold. Paragraph (g)(2) of this section addresses fall protection for scaffold erectors and dismantlers.
3. Inspect prior to each use
4. Should not allow a free-fall of more than 6 feet; there should be prompt rescue after a fall
5. Crossbracing 1926.451(g)(4)(xv) Crossbracing is acceptable in place of a midrail when the crossing point of two braces is between 20 inches (0.5 m) and 30 inches (0.8 m) above the work platform or as a toprail when the crossing point of two braces is between 38 inches (0.97 m) and 48 inches (1.3 m) above the work platform. The end points at each upright shall be no more than 48 inches (1.3 m) apart.
In addition to wearing hardhats, each employee on a scaffold shall be provided with additional protection from falling hand tools, debris, and other small objects through the installation of toeboards, screens, or guardrail systems, or through the erection of debris nets, catch platforms, or canopy structures that contain or deflect the falling objects. When the falling objects are too large, heavy, or massive to be contained or deflected by any of the above-listed measures, the employer shall place such potential falling objects away from the edge of the surface from which they could fall and shall secure those materials as necessary to prevent their falling.
**Protection From Electrical Hazards**

- Minimum distance based on voltage
  - Insulated lines
  - Uninsulated lines
- When exceeding minimum distance as necessary to perform work, utility company must be notified to
  - De-energize or relocate line
  - Install protective coverings to prevent contact

**1926.451(f)(6)**
The clearance between scaffolds and power lines shall be as follows: Scaffolds shall not be erected, used, dismantled, altered, or moved such that they or any conductive material handled on them might come closer to exposed and energized power lines than as follows:

a. Insulated lines
   i. Less than 300 volts – 3 feet
   ii. 300 volts to 50 kilovolts – 10 feet
   iii. More than 50 kilovolts – 10 feet plus 0.4 inches for each 1 kV over 50 kV

b. Uninsulated lines
   i. Less than 50 kV – 10 feet
   ii. More than 50 kV – 10 feet plus 0.4 inches for each 1 kV over 50 kV
Moving Scaffolds

• Workers may only be on moving scaffold when
  – Level ground surface
  – Height to width ratio
  – Outriggers installed on both sides
  – Standing inside the wheel base
  – Competent person onsite

Height to width ratio means height of scaffold cannot be more than twice the width.
Appropriate scaffold construction methods include
a. Meet platform requirements  
b. Component pieces must match  
c. Erect on stable and level ground  
d. Lock wheels and braces  
e. Meet requirements for height of scaffold to base ratio  
f. Base plates/mudsills  
g. Requirements for a professional engineer (PE)

Proper Access – 1926.451(e)(9)(i) The employer shall provide safe means of access for each employee erecting or dismantling a scaffold where the provision of safe access is feasible and does not create a greater hazard. The employer shall have a competent person determine whether it is feasible or would pose a greater hazard to provide, and have employees use a safe means of access. This determination shall be based on site conditions and the type of scaffold being erected or dismantled.

Competent Person – 1926.451(f)(7) Scaffolds shall be erected, moved, dismantled, or altered only under the supervision and direction of a competent person qualified in scaffold erection, moving, dismantling or alteration. Such activities shall be performed only by experienced and trained employees selected for such work by the competent person. 1926.451(g)(2) Effective September 2, 1997, the employer shall have a competent person determine the feasibility and safety of providing fall protection for employees erecting or dismantling supported scaffolds. Employers are required to provide fall protection for employees erecting or dismantling supported scaffolds where the installation and use of such protection is feasible and does not create a greater hazard.
Employer Requirements

- Comply with OSHA standards related to scaffolds
  - Training
  - Inspection
  - Designating competent person
- Comply with manufacturers’ requirements and recommendations
- Follow plans designed by qualified person

Training: 
**1926.454(a)** The employer shall have each employee who performs work while on a scaffold trained by a person qualified in the subject matter to recognize the hazards associated with the type of scaffold being used and to understand the procedures to control or minimize those hazards.

Inspection: 
**1926.451(f)(3)** Scaffolds and scaffold components shall be inspected for visible defects by a competent person before each work shift, and after any occurrence which could affect a scaffold's structural integrity.  
**1926.451(d)(10)** Ropes shall be inspected for defects by a competent person prior to each workshift and after every occurrence which could affect a rope's integrity.
Hazards and solutions:
- Fall hazards – ladder not secured at top; no guardrails, planks extend too far
- Secure ladder at proper angle, use guardrails, use planks of proper length.
Scaffold Hazard Recognition

Identify hazards and solutions

Hazards and solutions:
• Fall hazard – no guardrails
• Use guardrails
Hazards and solutions:
- Fall hazards – ladder not fully planked; planks extend too far.
- Platform needs to be fully planked; planks should not extend more than 12” beyond the scaffold support.

**1926.451(b)(4)**
Each end of a platform, unless cleated or otherwise restrained by hooks or equivalent means, shall extend over the centerline of its support at least 6 inches (15 cm).

**1926.451(b)(5)**
**1926.451(b)(5)(i)**
Each end of a platform 10 feet or less in length shall not extend over its support more than 12 inches (30 cm) unless the platform is designed and installed so that the cantilevered portion of the platform is able to support employees and/or materials without tipping, or has guardrails which block employee access to the cantilevered end.
Scaffold Hazard Recognition

Identify hazards and solutions

Hazards and solutions:
• Items may fall from scaffolding (no toeboard); no fall protection or guardrail.
• Use toeboard; secure items to prevent from falling; use fall protection/guardrail.
Scaffold Hazard Recognition

Identify hazards and solutions

Hazards and solutions:
• Ladder is not used for intended purpose (A-Frame ladder); improper planking; questionable scaffold assembly.
• Use ladder properly and for its intended purpose; use properly assembled scaffold with proper planking.
Always Remember

- Employers must
  - Designate a competent person for scaffold
  - Ensure that employees are trained in proper assembly, disassembly, and use of scaffolds
  - Utilize strategies to prevent and reduce scaffold hazards
Knowledge Check

10-hour Construction Outreach

Name: _____________________________    Date: _____________

Knowledge Check: Scaffolds

Answer Key

1. Who trains employees that work on scaffolds?
   a. Employees do not need training
   b. Employees are responsible for their own training
   c. Fellow employees who have experience
   d. Employer-designated competent person

2. Scaffolds must be designed by a _____.
   a. competent person
   b. construction site manager
   c. qualified person
   d. experience scaffold worker

3. Which of the following is NOT an example of proper access?
   a. Ladders
   b. Crossbraces
   c. Stair towers
   d. Walkways
IG  Scaffolds
F - 36  Knowledge Check
Tube and Coupler Scaffolds — Erection and Use

Workers building scaffolds risk serious injury from falls and tip-overs, being struck by falling tools and other hazards, and electrocution from energized power lines. Before starting any scaffold project, the employer should conduct a hazard assessment to ensure the safety of workers.

A tube and coupler scaffold has a platform(s) supported by tubing, and is erected with coupling devices connecting uprights, braces, bearers, and runners (see Fig. 1). Due to their strength, these scaffolds are frequently used where heavy loads need to be carried, or where multiple platforms must reach several stories high. These scaffolds can be assembled in multiple directions, making them the preferred option for work surfaces with irregular dimensions and/or contours.

When Erecting a Scaffold
- Use footings that are level, sound, rigid and capable of supporting the load without settlement or displacement.
- Plumb and brace poles, legs, posts, frames, and uprights to prevent swaying and displacement.
- Position the first level of bracing as close to the base as possible.
- Plumb and level the scaffold as it is being erected.
- Fasten all couplers and/or connections securely before assembling the next level.
- Install guys, ties, and braces according to the manufacturer’s recommendations.
- Do not intermix scaffold components from different manufacturers, unless you can do so while maintaining the scaffold’s structural integrity.
- When platform units are abutted together to create a long platform, each abutted end must rest on a separate support surface.
- Once erected, provide toeboards on all railed sides to prevent falling object hazards.

When Using a Scaffold
- Make sure that a competent person inspects the scaffold before each work shift.
- If during the inspection a defect or damage to the scaffold is discovered, the scaffold must be tagged out and not used until repairs are made. Attach tags at the access point to the scaffold.

One common tagging system uses the following tags:

Red tag indicates: unsafe, do not use.
Green tag indicates: ready to use.

- Use scaffolds according to the manufacturer’s instructions.
- Never load a scaffold beyond its maximum intended load or rated capacity.
- Do not use makeshift methods to increase the working height of the scaffold platform, such as with ladders, buckets or blocks.
Employees must not work on platforms covered with snow, ice, or other slippery material.

The employer must provide suitable access to and between scaffolds, such as portable ladders, hook-on ladders, attachable ladders and stairway-type ladders.

### When Dismantling a Scaffold

Check to ensure that the scaffold has not been structurally altered in a way which would make it unsafe. Before beginning dismantling procedures, reconstruct and/or stabilize the scaffold as necessary.

### Training Workers

Only trained and authorized persons should be allowed to use a scaffold. This training must be provided by a qualified person who understands the hazards associated with the type of scaffold being used and who knows the procedures to control or minimize those hazards. Training must include how to safely:

- Use the scaffold, handle materials on the scaffold and determine the maximum load limits when handling materials.
- Recognize and avoid scaffolding hazards such as electric shock, falls from heights, and being hit by falling objects.
- Erect, maintain and disassemble fall and falling object protection systems.

Erectors and dismantlers of tube and coupler scaffolds are at particular risk because their work starts before ladders, guardrails and platforms are completely installed. These workers must also be trained to:

- Recognize scaffold hazards.
- Properly erect, move, operate, repair, inspect, maintain and disassemble the scaffold; identify the maximum load-carrying capacity and intended use of the scaffold.

Employers should train workers on the following safety factors:

- The shape and structure of the building to be scaffolded.
- Distinctive site conditions and any special features of the building structure in relation to the scaffold (i.e., overhead electric power lines or storage tanks). Also consider the proximity and condition of surrounding buildings.
- Weather and environmental conditions.
- fall protection requirements for workers using scaffolds, such as guardrail systems or personal fall arrest systems.
- The type and amount of scaffold equipment needed to access all areas to be worked on.
- Proper storage and transporting of scaffolding components, materials and equipment.
- How to access the scaffold, (i.e., via ladders, stair rail systems, etc.).

Workers building scaffolds risk serious injury from falls and tip-overs, being struck by falling tools and other hazards, and electrocution from energized power lines.

To avoid scaffold hazards, employers must:

- Ensure that a competent person supervises and directs workers erecting, moving, dismantling, or altering a scaffold.
- Provide a safe means of access for each worker erecting or dismantling the scaffold. As early as possible, install hook-on or attachable ladders.
- Ensure that workers do not climb diagonal braces to reach the scaffold platform.
- Provide fall protection for workers erecting or dismantling the scaffold.
- Secure scaffolds to the structure during erection and dismantling.

For more information on scaffolding, see OSHA’s Safety and Health Topics page at www.osha.gov/SLTC/scaffolding.

### Contact OSHA

For more information, to report an emergency, fatality or catastrophe, to order publications, to file a confidential complaint, or to request OSHA’s free on-site consultation service, contact your nearest OSHA office, visit www.osha.gov, or call OSHA at 1-800-321-OSHA (6742), TTY 1-877-889-5627.
Worker Rights
Workers have the right to:

- Working conditions that do not pose a risk of serious harm.
- Receive information and training (in a language and vocabulary the worker understands) about workplace hazards, methods to prevent them, and the OSHA standards that apply to their workplace.
- Review records of work-related injuries and illnesses.
- File a complaint asking OSHA to inspect their workplace if they believe there is a serious hazard or that their employer is not following OSHA’s rules. OSHA will keep all identities confidential.
- Exercise their rights under the law without retaliation, including reporting an injury or raising health and safety concerns with their employer or OSHA. If a worker has been retaliated against for using their rights, they must file a complaint with OSHA as soon as possible, but no later than 30 days.

For more information, see OSHA's Workers page.
Scaffolds

OSHA Information Sheet
Section G

Stairs and Ladders
Lesson Plan

10-hour Construction Outreach

IDENTIFICATION

TOPIC TITLE: Stairs and Ladders
MINIMUM TIME: 30 minutes

OBJECTIVES

Terminal Objective:
Given best practices and current OSHA and industry information regarding worksite illnesses, injuries, and/or fatalities, the student will be able to recognize how to protect himself/herself from hazards associated with stairways and ladders.

Enabling Objectives:
1. Identify types of stairways and ladders used at a construction site.
2. Describe types of hazards (i.e., slips, trips, and falls) associated with the use of stairs and ladders.
3. Describe protective methods used to prevent stairway and ladder hazards.
4. Recognize employer requirements to protect workers from stairway and ladder hazards.

INSTRUCTOR MATERIALS AND RESOURCES

- PowerPoint Presentation: Stairs and Ladders
- Knowledge Check Answer Key: Stairs and Ladders

STUDENT MATERIALS

- OSHA Fact Sheet: Reducing Falls in Construction – Safe Use of Extension Ladders
- OSHA Fact Sheet: Reducing Falls in Construction – Safe Use of Stepladders
- OSHA Fact Sheet: Reducing Falls in Construction – Safe Use of Job-made Wooden Ladders
- Knowledge Check: Stairs and Ladders
10-hour Construction Outreach

TEACHING PROCEDURES ---Preparation, Presentation, Application, Evaluation

**Anticipatory Set (Focus Attention/Gain Interest)**

<table>
<thead>
<tr>
<th>Key Points</th>
<th>Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>From OSHA Construction eTool (2001):</td>
<td>Case Study</td>
</tr>
<tr>
<td>An employee was climbing a 10-foot ladder to access a landing which was 9 feet above the adjacent floor. The ladder slid down, and the employee fell to the floor, sustaining fatal injuries. Although the ladder had slip-resistant feet, it was not secured, and the railings did not extend 3 feet above the landing.</td>
<td>PPT slides #1 – #4</td>
</tr>
</tbody>
</table>

Every year, about 25,000 injuries occur that are due to falls from stairways and ladders. Whenever there is a break in elevation of 19 inches or more, there must be a stairway or ladder to provide proper access to a higher or lower level, unless a ramp, runway, embankment, or some personnel hoist is provided.

Use select OSHA Fatality Report related to ladder/stairway fatalities to emphasize hazards and need for safe use.

**Presentation (Instruction)**

<table>
<thead>
<tr>
<th>Key Points</th>
<th>Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Types of ladders and stairways in construction</td>
<td>PPT slides #5 – #7</td>
</tr>
<tr>
<td>A. Ladders</td>
<td></td>
</tr>
<tr>
<td>1. Portable – a ladder that can be readily moved or carried.</td>
<td></td>
</tr>
<tr>
<td>a. Self-supporting (Ex. Stepladder or other foldout types)</td>
<td></td>
</tr>
<tr>
<td>b. Non-self-supporting (Ex. Extension ladder or other leaning types)</td>
<td></td>
</tr>
<tr>
<td>2. Fixed – a ladder that cannot be readily moved or carried because it is an integral part of a building or structure.</td>
<td></td>
</tr>
<tr>
<td>3. Job-made wooden ladder</td>
<td></td>
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<tr>
<td>B. Stairways</td>
<td></td>
</tr>
<tr>
<td>1. Temporary stairways</td>
<td></td>
</tr>
<tr>
<td>2. Permanent</td>
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</tr>
</tbody>
</table>
II. Types of hazards

A. Slips
   1. Grease, oil, wet paint, or other slippery spills/debris
   2. Slippery coatings on ladder

B. Trips
   1. Poor housekeeping/clutter
   2. Power cords, construction materials, or other items in work area that create tripping hazard

C. Falls – conditions leading to injury-causing incidents involving falls from ladders or stairways
   1. Improper set-up
   2. Using ladders with structural defects
   3. Portable ladders not extending 3 feet above landing surface
   4. Not securing ladder correctly
   5. Standing on top two steps of a stepladder
   6. Overreaching when working from a ladder
   7. Inadequate or missing guardrails or handrails on stairways

D. Other potential hazards
   1. Ladder contact with power lines
   2. Falling objects from elevated level when objects are placed on ladders or stairways or are being carried up/down the ladder or stairway
   3. Protruding objects, sharp edges, or rough spots on stairways that could cause injuries

III. Reducing or eliminating hazards

A. Ladders
   1. Ladder-use practices related to OSHA’s general requirements:
      a. Extend side rails of portable ladders 3 feet above the upper landing surface.
      i. When extension is not possible, secure ladder and provide a grasping device to assist workers in mounting/dismounting ladder.

PPT slides #8 – #9
PPT slides #10 – #26
ii. A ladder extension must not deflect under a load that would cause the ladder to slip off its support.

iii. Keep ladders free of oil, grease, and other slippery substances.

b. Do not exceed maximum intended load of a ladder or the manufacturer’s rated capacity.

c. Use ladders only for the purpose for which they were designed.

d. Angle non-self-supporting ladders so that the horizontal distance from the top support to the foot of the ladder is \( \frac{1}{4} \) the working length of the ladder.

e. Pitch fixed ladders no more than 90 degrees from the horizontal, measured from the back side of the ladder, when used.

f. Use ladders only on stable and level surfaces or secure ladders to prevent movement.

g. Do not use ladders on slippery surfaces, unless they are secured or have slip-resistant feet to prevent movement. Slip-resistant feet must not be used as a substitute for the care in placing, lashing, or holding a ladder upon a slippery surface.

h. When using a ladder in a doorway, passageway, driveway, or other area where it can be displaced by workplace activities or traffic, secure the ladder to prevent movement or a barricade to keep traffic/activities away from the ladder.

i. Keep clear areas around top and bottom of ladders.

j. Equally support the two rails of a non-self-supporting ladder at the top, unless it is equipped with a single support attachment.

k. Do not move, shift, or extend ladder while in use.

l. When the worker or ladder could make contact with exposed energized electrical equipment, only use a ladder with nonconductive siderails.

m. Maintain 3-point contact when ascending or descending a ladder.

n. Face the ladder when going up or down.

o. Do not carry any object or load on a ladder that could cause a loss of balance and fall.

p. Do not use the top or top step of a stepladder.

q. Do not use the cross-bracing on the rear section of a stepladder for climbing.
r. Inspect ladders (competent person) for visible defects periodically and after any incident that could affect their safe use.
s. Do not use single-rail ladders.

2. Ladder requirements, per OSHA:
a. A double-cleated ladder or two or more ladders must be provided when ladders are the only way to enter or exit a work area having 25 or more employees, or when a ladder serves simultaneous two-way traffic.
b. Rungs, cleats, and steps:
   i. Must be parallel, level, and uniformly spaced when the ladder is ready for use;
   ii. Must be spaced 10 – 14 inches apart, along portable or fixed ladder side rails;
   iii. Must be 8 – 12 inches apart, between center lines of the rungs, cleats, and steps of step stools;
   iv. Must be 8 – 18 inches apart between center lines of rungs, cleats, and steps of extension trestle ladders; the rung spacing on the extension section must be 6 – 12 inches.
c. Do not tie or fasten together ladders to create longer sections, unless design is specific for that use.
d. The resulting side rail of spliced side rails must have strength equal to a one-piece side rail of same material.
e. Stepladder must have a metal spreader or locking device to hold ladder in open position during use
f. Platforms or landings must be used to offset two or more separate ladders used to reach an elevated work area.
g. The surface of ladder components must be free of projections, sharp edges, or abrasive materials that could puncture or cut user, or snag clothing.
h. Wood ladders must not be coated with any opaque covering, except for identification or warning labels which may be placed only on one face of a side rail.
3. Structural defects
   a. Remove from service any ladder with structural defect
      i. Broken or missing rungs, cleats, or steps
      ii. Broken or split rails
      iii. Corroded parts
      iv. Other faulty or defective components
   b. Mark as defective or tag "Do Not Use"
   c. Repair ladder to condition meeting its original design criteria before being returned to use

B. Reducing or eliminating hazards with stairs
   1. Install at least one handrail on stairways with four or more risers or more than 30 inches of rise
   2. Install a stair-rail system, including a top rail, mid-rail, and sometimes a toeboard, along the unprotected sides and edges of stairways that rise six feet or more
      a. Must be between 30-36 inches from the upper surface of the stair rail system to the surface of the tread
      b. Must be able to withstand a force of at least 200 pounds
   3. Build/maintain stairs that meet OSHA requirements
      a. Uniform riser height and uniform tread depth with less than ¼ inch variation
      b. Built and installed at an angle between 30 – 50 degrees on the diagonal
      c. On stairways that will not be permanent part of the structure, install landings (minimum 30 inches deep in direction of travel and 22 inches wide) at least every 12 feet of vertical rise; protect sides with standard 42” guardrail system
      d. Remove dangerous projections, such as protruding nails, from all stairway/rail parts
      e. Correct slippery conditions on stairways with slip-resistant material
   4. Fill temporary pan stairs to the top edge of each pan, and replace treads and landings when worn below the top edge.
### 10-hour Construction Outreach

<table>
<thead>
<tr>
<th>IV. Employer Requirements</th>
<th>PPT slide #27</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Comply with OSHA standards related to stairs and ladders, including:</td>
<td></td>
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<tr>
<td>1. Training requirements</td>
<td></td>
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<tr>
<td>2. Inspection requirements</td>
<td></td>
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<tr>
<td>B. Comply with manufacturers’ requirements and recommendations for all ladders.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Application (How students apply what they learn)</th>
<th>Estimated Time: ?? hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key Points</td>
<td>Methods</td>
</tr>
<tr>
<td>Show pictures of ladders and stair use and condition. Have students identify any unsafe actions or conditions and discuss related best practices.</td>
<td>PPT slides #28 – #29</td>
</tr>
<tr>
<td>Have students demonstrate the proper way to set up, ascend, and descend a ladder.</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation/Summary</th>
<th>Estimated Time: ?? hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key Points</td>
<td>Methods</td>
</tr>
<tr>
<td>Knowledge Check: <em>Stairs and Ladders</em></td>
<td>PPT slides #30 – #36</td>
</tr>
</tbody>
</table>
References

OSHA Standard:
  • 1926 Subpart X – Ladders
    1926.1050 – Scope, application, and definitions applicable to this subpart.
    1926.1051 – General requirements.
    1926.1052 – Stairways.
    1926.1053 – Ladders.
    1926.1060 – Training requirements.
    1926 Subpart X App A – Ladders

OSHA Publications
  • Ladder Safety: Reducing Falls in Construction – Safe Use of Stepladders, Fact Sheet (OSHA FS-3662 – 2013) (English: PDF)
  • Ladder Safety QuickCard™ (OSHA 3246) (English: HTML PDF)
  • Stairways and Ladders (OSHA 3124 – 2003) (English: HTML PDF)

OSHA References/Resources
Stairways and Ladders

10-hour Construction Outreach
1926 Subpart X - Stairways and Ladders

**Enabling Objectives:**
1. Identify types of stairways and ladders used at a construction site.
2. Describe types of hazards (i.e., slips, trips, and falls) associated with the use of stairs and ladders.
3. Describe protective methods used to prevent stairway and ladder hazards.
4. Recognize employer requirements to protect workers from stairway and ladder hazards.
Introduction

- Falls are the leading cause of fatalities in constructions
- Falls from ladders make up about one-third of these fatalities
- Approximately 25,000 injuries per year due to falls from stairways and ladders
- Falls are preventable

Abbreviations:
CFOI = Census of Fatal Occupational Injuries;
NEISS-Work = National Electronic Injury Surveillance System–occupational supplement;
* Percentage of ladder fall fatalities were generated with restricted access to BLS CFOI microdata and might differ from results released by BLS. Fatality counts on which the percentages are calculated are based on 82 cases where ladder height was indicated and include deaths to workers of all ages, volunteer workers, and resident military personnel.
† Excludes 31 fatalities and 22,600 nonfatal injuries with unknown fall height.
§ 95% confidence interval.
¶ Nonfatal emergency department–treated injuries in this height category did not meet criteria for publication without compromise of confidentiality.
Fixed ladder – a ladder that cannot be readily moved or carried because it is an integral part of a building or structure.

Job-made wooden ladder – “...a ladder constructed at the construction site. It is not commercially-manufactured. A job-made wooden ladder provides access to and from a work area. It is not intended to serve as a work platform. These ladders are temporary, and are used only until a particular phase of work is completed or until permanent stairways or fixed ladders are installed.” (OSHA DOC FS-3661 05/2013)

https://www.osha.gov/Publications/ladders/osha3124.html

https://www.osha.gov/Publications/OSHA3661.html
Portable ladder – a ladder that can be readily moved or carried
  • Self-supporting – stepladder, platform ladder, tressel ladder, or other foldout types
  • Non-self-supporting – extension ladder or other leaning types
Stairways

• Temporary stairways - stairways that will not be a permanent part of the structure on which construction work is being performed.

• Permanent stairways

• Metal pan stairs – metal pan landings and treads filled with concrete or other material for permanent use. During construction, “foot traffic is prohibited on stairways with pan stairs where the treads and/or landings are to be filled in with concrete or other material at a later date, unless the stairs are temporarily fitted with wood or other solid material at least to the top edge of each pan” [1926.1052(b)(1)]
Reference – OSHA Publication 3124, Stairways and Ladders

- **Slips**
  - Grease, oil, wet paint, or other slippery spills/debris, contaminants on floor
  - Slippery coatings on ladder

- **Trips**
  - Poor housekeeping/clutter, loose cords
  - Power cords, construction materials, loose wires, or other items in work area that create tripping hazard

- **Falls** – conditions leading to injury-causing incidents involving falls from ladders or stairways
  - Improper set-up
  - Using ladders with structural defects
  - Portable ladders not extending 3 feet above landing surface
  - Not securing ladder correctly
  - Standing on top two steps of a stepladder
  - Overreaching when working from a ladder
  - Inadequate or missing guardrails or handrails on stairways
• Other potential hazards
  • Ladder contact with power lines
  • Falling objects from elevated level when objects are placed on ladders or stairways or are being carried up/down the ladder or stairway
  • Protruding objects, sharp edges, or rough spots on stairways that could cause injuries
Reducing or Eliminating Hazards

- Ladders
  - Safe practices
  - Ladder requirements
  - Structural defects

Reference – OSHA Publication 3124, Stairways and Ladders
• Extend side rails of portable ladders 3 feet above the upper landing surface
  • When extension is not possible, secure ladder and provide a grasping device to assist workers in mounting/dismounting ladder
  • A ladder extension must not deflect under a load that would cause the ladder to slip off its support
  • Keep ladders free of oil, grease, and other slippery substances
• Do not exceed maximum intended load of a ladder or the manufacturer’s rated capacity
• Use ladders only for the purpose for which they were designed
• Angle non-self-supporting ladders so the horizontal distance from the top support to the foot of the ladder is ¼ the working length of the ladder. Job-made wooden ladders should have an angle that equals about 1/8 the working length.
Reference – OSHA Publication 3124, Stairways and Ladders

• Pitch fixed ladders no more than 90 degrees from the horizontal, measured from the back side of the ladder, when used.
• Use ladders only on stable and level surfaces or secure ladders to prevent movement.
• Do not use ladders on slippery surfaces, unless they are secured or have slip-resistant feet to prevent movement. Slip-resistant feet must not be used as a substitute for the care in placing, lashing, or holding a ladder upon a slippery surface.
Reference – OSHA Publication 3124, Stairways and Ladders

- When using a ladder in a doorway, passageway, driveway, or other area where it can be displaced by workplace activities or traffic, secure the ladder to prevent movement or a barricade to keep traffic/activities away from the ladder.
- Keep clear areas around top and bottom of ladders.
- Equally support the two rails of a non-self-supporting ladder at the top, unless it is equipped with a single support attachment.
• 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.

Additional reference – OSHA Fact Sheet, Reducing Falls in Construction: Safe Use of Extension Ladders, DOC FS-3660 (06/2013)

• Maintain a 3-point contact (two hands and a foot, or two feet and a hand) when climbing/descending a ladder.
• Face the ladder when climbing up or descending.
• Keep the body inside the side rails.
• Use extra care when getting on or off the ladder at the top or bottom. Avoid tipping the ladder over sideways or causing the ladder base to slide out.
• Carry tools in a tool belt or raise tools up using a hand line. Never carry tools in your hands while climbing up/down a ladder.
Reducing or Eliminating Hazards

- Don’t move, shift, or extend while in use.
- When exposed to energized electrical equipment, use nonconductive side rails.
- Don’t use the top step of a stepladder.
- Don’t climb the cross-bracing on the rear section of a stepladder.

Reference – OSHA Publication 3124, Stairways and Ladders
Reducing or Eliminating Hazards

- Don’t use single-rail ladders.
- Inspect (competent person)
  • visible defects periodically
  • and after any incident
  • that could affect their safe use.

Reference – OSHA Publication 3124, Stairways and Ladders
Reducing or Eliminating Hazards

- Ladder requirements:
  - Provide double-cleated ladder or two or more ladders:
    - when having 25 or more employees using as only means of access to work area;
    - when serves two-way traffic.

Reference – OSHA Publication 3124, Stairways and Ladders
Reducing or Eliminating Hazards

- Rungs, cleats, and steps:
  - Parallel, level, and uniformly spaced
  - Spacing
    - Along portable or fixed ladder side rails – 10 to 14 inches apart
    - Between center lines on step stool – 8 to 12 inches apart
    - Between center lines on extension trestle ladders – 8 to 18 inches apart;
      extension section 6 to 12 inches

Reference – OSHA Publication 3124, Stairways and Ladders
Reference – OSHA Publication 3124, Stairways and Ladders

- Do not tie or fasten together ladders to create longer sections, unless design is specific for that use.
- The resulting side rail of spliced side rails must have strength equal to a one-piece side rail of same material.
Reducing or Eliminating Hazards

- Platforms or landings - offset two or more separate ladders used to reach an elevated work area.
- Ladder surface - free of projections, sharp edges, or abrasive materials that could puncture or cut user, or snag clothing.
- Wood ladders - not coated with any opaque covering, except for identification or warning labels only on one face of a side rail.

Reference – OSHA Publication 3124, Stairways and Ladders
Reference – OSHA Publication 3124, Stairways and Ladders

- Remove from service any ladder with structural defect
  - Broken or missing parts
  - Corrosion
  - Other faulty or defective components
- “Do Not Use”
- Repair to original design criteria
Reducing or Eliminating Hazards

- Stairs
  - Handrails
  - Stair rail systems
  - Stair requirements
  - Temporary pan stairs

Reference – OSHA Publication 3124, Stairways and Ladders
Reduce or eliminating hazards

- Install handrail on stairways
  - 4 or more risers
  - 30 inches of rise

Reference – OSHA Publication 3124, Stairways and Ladders

Install at least one handrail on stairways with four or more risers or more than 30 inches of rise
Reference – OSHA Publication 3124, Stairways and Ladders

Install a stair-rail system, including a top rail, mid-rail, and sometimes a toeboard, along the unprotected sides and edges of stairways that rise six feet or more

• Must be between 30-36 inches from the upper surface of the stair rail system to the surface of the tread
• Must be able to withstand a force of at least 200 pounds
Build/maintain stairs that meet OSHA requirements:

- Uniform riser height and uniform tread depth with less than ¼ inch variation
- Built and installed at an angle between 30 – 50 degrees on the diagonal
- Install landings (minimum 30 inches deep in direction of travel and 22 inches wide) at least every 12 feet of vertical rise; protect sides with standard 42” guardrail system
- Remove dangerous projections, such as protruding nails, from all stairway/rail parts
- Correct slippery conditions on stairways with slip-resistant material

Reference – OSHA Publication 3124, Stairways and Ladders
Reducing or eliminating hazards

- Temporary pan stairs
  - Secure in place before filling
  - Fill to top edge
  - Replace worn treads and landings

Reference – OSHA Publication 3124, Stairways and Ladders

Fill temporary pan stairs to the top edge of each pan, and replace treads and landings when worn below the top edge.

Metal pan landings and metal pan treads must be secured in place before filling.
Employer requirements

- Comply with OSHA standards related to stairs and ladders
  - Training
  - Inspection
- Comply with manufacturers’ requirements and recommendations for all ladders.

Reference – OSHA Publication 3124, Stairways and Ladders
Reference – OSHA Publication 3124, Stairways and Ladders

**Photo on left:** Stepladder is not set up properly to be self-supporting.

**1926.1053(b)(4)** Ladders shall be used only for the purpose for which they were designed.

**Photo on right:** Ladder side rails do not extend at least 3 feet above upper landing surface.

**1926.1053(b)(1)** When portable ladders are used for access to an upper landing surface, the ladder side rails shall extend at least 3 feet (.9 m) above the upper landing surface to which the ladder is used to gain access; or, when such an extension is not possible because of the ladder’s length, then the ladder shall be secured at its top to a rigid support that will not deflect, and a grasping device, such as a grabrail, shall be provided to assist employees in mounting and dismounting the ladder.
Reference – OSHA Publication 3124, Stairways and Ladders

**Photo on left**: Cooler and bucket limiting access.

**1926.1051(a)(3)** When a building or structure has only one point of access between levels, that point of access shall be kept clear to permit free passage of employees. When work must be performed or equipment must be used such that free passage at that point of access is restricted, a second point of access shall be provided and used.

**Photo on right**: no handrails,

**1926.1052(c)(1)** Stairways having four or more risers or rising more than 30 inches (76 cm), whichever is less, shall be equipped with:

- **1926.1052(c)(1)(i)** At least one handrail; and
- **1926.1052(c)(1)(ii)** One stairrail system along each unprotected side or edge.
Summary

- Key components for ladder safety:
  - A competent person must inspect
  - Use the correct ladder for the job
  - Use the correct angle, supports, treads, cross braces, and rails
  - Don't overload
  - Your employer must train you in proper use of a ladder
Summary

• Key components for stairway safety
  – Treads
  – Rails
    • Handrails
    • Stair rails
    • Guardrails
  – Landings and Platforms
Knowledge Check

1. When portable ladders are used for access to an upper landing surface, how many feet above the upper landing must the side rails extend?
   a. 2 feet
   b. 3 feet
   c. 4 feet
   d. 5 feet

   b. 3 feet
Knowledge Check

2. You can use metal ladder around power lines or exposed energized electrical equipment.
   a. True – but only if there isn’t any other option to get the work done.
   b. False – you should never use a metal ladder in this circumstance.

b. False – never use a metal ladder in this circumstance
3. Handrails must be able to withstand, without failure, how many pounds of weight applied within 2 inches of the top edge in any downward or outward direction?
   a. 300 pounds
   b. 250 pounds
   c. 200 pounds
   d. 175 pounds

   c. 200 pounds
4. Stairways that have four or more risers MUST have a stair rail.
   a. True
   b. False

   a. True
Knowledge Check

5. A non-self-supporting ladder should be set up at ___ (horizontal distance/working length of ladder).
   a. 90 degree angle
   b. 30 degree angle
   c. 1:2 angle
   d. 1:4 angle

   d. 1:4 angle
**Knowledge Check: Stairways and Ladders**

**Answer Key**

1. When portable ladders are used for access to an upper landing surface, how many feet above the upper landing must the side rails extend?
   - a. 2 feet
   - b. **3 feet**
   - c. 4 feet
   - d. 5 feet

2. You can use a metal ladder around power lines or exposed energized electrical equipment.
   - a. True, but ONLY if there is no other option to get the work done.
   - b. **False, you should NEVER use a metal ladder in this circumstance.**

3. Handrails must be able to withstand, without failure, how many pounds of weight applied within 2 inches of the top edge in any direction or outward direction?
   - a. 300 pounds
   - b. 250 pounds
   - c. **200 pounds**
   - d. 175 pounds

4. Stairways that have four or more risers MUST have a stair rail.
   - a. **True**
   - b. False

5. A non-self-supporting ladder should be set up at _____ (horizontal distance/working length of ladder).
   - a. 90 degree angle
   - b. 30 degree angle
   - c. 1:2 angle
   - d. **1:4 angle**
Stairs and Ladders

Knowledge Check
Falls from portable ladders (step, straight, combination and extension) are one of the leading causes of occupational fatalities and injuries.

- Read and follow all labels/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 (see diagram).
- 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 top step/rung of a ladder as a step/rung unless it was designed for that purpose.

(continued on reverse)
• 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 (see diagram). Do not stand on the three top rungs of a straight, single or extension ladder.

• The proper angle for setting up a ladder is to place its base a quarter of the working length of the ladder from the wall or other vertical surface (see diagram).

• 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 a ladder. Be aware of the ladder’s load rating and of the weight it is supporting, including the weight of any tools or equipment.
Hand and Power Tools
Lesson Plan

10-hour Construction Outreach

IDENTIFICATION

TOPIC TITLE: Tools – Hand and Power
MINIMUM TIME: 30 minutes

OBJECTIVES

Terminal Objective:
Given best practices and current OSHA and industry information regarding worksite illnesses, injuries, and/or fatalities, the student will be able to recognize how to protect themselves from hazards associated with the use of tools (i.e., hand and power).

Enabling Objectives:
1. Identify various types of tools commonly used at construction worksites.
2. Describe types of hazards associated with the use of tools.
3. Describe guarding requirements (i.e., techniques and principles) for various types of tools.
4. Describe safe operation methods while working with various types of tools.
5. Recognize employer requirements to protect workers from tool hazards.

INSTRUCTOR MATERIALS AND RESOURCES

- PowerPoint Presentation: Hand and Power Tools
- Knowledge Check Answer Key: Hand and Power Tools

STUDENT MATERIALS

- OSHA Fact Sheet
- Knowledge Check: Hand and Power Tools
Sample Lesson Plan: Tools – Hand and Power Revised by OTIEC Outreach Workgroup v.05.18.15

10-hour Construction Outreach

TEACHING PROCEDURES ---Preparation, Presentation, Application, Evaluation

Anticipatory Set (Focus Attention/Gain Interest)            Estimated Time: ?? hours

**Key Points**

A 22-year-old carpenter’s apprentice was killed when he was struck in the head by a nail fired from a powder-actuated nail gun. The nail gun operator fired the gun while attempting to anchor a plywood concrete form, causing the nail to pass through the hollow form. The nail traveled 27 feet before striking the victim. The nail gun operator had never received training on how to use the tool, and none of the employees in the area was wearing PPE. (OSHA Fatal Facts Report)

Hand and power tools are a part of our everyday lives and help us to easily perform tasks that otherwise would be difficult or impossible. However, these simple tools can be hazardous, and have the potential for causing severe injuries when used or maintained improperly. Special attention toward hand and power tool safety is necessary in order to reduce or eliminate these hazards. Employees using hand and power tools are exposed to hazards of falling, flying, abrasive or splashing materials, as well as harmful dusts, fumes, mists, vapors or gases. Workers must be provided with appropriate personal protective equipment to guard against injury. All electrical connections for tools must be suitable for the type of tool and the working conditions (e.g. wet, dusty, flammable vapors). Employees should be trained in the proper use of all tools. Workers should be able to recognize the hazards associated with the different types of tools and the safety precautions necessary.

Presentation (Instruction)            Estimated Time: ?? hours

**Key Points**

I. Types of Tools

A. Manually operated hand tools
   1. Wrenches
   2. Impact tools – drift pins, wedges, chisels
   3. Hammers
   4. Screw drivers
B. Power-operated tools
   1. Electrical
      i. Cord or battery
      ii. Examples – drills, saws, grinders
   2. Pneumatic
      i. Powered by compressed air
      ii. Examples – nailers, chippers, drills, sanders, and staplers
   3. Liquid fuel
      i. Powered by fuel, usually gasoline
      ii. Example – chainsaw, weed-eater, drills, blowers, edgers, augers
   4. Hydraulic
      i. Fluid provides medium for power transfer
      ii. Example – hydraulic jack
   5. Powder-actuated
      i. Operates like a loaded gun
      ii. Example – nailer, riveter, framing tool, and other fastener tools

II. Hazards Associated with Hand and Power Tools

C. Types of hazards
   1. Struck-by hazards from flying, falling, impact, or abrasive objects
   2. Electrical shock or electrocution
   3. Caught-in hazards with tools that have moving parts
   4. Exposure to harmful dusts, fumes, mists, vapors, or gases
   5. Tripping or slipping hazards
   6. Contact with sharp edges, or protruding objects that cause cuts, punctures, or contusions

D. Exposure to hazards
   1. Using the wrong tool for the job
   2. Using a tool the wrong way
   3. Using damaged or broken tools
   4. Using tools that are dull
   5. Using spark-producing tools near flammable sources
   6. Using power tools with moving parts that are not properly guarded
### 10-hour Construction Outreach

<table>
<thead>
<tr>
<th>Hand and Power Tools</th>
</tr>
</thead>
</table>
| **III. Guarding techniques for hand and power tools** | PPT slides #12 – #14  
| E. Guard exposed moving parts of power tools. |  
| F. Guard belts, gears, shafts, pulleys, sprockets, spindles, flywheels, chains, or other moving parts. |  
| G. Never remove a guard when a tool is in use. |  
| H. Guard the point of operation, in-running nip points, and rotating parts. |  
| I. Guard the operator and others from flying chips and sparks. |  
| J. Appropriate guards must be in place to prevent operator from coming in contact with saw blades. |  
| K. Guard an abrasive wheel so that the minimal amount of the wheel is exposed, and ensure the guard is properly aligned with the wheel. |  

| Precautions for safe use of hand and power tools | PPT slides #15 – #28  
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>III. Precautions for safe use of hand and power tools</strong></td>
</tr>
<tr>
<td><strong>A. Basic hand and power tool safety practices</strong></td>
</tr>
<tr>
<td>1. Always keep tools in good condition with regular maintenance.</td>
</tr>
<tr>
<td>2. Use the right tool for the job.</td>
</tr>
<tr>
<td>3. Examine each tool for any damage before using it and, if the tool is damaged, don’t use it.</td>
</tr>
<tr>
<td>4. Follow manufacturers’ instructions when using tools and use them the right way. This includes using the guards that are part of a tool.</td>
</tr>
<tr>
<td>5. Always wear the right PPE and use it properly.</td>
</tr>
<tr>
<td><strong>B. Precautions for all hand and power tools</strong></td>
</tr>
<tr>
<td>1. Keep the floors in the work clean and free from any debris that could cause tripping or slipping.</td>
</tr>
<tr>
<td>2. Keep work areas well lit.</td>
</tr>
<tr>
<td>3. Use the proper PPE, such as safety glasses, respiratory protection, and gloves, for protection from falling, flying, abrasive, and splashing objects or materials and from harmful dusts, fumes, mists, vapors, or gases.</td>
</tr>
<tr>
<td>4. Keep all cutting tools sharp.</td>
</tr>
</tbody>
</table>
5. Keep all tools clean and well-maintained.
6. Inspect all tools for defects and remove any broken or damaged tools from service.
7. Use tools only for the purposes for which they were designed and use tools the right way.

C. Precautions for power tools
1. Disconnect tools from power source when not in use, before servicing and cleaning them, and when changing accessories such as blades, bits, and cutters.
2. Keep all people not involved with the work at a safe distance from the work area.
3. Secure work with clamps or a vise so that both hands are free to operate the tool.
4. Avoid accidental starting; do not hold fingers on the switch button while carrying a tool that is still attached to its power source.
5. Power tools must be fitted with guards and safety switches.
6. Be sure to maintain good footing and balance when operating power tools.
7. Wear proper clothing for the task; do not wear loose clothing, ties, or jewelry when working in an area or a tool that has moving parts.
8. Safeguard exposed moving parts of power tools, including belts, gears, shafts, pulleys, sprockets, spindles, drums, flywheels, chains, or other reciprocating, rotating, or moving parts of equipment.

D. Electric tools
1. Electric tools that are damaged must be removed from service and tagged “Do Not Use.”
2. To protect a worker from shock, electrical tools must:
   i. have a three-pronged plug that is used with a grounded receptacle;
   ii. be double-insulated; or
   iii. be powered by a low-voltage isolation transformer
3. Never remove the third prong (grounding pin) from a three-prong plug. An adapter may be used to accommodate a two-prong receptacle, but it must be attached to a known ground.

4. Do NOT:
   i. pull cords to disconnect tool from outlet
   ii. use cords to hoist or lower tools
   iii. carry portable tools by the cord
   iv. run cords across walkways and traffic areas

5. Keep cords and hoses away from heat, oil, and sharp edges.

6. Store electrical tools in a dry place and do NOT use in damp or wet locations, unless they are approved for that purpose.

7. Use Ground Fault Circuit Interrupter (GFCI) or Assured Equipment Ground Conductor (AEGC) program.

E. Abrasive wheels and tools

1. Equip with guards that:
   i. cover the spindle end, nut, and flange projections;
   ii. maintain proper alignment with the wheel; and
   iii. do not exceed the strength of the fastenings.

2. Before an abrasive wheel is mounted:
   i. inspect it for damage; and
   ii. sound- or ring-test it to ensure that it is free from cracks or defects.

3. Follow manufacturer recommendations for operating speeds.

4. Allow the abrasive wheel to accelerate to operating speed before beginning grinding or cutting work to prevent disintegration or explosion during start-up.

5. Do not stand in front of the grinding wheel as it comes up to speed; use eye and/or face protection.

6. Properly adjust the work rest (1/8” opening) on grinding tools and use it to support the work and prevent it from being jammed.
10-hour Construction Outreach

F. Pneumatic tools
1. Use same precautions with air hose as with electric cords
2. Check that the tool is fastened securely to the air hose to prevent them from being disconnected and use a positive locking device as an added safeguard.
3. Pneumatic tools that shoot nails, rivets, staples, or similar fasteners must be equipped with a special device to keep fastener from being accidently ejected.
4. Screens must be set up to protect nearby workers from being struck by flying fragments.
5. Do not use compressed air for cleaning off clothing and never point compressed air guns at anyone

G. Fuel-powered tools
1. Handle, transport, and store gas or fuel in approved flammable liquid containers only.
2. Shut down the engine and allow it to cool before refilling a fuel-powered tool tank.
3. Provide satisfactory ventilation or appropriate respiratory protection when using these tools inside a closed area.

H. Powder-actuated tools
1. Need to be treated with extreme caution, like a loaded gun
2. Must be trained and licensed to use them
3. Wear suitable ear, eye, and face protection.
4. Select either a high-velocity or low-velocity powder level that is appropriate for the tool and task without applying excessive force.
5. Test the tool each day before loading to ensure the safety devices are working properly.
6. Inspect tool before each use to make sure that it is clean, the moving parts operate freely, the barrel is free from obstructions, and the proper shield, guard, and attachments are in place.
7. Immediately remove from service any defective tool and do not use until properly repaired.
8. Do not load tools until just prior to use.
9. Never point the tool (loaded or empty) at any employee.
10. Keep hands clear of the open barrel end.
12. Do not drive fasteners into very hard or brittle materials; and, avoid driving into easily penetrated materials unless they are backed by an impenetrable backing.

13. Do not drive fastener into a spalled area.

14. Do not use tools in an explosive or flammable atmosphere.

15. Use manufacturer-recommended correct shield, guard, or attachment on tools.

16. Store tool unloaded and in a locked box.

IV. Employer Requirements

A. Comply with OSHA standards related to hand and power tools, including:
   1. Training requirements
   2. Inspection requirements

B. Comply with manufacturers’ requirements and recommendations for all hand and power tools.

Application (How students apply what they learn)  Estimated Time: ?? hours

Key Points

Have students inspect various hand and power tools (or pictures of tools) and report on any safety issues that they find, as well as how they would fix the problem.

Evaluation/Summary  Estimated Time: ?? hours

Key Points

Knowledge Check: Hand and Power Tools

Questioning

PPT slides #30 – #33

PPT slides #34 – #38
10-hour Construction Outreach

References

OSHA Standard:

- 1926 Subpart I - Tools - Hand and Power
  1926.300 - General requirements.
  1926.301 - Hand tools.
  1926.302 - Power-operated hand tools.
  1926.303 - Abrasive wheels and tools.
  1926.304 - Woodworking tools.
  1926.305 - Jacks-lever and ratchet, screw, and hydraulic.
  1926.306 - Air receivers.
  1926.307 - Mechanical power-transmission apparatus.

OSHA Publications

- Amputation Fact Sheet (English: PDF)
- Amputations: Safeguarding Equipment and Protecting Employees from Amputations (OSHA 3170 - 2007) (English: HTML PDF)


OSHA References/Resources

Tools – Hand and Power

10-Hour Construction Outreach
Fatal Facts:
A 22-year-old carpenter’s apprentice was killed when he was struck in the head by a nail fired from a powder-actuated tool. The nail gun operator fired the gun while attempting to anchor a plywood concrete form, causing the nail to pass through the hollow form. The nail traveled 27 feet before striking the victim. The nail gun operator had never received training on how to use the tool, and none of the employees in the area was wearing PPE.
Hand and power tools are a part of our everyday lives. These tools help us to perform tasks that otherwise would be difficult or impossible. However, even simple tools can be hazardous, and have the potential for causing severe injuries when used or maintained improperly. Special attention toward hand and power tool safety is necessary in order to reduce or eliminate these hazards.
Upon successful completion of the topic, participants will be able to:
1. Identify various types of tools commonly used at construction work sites.
2. Describe types of hazards associated with the use of tools.
3. Describe guarding requirements for various types of tools.
4. Describe safe operation methods while working with various types of tools.
5. Recognize employer requirements to protect workers from tool hazards.
Examples:
1. Wrenches
2. Impact tools – drift pins, wedges, chisels
3. Hammers
4. Screw drivers
Types of Tools

- Power-operated tools
  - Electrical
  - Pneumatic
  - Liquid fuel
  - Hydraulic
  - Powder-actuated

Examples:
1. Electrical – cord or battery provides electrical power; Examples: drills, saws, grinders
2. Pneumatic – powered by compressed air; Examples: chippers, drills, hammers, and Sanders
3. Liquid fuel – powered by fuel, usually gasoline; Examples: chainsaw, weed-eater, drills, blowers, edgers, and augers
4. Hydraulic – fluid provides medium for power transfer; Example: hydraulic jacks
5. Powder-actuated – operates like a loaded gun; Example: nailer, riveter, framing tool, and other fastener tools
Hand and Power Tool Hazards

Types of hazards
- Struck-by
- Electrical
- Caught-in

Hazards:
- Struck-by due to flying, falling, impact, or abrasive objects
- Electrical shock or electrocution
- Caught-in hazards with tools that have moving parts

Photos:
Top right - shows entrance wound and thermal burns a worker received when he was shocked by an overheated tool that he was holding.
Bottom left – shows hazardous situation that could occur when using powder-actuated tools to drive fasteners into materials. If material is easily penetrated, the worker on the other side of the wall is at risk of being struck by flying objects.
Hazards:
• Exposure to harmful dusts, fumes, mists, vapors, or gases
• Trips and slips – housekeeping issues, cords and hoses, tools left lying around, etc.
• Contact with sharp edges or protruding objects that cause cuts, punctures, or contusions

Photos:
On left – worker cutting through cinder block is exposed to silica dust.
On right – worker using chainsaw is potentially exposed to the sharp edges of the cutting chain; additional hazards include flying particles and noise.
Exposure to hazards occur when a worker:
• Uses the wrong tool for the job.
• Uses a tool the wrong way.

Photos:
Worker is using a screwdriver as a pry bar, a task for which it was not designed.
Exposure to hazards occur when a worker:
- Uses damaged or broken tools.
- Uses tools that are dull.

Photos:
On left – cracked handle on hammer; do not use damaged tools
On right – chisel rounded on corners
Exposure to hazards occur when a worker:
• Uses spark-producing tools near flammable sources.
• Uses tools not properly guarded.

Photos:
On left – tools that produce sparks when used, such as a grinder, should not be used around flammable sources.
In middle – there is no guard on circular saw to prevent exposure to cutting blade.
On right – worker is wearing proper PPE, including eye and face protection, while grinding.
Photos:
On left – nip points occur between rotating and fixed parts, such as the area where the rotating abrasive wheel meets the work rest and tongue.
On right – rotating, reciprocating, or transverse motions in cutting actions can create hazards at the point of operation or with flying particles.
Guarding techniques:
- Guard exposed moving parts
- Guard belts, gears, shafts, pulleys, sprockets, spindles, flywheels, chains, or other moving parts.
- Never remove a guard when a tool is in use.
- Guard the point of operation, in-running nip points, and rotating parts.
- Guard the operator and others from flying chips and sparks.
- Appropriate guards must be in place to prevent operator from coming in contact with saw blades.
- Guard an abrasive wheel so that the minimal amount of the wheel is exposed, and ensure the guard is properly aligned with the wheel.

Photos:
On left – portable circular saw with upper and lower guards in place.
On right – hand-held grinder with guard.
Guarding

- Properly guarded blower
Basic hand and power tool safety practices:

- Always keep tools in good condition with regular maintenance.
- Use the right tool for the job. Use the tool that was designed for the job and use it the right way.
- Examine each tool for any damage before using it and, if the tool is damaged, don’t use it.
- Follow manufacturers’ instructions when using tools and use them the right way. This includes using the guards that are part of a tool.
- Always wear the right PPE and use it properly.

Photo: select appropriate PPE for the task, such as footwear, hand protection, head and face protection, eye protection, hearing protection, and respiratory protection.
Hand and Power Tools

Precautions for all hand and power tools

- Keep the floors in the work clean and free from any debris that could cause tripping or slipping.
- Keep work areas well lit.
- Inspect tools; remove from service if needed.
- Keep all cutting tools sharp.

Photo:
On left - worker wearing full-face respiratory protection, hard hat, and protective clothing while operating a portable electric reciprocating saw.
On right - both hand tools and power tools need to be well-maintained, inspected, and removed from service if damaged.
Precautions for Safe Use

- Precautions for power tools
  - Disconnect from power source.
  - Keep people at safe distance.
  - Secure work.

Photo: shows a vice mounted on a three-legged stand.

Precautions for power tools:
- Disconnect tools from power source when not in use, before servicing and cleaning them, and when changing accessories such as blades, bits, and cutters.
- Keep all people not involved with the work at a safe distance from the work area.
- Secure work with clamps or a vise so that both hands are free to operate the tool.
Precautions for power tools:

- Avoid accidental starting; do not hold fingers on the switch button while carrying a tool that is still attached to its power source.
- Power tools must be fitted with guards and safety switches.
- Be sure to maintain good footing and balance when operating power tools.
- Wear proper clothing for the task; do not wear loose clothing, ties, or jewelry when working in an area or a tool that has moving parts.
- Safeguard exposed moving parts of power tools, including belts, gears, shafts, pulleys, sprockets, spindles, drums, flywheels, chains, or other reciprocating, rotating, or moving parts of equipment.

Photo: shows reciprocating saw with deadman switch.
Electric tools safety practices:

- Electric tools that are damaged must be removed from service and tagged “Do Not Use.”
- To protect a worker from shock, electrical tools must:
  - have a three-pronged plug that is used with a grounded receptacle;
  - be double-insulated; or
  - be powered by a low-voltage isolation transformer
- Never remove the third prong (grounding pin) from a three-prong plug. An adapter may be used to accommodate a two-prong receptacle, but it must be attached to a known ground.

Photos:

- On left: Shows use of grounded electrical device (receptacle and 3-prong plug).
- On right: Shows stamp of a double-insulated electric power tool.
Electric tools safety practices:

- Do NOT:
  - pull cords to disconnect tool from outlet
  - use cords to hoist or lower tools
  - carry portable tools by the cord
  - run cords across walkways and traffic areas
- Keep cords and hoses away from heat, oil, and sharp edges.
- Store electrical tools in a dry place and do NOT use in damp or wet locations, unless they are approved for that purpose.

- Use Ground Fault Circuit Interrupter (GFCI) or Assured Equipment Ground Conductor (AEGC) program.

Photos:
On left – shows electric power tool being carried improperly by cord.
On right – shows portable GFCI.
Precautions with abrasive wheels and tools:

- Equip with guards that:
  - cover the spindle end, nut, and flange projections;
  - maintain proper alignment with the wheel; and
  - do not exceed the strength of the fastenings.

- Before an abrasive wheel is mounted:
  - inspect it for damage; and
  - sound- or ring-test it to ensure that it is free from cracks or defects.

- Follow manufacturer recommendations for operating speeds.

Photos:

On left – abrasive wheel equipped with guards and work rest.
In middle – ring test abrasive wheel before mounting:

1910.215(d)(1)
Inspection. Immediately before mounting, all wheels shall be closely inspected and sounded by the user (ring test) to make sure they have not been damaged in transit, storage, or otherwise. The spindle speed of the machine shall be checked before mounting of the wheel to be certain that it does not exceed the maximum operating speed marked on the wheel. Wheels should be tapped gently with a light nonmetallic implement, such as the handle of a screwdriver for light wheels, or a wooden mallet for heavier wheels. If they sound cracked (dead), they shall not be used. This is known as the "Ring Test".

1910.215(d)(1)(i)
Wheels must be dry and free from sawdust when applying the ring test, otherwise the sound will be deadened. It should also be noted that organic bonded wheels do not emit the same clear metallic ring as do vitrified and silicate wheels.

On right – maximum speed as indicated by manufacturer on abrasive wheel.
Precautions with abrasive wheels and tools:

- Allow the abrasive wheel to accelerate to operating speed before beginning grinding or cutting work to prevent disintegration or explosion during start-up.
- Do not stand in front of the grinding wheel as it comes up to speed; use eye and/or face protection.
- Properly adjust the work rest on grinding tools and use it to support the work and prevent it from being jammed. “Work rests shall be kept adjusted closely to the wheel with a maximum opening of one-eighth inch” [1910.215(a)(4)].

Photo: Shows proper guarding of wheel and correctly adjusted work rest on bench grinder.
Precautions for Safe Use

• Pneumatic tools
  – Use same precautions with air hose as with electric cords
  – Securely fasten air hose to tool and safeguard with a positive locking device

Precautions for safe use of pneumatic tools:
• Use same precautions with air hose as with electric cords.
  • Do not use hose to hoist or lower tools.
  • Do not carry portable tools by the hose.
  • Do not run hose across walkways and traffic areas.
  • Keep away from heat, oil, and sharp edges.
• Check that the tool is fastened securely to the air hose to prevent them from being disconnected and use a positive locking device as an added safeguard.

Photo: pneumatic tool
Precautions for safe use of pneumatic tools:

- Pneumatic tools that shoot nails, rivets, staples, or similar fasteners must be equipped with a special device to keep fastener from being accidently ejected.
- Screens must be set up to protect nearby workers from being struck by flying fragments.
- Do not use compressed air for cleaning off clothing and never point compressed air guns at anyone.

Photos:
On left – pneumatic nailer
On right – air compressor
Precautions for Safe Use

- Fuel-powered tools
  - Handle, transport, and store gas or fuel in approved containers.
  - Shut down and allow engine to cool before refilling fuel tank.
  - Use ventilation and respiratory protection as needed.

Precautions for safe use of fuel-powered tools:
- Handle, transport, and store gas or fuel in approved flammable liquid containers only.
- Shut down the engine and allow it to cool before refilling a fuel-powered tool tank.
- Provide satisfactory ventilation or appropriate respiratory protection when using these tools inside a closed area.

Photo:
On left – fuel-powered blower
On right – workers may be exposed to toxic gases (carbon monoxide, nitrogen oxides, or diesel exhausts) when operating portable equipment with internal combustion engines in enclosed or confined spaces.
Precautions with powder-actuated tools:
• Need to be treated with extreme caution, like a loaded gun
• Must be trained and licensed to use them
• Wear suitable ear, eye, and face protection.

Photo: powder-actuated nail gun, nails, and powder
Precautions with powder-actuated tools:

- Select either a high-velocity or low-velocity powder level that is appropriate for the tool and task without applying excessive force.
- Test the tool each day before loading to ensure the safety devices are working properly.
- Inspect tool before each use to make sure that it is clean, the moving parts operate freely, the barrel is free from obstructions, and the proper shield, guard, and attachments are in place.
- Immediately remove from service any defective tool and do not use until properly repaired.

Photo: powder-actuated tool
Precautions for Safe Use

- Do not load tools until just prior to use
- Never point tool at anyone
- Keep hands clear of open barrel end
- Never leave loaded tool unattended
- Do not drive fasteners into materials that are very hard, brittle, or easily penetrated
- Do not drive fastener into a spalled area
- Use manufacturer-recommended shields, guards, or attachments.
- Store unloaded in a locked box.

Precautions with powder-actuated tools:
- Do not load tools until just prior to use.
- Never point the tool (loaded or empty) at any employee.
- Keep hands clear of the open barrel end.
- Never leave loaded tools unattended.
- Do not drive fasteners into very hard or brittle materials; and, avoid driving into easily penetrated materials unless they are backed by an impenetrable backing.
- Do not drive fastener into a spalled area.
- Do not use tools in an explosive or flammable atmosphere.
- Use manufacturer-recommended correct shield, guard, or attachment on tools.
- Store tool unloaded and in a locked box.
Employer Requirements

- Comply with OSHA standards
  - Training
  - Inspection
- Comply with manufacturer’s requirements and recommendations
Identify Hazards

Hand-held sander with exposed wires should not be used.
Identify Hazards

This three-prong grounding plug has the ground prong broken off.
Identify Hazards

Grinder guard removed to accommodate larger wheel.
Identify Hazards

- Working in street with power cords potentially exposed to traffic.
- Guard removed from saw blade.
- Power take-off guard is missing.
Knowledge Check

1. Which of the following is an example of an unsafe practice regarding the use of tools?
   a. Keeping cutting tools sharp
   b. Wearing eye and face protection while operating a grinder
   c. Using a screwdriver to carve or cut wood
   d. Following manufacturer’s instructions when using a tool

   c. Using a screwdriver to carve or cut wood
Knowledge Check

2. Which term describes a tool that is powered by compressed air?
   a. Hydraulic
   b. Powder-actuated
   c. Electrical
   d. Pneumatic

   d. Pneumatic
Knowledge Check

3. Which of the following actions may expose workers to electrical shock hazards and should be avoided?
   a. Removing the grounding pin on a three-prong plug
   b. Using double-insulated tools
   c. Using a grounded adaptor to accommodate a two-prong receptacle
   d. Removing damaged tools from service and tagging them "Do Not Use"

a. Removing the grounding pin on a three-prong plug
Knowledge Check

4. Which of the following statements about guarding techniques is true?
   a. Guard the point of operation, in-running nip points, and rotating parts of tools.
   b. Remove guard from tool while it is in use, then replace when the job is completed.
   c. Adjust guard on abrasive wheel to allow maximum exposure of the wheel surface.
   d. Wear PPE because guards will not protect operator from flying chips and sparks or moving parts of tool.

   a. Guard the point of operation, in-running nip points, and rotating parts of tools.
Knowledge Check

5. Employers must satisfy all of the following requirements, except:
   a. Provide PPE necessary to protect employees who are operating hand and power tools and are exposed to hazards.
   b. Comply with OSHA training and inspection standards related to hand and power tools.
   c. Determine which manufacturer’s requirements and recommendations for a tool shall be followed or ignored.
   d. Do not issue or permit the use of unsafe hand tools.
   c. Determine which manufacturer’s requirements and recommendations for a tool shall be followed or ignored.
Knowledge Check:

10-hour Construction Outreach

Name: _____________________________    Date: _____________

Knowledge Check: Tools – Hand and Power

1. Which of the following is an example of an unsafe practice regarding the use of tools?
   a. Keeping cutting tools sharp
   b. Wearing eye and face protection while operating a grinder
   c. Using a screwdriver to carve or cut wood
   d. Following manufacturer’s instructions when using a tool

2. Which term describes a tool that is powered by compressed air?
   a. Hydraulic
   b. Powder-actuated
   c. Electrical
   d. Pneumatic

3. Which of the following actions may expose workers to electrical shock hazards and should be avoided?
   a. Removing the grounding pin on a three-prong plug
   b. Using double-insulated tools
   c. Using a grounded adaptor to accommodate a two-prong receptacle
   d. Removing damaged tools from service and tagging them “Do Not Use”

4. Which of the following statements about guarding techniques is true?
   a. Guard the point of operation, in-running nip points, and rotating parts of tools.
   b. Remove guard from tool while it is in use, then replace when the job is completed.
   c. Adjust guard on abrasive wheel to allow maximum exposure of the wheel surface.
   d. Wear PPE because guards will not protect operator from flying chips and sparks or moving parts of tools.

5. Employers must satisfy all of the following requirements, except:
   a. Provide PPE necessary to protect employees who are operating hand and power tools and are exposed to hazards.
   b. Comply with OSHA training and inspection standards related to hand and power tools.
   c. Determine which manufacturer’s requirements and recommendations for a tool shall be followed or ignored.
   d. Do not issue or permit the use of unsafe hand tools.
Hand and Power Tools

Knowledge Check
What are the sources of amputations in the workplace?

Amputations are some of the most serious and debilitating workplace injuries. They are widespread and involve a variety of activities and equipment. Amputations occur most often when workers operate unguarded or inadequately safeguarded mechanical power presses, power press brakes, powered and non-powered conveyors, printing presses, roll-forming and roll-bending machines, food slicers, meat grinders, meat-cutting band saws, drill presses, and milling machines as well as shears, grinders, and slitters. These injuries also happen during materials handling activities and when using forklifts and doors as well as trash compactors and powered and non-powered hand tools. Besides normal operation, the following activities involving stationary machines also expose workers to potential amputation hazards: setting-up, threading, preparing, adjusting, cleaning, lubricating, and maintaining machines as well as clearing jams.

What types of machine components are hazardous?

The following types of mechanical components present amputation hazards:

- **Point of operation**—the area of a machine where it performs work on material.
- **Power-transmission apparatuses**—flywheels, pulleys, belts, chains, couplings, spindles, cams, and gears in addition to connecting rods and other machine components that transmit energy.
- **Other moving parts**—machine components that move during machine operation such as reciprocating, rotating, and transverse moving parts as well as auxiliary machine parts.

What kinds of mechanical motion are hazardous?

All mechanical motion is potentially hazardous. In addition to in-running nip points (“pinch points”)—which occur when two parts move together and at least one moves in a rotary or circular motion that gears, rollers, belt drives, and pulleys generate—the following are the most common types of hazardous mechanical motion:

- **Rotating**—circular movement of couplings, cams, clutches, flywheels, and spindles as well as shaft ends and rotating collars that may grip clothing or otherwise force a body part into a dangerous location.
- **Reciprocating**—back-and-forth or up-and-down action that may strike or entrap a worker between a moving part and a fixed object.
- **Transversing**—movement in a straight, continuous line that may strike or catch a worker in a pinch or shear point created between the moving part and a fixed object.
- **Cutting**—action generated during sawing, boring, drilling, milling, slicing, and slitting.
- **Punching**—motion resulting when a machine moves a slide (ram) to stamp or blank metal or other material.
- **Shearing**—movement of a powered slide or knife during metal trimming or shearing.
- **Bending**—action occurring when power is applied to a slide to draw to or form metal or other materials.

Are there any OSHA standards that cover amputation hazards in the workplace?

Yes. The Occupational Safety and Health Administration (OSHA) has the following standards in Title 29 of the Code of Federal Regulations (CFR) to protect workers from amputations in the workplace:

- 29 CFR 1926 Subpart I covers hand tools and powered tools.
- 29 CFR Part 1928 Subpart D covers agricultural equipment.
What can employers do to help protect workers from amputations?

You should be able to recognize, identify, manage, and control amputation hazards commonly found in the workplace such as those caused by mechanical components of machinery, the mechanical motion that occurs in or near these components, and the activities that workers perform during mechanical operation.

Work practices, employee training, and administrative controls can help prevent and control amputation hazards. Machine safeguarding with the following equipment is the best way to control amputations caused by stationary machinery:

- **Guards** provide physical barriers that prevent access to hazardous areas. They should be secure and strong, and workers should not be able to bypass, remove, or tamper with them. Guards should not obstruct the operator’s view or prevent employees from working.

- **Devices** help prevent contact with points of operation and may replace or supplement guards. Devices can interrupt the normal cycle of the machine when the operator’s hands are at the point of operation, prevent the operator from reaching into the point of operation, or withdraw the operator’s hands if they approach the point of operation when the machine cycles. They must allow safe lubrication and maintenance and not create hazards or interfere with normal machine operation. In addition, they should be secure, tamper-resistant, and durable.

You are responsible for safeguarding machines and should consider this need when purchasing machinery. New machinery is usually available with safeguards installed by the manufacturer. You can also purchase appropriate safeguards separately or build them in-house.

Are certain jobs particularly hazardous for some employees?

Yes. Under the *Fair Labor Standards Act*, the Secretary of Labor has designated certain non-farm jobs as especially hazardous for employees under the age of 18. These workers generally are prohibited from operating band saws, circular saws, guillotine shears, punching and shearing machines, meat-packing or meat-processing machines, paper products machines, woodworking machines, metal-forming machines, and meat slicers.

How can I get more information?

You can find more information about amputations, including the full text of OSHA’s standards, on OSHA’s website at [www.osha.gov](http://www.osha.gov). In addition, publications explaining the subject of amputations in greater detail are available from OSHA. *Concepts and Techniques of Machine Safeguarding* (OSHA 3067) and *Control of Hazardous Energy (Lockout/Tagout)* (OSHA 3120) are available on OSHA’s website. For other information about machine guarding see [http://www.osha-slc.gov/SUTC/machineguarding/index.html](http://www.osha-slc.gov/SUTC/machineguarding/index.html).

*A Guide for Protecting Workers from Woodworking Hazards* (OSHA 3157) is available either on OSHA’s website at [www.osha.gov](http://www.osha.gov) or from the Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250-7954, or phone (202) 512-1800, or online at [http://bookstore.gpo.gov/index.html](http://bookstore.gpo.gov/index.html).

To file a complaint by phone, report an emergency, or get OSHA advice, assistance, or products, contact your nearest OSHA office under the “U.S. Department of Labor” listing in your phone book, or call us toll-free at (800) 321-OSHA (6742); teletypewriter (TTY) number is (877) 889-5627. To file a complaint online or obtain more information on OSHA federal and state programs, visit OSHA’s website at [www.osha.gov](http://www.osha.gov).

This is one in a series of informational fact sheets highlighting OSHA programs, policies, or standards. It does not impose any new compliance requirements or carry the force of legal opinion. For compliance requirements of OSHA standards or regulations, refer to Title 29 of the Code of Federal Regulations. This information will be made available to sensory-impaired individuals upon request. Voice phone: (202) 693-1999. See also OSHA’s website at [www.osha.gov](http://www.osha.gov).