

# Focus Four

## Construction Hazards

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**This book focuses on the “Focus Four” Construction Hazards: Falls, Electrical, Caught-in, Struck-by**



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## **TABLE OF CONTENTS**

<b>DISCLAIMER.....</b>	<b>3</b>
<b>CHAPTER I - FALL HAZARDS .....</b>	<b>4</b>
SECTION I - HAZARDS.....	5
SECTION II - HAZARD PREVENTION.....	15
<b>CHAPTER II - ELECTRICAL HAZARDS .....</b>	<b>26</b>
SECTION I - HAZARDS.....	27
SECTION II - HAZARD PREVENTION.....	41
<b>CHAPTER III - STRUCK-BY HAZARDS.....</b>	<b>53</b>
SECTION I - HAZARDS.....	54
SECTION II - HAZARD PREVENTION.....	66
<b>CHAPTER IV - CAUGHT-IN HAZARDS.....</b>	<b>91</b>
SECTION I - HAZARDS.....	92
SECTION II - HAZARD PREVENTION.....	98
<b>GLOSSARY OF TERMS .....</b>	<b>120</b>
<b>REFERENCES .....</b>	<b>135</b>

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# Chapter I

## FALL HAZARDS

### INTRODUCTION

This chapter provides an overview of fall hazards typically found at construction sites. It will help you recognize and prevent these hazards at your worksites.

Falls may occur at anytime while working and can be on the same level you are working on or a fall to another level. Let's say you are walking along a dirt road. You are not looking where your feet are and you trip over a rock and fall. That is a fall to the same level. You landed on the same level where you started.

Now let's say you are working on the roof of a building. You get a little too close to the edge, lose your balance and fall to the ground. This is a fall to another level. You landed on a different level than where you started.

Either type of fall can result in serious injuries and even death. Each year hundreds of workers die from falls. In the year 2004, 815 workers died from falls. In the construction industry, 441 workers never returned home. They died after falling.

The following sections will discuss common fall hazards, their prevention and OSHA requirements. Remember, this book does not include every hazard or regulation.

Section I - Hazards; this section will focus on the hazards found in the following areas:

- Building Structures
- Exterior Construction Areas
- Scaffolds
- Stairways
- Ladders

Section II - Hazard Prevention; this section will focus on the prevention of falls, specifically:

- Guardrails

## FALL HAZARDS

- Warning Lines
- Personal Fall Arrest Systems
- Floor Holes

# SECTION I - HAZARDS

## BUILDING STRUCTURES

Working on the exterior of a building exposes you to falls. You may be on the roof of a building and be exposed to a fall of 10, 20, 30 feet or even more or you may be working on concrete forming with no scaffolding. Anytime you are working above the ground level, you may be exposed to a fall.

To protect you from falling, fall protection is required anytime you are working higher than 6 feet from a lower level. When erecting steel, the fall protection requirements are not the same and will not be discussed here.

The construction or renovation of building structures may expose you to falls from:

- Unprotected sides and edges
- Leading edges
- Hoist areas
- Holes
- Formwork and reinforcing steel
- Ramps, runways, or other walkways
- Excavations
- Dangerous equipment
- Walking/working surfaces
- Overhand bricklaying and related work
- Roofing work on low sloped roofs
- Steep roofs
- Pre-cast concrete erection
- Residential construction
- Wall openings

When working near any of these areas, fall protection is required if you are 6 feet or more above a lower level.

The OSHA requirement can be found in 29 CFR 1926.501(b)(1)-(b)(15) under “Duty to have fall protection”. Each topic states that employees working 6 feet or more above a lower level **shall** be protected from falling.

Guardrail systems, safety net systems, personal fall arrest systems, and hole covers are acceptable means of fall protection. Prevention will be covered later in this guide.



## EXTERIOR CONSTRUCTION AREAS

When working in exterior construction areas, there are two types of falls that need to be considered. First are falls to the same level. And second are falls to a lower level.

Serious injuries can occur with each type of fall. The severity of your injuries will increase depending on what you fall on and how far you fall.

## FALL HAZARDS

If you fall onto rebar or other sharp objects, you may be impaled. The force of falling will drive the rebar or other sharp object into your body. Depending on the height of the fall and length of the rebar, it may go completely through you.

Two levels of protection must be put into place to protect workers from falling onto sharp objects. The first is to install a fall protection system to prevent the workers from falling. The second is to cover the sharp objects so workers cannot be impaled. The covers must be strong enough to withstand 250 pounds dropped from a height of 10 feet.

Some types of rebar caps are not strong enough and will only make a larger hole as the rebar goes through the worker's body.

The OSHA requirement for impalement protection is found in 29 CFR 1926.701(b)(1). It states "All protruding reinforcing steel, onto and into which employees could fall, **shall** be guarded to eliminate the hazard of impalement."

Falling into or onto can be either vertically or horizontally. Bottom line is that if a worker can get impaled, the rebar or other reinforcing steel must be protected.

Letters of interpretation have clarified the need and requirements for protection from reinforcing steel. A letter of interpretation dated August 3, 1999 references a January 5, 1997 memorandum. It states "... we would consider protective devices (covers or wooden troughs) for rebar that are capable of withstanding at least 250 pounds dropped from a height of ten feet to be adequate to meet the §1926.701(b) rebar requirements."

Open excavations and pier holes must also be guarded or protected to prevent workers from falling into them. Workers must be protected from falling more than 6 feet and from falling onto or into reinforcing steel.

One way to guard excavations and pier holes is to build a guardrail system to keep workers away from the edge. If they cannot get to the edge, they cannot fall into the hole.



## SCAFFOLDS

Scaffolds are used to create a safe work platform at the job site. They are elevated, temporary work platforms.

Supported scaffolds are the type of scaffolding most often used on construction sites. They are made from one or more platforms supported by outrigger beams, brackets, poles, legs, uprights, posts, frames, or similar ridged support.

When building scaffolding, the foundation is just as important as the foundation of your house. The scaffolding must be placed on a firm foundation to prevent movement or collapse.

The foundation begins with the base plate. The base plate must then rest on mud sills or other firm surface. Never place the scaffold legs on items such as rocks, sand, uneven surfaces, or cement blocks.

The requirements for a firm foundation are located in 29 CFR 1926.451 (c)(2)

Supported scaffold poles, legs, posts, frames, and uprights **shall** bear on base plates and mud sills or other adequate firm foundation. {see1926.451(c)(2)}

## FALL HAZARDS

Footings **shall** be level, sound, rigid, and capable of supporting the loaded scaffold without settling or displacement. {see 1926.451(c)(2)(i)}

Unstable objects **shall** not be used to support scaffolds or platform units. {see 1926.452(c)(2)(ii)}

Never work on a scaffold that does not have a firm foundation. If the scaffold does not have a stable foundation, then it may move or shift causing either the scaffold or you to fall.



Scaffolding must be properly constructed. Working levels must be fully planked to create a safe working surface as required by 1926.451(b)(1), and have no more than 1 inch of space between the uprights and the platforms (see 1926.451(b)(1)(i)).

When wooden planks are used to create the working surface, they must not be painted with opaque finishes. They can be coated with wood preservatives, fire-retardant finishes, and slip-resistant finishes as long as the coatings do not obscure the top or bottom wood surfaces. This can be found in 29 CFR 1926.451(b)(9) .

Workers must have a safe way to get up and down the scaffolding. Never use blocks, bricks, walk boards, and other unsafe methods to access a scaffold. Access ladders must be properly designed and provide safe access for workers. Use only properly designed ladders and never climb on the cross bracing, guardrails, or other pieces of the scaffold to reach higher platforms. Regulations for accessing scaffolding can be found in 29 CFR 1926.451(e).

When guardrail systems are being used for fall protection, they must be constructed properly. 29 CFR 1926.451(g)(4) has the specific regulations. Some of the requirements are highlighted below.

Guardrail systems **shall** be installed along open sides and ends. {see 1926.451(g)(4)(i)}

The height of the top rail **shall** be between 38 and 45 inches. {see 1926.451(g)(4)(ii)}

Each top rail **shall** be capable of withstanding 200 pounds of force applied in a downward or horizontal direction. {see 1926.451(g)(4)(vii)}

When working on scaffolding, do not use a ladder to increase your reach, this requirement is found in 29 CFR 1926.451(f)(15). To work safely, never stand on blocks, pallets, buckets or anything else. By standing on unstable objects, you risk falling.

Aerial lifts, are elevated work platforms that allow workers to work safely at heights.

When working from extensible or articulating boom platforms the lift controls must be tested each day prior to use as required by 29 CFR 1926.453(b)(2)(i).

You must stay inside the basket or bucket of the aerial lift. If you climb outside of the bucket or onto the guardrails of the platform, you are at risk of falling. This requirement is found in 29 CFR 1926.453(b)(2)(iv).

While working from an aerial lift, you must be tied off. A body belt is acceptable if you use it in a tethering system or in a restraint system. A body belt is not allowed to be used for fall protection. This regulation is found in 29 CFR 1926.453(b)(2)(v).

If you need to move the aerial lift while working in it, lower the platform, get out and then move it into a new position. Moving an aerial lift while you are in it exposes you to falls. See 29 CFR 1926.453(b)(2)(viii).

Only use equipment that is designed for lifting people. Never improvise and build your own lifting platform.

## STAIRWAYS

A stairway or ladder **shall** be provided at all personnel points of access where there is a break in elevation of 19 inches or more, and no ramp, runway, sloped embankment, or personnel hoist is provided. See 1926.1051(a).

## FALL HAZARDS

All stairs that are used by workers must be fully constructed. 29 CFR 1926.1052 lists the requirements for stairs. Some of the major requirements are listed below.

Riser height and tread depth **shall** be uniform within each flight of stairs. {see 1926.1052(a)(3)}

Where doors open directly on a stairway, a platform **must** be provided. {see 1926.1052(a)(4)}

All parts of stairways **shall** be free of hazardous projections, such as nails. {see 1926.1052(a)(6)}

Slippery conditions on stairways **shall** be eliminated before they are used. {see 1926.1052(a)(7)}

Stairways having four or more risers or rising more than 30 inches **shall** be equipped with: {see 1926.1052(c)(1)}

(i) - at least one handrail; **and**

(ii) - one stair rail system along each unprotected side or edge.

Stair rails **shall** not be less than 36 inches from the top of the tread to the top of the rail. {see 1926.1052(c)(3)}

Midrails **shall** be located midway between the top rail and the stairway steps. {see 1926.1052(c)(4)(i)}

Handrails and the top rails of stair rail systems **shall** be capable of withstanding a force of at least 200 pounds in any downward or outward direction. {see 1926.1052(c)(5)}

When the top edge of a stair rail system also serves as a handrail, the height of the top edge **shall** not be more than 37 inches or less than 36 inches from the upper surface of the handrail to the surface of the tread. {see 1926.1052(c)(7)}

If you use stairs that are not complete or do not have a proper stair rail system, you are at risk of falling. Never put yourself at risk by using stairs that are unsafe.



## LADDERS

Ladders are used on construction sites to access overhead work surfaces because they are convenient, portable and can be used almost anywhere on the site. Because ladders are so common, workers may overlook the hazards associated with using them.

Ladders used on a job site might be manufactured or job made. It doesn't matter if the ladder is manufactured at a factory or on the job, it must be safe and safely used. Always inspect ladders before using them. When inspecting ladders look for cracks in the frame, breaks in any area, missing or broken rungs, protruding objects that can catch you or your clothing, and oil, grease, or mud that can make the steps slippery. If you find any defects on the ladder, take it out of service immediately and dispose of it. Never use a broken ladder!

Ladders are one of the most commonly misused pieces of equipment on a construction site. The safe use of ladders will help prevent many common work accidents. 29 CFR 1926.1053 addresses the use of ladders on construction sites. Some of the standards are highlighted below.

Ladder rungs, cleats and steps **shall** be parallel, level and uniformly spaced when the ladder is in position for use. {see 1926.1053(a)(2)}

Rungs, cleats, and steps **shall** be spaced not less than 10 inches apart and not more than 14 inches apart. {see 1926.1053(a)(3)(i)}

## FALL HAZARDS

Ladders **shall** not be tied together to provide longer sections. {see 1926.1053(a)(7)}

A metal spreader or locking device **shall** be provided on each step ladder to hold the front and back sections in an open position. {see 1926.1053(a)(8)}

Wooden ladders **shall not** be coated with opaque coverings, except for identification or warning labels. {see 1926.1053(a)(12)}

When portable ladders are used for access to an upper landing surface, the ladder side rails **shall** extend at least 3 feet above the upper landing surface to which the ladder is used to gain access. {see 1926.1053(b)(1)}

Ladders **shall** be maintained free of oil, grease, and other slipping hazards. {see 1926.1053(b)(2)}

Ladders **shall** be used only on stable and level surfaces. {see 1926.1053(b)(6)}

Ladders **shall not** be moved, shifted, or extended while occupied. {see 1926.1053(b)(11)}

The top or top step of a step ladder **shall not** be used as a step. {see 1926.1053(b)(13)}

Ladders **shall** be inspected by a competent person for visible defects on a periodic basis and after any occurrence that could affect their safe use. {see 1926.1053(b)(15)}

Portable ladders with structural defects, (such as, but not limited to, broken or missing rungs, cleats, or steps, broken or split rails, or corroded components, or other faulty or defective components), {see 1926.1053(b)(16)}

**>shall** either be immediately marked in a manner that readily identifies them as defective, or be tagged with “Do Not Use” or similar language, **and**

**>shall** be withdrawn from service until repaired.

When ascending or descending a ladder, the user **shall** face the ladder. {see 1926.1053(b)(20)}



Each employee **shall** use one hand to grasp the ladder when progressing up and/or down the ladder. {see 1926.1053(b)(21)}

An employee **shall not** carry any object or load that could cause the employee to lose balance and fall. {see 1926.1053(b)(22)}

You must be trained on the proper use of stairs or ladders on the job site.

The employer **shall** provide a training program for each employee using ladders and stairways, as necessary. {see 1926.1060(a)}

The employer **shall** ensure that each employee has been trained by a competent person in the following areas, as applicable:  
{see 1926.1060(a)(1)}

- (i) - the nature of the fall hazards in the work area;
- (ii) - the correct procedures for erecting, maintaining, and disassembling the fall protection systems to be used;
- (iii) - the proper construction, use, placement, and care in handling of all stairways and ladders;
- (iv) - the maximum intended load-carrying capacities of ladders used;  
and
- (v) - the standards contained in this subpart.

## FALL HAZARDS

29 CFR 1926.1060(b) states that re-training must also be provided as necessary so that the employee maintains the understanding and knowledge acquired through compliance with this section.

Always use the right equipment for the job. Scaffolds and ladders are designed to create safe work platforms so workers can reach the job safely. But sometimes workers take a shortcut and try to make a temporary scaffold out of saw horses, blocks, boards, ladders, 5 gallon buckets or whatever is at hand. Never take a short cut because it takes too much time or effort to do the job correctly. Do it right the first time! Short cuts lead to hazardous situations where you may be injured or possibly even killed.



## SECTION II - HAZARD PREVENTION

You must recognize potential hazards around you and make every effort to avoid and reduce them. Hazard recognition is the first step in having a safe workplace. But you must do more. Once you recognize the hazard, you must do something about it. By controlling or eliminating the hazard, you have made the workplace safer.

Remember, safety starts with you. You need to have a willing, positive attitude about safety in the workplace. You have people depending on you everyday and they expect you to come home alive and well. Practicing safety on the job will allow you to go home to the ones you love.

This section will focus on fall prevention measures. Measures that you can take to make your worksite safer.

Remember, when construction activities are performed 6 feet or more above a lower level, fall protection must be provided to protect the worker.

But what is “fall protection”? Fall protection is a method that has been put in place to keep you from falling to a lower level. Fall protection may be a physical barrier or a system of rules put in place to keep you from entering an area that exposes you to a fall. Some methods of fall protection are:

- Guardrails – physical barriers that are put into place to prevent you from falling.
- Warning lines – a physical barrier used to keep you a safe distance from an open edge. Warning lines do not keep you from falling, they are used to keep you out of a hazardous area.
- Fall arrest systems - a system used to arrest or stop your fall. They do not keep you from falling. They only arrest or stop your fall.
- Floor covers – physical barriers used to cover a hole in a floor or other walking/working surface. The floor openings can be a trip hazard or large enough that you can fall through to a lower level. An example of a large floor opening is a skylight. An uncovered skylight exposes you to a fall through the roof to a lower level.

Each of these methods will be discussed.

## GUARDRAILS

As stated earlier, guardrails are a physical barrier used to prevent you from falling. They are typically made of wood or steel cables.

## FALL HAZARDS

The guardrail system includes the top rail, the mid rail, the posts and footings. The guardrail must be constructed with a top rail at approximately 42 inches (plus or minus 3"). This height is designed to prevent workers from going over the top of the guardrail system. If workers are working on stilts, then the top rail must be elevated to accommodate the workers extended height.

The mid rail is designed to prevent fallen workers from going under the top rail and falling to the lower level. The mid rail must be in the center between the top rail and the working surface.

A toe board must also be installed to protect workers below from falling objects such as nails, tools and other equipment.

A guardrail system must be strong enough to prevent workers from falling through. The top rails must be able to support 200 pounds of force downward and outward. Downward force is the force applied to the top of the rail by pushing or pulling it down. This means that the top rail will support a 200 pound weight hanging from it without breaking.



When a guardrail system is constructed out of cables, they must meet the same requirements as guardrails constructed from wood. The top rail must be the same height and meet the 200 lbs. downward and outward force requirement.

It is very important the cables remain tight. Cables can loosen over time and then they will droop or sag. When this happens, the rail

height can be less than 42 inches. Additionally, a cable that is not tight will have play in it allowing it to move and not prevent a worker from falling.

Steel cables are smaller in diameter than wooden rails and cannot be seen as easily from a distance. So if you use steel cables, the top rail must be flagged with a high visibility material. The flags must be placed every 6 feet for the entire length of the rail. The flags can be made of highly visible caution tape, reflective tape, manufactured flag banners or any other material that is highly visible and can be seen from a distance.

When using steel cables, or wire rope, you must know how to properly secure the end of the cable. A cable cannot be tied in a knot or left to hang freely. Clamps are used to secure the ends of a steel cable. The clamps used consist of a U-bolt, a saddle, and nuts. The U-bolt is placed on the “dead end” of the cable. The “dead end” is the short end of the cable. The saddle is placed on the load bearing cable. This is the long end or the “live end” of the cable. The nuts are placed on the U-bolt and tightened to hold the clamp assembly in place. Be sure to place all clamps in the same direction.

Regulations for guardrails can be found in Subpart M of 29 CFR. Some are highlighted below:

Top edge height of top rails, or equivalent guardrail system members, **shall** be 42 inches (1.1 m) plus or minus 3 inches (8 cm) above the walking/working level. When conditions warrant, the height of the top edge may exceed the 45-inch height, provided the guardrail system meets all other criteria of this paragraph. {see 1926.502(b)(1)}

Note: When employees are using stilts, the top edge height of the top rail, or equivalent member, **shall** be increased an amount equal to the height of the stilts.

Midrails, screens, mesh, intermediate vertical members, or equivalent intermediate structural members **shall** be installed between the top edge of the guardrail system and the walking/working surface when there is no wall or parapet wall at least 21 inches (53 cm) high. {see 1926.502(b)(2)}

## FALL HAZARDS

Guardrail systems **shall** be capable of withstanding, without failure, a force of at least 200 pounds applied in any outward or downward direction, at any point along the top edge. {see 1926.502(b)(3) }

Guardrail systems **shall** be so surfaced as to prevent injury to an employee from punctures or lacerations, and to prevent snagging of clothing. {see 1926.502(b)(6)}



Steel banding and plastic banding **shall not** be used as top rails or midrails. {see 1926.502(b)(8)}

Top rails and midrails **shall** be at least 1/4 inch nominal diameter or thickness to prevent cuts or lacerations. If wire rope is used for top rails, it **shall** be flagged at not more than 6-foot intervals with high-visibility material. {see 1926.502(b)(9)}

When guardrail systems are used at hoisting areas, a chain, gate or removable guardrail section **shall** be placed across the access opening between guardrail sections when hoisting operations are not taking place. {see 1926.502(b)(10)}

When guardrails are used at holes, they **shall** be erected on all unprotected sides or edges of the hole. {see 1926.502(b)(11)}

## WARNING LINES

Warning line systems are used to keep workers away from an unsafe edge while working in specific situations. Typically, the situations are low sloped roof work, some leading-edge work, precast concrete erection and residential construction.

Warning lines are a physical barrier designed to keep workers a safe distance from the edge **not** from falling over the edge. They do not physically prevent a worker from gaining access to the edge. They do not stop a fall. They are designed to work with a comprehensive program and serve as a warning that hazards lie beyond the line.

The parts of the warning line system include the ropes, wires or chains supported by stanchions and must be erected a minimum of 6 feet from the edge. Workers are never to be in the area between the warning line and the edge.

Since warning lines only warn you and do not keep you from falling over the edge, they do no good if they are not properly maintained. A warning line that has fallen to the ground or is in disrepair does not properly warn workers of the hazard.

Warning lines must be repaired or replaced immediately when damaged. Never work in an area if the warning line has been knocked down or damaged.

When using a warning line system, the following regulations apply.

The warning line shall be erected around all sides of the roof work area. {see 1926.502(f)(1)}

Warning lines **shall** consist of ropes, wires, or chains and supporting stanchions erected as follows: {see 1926.502(f)(2)}

(i) - The rope, wire, or chain **shall** be flagged at not more than 6-foot intervals with high-visibility material;

(ii) - The rope, wire, or chain **shall** be rigged and supported in such a way that its lowest point (including sag) is no less than 34 inches from the walking/working surface and its highest point is no more than 39 inches from the walking/working surface;

## FALL HAZARDS

(iii) - After being erected , with the rope, wire, or chain attached, stanchions **shall** be capable of resisting, without tipping over, a force of at least 16 pounds applied horizontally against the stanchion;

No employee **shall** be allowed in the areas between a roof edge and a warning line unless the employee is performing roofing work in that area. {see 1926.502(3)}

## PERSONAL FALL ARREST SYSTEMS

Another common system for protecting workers from falls is the use of a personal fall arrest system. A properly designed fall arrest system will allow a worker to fall only a short distance and then stop the fall. The fall arrest system does not prevent falls, it only stops the worker from falling any further.

The fall arrest system consists of a body harness, lanyard, and an anchorage point. Each of these components must be properly maintained and used.

Body harnesses come in different sizes and styles. But each harness, no matter the style, is designed to hold your body securely after you have fallen and are hanging from an anchorage point waiting for rescue. Your harness will protect your body from further damage while you wait for rescue. Its design allows your body to maintain blood flow and does not put pressure on internal organs.

You must wear your harness properly. All straps must be snug and not loose. The D-ring, where the lanyard connects to the body harness, must be worn between the shoulder blades, not low on the back. If you fall, you will be hanging from that D-ring. If it is positioned properly, you will hang in an upright position. If the D-ring is positioned further down the back, you will hang more horizontally and risk cutting off blood flow.

Harness styles vary. You need to refer to the manufacturer's instructions to put the harness on correctly.

Once the harness is properly adjusted, a lanyard needs to be connected. The lanyard hooks to the D-ring on the harness with a locking snap-hook. The snap-hook must lock and be able to handle 3,600 lbs.

The lanyard is the connecting piece between the harness and the anchorage point. Lanyards are designed with a minimum breaking strength of 5,000 pounds.

Some lanyards are equipped with a shock absorber that will lessen the forces of the fall on the workers body. If the lanyard you are using has a shock absorber, be sure to attached it to the harness with the D-ring closest to the shock absorber. You want the shock absorber close to the body. Shock absorbers can only be used once and then must be replaced. Never use a lanyard with a shock absorber that has been used, it offers you no protection.

Lanyards must be inspected before each use for visible damage. Look for cuts, burns, oil, grease or any other defect.

Never use a damaged lanyard.

Test the locking snap-hook to make sure it is working properly.

Now that you have the body harness on and properly adjusted, and the lanyard is attached you need to attach the other end of the lanyard to the anchorage point.

The anchorage point must be strong enough to withstand the forces of the fall and the weight of the worker hanging on the lanyard.

The anchorage point must be able to hold at least 5,000 pounds of force. Never anchor or tie off to pipes, wood structures, electrical wires, or other areas not designed for anchorage points because they will not hold the minimum 5,000 pounds required in the event of a fall.

Sometimes the work will not allow you to tie off to a stationary point. You may need to tie off onto a horizontal lifeline. A horizontal life line is used to allow workers to be tied off while they move through the work area. These are used on bridges, building structures, and other areas to allow workers the freedom to move around. The horizontal life line system must be designed, installed, and used under the supervision of a qualified person. These lines must be maintained and kept free from abrasions and cuts.

The regulations for personal fall arrest systems are found in 29 CFR 1926.502(d). Some of the regulations are listed below.

Personal fall arrest systems and their use **shall** comply with the provisions set forth below. Effective January 1, 1998 body belts are not acceptable as part of a personal fall arrest system. {see 1926.502(d)}

## FALL HAZARDS

D-rings and snap hooks **shall** have a minimum tensile strength of 5,000 pounds. {see 1926.502(d)(3)}

Unless the snap hook is a locking type and designed for the following connections, snap hooks **shall** not be engaged: {see 1926.502(d)(6)}

- (i) - directly to webbing, rope, or wire rope;
- (ii) - to each other;
- (iii) - to a D-ring to which another snap hook or other connector is attached;
- (iv) - to a horizontal lifeline; or
- (v) - to any object which is incompatibly shaped or dimensioned in relation to the snap hook such that unintentional disengagement could occur by the connected object being able to depress the snap hook keeper and release itself.

Horizontal lifelines **shall** be designed, installed, and used, under the supervision of a qualified person, as part of a complete personal fall arrest system, which maintains a safety factor of at least 2. {see 1926.502(d)(8)}

Lanyards and vertical lifelines **shall** have a minimum breaking strength of 5,000 pounds. {see 1926.502(d)(9)}

Lifelines **shall** be protected against being cut or abraded. {see 1926.502(d)(11)}

Ropes and straps (webbing) used in lanyards, lifelines, and strength components of body belts and body harnesses **shall** be made from synthetic fibers. {see 1926.502(d)(14)}

Anchorage used for attachment of personal fall arrest equipment **shall** be independent of any anchorage being used to support or suspend platforms and capable of supporting at least 5,000 pounds per employee attached, or **shall** be designed, installed, and used as follows: {see 1926.502(d)(15)}

- (i) - as part of a complete personal fall arrest system which maintains a safety factor of at least 2; and
- (ii) - under the supervision of a qualified person.

The attachment point of the body harness **shall** be located in the center of the wearer's back near shoulder level, or above the wearer's head. {see 1926.502(d)(17)}

Personal fall arrest systems and components subjected to impact loading **shall** be immediately removed from service and **shall not** be used again for employee protection until inspected and determined by a competent person to be undamaged and suitable for reuse. {see 1926.502(d)(19)}

The employer **shall** provide for prompt rescue of employees in the event of a fall or **shall** assure that employees are able to rescue themselves. {see 1926.502(d)(20)}

Personal fall arrest systems **shall** be inspected prior to each use for wear, damage, and other deterioration, and defective components **shall** be removed from service. {see 1926.502(d)(21)}

Personal fall arrest systems **shall** not be attached to guardrail systems, nor **shall** they be attached to hoists except as specified in other subparts of this part. {see 1926.502(d)(23)}

## FLOOR HOLES

Holes are defined as a gap or void 2 inches or more in a floor, roof or other walking or working surface. Holes can be small and cause tripping hazards that cause workers to fall to the same level. Or they can be large and cause workers to fall through them to another level.

Workers must be protected from falling through holes that would allow them to fall 6 feet or more to another level.

One method of protecting workers is to cover the hole. The cover must be able to support the weight of a worker, be labeled and be secured so it does not move.

Floor holes include skylights and skylight openings. When working on a roof with skylights, the skylights are considered floor holes since they are on the walking/working surface.

## FALL HAZARDS

The covering on a skylight is designed to let light in and is not designed to hold the weight of a worker. Many times workers do not realize that skylights cannot support their weight and will sit or stand on them.

Never place tools or other items on a skylight. The weight of the tool or object may be enough to break the skylight and cause the items to fall on workers below.

Pier holes and other footing holes that are more than 6 feet deep must also be protected. These types of holes may be protected with guardrails protecting all sides or may be covered.

The duty to have fall protection for floor holes is found in 29 CFR 1926.501(b)(4)(i) - (iii).

Each employee on walking/working surfaces **shall** be protected from falling through holes (including skylights) more than 6 feet above lower levels, by personal fall arrest systems, covers, or guardrail system erected around such holes. {see 1926.501(b)(4)(i)}

Each employee on a walking/working surface **shall** be protected from tripping in or stepping into or through holes (including skylights) by covers. {see 1926.501(b)(4)(ii)}

Each employee on a walking/working surface **shall** be protected from objects falling through holes (including skylights) by covers. {see 1926.501(b)(4)(iii)}

## CONCLUSION

This chapter has highlighted only some of the fall hazards and their controls commonly found on construction sites.

You, as a worker, must take this information and use it. It is your choice to work in a safe or unsafe manner. If you encounter an unsafe condition, you must make the choice to work safely. If you cannot correct the situation, tell a supervisor who can help.

Do not take short cuts. It only takes a second to fall.

Keep yourself safe so you can go home to the ones you love!

## Chapter II

# ELECTRICAL HAZARDS

### INTRODUCTION

This Chapter provides an overview of basic electrical safety on the job. Electricity is essential to modern life, both at home and on the job. Some employees - engineers, electricians, electronic technicians, and power line workers - work with electricity directly. Others, such as office workers and sales people, work indirectly with electricity. Perhaps because it has become such a familiar part of our daily life, many of us don't give much thought to how much our work depends on a reliable source of electricity. More importantly, we tend to overlook the hazards electricity poses and fail to treat it with the respect it deserves.

Even though we use it every day, electricity can be a serious workplace hazard that may expose you to:

- Electric Shock,
- Burns,
- Fires,
- Explosions,
- Electrocutation, and/or
- Death.

Every year workers die due to contacting electric current. During 2004, there were 5,703 occupational fatalities. Nearly 5%, or 253, of those fatalities were caused by contacting electric current. The construction industry accounted for 48%, or 121, of the deaths from electrical contact.

Section I - Hazards; this section will focus on the electrical hazards commonly found in the construction industry and applicable OSHA standards. Each of the following hazards are included in this section:

- Improper Grounding
- Exposed Electrical Parts
- Inadequate Wiring
- Overhead Power Lines
- Damaged Insulation
- Overloaded Circuits
- Wet Conditions

## ELECTRICAL HAZARDS

- Damaged Tools and Equipment

Section II - Hazard Prevention; this section will focus on the electrical hazard preventions, specifically:

- Personal Protective Equipment
- Tool Inspections
- GFCI's
- Lock Out/Tag Out Program

The regulatory requirements for electrical hazards are found in 29 CFR 1926 Subpart K.

## SECTION I - HAZARDS

### IMPROPER GROUNDING

A ground is a physical connection to earth and grounding is the process used to eliminate unwanted voltage. Grounding allows leakage voltage to dissipate to the ground instead of going through the worker and causing an injury. When a power tool is not grounded properly, a hazard exists because unwanted voltage cannot be safely eliminated. The metal parts of an electrical wiring system that we touch such as switch plates, light fixtures, conduit, etc., must be grounded and at 0 volts. These parts may become energized if the system is not grounded properly. When you contact an electrical device that is not grounded or grounded improperly, the electrical current will take the path of least resistance which will be YOU. You will be shocked!

29 CFR 1926.404(f) contains grounding requirements for systems, circuits, and equipment.

The path to ground from circuits, equipment and enclosures shall be permanent and continuous as required by 1926.404(f)(6).

States which supports, enclosures and equipment are to be grounded. {see 1926.404(f)(7)(i)-(v)}

Methods of grounding equipment. {see 1926.404(f)(8)}

With circuit conductors. Non-current-carrying metal parts of fixed equipment, if required to be grounded by this subpart, shall be grounded by an equipment grounding conductor which is contained within the same raceway, cable, or cord, or runs with or encloses the circuit conductors. For DC circuits only, the equipment grounding conductor may be run separately from the circuit conductors. {see 1926.404(f)(8)(i)}

Grounding conductor. A conductor used for grounding fixed or movable equipment shall have capacity to conduct safely any fault current which may be imposed on it. {see 1926.404(f)(8)(ii)}

Equipment considered effectively grounded. Electric equipment is considered to be effectively grounded if it is secured to, and in electrical contact with, a metal rack or structure that is provided for its support and the metal rack or structure is grounded by the method specified for the non-current-carrying metal parts of fixed equipment in paragraph (f) (8)(i) of this section. Metal car frames supported by metal hoisting cables attached to or running over metal sheaves or drums of grounded elevator machines are also considered to be effectively grounded. {see 1926.404(f)(8)(iii)}

The grounding pin in a flexible cord is designed to return leakage current back to ground. The path from the pin to the ground must be continuous in order to dissipate leakage current. If a flexible cord has a broken or removed ground pin, it may not provide a continuous path to ground. This is an electrical hazard and should be corrected immediately.



## ELECTRICAL HAZARDS

When you remove the grounding pin, you have removed one of the most important safety features built into the flexible extension cord. Without the direct path to ground, any leakage current has the potential to shock and injure you!

**NEVER** use an extension cord or electric tool that has a broken or missing ground pin!

## EXPOSED ELECTRICAL PARTS

Anytime electric wires, conductors, transformers, etc. are exposed you may contact them and get shocked. Missing or broken covers of electrical panels or equipment creates a serious hazard. You can contact exposed electric parts and be shocked or electrocuted. Exposed parts come in various forms, such as:

- Missing or removed covers from a junction or breaker box.
- A panel box with missing circuit breakers that expose the wires or terminals.
- Damaged outer insulation on electric cords that expose the inner conductors.
- Un-insulated overhead wires coming onto the jobsite.
- Electric terminals in motors, appliances, and electronic equipment that do not have covers.
- Older equipment that does not have guards or covers to cover exposed electrical parts.

Exposed electrical components are a hazard. If you see these conditions, report them to your supervisor immediately.

Working around panel boxes that have missing circuit breakers and other openings is a hazard. This exposes you to shock hazards. All openings in panel boxes, junction boxes, and any other electrical boxes must be closed.

Covers and canopies. All pull boxes, junction boxes, and fittings shall be provided with covers. If metal covers are used, they shall be grounded. In energized installations each outlet box shall have a cover, faceplate, or fixture canopy. Covers of outlet boxes having holes through which flexible cord pendants pass shall be provided with bushings designed for this purpose or shall have smooth, well-rounded surfaces on which the cords may bear.

The inner wires of a cord may be exposed when the outer insulation pulls away from the plug. When the inner wires are exposed to abrasions, breakage, and environmental conditions, you are exposed to shock and electrocution hazards. Make sure the outer insulation enters the plug completely so the inner wires are covered and protected. Flexible cords are to be fitted with strain relief to keep this from happening. {see 1926.405(b)(2)}

Strain relief. Flexible cords **shall** be connected to devices and fittings so that strain relief is provided which will prevent pull from being directly transmitted to joints or terminal screws. {see 1926.405(g)(2)(iv)}

Paragraph (j) lists the regulations for “Equipment for general use”.

Lighting fixtures. {see 1926.405(j)(1)}

Live parts. Fixtures, lamp holders, lamps, rosettes, and receptacles **shall** have no live parts normally exposed to employee contact. However, rosettes and cleat-type lamp holders and receptacles located at least 8 feet above the floor may have exposed parts. {see 1926.405(j)(1)(i)}

Appliances. {see 1926.405(j)(3)}

Live parts. Appliances, other than those in which the current carrying parts at high temperatures are necessarily exposed, **shall** have no live parts normally exposed to employee contact. {see 1926.405(j)(3)(i)}

Remember, when live parts are exposed you are at risk of being shocked or electrocuted.

## INADEQUATE WIRING

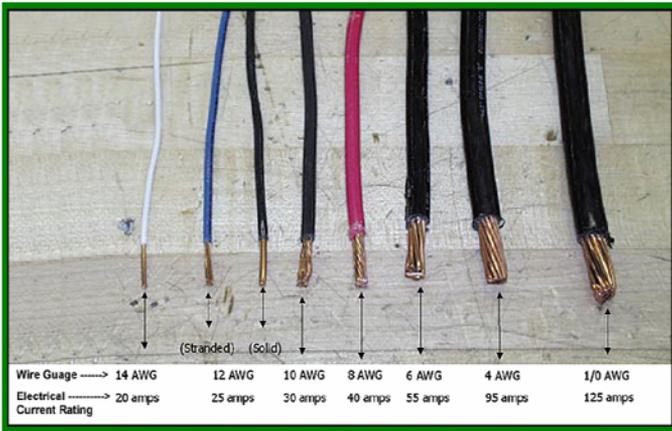
Electrical hazards result from using the wrong size or type of wire, such as when the gauge of the wire is too small for the current it will carry.

When you use an extension cord, the size of the wire you are placing into the circuit may be too small for the equipment. The circuit breaker could be the right size for the circuit but not right for the smaller-gauge extension cord. A tool plugged into the extension cord may use more current than the cord can handle without tripping the circuit breaker. The wire will overheat and could cause a fire.

## ELECTRICAL HAZARDS

You must avoid such hazards and create a safe work environment. You must choose the right size wire for the amount of electrical current expected in a circuit. The wire must be able to handle the current safely without heating up or tripping the circuit breaker.

Make sure to use properly rated extension cords when working with power tools. A tool plugged into the extension cord may use more current than the cord can handle without tripping the circuit breaker. This could damage the tool in addition to causing a fire. Always make sure that the extension cords you are using are properly rated for the equipment you are going to plug into it.



Covers wiring methods, components, and equipment for general use. {see 1926.405}

Wiring methods are covered in paragraph (a).

Extension cord sets used with portable electric tools and appliances shall be of three-wire type and shall be designed for hard or extra-hard usage. Flexible cords used with temporary and portable lights shall be designed for hard or extra-hard usage. {see 1926.405(a)(2)(ii)[J]}

*Note:* The National Electric Code, ANSI/NFPA 70, in Article 400 Table 400-4, lists various types of flexible cords, some of which are noted as being designed for hard or extra-hard usage. Examples of these types of flexible cords include hard service cord (types S, ST, SO, STO) and junior hard service cord (types SJ, SJO, SJT, SJTO).

To ensure you use the proper rated cord, 1926.405(g)(2)(i) requires that cords be marked. It states:

*Marking.* Type SJ, SJO, SJT, SJTO, S, SO, ST, and STO cords **shall not** be used unless durably marked on the surface with the type designation, size, and numbers of conductors.

## OVERHEAD POWER LINES

Most workers do not realize that overhead power lines are usually not insulated. More than half of all electrocutions are caused by direct worker contact with energized power lines. Most electrocutions involving overhead power lines are caused by failure to maintain proper work distances.

Shocks and electrocutions occur where physical barriers are not in place to prevent contact with the wires. When dump trucks, cranes, work platforms, or other conductive materials (such as pipes and ladders) contact overhead wires, the equipment operator or other workers can be killed. If you do not maintain required clearance distances from power lines, you can be shocked and killed. The minimum distance for voltages up to 50kV is 10 feet. For voltages over 50kV, the minimum distance is 10 feet plus 4 inches for every 10 kV over 50kV.



## ELECTRICAL HAZARDS

When working on a construction site, you should always survey the site to look for overhead power lines. Always look up! This situation is the most serious electrical hazard. It could cost you your life if you're not careful and aware of overhead power lines.



Never store materials and equipment under or near overhead power lines.

When working around overhead power lines and using ladders, be sure to use ladders made of non-conductive materials such as wood or plastic.

Ladders **shall** have non-conductive side rails if they are used where the employee or the ladder could contact exposed energized electrical equipment, except as provided in 1926.951(c)(1) of this part. {see 1926.1053(b)(12)}

Portable metal or conductive ladders **shall not** be used near energized lines or equipment except as necessary in specialized work such as in high voltage situations where non-conductive ladders might present a greater hazard than conductive ladders. {see 1926.951(c)(1)}

When working with scaffolding, you must stay clear of power lines - including when they are erected, used, dismantled, altered, or moved. Contact the power company and have the power shut-off to those lines while working near them. If that is not possible, have the power company insulate the lines. Always maintain the minimum safe distance from the lines.

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: {see 1926.451(f)(6)}

## Insulated Lines

Voltage	Minimal Distance	Alternatives
< 300	3 feet	
300 - 50 kv	10 feet	
> 50 kv	10 feet plus 0.4 inches for each kv over 50 kv	2 times the length of the line insulator but never less than 10 feet

## No insulated Lines

Voltage	Minimal Distance	Alternatives
< 300	3 feet	
> 50 kv	10 feet plus 0.4 inches for each kv over 50 kv	2 times the length of the line insulator but never less than 10 feet

Make sure that any conductive materials, such as ladders, conduit, long handled tools, and any other conductive material, used on the scaffolding do not come near the power lines.

Because overhead power lines are very dangerous, you must always be extra careful when working near them. Remember, power lines carry higher voltage on them. If you or your equipment comes in contact with them you could risk shock and possibly death by electrocution.

## DAMAGED INSULATION

Insulation on electrical cords must be intact and undamaged. Insulation that is defective or inadequate is an electrical hazard.

Insulation is usually made of a plastic or rubber material that covers each of the wire conductors. It prevents the conductors from coming in contact with each other, tools, water or people. Insulation also protects the wires from getting damaged due to the environment.

A tool with damaged insulation is especially dangerous. “Live” wires can contact metal parts of the tool and energize it. When you touch the tool, you may be shocked. You are more likely to receive a shock if the tool is not grounded or not double-insulated. Double-insulated tools have two insulation barriers and no exposed metal parts.

The requirement for insulation is found in 1926.405(f). It states:

Conductors for general wiring. All conductors used for general wiring shall be insulated unless otherwise permitted in this Subpart. The conductor insulation shall be of a type that is suitable for the voltage, operating temperature, and location of use. Insulated conductors shall be distinguishable by appropriate color or other means as being grounded conductors, ungrounded conductors, or equipment grounding conductors.

It is important that all flexible cords are kept in good condition so you don't get shocked or electrocuted. Paragraph (g) of 1926.405 contains the regulations for flexible cords. Those concerning insulation are listed below.

Prohibited uses. Unless necessary for a use prohibited in paragraph (g)(1)(i) of this section, flexible cords and cables **shall not** be used:  
{ see 1926.405(g)(1)(iii)}

[B] - Where run through holes in walls, ceilings, or floors;

[C] - Where run through doorways, windows, or similar openings, except as permitted in paragraph (a)(2)(ii)(1) of this section;

[D] - Where attached to building surfaces.

Each of these conditions could abrade the cord and damage the insulation.

When a flexible extension cord is damaged, it should be removed from service and replaced immediately. It is allowable to splice a cord to repair it, however, most methods of repairing an extension cord do not maintain the original integrity of the insulation. It is safer to get a new cord.

Splices. Flexible cords shall be used only in continuous lengths without splice or tap. Hard service flexible cords No. 12 or larger may be repaired if spliced so that the splice retains the insulation, outer sheath properties, and the usage characteristics of the cord being spliced.  
{see 1926.405(g)(2)(iii)}



When using extension cords, be careful you do not damage the insulation. Follow these basic precautions:

- **Do not** hang flexible cords from nails or other sharp objects that may damage the insulation.
- **Do not** run flexible cords through windows, doors, walls or other areas where they could be cut, pinched or otherwise damaged. When a cord is pinched or cut, damage may occur to the inner wires without evidence on the outside.
- **Do not** hang or drape an electrical cord on conductive objects. If they damage the cord, or if it is already damaged, the conductive surface may become energized and shock you or another worker.

## OVERLOADED CIRCUITS

Overloads in an electrical system are hazardous because they can produce heat, arcing or even a fire. Wires and other components in an electrical system have a maximum amount of electrical current they can carry safely.

## ELECTRICAL HAZARDS

If too many devices are plugged into a circuit, or if any one tool uses too much current, the electrical current will heat the wires to a very high temperature.

In order to prevent too much electrical current in a circuit, a circuit breaker or fuse is placed in the circuit. If there is too much current in the circuit, the breaker “trips” and opens like a switch. If an overloaded circuit is equipped with a fuse, an internal part of the fuse melts, opening the circuit.

Both circuit breakers and fuses do the same thing: open the circuit to shut off the electrical current. If the breakers or fuses are too big for the wires they are supposed to protect, an overload in the circuit will not be detected and the current will not be shut off. Overloading leads to overheating of circuit components (including wires) and may cause a fire.

Never overload an outlet by plugging too many cords into the same receptacle. Too much current will be pulled, the wires can overheat and may cause a fire! The worse part of all is that sometimes the fires occur inside the walls.

Do not use power strips or surge protectors at the construction site, they are not designed for that use. Power strips are usually designed for home use and cannot be used with power tools on a construction site. They are very hazardous if used in wet areas.

Paragraph (e) of 1926.405 contains the regulations for over current protection.

600 volts, nominal, or less. The following requirements apply to over current protection of circuits rated 600 volts, nominal, or less. {see 1926.404(e)(1)}

- (i) - Protection of conductors and equipment. Conductors and equipment shall be protected from over current in accordance with their ability to safely conduct current. Conductors shall have sufficient ampacity to carry the load.
- (ii) - Grounded conductors. Except for motor-running overload protection, overcurrent devices shall not interrupt the continuity of the grounded conductor unless all conductors

of the circuit are opened simultaneously.

- (iii) - Disconnection of fuses and thermal cutouts. Except for devices provided for current-limiting on the supply side of the service disconnecting means, all cartridge fuses which are accessible to other than qualified persons and all fuses and thermal cutouts on circuits over 150 volts to ground shall be provided with disconnecting means. This disconnecting means shall be installed so that the fuse or thermal cutout can be disconnected from its supply without disrupting service to equipment and circuits unrelated to those protected by the over current device.
- (iv) - Location in or on premises. Over current devices shall be readily accessible. Over current devices shall not be located where they could create an employee safety hazard by being exposed to physical damage or located in the vicinity of easily ignitable material.
- (v) - Arcing or suddenly moving parts. Fuses and circuit breakers shall be so located or shielded that employees will not be burned or otherwise injured by their operation.
- (vi) - Circuit breakers -
  - (vi)(A) - Circuit breakers shall clearly indicate whether they are in the open (off) or closed (on) position.
  - (vi)(B) - Where circuit breaker handles on switchboards are operated vertically rather than horizontally or rotationally, the up position of the handle shall be the closed (on) position.
  - (vi)(C) - If used as switches in 120-volt, fluorescent lighting circuits, circuit breakers shall be marked "SWD."

## WET CONDITIONS

Anyone working with electricity in a damp or wet environment needs to exercise extra caution to prevent injury.

Working in wet conditions is hazardous because you may become an easy path for electrical current. If you touch a live wire or other electrical component—and you are well-grounded because you are standing in a small puddle of water—you will receive a shock and can be killed.

Always avoid using electric tools in wet locations. Any water or humidity will increase your risk of receiving an electric shock. Remember, electrical current will take all paths to ground. You can become part of that path if you're standing in a puddle of water.

As noted earlier, damaged insulation, equipment, or tools can expose you to live electrical parts. A damaged tool may not be grounded properly, so the housing of the tool may be energized, causing you to receive a shock. Improperly grounded metal switch plates and ceiling lights are especially hazardous in wet conditions. If you touch a live electrical component with an no insulated hand tool, you are more likely to receive a shock when standing in water. But remember: you don't have to be standing in water to be electrocuted. Wet clothing, high humidity, and perspiration also increase your chances of being electrocuted. You need to recognize that all wet conditions are hazards.



Electric equipment installed in damp locations must meet the following:

Enclosures for damp or wet locations. {see 1926.405(e)}

Cabinets, fittings, and boxes. Cabinets, cutout boxes, fittings, boxes, and panel board enclosures in damp or wet locations shall be installed so as to prevent moisture or water from entering and accumulating within the enclosures. In wet locations the enclosures shall be weather-proof. {see 1926.405(e)(1)}

Switches and circuit breakers. Switches, circuit breakers, and switchboards installed in wet locations shall be enclosed in weather-proof enclosures. {see 1926.405(e)(2)}

## DAMAGED TOOLS/EQUIPMENT

Do not use electrical tools that are damaged. Many workers do not inspect their tools before using them. This is a dangerous practice that can lead to electric shock and death. You should always inspect your tools and electric cords before using them.

It's a simple concept, if you use tools that are damaged you may be shocked. Electrical energy can "leak" from the conductors to other parts of the tool causing it to be energized. When you use it, the electrical current can pass through you.

Use double insulated tools. These tools are designed with a greater level of safety for the user. Typically, the outside case is made of plastic or other non-conductive materials that will not allow the electric current to pass through you.

Look at the manufacturer's label on your tools. If it is a double insulated tool, it will have a "square inside a square" symbol on the label.

Requirements for power operated hand tools are located in 1926.302 and are as follows:

Electric power operated tools **shall** either be of the approved double insulated type or grounded in accordance with Subpart K of this part. {see 1926.302(a)(1)}

## ELECTRICAL HAZARDS

The use of electric cords for hoisting or lowering tools **shall not** be permitted. {see 1926.302(a)(2)}

The bottom line is - if a tool is damaged, or you suspect it is damaged, do not use it! Take the tool out of service and do not allow anyone else to use it.



## SECTION II - HAZARD PREVENTION

You must recognize potential hazards around you and make every effort to avoid and reduce them. Hazard recognition is the first step in having a safe workplace. But you must do more. Once you recognize the hazard, you must do something about it. By controlling or eliminating the hazard, you have made the workplace safer.

Remember, safety starts with you. You need to have a willing, positive attitude about safety in the workplace. You have people depending on you everyday and they expect you to come home alive and well. Practicing safety on the job will allow you to go home to the ones you love.

This section will focus on prevention measures. Measures that you can take to make your worksite safer.

Electrical accidents can be extremely dangerous and often result in serious injury or death. The safety measures listed below will help you work safer around electricity.

Each of the following will be discussed.

- Personal protective equipment (PPE)
- Tool inspection
- Ground fault circuit interrupters (GFCIs)
- Lock-out/Tag-out program

## PERSONAL PROTECTIVE EQUIPMENT

When exposed to possible electrical hazards PPE can be used for an additional measure of safety. Such PPE includes hardhats, rubber gloves, and insulating clothing. It is important to use the proper PPE when protecting yourself from electrical hazards. **NEVER** use damaged PPE.

29 CFR 1926.28 states - The employer is responsible for requiring the wearing of appropriate personal protective equipment in all operations where there is an exposure to hazardous conditions or where this part indicates the need for using such equipment to reduce the hazards to the employees.

This means that you must wear PPE. The type of PPE used will depend on the work you are doing.

You may be required to wear a hardhat to protect you from contacting electricity with your head.

Employees working in areas where there is a possible danger of head injury from impact, or from falling or flying objects, or from electrical shock and burns, shall be protected by protective helmets. {see 1926.100(a)}

Helmets for head protection of employees exposed to high voltage electrical shock and burns shall meet the specifications contained in American National Standards Institute, Z89.2-1971. {see 1926.100(c)}

## ELECTRICAL HAZARDS

Be sure to use the appropriately rated hardhat. Never use a metal or fiber-metal hardhat when working with electrical equipment. If you're not sure about the material of the hard hat, don't use it - find one that is properly marked. Remember, you can become a very good conductor if you wear a metal hard hat, and that could be fatal.

When performing work that may bring you in contact with electrical energy, such as power transmission and distribution, you should use the appropriate rubber insulating gloves. Make sure the glove rating matches the work to be conducted.

The gloves are required by 1926.951.

Rubber protective equipment shall be in accordance with the provisions of the American National Standards Institute (ANSI), ANSI J6 series, as follows: {see 1926.951(a)(1)(i)}

Item	Standard
Rubber insulating gloves	J6.6-1971.
Rubber matting for use around electric apparatus	J6.7-1935 (R1971).
Rubber insulating blankets	J6.4-1971.
Rubber insulating hoods	J6.2-1950 (R1971).
Rubber insulating line hose	J6.1-1950 (R1971).
Rubber insulating sleeves	J6.5-1971.

Rubber protective equipment shall be visually inspected prior to use. {see 1926.951(a)(1)(ii)}

In addition, an "air" test shall be performed for rubber gloves prior to use. {see 1926.951(a)(1)(iii)}

Protective equipment of material other than rubber shall provide equal or better electrical and mechanical protection. {see 1926.951(a)(1)(iv)}

Additionally, you must be trained in the use of specific types of gloves before working with electricity.

## TOOL INSPECTION

As previously discussed, tools that are damaged or in poor condition are hazardous and can expose you to electric shock and even death. When using hand and power tools, you are required to keep them in good condition.

Condition of tools. All hand and power tools and similar equipment, whether furnished by the employer or the employee, shall be maintained in a safe condition. {see 1926.300(a)}

You must inspect power tools regularly to ensure they are in good condition. As an everyday routine at work or home, before using any electrical tool or extension cord, be sure to inspect it completely for:

- Cracks
- Damaged insulation
- Broken ground pins
- Damaged cords
- Loose parts
- Any other damage

## GROUND FAULT CIRCUIT INTERRUPTERS (GFCIs)

OSHA ground-fault protection rules and regulations are necessary for employee safety and health. Therefore, it is the employer's responsibility to provide either:

- a) GFCIs on construction sites for receptacle outlets in use and not part of the permanent wiring of the building or structure; or
- b) a scheduled and recorded assured equipment grounding conductor program on construction sites, covering all cord sets, receptacles which are not part of the permanent wiring of the building or structure, and equipment connected by cord and plug which are available for use or used by employees.

The employer is required to provide approved GFCIs for all 120- volt, single-phase, 15- and 20-ampere receptacle outlets on construction sites that are not a part of the permanent wiring of the building or structure and that are in use by employees. If a receptacle or receptacles are installed as part of the permanent wiring of the building or structure and they are used for temporary electric power, GFCI protection shall be provided. Receptacles on the ends of extension cords are not part of the permanent wiring and, therefore the cord's receptacle must be of the GFCI type whether or not the extension cord is plugged into permanent wiring. These GFCIs monitor the current-to-the-load for leakage to ground.

A GFCI is a fast-acting circuit breaker that senses small imbalances in the circuit caused by current leakage to ground and, in a fraction of a second, shuts off the electricity.

The GFCI continually matches the amount of current going to an electrical device against the amount of current returning from the device along the electrical path. Whenever the amount "going" differs from the amount "returning" by approximately 5 milliamps, the GFCI interrupts the electric power within as little as 1/40 of a second.

When using a GFCI it is important to test the GFCI and make sure it is working properly. Just press the button marked "Test" and it will trip the device. No electricity will pass. Secondly press the button marked "Reset" and the device is ready for use.

Regulates wiring design and protection, paragraph (b) is specific for branch circuits and paragraph (f) is specific for grounding. {see 1926.404 }

Ground-fault protection. {see 1926.404(b)(1)}

General. The employer shall use either ground fault circuit interrupters as specified in paragraph (b)(1)(ii) of this section or an assured equipment grounding conductor program as specified in paragraph (b)(1)(iii) of this section to protect employees on construction sites. These requirements are in addition to any other requirements for equipment grounding conductors. {see 1926.404(b)(1)(i)}

Ground-fault circuit interrupters. All 120-volt, single-phase 15- and 20-ampere receptacle outlets on construction sites, which are not a part of the permanent wiring of the building or structure and which are in use by employees, shall have approved ground-fault circuit interrupters for personnel protection. Receptacles on a two-wire, single-phase portable or vehicle-mounted generator rated not more than 5kW, where the circuit conductors of the generator are insulated from the generator frame and all other grounded surfaces, need not be protected with ground-fault circuit interrupters. {see 1926.404(b)(1)(ii)}

Assured equipment grounding conductor program. The employer shall establish and implement an assured equipment grounding conductor program on construction sites covering all cord sets, receptacles which are not a part of the building or structure, and equipment connected by cord and plug which are available for use or used by employees. This program shall comply with the following minimum requirements: {see 1926.404(b)(1)(iii)}

[A] - A written description of the program, including the specific procedures adopted by the employer, shall be available at the jobsite for inspection and copying by the Assistant Secretary and any affected employee.

[B] - The employer shall designate one or more competent persons (as defined in 1926.32(f)) to implement the program.

## ELECTRICAL HAZARDS

- [C] - Each cord set, attachment cap, plug and receptacle of cord sets, and any equipment connected by cord and plug, except cord sets and receptacles which are fixed and not exposed to damage, shall be visually inspected before each day's use for external defects, such as deformed or missing pins or insulation damage, and for indications of possible internal damage. Equipment found damaged or defective shall not be used until repaired.
  
- [D] - The following tests shall be performed on all cord sets, receptacles which are not a part of the permanent wiring of the building or structure, and cord- and plug-connected equipment required to be grounded:
  - [1] - All equipment grounding conductors shall be tested for continuity and shall be electrically continuous.
  - [2] Each receptacle and attachment cap or plug shall be tested for correct attachment of the equipment grounding conductor. The equipment grounding conductor shall be connected to its proper terminal.
  
- [E] - All required tests shall be performed:
  - [1] - Before first use;
  - [2] - Before equipment is returned to service following any repairs;
  - [3] - Before equipment is used after any incident which can be reasonably suspected to have caused damage (for example, when a cord set is run over); and
  - [4] - At intervals not to exceed 3 months, except that cord sets and receptacles which are fixed and not exposed to damage shall be tested at intervals not exceeding 6 months.

- [F] - The employer shall not make available or permit the use by employees of any equipment which has not met the requirements of this paragraph (b)(1)(iii) of this section.
- [G] - Tests performed as required in this paragraph shall be recorded. This test record shall identify each receptacle, cord set, and cord-and plug-connected equipment that passed the test and shall indicate the last date it was tested or the interval for which it was tested. This record shall be kept by means of logs, color coding, or other effective means and shall be maintained until replaced by a more current record. The record shall be made available on the jobsite for inspection by the Assistant Secretary and any affected employee.

Secretary and any affected employee.

Grounding. Paragraphs (f)(1) through (f)(11) of this section contain grounding requirements for systems, circuits, and equipment. {see 1926.404(f)}

Systems to be grounded. The following systems which supply premises wiring shall be grounded: {see 1926.404(f)(1)}

Three-wire DC systems. All 3-wire DC systems shall have their neutral conductor grounded. {see 1926.404(f)(1)(i)}

Two-wire DC systems. Two-wire DC systems operating at over 50 volts through 300 volts between conductors shall be grounded unless they are rectifier-derived from an AC system complying with paragraphs (f)(1)(iii), (f)(1)(iv), and (f)(1)(v) of this section. {see 1926.404(f)(1)(ii)}

AC circuits, less than 50 volts. AC circuits of less than 50 volts shall be grounded if they are installed as overhead conductors outside of buildings or if they are supplied by transformers and the transformer primary supply system is ungrounded or exceeds 150 volts to ground. {see 1926.404(f)(1)(iii)}

## ELECTRICAL HAZARDS

AC systems, 50 volts to 1000 volts. AC systems of 50 volts to 1000 volts shall be grounded under any of the following conditions, unless exempted by paragraph (f)(1)(v) of this section: {see 1926.404(f)(1)(iv)}

- [A] If the system can be so grounded that the maximum voltage to ground on the ungrounded conductors does not exceed 150 volts;
- [B] If the system is nominally rated 480Y/277 volt, 3-phase, 4-wire in which the neutral is used as a circuit conductor;
- [C] If the system is nominally rated 240/120 volt, 3-phase, 4-wire in which the midpoint of one phase is used as a circuit conductor; or
- [D] If a service conductor is un-insulated.

Exceptions. AC systems of 50 volts to 1000 volts are not required to be grounded if the system is separately derived and is supplied by a transformer that has a primary voltage rating less than 1000 volts, provided all of the following conditions are met: {see 1926.404(f)(1)(v)}

- [A] The system is used exclusively for control circuits,
- [B] The conditions of maintenance and supervision assure that only qualified persons will service the installation,
- [C] Continuity of control power is required, and
- [D] Ground detectors are installed on the control system.

Portable and vehicle-mounted generators {see 1926.404(f)(3)}

Portable generators. Under the following conditions, the frame of a portable generator need not be grounded and may serve as the grounding electrode for a system supplied by the generator: {see 1926.404(f)(3)(i)}

- [A] The generator supplies only equipment mounted on the generator and/or cord- and plug-connected equipment through receptacles mounted on the generator, and
- [B] The no current-carrying metal parts of equipment and the equipment grounding conductor terminals of the receptacles are bonded to the generator frame.

Vehicle-mounted generators. Under the following conditions the frame of a vehicle may serve as the grounding electrode for a system supplied by a generator located on the vehicle: {see 1926.404(f)(3)(ii)}

- [A] The frame of the generator is bonded to the vehicle frame, and
- [B] The generator supplies only equipment located on the vehicle and/or cord- and plug-connected equipment through receptacles mounted on the vehicle or on the generator, and
- [C] The no current-carrying metal parts of equipment and the equipment grounding conductor terminals of the receptacles are bonded to the generator frame, and
- [D] The system complies with all other provisions of this section.

Grounding connections. {see 1926.404(f)(5)}

Grounded system. For a grounded system, a grounding electrode conductor shall be used to connect both the equipment grounding conductor and the grounded circuit conductor to the grounding electrode. Both the equipment grounding conductor and the grounding electrode conductor shall be connected to the grounded circuit conductor on the supply side of the service disconnecting means, or on the supply side of the system disconnecting means or overcurrent devices if the system is separately derived. {see 1926.404(f)(5)(i)}

## ELECTRICAL HAZARDS

Ungrounded systems. For an ungrounded service supplied system, the equipment grounding conductor shall be connected to the grounding electrode conductor at the service equipment. For an ungrounded separately derived system, the equipment grounding conductor shall be connected to the grounding electrode conductor at, or ahead of, the system disconnecting means or over current devices. {see 1926.404(f)(5)(ii)}

Grounding path. The path to ground from circuits, equipment, and enclosures shall be permanent and continuous. {see 1926.404(f)(6)}

Methods of grounding equipment {see 1926.404(f)(8)}

With circuit conductors. No current-carrying metal parts of fixed equipment, if required to be grounded by this subpart, shall be grounded by an equipment grounding conductor which is contained within the same raceway, cable, or cord, or runs with or encloses the circuit conductors. For DC circuits only, the equipment grounding conductor may be run separately from the circuit conductors. {see 1926.404(f)(8)(i)}

Grounding conductor. A conductor used for grounding fixed or movable equipment shall have capacity to conduct safely any fault current which may be imposed on it. {see 1926.404(f)(8)(ii)}

Equipment considered effectively grounded. Electric equipment is considered to be effectively grounded if it is secured to, and in electrical contact with, a metal rack or structure that is provided for its support and the metal rack or structure is grounded by the method specified for the no current-carrying metal parts of fixed equipment in paragraph (f)(8)(i) of this section. Metal car frames supported by metal hoisting cables attached to or running over metal sheaves or drums of grounded elevator machines are also considered to be effectively grounded. {see 1926.404(f)(8)(iii)}

## LOCK-OUT/TAG-OUT PROGRAM

Using a Lock-out/Tag-out program is another way to keep workers safe when working with electricity. Before any work is performed on electrical systems, workers must ensure that the equipment is turned off and “locked-out”.

The following is an overview of the Lock-out/Tag-out program.

When working with electricity, turning the equipment off is not enough. Someone could turn the equipment back on without the worker knowing about it. To prevent this, the power switch must be locked in the off position. This is referred to as “locking-out”.

Once the power switch is securely locked out, it must be tagged. The tag serves as a warning to let others know why the switch has been turned off and who turned it off.

The lock and the tag are warning signs. If you see equipment that is locked and tagged do not touch it. It is locked and tagged for a reason.

If you are required to work on electrical equipment you must be trained in Lock-out/Tag-out procedures specific for that site.

OSHA has an entire standard devoted to Lock-Out/Tag-Out. It is located in 29 CFR 1910.147.

## CONCLUSION

This chapter has highlighted only some of the electrical hazards and their controls commonly found on construction sites.

You as a worker must take this information and use it. It is your choice to work in a safe or unsafe manner. If you encounter an unsafe condition, you must make the choice to work safely. If you cannot correct the situation, tell a supervisor who can help.

Do not take short cuts, It only takes a second to get electrocuted or shocked.

Keep yourself safe so you can go home to the ones you love.

## Chapter III

# STRUCK-BY HAZARDS

### INTRODUCTION

This chapter provides an overview of struck-by hazards typically found at construction sites. It will help you recognize and prevent these hazards at your worksite.

A struck-by hazard exists anytime a worker has the potential to be struck or hit by an object. That object could be anything found on the job site. A worker could be struck on the head by a brick that has fallen from a scaffold. A nail that was fired from a nail gun can strike a worker in the eye. Materials being hoisted can swing into a worker striking him on the leg. Any number of tools, materials or equipment can strike a worker and cause serious injury or death.

Each year hundreds of workers die from struck-by incidents. In the year 2004, 96 workers died from struck-by accidents. In the construction industry, 148 workers never returned home. They died after being struck-by some object. Struck-by deaths account for 10% of all deaths in the construction industry.

The following sections will discuss common struck-by hazards, their prevention and OSHA requirements. Remember, this book does not include every hazard or regulation.

Section I - Hazards; this section will focus on the hazards from:

- Falling objects;
- Flying objects;
- Swinging/slipping objects; and
- Objects at ground level.

Section II - Hazard Prevention; this section will focus on the prevention of struck-by hazards, specifically:

- Personal Protection Equipment
- Material Storage
- Proper Material Handling
- Work Zone Safety

## SECTION I - HAZARDS

### FALLING OBJECTS

A falling object will eventually land on the ground. Gravity will always pull the object to the earth. If you happen to be in the path of where the object began its fall and the ground, you will be struck by that object. On a construction site, the object could be building materials, debris, bricks, tools, etc. Objects may fall from elevated work surfaces, while they are being moved from one area to another or even while in storage.

Elevated working surfaces increase the risk of objects falling onto workers below. Because anything that is dropped or pushed off the surface will fall to a lower level. Where that object lands is anybody's guess.

If you are working on elevated work surfaces, you are a hazard to all workers who are working below you. Any materials or debris that you throw, drop or push off the work surface have the potential to fall on workers below you.

When working on scaffolding, you have to protect yourself from falling objects and prevent objects from falling onto workers below. You can protect yourself by wearing a hardhat and protect others by using toe boards and/or netting to keep objects from falling. The requirements for falling object protection while working on scaffolding are found in 29 CFR 1926.451(h) and are as follows:

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 toe boards, 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. {see 1926.451(h)(1)}

Where there is a danger of tools, materials, or equipment falling from a scaffold and striking employees below, the following provisions apply: {see 1926.451(h)(2)}

The area below the scaffold to which objects can fall **shall** be barricaded, and employees **shall not** be permitted to enter the hazard area; {see 1926.451(h)(2)(i)}

A toeboard **shall** be erected along the edge of platforms more than 10 feet 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 wood or equivalent may be used in lieu of toeboards; {see 1926.451(h)(2)(ii)}

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 {see 1926.451(h)(2)(iii)}

A guardrail system **shall** be installed with openings small enough to prevent passage of potential falling objects; or {see 1926.451(h)(2)(iv)}

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. {see 1926.451(h)(2)(v)}

Canopies, when used for falling object protection, **shall** comply with the following criteria: {see 1926.451(h)(3)}

Canopies **shall** be installed between the falling object hazard and the employees. {see 1926.451(h)(3)(i)}

When canopies are used on suspension scaffolds for falling object protection, the scaffold **shall** be equipped with additional independent support lines equal in number to the number of points supported, and equivalent in strength to the strength of the suspension ropes. {see 1926.451(h)(3)(ii)}

Independent support lines and suspension ropes **shall not** be attached to the same points of anchorage. {see 1926.451(h)(3)(iii)}

Where used, toe boards **shall** be: {see 1926.451(h)(4)}

## STUCK-BY HAZARD

Capable of withstanding, without failure, a force of at least 50 pounds applied in any downward or horizontal direction at any point along the toeboard (toeboards built in accordance with Appendix A to this subpart will be deemed to meet this requirement); and {see 1926.451(h)(4)(i)}

At least three and one-half inches high from the top edge of the toeboard to the level of the walking/working surface. Toeboards **shall** be securely fastened in place at the outermost edge of the platform and have not more than 1/4 inch clearance above the walking/working surface. Toeboards **shall** be solid or with openings not over one inch in the greatest dimension. {see 1926.451(h)(4)(ii)}



When you work or walk below elevated work surfaces, you may be exposed to falling objects. Falling objects may strike you on the head or any other part of your body. These falling objects are the primary reason you need to wear a hardhat.

Many times workers will toss materials from one level to another as a quick way to move them. This is extremely hazardous. If the material is not caught gravity will always draw it back to the ground.

Additionally, the materials could break into many pieces that can rain down on workers below. Never take a shortcut and toss or throw materials from one level to another.

Another cause of falling materials is trash and debris removal. A window or other opening in a building is often used as an easy way to get debris from the inside to the outside.

Never use a building opening or window without a chute to throw out trash and debris. While you are clearing your work space, you are creating serious struck-by hazards for those working below you.

29 CFR 1926.252 requires the use of chutes, enclosures and barricades when disposing of waste materials.

Whenever materials are dropped more than 20 feet to any point lying outside the exterior walls of the building, an enclosed chute of wood, or equivalent material, **shall** be used. For the purpose of this paragraph, an enclosed chute is a slide, closed in on all sides, through which material is moved from a high place to a lower one. {see 1926.252(a)}

When debris is dropped through holes in the floor without the use of chutes, the area onto which the material is dropped **shall** be completely enclosed with barricades not less than 42 inches high and not less than 6 feet back from the projected edge of the opening above. Signs warning of the hazard of falling materials **shall** be posted at each level. Removal **shall not** be permitted in this lower area until debris handling ceases above. {see 1926.252(b)}

Objects can also fall when they are being moved from one location to another. A tremendous amount of materials are moved on, off and around construction sites. Some are moved by hand, but most are moved by mechanical methods. Moving materials by elevated means exposes all workers in the path to potential struck-by hazards. At any point along the move, the materials can fall.

Overhead loads can create serious struck-by hazards. The materials can fall if not properly secured. A load that consists of a single piece of material is sometimes easier to handle than a load that has multiple pieces.

When moving a load with multiple pieces, it must be tightly secured so none of the pieces fall on workers.



All materials being lifted must be picked up evenly so they don't shift causing part or all of the load to fall. Be sure to properly secure the load and don't lift more than the equipment can handle.

Never put yourself at risk by walking or working under a load as it is being carried overhead.

Proper rigging and lifting practices will be covered in the hazard prevention section of this guide.

Even if materials are not being moved or used at the moment, they can still cause struck-by hazards. Stored materials can be a hazard.

Materials that are stored on elevated surfaces, or in receiving areas have the potential to fall onto workers. All materials must be stored in such a way that they can not fall.

29 CFR 1926.250(a)(1) - All materials stored in tiers **shall** be stacked, racked, blocked, interlocked, or otherwise secured to prevent sliding, falling or collapse.

Make sure materials are secured when they are moved in and out of storage. If not, the entire load can fall or parts of the load can fall. The materials may fall on you or another worker.

Working below material storage areas also exposes you to falling objects. Improperly stored materials have the potential to shift and fall.

## FLYING OBJECTS

Flying objects are objects that have been discharged or dislodged from something. These objects are typically propelled from their source and can cause greater injury due to the forces behind them.

An example of a discharged object is a nail from a nail gun. The nail is propelled from the gun by force, it is discharged. This force can be either pneumatic or powder actuated.

An example of dislodged objects are pieces of wood that splintered when driven into forms. The splinters can fly causing struck-by hazards.

Pushing, pulling, prying or grinding objects and using power tools are some activities that cause flying objects. These activities can cause objects to become airborne and fly like missiles.

29 CFR 1926.301 has regulations concerning the use of hand tools to prevent flying object hazards.

Impact tools, such as drift pins, wedges, and chisels, **shall** be kept free of mushroomed heads. {see 1926.301©}

If you strike a tool that has a mushroom head, chips can fly off of it.

The wooden handles of tools **shall** be kept free of splinters or cracks and **shall** be kept tight in the tool. {see 1926.301(d)}

Powder actuated tools are particularly hazardous due to the force behind the fastener. These fasteners are designed to go through wood, concrete and steel and they can certainly go through you!

Using a powder actuated tool is like using a hand gun. You must use it safely or you will seriously injure or kill yourself or other workers. 29 CFR 1926.302(e) has the regulations for these tools.

Only employees who have been trained in the operation of the particular tool in use **shall** be allowed to operate a powder-actuated tool. {see 1926.302(e)(1)}



The tool **shall** be tested each day before loading to see that safety devices are in proper working condition. The method of testing **shall** be in accordance with the manufacturer's recommended procedure. {see 1926.302(e)(2)}

Any tool found not in proper working order, or that develops a defect during use, **shall** be immediately removed from service and not used until properly repaired. {see 1926.302(e)(3)}

Personal protective equipment **shall** be in accordance with Subpart E of this part. {see 1926.302(e)(4)}

Tools **shall not** be loaded until just prior to the intended firing time. Neither loaded nor empty tools are to be pointed at any employees. Hands **shall** be kept clear of the open barrel end. {see 1926.302(e)(5)}

Loaded tools **shall not** be left unattended. {see 1926.302(e)(6)}

Fasteners **shall not** be driven into very hard or brittle materials including, but not limited to, cast iron, glazed tile, surface-hardened steel, glass block, live rock, face brick, or hollow tile. {see 1926.302(e)(7)}

Driving into materials easily penetrated **shall** be avoided unless such materials are backed by a substance that will prevent the pin or fastener from passing completely through and creating a flying missile hazard on the other side. {see 1926.302(e)(8)}

No fastener **shall** be driven into a spalled area caused by an unsatisfactory fastening. {see 1926.302(e)(9)}

All tools **shall** be used with the correct shield, guard, or attachment recommended by the manufacturer. {see 1926.302(e)(11)}

Powder-actuated tools used by employees **shall** meet all other applicable requirements of American National Standards Institute, A10.3-1970, Safety Requirements for Explosive-Actuated Fastening Tools. {see 1926.302(e)(12)}

Using compressed air can also cause flying object hazards. Compressed air is commonly used to power tools and clean surfaces. Unfortunately, many workers also use compressed air to clean dirt and debris off themselves. This is addressed in 29 CFR 1926.302(b) - Pneumatic power tools.

Compressed air **shall not** be used for cleaning purposes except where reduced to less than 30 p.s.i. and then only with effective chip guarding and personal protective equipment which meets the requirements of Subpart E of this part. The 30 p.s.i. requirement does not apply for concrete form, mill scale and similar cleaning purposes. {see 1926.302(b)(4)}

The compressed air will blow particles into the air around you and can drive those particles into your eyes or body. Anytime you have compressed air pressurized above 30 psi, you can drive oils and other particles through your skin. You can also injure other workers around you.

## ● SWINGING/SLIPPING OBJECTS

When materials are lifted, they have the potential to swing and strike workers. As the load is lifted, the materials may swing, twist or turn. This movement can catch workers by surprise and they could be hit by the swinging load. Depending on where the worker is standing and the force behind the load, the worker may fall to another level after being struck and sustain even greater injuries.

## STUCK-BY HAZARD

Windy conditions are especially hazardous because the load will swing more. Never lift loads overhead on windy days.

Always lift the loads evenly. An uneven load may swing out of control striking workers and damaging equipment.

In addition to swinging, loads can slip from their riggings and strike workers. Loads must be rigged properly to prevent slippage.

As the load is being secured, the rigging must be placed to evenly distribute the weight of the load. This will ease the work of the crane or other lifting equipment, put less strain on each leg of the rigging, and reduce slipping and swinging.

After the sling is properly attached to the load, there are a number of good lifting techniques that are common to all slings.

- A. Make sure that the load is not lagged, clamped, or bolted to the floor.
- B. Guard against shock loading by taking up the slack in the sling slowly. Apply power cautiously to prevent jerking at the beginning of the lift, and slowly accelerate or decelerate.
- C. Check the tension on the sling. Raise the load a few inches, stop, and check for proper balance and that all items are clear of the path of travel. Never allow anyone to ride on the load.
- D. Keep all personnel clear while the load is being raised, moved, or lowered. Crane or hoist operators should watch the load at all times when it is in motion.
- E. Obey the following "nevers":
  - Never allow more than one person to control a lift or give signals to a crane or hoist operator except to warn of a hazardous situation;
  - Never raise the load more than necessary;
  - Never leave the load suspended in the air; and
  - Never work under a suspended load or allow anyone else to.



Remember, the load must be lifted with the hook over its center of gravity. To make a level lift, the hook must be directly above this point. If the hook is too far to one side of the center of gravity, dangerous tilting will result causing unequal stresses in the different sling legs.

Once the load is properly secured and balanced, a tag line can be used to control the load. Even if a tag line is used, the load can still swing and strike workers. Remember, as the load is lifted, the tag line will lift until it is out of reach.

## OBJECTS AT GROUND LEVEL

We often don't think of struck-by hazards occurring from objects that are at ground level. However, you may be at the greatest risk from those ground level hazards. You may be exposed to struck-by hazards from materials, heavy equipment, vehicular traffic, or traffic in a workzone area.

You may be struck-by materials as they are moved around the site by trucks, forklifts or other equipment. The equipment operators have the responsibility to keep the load as low as possible and watch for workers who are in their path. The load must not obstruct the operators view.

Anytime you work around heavy equipment, you are exposed to struck-by hazards. These powerful machines are used to dig holes, deliver concrete, tear down buildings, pick up materials and various other tasks as needed. Without them, construction as we know it would not exist.



The disadvantages of using heavy equipment are that they are dangerous and often the operators have a limited view. If you are in a position where the operator cannot see you, your very life is in danger. Many workers have been struck and then run over by heavy equipment.

Heavy equipment also has many moving parts that you can be struck by. For instance, the arm of a backhoe or excavator swings in multiple directions as it works. If you are in its path, you may be struck. Many workers have been killed by the bucket of a backhoe or excavator.

When working near these types of equipment, you need to stay beyond the reach of the arm and maintain eye contact with the operator.

Other pieces of equipment have moving parts that you need to watch for. The chute on a concrete truck is an example. Make sure all moving parts are secured so they can't move or swing freely and strike you. Secure all movable parts.

Moving parts can also cause dirt and debris to fall on you. Such as when a backhoe or excavator is digging and placing the dirt on the spoils pile. Never work under this type of load.

Another concern is vehicle traffic which is constant on construction sites. The vehicle traffic may be heavy equipment working the site, equipment delivering or moving materials, or personnel lifts. Whatever the traffic may be, you are exposed to struck-by hazards.

Both the operators and the workers have responsibilities to keep everyone safe on the job.



If you are an operator, you must:

- Always drive in designated areas;
- Always use a spotter when backing; and
- Always watch for workers who may not be watching you.

If you are working near vehicles and equipment, you must:

- Never place yourself between a vehicle and an immovable object such as a building;
- Make eye contact with the operator before crossing the path of the vehicle; and
- Always watch for operators who may not be watching you.

Traffic workzones expose workers to injury from the movement of construction vehicles and equipment within the workzone, as well as from passing motor vehicle traffic. Flaggers and other workers on foot have a greater exposure to being struck, therefore, they must be visible to both motorists and equipment operators. These workers and others in traffic workzones must protect themselves from being struck-by motorist who are often driving too fast for the conditions, driving in unfamiliar areas, and who are distracted while driving. For these reasons and others, workers are at great risk of being struck-by a motor vehicle.



One of the most important things you can do when working in a work zone is be visible. You need to be visible to other workers as well as passing motorists. Wearing highly visible reflective vests can save your life.

Another way to protect yourself from motor vehicle traffic is to place physical barriers between the work and the roadway. Never work near vehicle traffic without barricades.

## SECTION II - HAZARD PREVENTION

To be safe on the job, you must recognize the hazards around you and make every effort to avoid and reduce them. The previous section showing various struck-by hazards were used to help you recognize hazards on the job. Hazard recognition is the first step in having a safe workplace. But you must do more. Once you recognize the hazard, you must do something about it. By controlling or eliminating the hazard, you have made the workplace safer.

Remember, safety starts with you. You need to have a willing, positive attitude towards safety in the workplace. You have people depending on you everyday and they expect you to come home alive and well. Practicing safety on the job will allow you to go home to the ones you love.

In the following section we will focus on the methods used to control struck-by hazards.

Struck-by hazards can be found in many different areas of construction work.

For this reason it is important to plan your work and look at the possible hazards every day. As the work progresses, the hazards will change. Also, specific activities will have hazards that you will have to deal with individually.

Prevention is the key to reducing struck-by injuries and fatalities. You have seen examples of struck-by hazards and now we will focus on how to prevent or correct the hazards. We will focus on:

- Personal Protection Equipment
- Material Storage
- Proper Material Handling
- Work Zone Safety

## **PERSONAL PROTECTIVE EQUIPMENT**

One way to protect yourself from injury from struck-by hazards is to wear Personal Protective Equipment or PPE. Many times workers wear PPE because they are told to, never knowing the reason why they should wear it. They think its just a ridiculous requirement placed on them that gets in the way of their work.

The simple reason for wearing PPE is that it just might save your life! Wearing the proper PPE can protect you while you work and allow you to go home uninjured.

The three types of PPE to consider when discussing struck-by hazards are:

- Hardhats;
- Safety glasses and face shields; and
- Safety vests.

Anytime you work in an area where there are overhead hazards, you must wear a hard hat. The hard hat will prevent injury if materials fall on your head.

## STUCK-BY HAZARD

A hard hat can protect you from:

- Objects that have fallen,
- Objects that are flying, and
- Objects that you may bump into.

Subpart E of 29 CFR 1926 states the requirements for wearing PPE.

Application. Protective equipment, including personal protective equipment for eyes, face, head, and extremities, protective clothing, respiratory devices, and protective shields and barriers, **shall** be provided, used, and maintained in a sanitary and reliable condition wherever it is necessary by reasons of hazards of processes or environment, chemical hazards, radiological hazards, or mechanical irritants encountered in a manner capable of causing injury or impairment in the function of any part of the body through absorption, inhalation or physical contact. {see 1926.95(a)}

This means that if you can be injured by something on the job, you must use PPE.

If there is a hazard of objects striking you on the head, you must wear head protection. This is usually in the form of a hardhat.

Employees working in areas where there is a possible danger of head injury from impact, or from falling or flying objects, or from electrical shock and burns, **shall** be protected by protective helmets. {see 1926.100(a)}

Helmets for the protection of employees against impact and penetration of falling and flying objects **shall** meet the specifications contained in American National Standards Institute, Z89.1-1969. Safety Requirements for Industrial Head Protection. {see 1926.100(b)}

When wearing a hardhat there are some “nevers” to remember.

- Never wear a hard hat backwards.

- Never place anything between the inside of the hat and your head.
- Never wear a damaged hard hat. If your hard hat is damaged, remove it and get another one. A damaged hard hat will not protect you.

Eye and face protection can protect you from flying objects. Wearing safety glasses can prevent serious injuries, including blindness.

Employees **shall** be provided with eye and face protection equipment when machines or operations present potential eye or face injury from physical, chemical, or radiation agents. {see 1926.102(a)(1)}

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. {see 1926.102(b)(2)}

Employees whose vision requires the use of corrective lenses in spectacles, when required by this regulation to wear eye protection, **shall** be protected by goggles or spectacles of one of the following types: {see 1926.102(b)(3)}

(i) - Spectacles whose protective lenses provide optical correction;

(ii) - Goggles that can be worn over corrective spectacles without disturbing the adjustment of the spectacles;

(iii) - Goggles that incorporate corrective lenses mounted behind the protective lenses.

Face and eye protection equipment **shall** be kept clean and in good repair. The use of this type of equipment with structural or optical defects **shall** be prohibited. {see 1926.102(a)(4)}

Protectors **shall** meet the following minimum requirements: {see 1926.102(a)(6)}

(i) - They **shall** provide adequate protection against the particular hazards for which they are designed.

## STUCK-BY HAZARD

(ii) - They **shall** be reasonably comfortable when worn under the designated conditions.

(iii) - They **shall** fit snugly and **shall not** unduly interfere with the movements of the wearer.

(iv) - They **shall** be durable.

(v) - They **shall** be capable of being disinfected.

(vi) - They **shall** be easily cleanable.

Every protector **shall** be distinctly marked to facilitate identification only of the manufacturer. {see 1926.102(a)(7)}

When limitations or precautions are indicated by the manufacturer, they **shall** be transmitted to the user and care taken to see that such limitations and precautions are strictly observed. {see 1926.102(a)(8)}

If you are in an area where pneumatic or powder actuated tools are used, you must use PPE. If you are using compressed air to clean with, you must wear eye and face protection to prevent flying particles from injuring you.

As stated previously, when working around traffic, either construction or motor vehicle, you must wear a reflective vest. A highly visible reflective vest may be the only thing that catches the eye of a motorist and prevents them from hitting you.

29 CFR 1926.201 specifically addresses flaggers and the need for safety garments.

Signaling by flaggers and the use of flaggers, including warning garments worn by flaggers **shall** conform to Part VI of the Manual on Uniform Traffic Control Devices, or MUTCD, (1988 Edition, Revision 3 or the Millennium Edition), which are incorporated by reference in 1926.200(g)(2). {see 1926.201(a)}

The requirements for wearing safety vests for other duties are also found in the MUTCD.

Working in a traffic work zone without wearing a safety vest is the same as wearing camouflage in the woods. You can't be seen!

## MATERIAL STORAGE

All stored materials must be stored properly to prevent them from falling on workers. Proper storage means that all materials must be stored in such a way that they do not shift, lean, or fall. As previously stated, they must be stacked, racked, blocked, and interlocked to prevent them from sliding, falling, or collapsing. Additional materials storage requirements are found in 29 CFR 1926.250.

Maximum safe load limits of floors within buildings and structures, in pounds per square foot, **shall** be conspicuously posted in all storage areas, except for floor or slab on grade. Maximum safe loads **shall not** be exceeded. {see 1926.250(a)(2)}

Aisles and passageways **shall** be kept clear to provide for the free and safe movement of material handling equipment or employees. Such areas **shall** be kept in good repair. {see 1926.250(a)(3)}

Material stored inside buildings under construction **shall not** be placed within 6 feet of any hoistway or inside floor openings, nor within 10 feet of an exterior wall which does not extend above the top of the material stored. {see 1926.250(b)(1)}

Non-compatible materials **shall** be segregated in storage. {see 1926.250(b)(3)}

Bagged materials **shall** be stacked by stepping back the layers and cross-keying the bags at least every 10 bags high. {see 1926.250(b)(4)}

Materials **shall not** be stored on scaffolds or runways in excess of supplies needed for immediate operations. {see 1926.250(b)(5)}

Brick stacks **shall not** be more than 7 feet in height. When a loose brick stack reaches a height of 4 feet, it **shall** be tapered back 2 inches in every foot of height above the 4-foot level. {see 1926.250(b)(6)}

When masonry blocks are stacked higher than 6 feet, the stack **shall** be tapered back one-half block per tier above the 6-foot level. {see 1926.250(b)(7)}

## STUCK-BY HAZARD

Lumber: {see 1926.250(b)(8)}

(i) - Used lumber **shall** have all nails withdrawn before stacking.

(ii) - Lumber **shall** be stacked on level and solidly supported sills.

(iii) - Lumber **shall** be so stacked as to be stable and self-supporting.

(iv) - Lumber piles **shall not** exceed 20 feet in height provided that lumber to be handled manually **shall not** be stacked more than 16 feet high.

Structural steel, poles, pipe, bar stock, and other cylindrical materials, unless racked, **shall** be stacked and blocked so as to prevent spreading or tilting. {see 1926.250(b)(9)}

Housekeeping. Storage areas **shall** be kept free from accumulation of materials that constitute hazards from tripping, fire, explosion, or pest harborage. Vegetation control will be exercised when necessary. {see 1926.250(c)}

## PROPER MATERIAL HANDLING

Material handling includes the moving, lifting and storing of materials. Handling materials properly means handling them so workers do not get injured.

Since storage has been discussed, this section will focus on the lifting and moving aspects of material handling.

In order to lift any materials, they must first be properly rigged. The rigging includes slings, chains, wire rope, natural and synthetic rope, and the shackles and hooks used to lift the load.

Requirements for rigging equipment are found in 29 CFR 1926.251.

Rigging equipment for material handling **shall** be inspected prior to use on each shift and as necessary during its use to ensure that it is safe. Defective rigging equipment **shall** be removed from service. {see 1926.251(a)(1)}

Rigging equipment **shall not** be loaded in excess of its recommended safe working load, as prescribed in Tables H-1 through H-20 in this subpart, following 1926.252(e) for the specific equipment. {see 1926.251(a)(2)}

Rigging equipment, when not in use, **shall** be removed from the immediate work area so as not to present a hazard to employees. {see 1926.251(a)(3)}

Special custom design grabs, hooks, clamps, or other lifting accessories, for such units as modular panels, prefabricated structures and similar materials, **shall** be marked to indicate the safe working loads and **shall** be proof-tested prior to use to 125 percent of their rated load. {see 1926.251(a)(4)}

Scope. This section applies to slings used in conjunction with other material handling equipment for the movement of material by hoisting, in employments covered by this part. The types of slings covered are those made from alloy steel chain, wire rope, metal mesh, natural or synthetic fiber rope (conventional three strand construction), and synthetic web (nylon, polyester, and polypropylene). {see 1926.251(a)(5)}

Inspections. Each day before being used, the sling and all fastenings and attachments **shall** be inspected for damage or defects by a competent person designated by the employer. Additional inspections **shall** be performed during sling use, where service conditions warrant. Damaged or defective slings **shall** be immediately removed from service. {see 1926.251(a)(6)}

Alloy steel chains. {see 1926.251(b)}

Welded alloy steel chain slings **shall** have permanently affixed durable identification stating size, grade, rated capacity, and sling manufacturer. {see 1926.251(b)(1)}

Hooks, rings, oblong links, pear-shaped links, welded or mechanical coupling links, or other attachments, when used with alloy steel chains, **shall** have a rated capacity at least equal to that of the chain. {see 1926.251(b)(2)}

Job or shop hooks and links, or makeshift fasteners, formed from bolts, rods, etc., or other such attachments, **shall not** be used. {see 1926.251(b)(3)}

Rated capacity (working load limit) for alloy steel chain slings **shall** conform to the values shown in Table H-1. {see 1926.251(b)(4)}

## STUCK-BY HAZARD

Whenever wear at any point of any chain link exceeds that shown in Table H-2, the assembly **shall** be removed from service. {see 1926.251(b)(5)}

Inspections. {see 1926.251(b)(6)}

(i) - In addition to the inspection required by other paragraphs of this section, a thorough periodic inspection of alloy steel chain slings in use **shall** be made on a regular basis, to be determined on the basis of (A) frequency of sling use; (B) severity of service conditions; (C) nature of lifts being made; and (D) experience gained on the service life of slings used in similar circumstances. Such inspections **shall** in no event be at intervals greater than once every 12 months.

(ii) - The employer **shall** make and maintain a record of the most recent month in which each alloy steel chain sling was thoroughly inspected, and **shall** make such record available for examination.

Wire rope. {see 1926.251(c)}

Tables H-3 through H-14 **shall** be used to determine the safe working loads of various sizes and classifications of improved plow steel wire rope and wire rope slings with various types of terminals. For sizes, classifications, and grades not included in these tables, the safe working load recommended by the manufacturer for specific, identifiable products **shall** be followed, provided that a safety factor of not less than 5 is maintained. {see 1926.251(c)(1)}

Protruding ends of strands in splices on slings and bridles **shall** be covered or blunted. {see 1926.251(c)(2)}

Wire rope **shall not** be secured by knots, except on haul back lines on scrapers. {see 1926.251(c)(3)}

The following limitations **shall** apply to the use of wire rope: {see 1926.251(c)(4)}

(i) - An eye splice made in any wire rope **shall have not** less than three full tucks. However, this requirement **shall not** operate to preclude the use of another form of splice or connection which can be shown to be as efficient and which is not otherwise prohibited.

(ii) - Except for eye splices in the ends of wires and for endless rope slings, each wire rope used in hoisting or lowering, or in pulling loads, **shall** consist of one continuous piece without knot or splice.

(iii) - Eyes in wire rope bridles, slings, or bull wires **shall not** be formed by wire rope clips or knots.

(iv) - Wire rope **shall not** be used if, in any length of eight diameters, the total number of visible broken wires exceeds 10 percent of the total number of wires, or if the rope shows other signs of excessive wear, corrosion, or defect.

When U-bolt wire rope clips are used to form eyes, Table H-20 **shall** be used to determine the number and spacing of clips.  
{see 1926.251(c)(5)}

(i) - When used for eye splices, the U-bolt **shall** be applied so that the "U" section is in contact with the dead end of the rope.

Slings **shall not** be shortened with knots or bolts or other makeshift devices. {see 1926.251(c)(6)}

Sling legs **shall not** be kinked. {see 1926.251(c)(7)}

Slings used in a basket hitch **shall** have the loads balanced to prevent slippage. {see 1926.251(c)(8)}

Slings **shall** be padded or protected from the sharp edges of their loads. {see 1926.251(c)(9)}

Hands or fingers **shall** not be placed between the sling and its load while the sling is being tightened around the load.  
{see 1926.251(c)(10)}

Shock loading is prohibited. {see 1926.251(c)(11)}

A sling **shall not** be pulled from under a load when the load is resting on the sling. {see 1926.251(c)(12)}

Minimum sling lengths. {see 1926.251(c)(13)}

(i) - Cable laid, 6 x 19 and 6 x 37 slings **shall** have minimum clear length of wire rope 10 times the component rope diameter between splices, sleeves or end fittings.

## STUCK-BY HAZARD

(ii) - Braided slings **shall** have a minimum clear length of wire rope 40 times the component rope diameter between the loops or end fittings.

(iii) - Cable laid grommets, strand laid grommets and endless slings **shall** have a minimum circumferential length of 96 times their body diameter.

(jjj) Safe operating temperatures. Fiber core wire rope slings of all grades **shall** be permanently removed from service if they are exposed to temperatures in excess of 200 deg. F. When nonfiber core wire rope slings of any grade are used at temperatures above 400 deg. F or below minus 60 deg. F, recommendations of the sling manufacturer regarding use at that temperature **shall** be followed.  
{see 1926.251(c)(14)}

End attachments. {see 1926.251(c)(15)}

(i) - Welding of end attachments, except covers to thimbles, **shall** be performed prior to the assembly of the sling.

(ii) - All welded end attachments **shall not** be used unless proof tested by the manufacturer or equivalent entity at twice their rated capacity prior to initial use. The employer **shall** retain a certificate of proof test, and make it available for examination.

Natural rope, and synthetic fiber. {see 1926.251(d)}

General. When using natural or synthetic fiber rope slings, Tables H-15, 16, 17, and 18 **shall** apply. {see 1926.251(d)(1)}

All splices in rope slings provided by the employer **shall** be made in accordance with fiber rope manufacturers recommendations.  
{see 1926.251(d)(2)}

(i) - In manila rope, eye splices **shall** contain at least three full tucks, and short splices **shall** contain at least six full tucks (three on each side of the center line of the splice).

(ii) - In layered synthetic fiber rope, eye splices **shall** contain at least four full tucks, and short splices **shall** contain at least eight full tucks (four on each side of the center line of the splice).

(iii) - Strand end tails **shall not** be trimmed short (flush with the surface of the rope) immediately adjacent to the full tucks. This precaution applies to both eye and short splices and all types of fiber rope. For fiber ropes under 1-inch diameter, the tails **shall** project at least six rope diameters beyond the last full tuck. For fiber ropes 1-inch diameter and larger, the tails **shall** project at least 6 inches beyond the last full tuck. In applications where the projecting tails may be objectionable, the tails **shall** be tapered and spliced into the body of the rope using at least two additional tucks (which will require a tail length of approximately six rope diameters beyond the last full tuck).

(iv) - For all eye splices, the eye **shall** be sufficiently large to provide an included angle of not greater than 60 deg. at the splice when the eye is placed over the load or support.

(v) - Knots **shall not** be used in lieu of splices.

Safe operating temperatures. Natural and synthetic fiber rope slings, except for wet frozen slings, may be used in a temperature range from minus 20 deg. F to plus 180 deg. F without decreasing the working load limit. For operations outside this temperature range and for wet frozen slings, the sling manufacturer's recommendations **shall** be followed. {see 1926.251(d)(3)}

Splicing. Spliced fiber rope slings **shall not** be used unless they have been spliced in accordance with the following minimum requirements and in accordance with any additional recommendations of the manufacturer: {see 1926.251(d)(4)}

(i) - In manila rope, eye splices **shall** consist of at least three full tucks, and short splices **shall** consist of at least six full tucks, three on each side of the splice center line.

(ii) - In synthetic fiber rope, eye splices **shall** consist of at least four full tucks, and short splices **shall** consist of at least eight full tucks, four on each side of the center line.

## STUCK-BY HAZARD

(iii) - Strand end tails **shall not** be trimmed flush with the surface of the rope immediately adjacent to the full tucks. This applies to all types of fiber rope and both eye and short splices. For fiber rope under 1 inch (2.54 cm) in diameter, the tail **shall** project at least six rope diameters beyond the last full tuck. For fiber rope 1 inch (2.54 cm) in diameter and larger, the tail **shall** project at least 6 inches (15.24 cm) beyond the last full tuck. Where a projecting tail interferes with the use of the sling, the tail **shall** be tapered and spliced into the body of the rope using at least two additional tucks (which will require a tail length of approximately six rope diameters beyond the last full tuck).

(iv) - Fiber rope slings **shall** have a minimum clear length of rope between eye splices equal to 10 times the rope diameter.

(v) - Knots **shall not** be used in lieu of splices.

(vi) - Clamps not designed specifically for fiber ropes **shall not** be used for splicing.

(vii) - For all eye splices, the eye **shall** be of such size to provide an included angle of not greater than 60 degrees at the splice when the eye is placed over the load or support.

End attachments. Fiber rope slings **shall not** be used if end attachments in contact with the rope have sharp edges or projections. {see 1926.251(d)(5)}

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

(i) - Abnormal wear.

(ii) - Powdered fiber between strands.

(iii) - Broken or cut fibers.

(iv) - Variations in the size or roundness of strands.

(v) - Discoloration or rotting.

(vi) - Distortion of hardware in the sling.

Synthetic webbing (nylon, polyester, and polypropylene).  
{see 1926.251(e)}

The employer **shall** have each synthetic web sling marked or coded to show: {see 1926.251(e)(1)}

- (i) - Name or trademark of manufacturer.
- (ii) - Rated capacities for the type of hitch.
- (iii)- Type of material.

Rated capacity **shall not** be exceeded. {see 1926.251(e)(2)}

Webbing. Synthetic webbing **shall** be of uniform thickness and width and selvage edges **shall not** be split from the webbing's width. {see 1926.251(e)(3)}

Fittings. Fittings **shall** be: {see 1926.251(e)(4)}

- (i) - Of a minimum breaking strength equal to that of the sling; and
- (ii) - Free of all sharp edges that could in any way damage the webbing.

Attachment of end fittings to webbing and formation of eyes. Stitching **shall** be the only method used to attach end fittings to webbing and to form eyes. The thread **shall** be in an even pattern and contain a sufficient number of stitches to develop the full breaking strength of the sling. {see 1926.251(e)(5)}

Environmental conditions. When synthetic web slings are used, the following precautions **shall** be taken: {see 1926.251(e)(6)}

- (i) - Nylon web slings **shall not** be used where fumes, vapors, sprays, mists or liquids of acids or phenolics are present.
- (ii) - Polyester and polypropylene web slings **shall not** be used where fumes, vapors, sprays, mists or liquids of caustics are present.
- (iii) - Web slings with aluminum fittings **shall not** be used where fumes, vapors, sprays, mists or liquids of caustics are present.

## STUCK-BY HAZARD

Safe operating temperatures. Synthetic web slings of polyester and nylon **shall not** be used at temperatures in excess of 180 deg. F. Polypropylene web slings **shall not** be used at temperatures in excess of 200 deg. F. {see 1926.251(e)(7)}

Removal from service. Synthetic web slings **shall** be immediately removed from service if any of the following conditions are present: {see 1926.251(e)(8)}

- (i) - Acid or caustic burns;
- (ii) - Melting or charring of any part of the sling surface;
- (iii) - Snags, punctures, tears or cuts;
- (iv) - Broken or worn stitches; or
- (v) - Distortion of fittings.

Shackles and hooks. {see 1926.251(f)}

Table H-19 **shall** be used to determine the safe working loads of various sizes of shackles, except that higher safe working loads are permissible when recommended by the manufacturer for specific, identifiable products, provided that a safety factor of not less than 5 is maintained. {see 1926.251(f)(1)}

The manufacturer's recommendations **shall** be followed in determining the safe working loads of the various sizes and types of specific and identifiable hooks. All hooks for which no applicable manufacturer's recommendations are available **shall** be tested to twice the intended safe working load before they are initially put into use. The employer **shall** maintain a record of the dates and results of such tests. {see 1926.251(f)(2)}

Tables H-1 through H-20 are not included in this guide. They can be found on the internet at [www.osha.gov](http://www.osha.gov).

Once the materials are properly secured and rigged, the load is ready to lift. Most often, loads are lifted using a crane.

Cranes are carefully designed, tested, and manufactured for safe operation. When used properly they can safely lift and move extremely heavy loads. Because cranes have the ability to lift heavy loads to great heights, they also have an increased potential for catastrophic accidents. Safe lifting practices must always be followed.

Crane operators and personnel working with cranes need to know the basics of the crane's lifting capacities, limitations, and specific job site restrictions. Operators and workers must also be aware of the location of overhead power lines, unstable soil, and high wind conditions.

These requirements and more are found in 29 CFR 1926.550.

The employer **shall** comply with the manufacturer's specifications and limitations applicable to the operation of any and all cranes and derricks. Where manufacturer's specifications are not available, the limitations assigned to the equipment **shall** be based on the determinations of a qualified engineer competent in this field and such determinations will be appropriately documented and recorded. Attachments used with cranes **shall not** exceed the capacity, rating, or scope recommended by the manufacturer. {see 1926.550(a)(1)}

Rated load capacities, and recommended operating speeds, special hazard warnings, or instruction, **shall** be conspicuously posted on all equipment. Instructions or warnings **shall** be visible to the operator while he is at his control station. {see 1926.550(a)(2)}

Hand signals to crane and derrick operators **shall** be those prescribed by the applicable ANSI standard for the type of crane in use. An illustration of the signals **shall** be posted at the job site. {see 1926.550(a)(4)}

The employer **shall** designate a competent person who **shall** inspect all machinery and equipment prior to each use, and during use, to make sure it is in safe operating condition. Any deficiencies **shall** be repaired, or defective parts replaced, before continued use. {see 1926.550(a)(5)}

A thorough, annual inspection of the hoisting machinery **shall** be made by a competent person, or by a government or private agency recognized by the U.S. Department of Labor. The employer **shall** maintain a record of the dates and results of inspections for each hoisting machine and piece of equipment. {see 1926.550(a)(6)}

## STUCK-BY HAZARD

Wire rope **shall** be taken out of service when any of the following conditions exist: {see 1926.550(a)(7)}

(i) - In running ropes, six randomly distributed broken wires in one lay or three broken wires in one strand in one lay;

(ii)- Wear of one-third the original diameter of outside individual wires. Kinking, crushing, bird caging, or any other damage resulting in distortion of the rope structure;

(iii) - Evidence of any heat damage from any cause;

(iv) - Reductions from nominal diameter of more than one-sixty-fourth inch for diameters up to and including five-sixteenths inch, one-thirty-second inch for diameters three-eighths inch to and including one-half inch, three-sixty-fourths inch for diameters nine-sixteenths inch to and including three-fourths inch, one-sixteenth inch for diameters seven-eighths inch to 1 1/8 inches inclusive, three-thirty-seconds inch for diameters 1 1/4 to 1 1/2 inches inclusive;

(v) - In standing ropes, more than two broken wires in one lay in sections beyond end connections or more than one broken wire at an end connection.

(vi) - Wire rope safety factors **shall** be in accordance with American National Standards Institute B 30.5-1968 or SAE J959-1966.

Belts, gears, shafts, pulleys, sprockets, spindles, drums, fly wheels, chains, or other reciprocating, rotating, or other moving parts or equipment **shall** be guarded if such parts are exposed to contact by employees, or otherwise create a hazard. Guarding **shall** meet the requirements of the American National Standards Institute B 15.1-1958 Rev., Safety Code for Mechanical Power Transmission Apparatus. {see 1926.550(a)(8)}

Accessible areas within the swing radius of the rear of the rotating superstructure of the crane, either permanently or temporarily mounted, **shall** be barricaded in such a manner as to prevent an employee from being struck or crushed by the crane. {see 1926.550(a)(9)}

All exhaust pipes **shall** be guarded or insulated in areas where contact by employees is possible in the performance of normal duties. {see 1926.550(a)(10)}

Whenever internal combustion engine powered equipment exhausts in enclosed spaces, tests **shall** be made and recorded to see that employees are not exposed to unsafe concentrations of toxic gases or oxygen deficient atmospheres. {see 1926.550(a)(11)}

All windows in cabs **shall** be of safety glass, or equivalent, that introduces no visible distortion that will interfere with the safe operation of the machine. {see 1926.550(a)(12)}

Where necessary for rigging or service requirements, a ladder, or steps, **shall** be provided to give access to a cab roof. {see 1926.550(a)(13)(i)}

(ii) - Guardrails, handholds, and steps **shall** be provided on cranes for easy access to the car and cab, conforming to American National Standards Institute B30.5.

(iii) - Platforms and walkways **shall** have anti-skid surfaces.

Fuel tank filler pipe **shall** be located in such a position, or protected in such manner, as to not allow spill or overflow to run onto the engine, exhaust, or electrical equipment of any machine being fueled. {see 1926.550(a)(14)}

(i) - An accessible fire extinguisher of 5BC rating, or higher, **shall** be available at all operator stations or cabs of equipment.

(ii) - All fuels **shall** be transported, stored, and handled to meet the rules of Subpart F of this part. When fuel is transported by vehicles on public highways, Department of Transportation rules contained in 49 CFR Parts 177 and 393 concerning such vehicular transportation are considered applicable.

Except where electrical distribution and transmission lines have been de-energized and visibly grounded at point of work or where insulating barriers, not a part of or an attachment to the equipment or machinery, have been erected to prevent physical contact with the lines, equipment or machines **shall** be operated proximate to power lines only in accordance with the following: {see 1926.550(a)(15)}

## STUCK-BY HAZARD

(i) - For lines rated 50 kV. or below, minimum clearance between the lines and any part of the crane or load **shall** be 10 feet;

(ii) - For lines rated over 50 kV., minimum clearance between the lines and any part of the crane or load **shall** be 10 feet plus 0.4 inch for each 1 kV. over 50 kV., or twice the length of the line insulator, but never less than 10 feet;

(iii) - In transit with no load and boom lowered, the equipment clearance **shall** be a minimum of 4 feet for voltages less than 50 kV., and 10 feet for voltages over 50 kV., up to and including 345 kV., and 16 feet for voltages up to and including 750 kV.

(iv) - A person **shall** be designated to observe clearance of the equipment and give timely warning for all operations where it is difficult for the operator to maintain the desired clearance by visual means;

(v) - Cage-type boom guards, insulating links, or proximity warning devices may be used on cranes, but the use of such devices **shall not** alter the requirements of any other regulation of this part even if such device is required by law or regulation;

(vi) - Any overhead wire **shall** be considered to be an energized line unless and until the person owning such line or the electrical utility authorities indicate that it is not an energized line and it has been visibly grounded;

(vii) - Prior to work near transmitter towers where an electrical charge can be induced in the equipment or materials being handled, the transmitter **shall** be de-energized or tests **shall** be made to determine if electrical charge is induced on the crane. The following precautions **shall** be taken when necessary to dissipate induced voltages:

(a) - The equipment **shall** be provided with an electrical ground directly to the upper rotating structure supporting the boom; and

(b) - Ground jumper cables **shall** be attached to materials being handled by boom equipment when electrical charge is induced while working near energized transmitters. Crews **shall** be provided with nonconductive poles having large alligator clips or other similar protection to attach the ground cable to the load.

(c) - Combustible and flammable materials **shall** be removed from the immediate area prior to operations.

No modifications or additions which affect the capacity or safe operation of the equipment **shall** be made by the employer without the manufacturer's written approval. If such modifications or changes are made, the capacity, operation, and maintenance instruction plates, tags, or decals, **shall** be changed accordingly. In no case **shall** the original safety factor of the equipment be reduced. {see 1926.550(a)(16)}

The employer **shall** comply with Power Crane and Shovel Association Mobile Hydraulic Crane Standard No. 2. {see 1926.550(a)(17)}

Sideboom cranes mounted on wheel or crawler tractors **shall** meet the requirements of SAE J743a-1964. {see 1926.550(a)(18)}

All employees **shall** be kept clear of loads about to be lifted and of suspended loads. {see 1926.550(a)(19)}

Here are some important things to remember about materials handling:

- Never try to lift a load that is greater than the crane's lifting capacity.
- Cranes must be inspected prior to the start of each day.
- Workers working around crane operations also need to be aware of hoisting activities.
- Workers must stay clear of loads as they are being lifted and never walk or work under a load.
- If the load shifts it can slip and fall onto workers.
- Never lift loads on windy days. If the wind is high enough it can cause the load to swing out of control. Once the load starts swinging, it can injure workers, damage buildings, or even topple the crane.

## STUCK-BY HAZARD

- The use of a tag line can help guide the load as it is being raised and lowered. Remember, even when using a tag line, do not walk under the load. You need to be out of the path of the load if it falls.

## WORKZONE SAFETY

Anytime you are working near heavy equipment or motor vehicle traffic you are at risk from serious struck-by injuries.

As stated earlier, you may be exposed to vehicular traffic from construction vehicles, heavy equipment and motor vehicles.

The regulations for motor vehicles and heavy equipment are found in Subpart O.

All equipment left unattended at night, adjacent to a highway in normal use, or adjacent to construction areas where work is in progress, **shall** have appropriate lights or reflectors, or barricades equipped with appropriate lights or reflectors, to identify the location of the equipment. {see 1926.600(a)(1)}

Heavy machinery, equipment, or parts thereof, which are suspended or held aloft by use of slings, hoists, or jacks **shall** be substantially blocked or cribbed to prevent falling or shifting before employees are permitted to work under or between them. Bulldozer and scraper blades, end-loader buckets, dump bodies, and similar equipment, **shall** be either fully lowered or blocked when being repaired or when not in use. All controls **shall** be in a neutral position, with the motors stopped and brakes set, unless work being performed requires otherwise. {see 1926.600(a)(3)(i)}

Whenever the equipment is parked, the parking brake **shall** be set. Equipment parked on inclines **shall** have the wheels chocked and the parking brake set. {see 1926.600(a)(3)(ii)}

Coverage. Motor vehicles as covered by this part are those vehicles that operate within an off-highway jobsite, not open to public traffic. The requirements of this section do not apply to equipment for which rules are prescribed in 1926.602. {see 1926.601(a)}

All vehicles **shall** have a service brake system, an emergency brake system, and a parking brake system. These systems may use common components, and **shall** be maintained in operable condition. {see 1926.601(b)(1)}

Whenever visibility conditions warrant additional light, all vehicles, or combinations of vehicles, in use **shall** be equipped with at least two headlights and two taillights in operable condition. {see 1926.601(b)(2)(i)}

(ii) - All vehicles, or combination of vehicles, **shall** have brake lights in operable condition regardless of light conditions.

All vehicles **shall** be equipped with an adequate audible warning device at the operator's station and in an operable condition. {see 1926.601(b)(3)}

No employer **shall** use any motor vehicle equipment having an obstructed view to the rear unless: {see 1926.601(b)(4)}

(i) - The vehicle has a reverse signal alarm audible above the surrounding noise level or:

(ii) - The vehicle is backed up only when an observer signals that it is safe to do so.

All haulage vehicles, whose pay load is loaded by means of cranes, power shovels, loaders, or similar equipment, **shall** have a cab shield and/or canopy adequate to protect the operator from shifting or falling materials. {see 1926.601(b)(6)}

Tools and material **shall** be secured to prevent movement when transported in the same compartment with employees. {see 1926.601(b)(7)}

Trucks with dump bodies **shall** be equipped with positive means of support, permanently attached, and capable of being locked in position to prevent accidental lowering of the body while maintenance or inspection work is being done. {see 1926.601(b)(10)}

All vehicles in use **shall** be checked at the beginning of each shift to assure that the following parts, equipment, and accessories are in safe operating condition and free of apparent {see 1926.601(b)(14)}

## STUCK-BY HAZARD

damage that could cause failure while in use: service brakes, including trailer brake connections; parking system (hand brake); emergency stopping system (brakes); tires; horn; steering mechanism; coupling devices; seat belts; operating controls; and safety devices. All defects **shall** be corrected before the vehicle is placed in service. These requirements also apply to equipment such as lights, reflectors, windshield wipers, defrosters, fire extinguishers, etc., where such equipment is necessary.

Earthmoving equipment; General. {see 1926.602(a)}

These rules apply to the following types of earthmoving equipment: scrapers, loaders, crawler or wheel tractors, bulldozers, off-highway trucks, graders, agricultural and industrial tractors, and similar equipment. The promulgation of specific rules for compactors and rubber-tired "skid-steer" equipment is reserved pending consideration of standards currently being developed. {see 1926.602(a)(1)}

Brakes. All earthmoving equipment mentioned in this 1926.602(a) **shall** have a service braking system capable of stopping and holding the equipment fully loaded, as specified in Society of Automotive Engineers SAE-J237, Loader Dozer-1971, J236, Graders-1971, and J319b, Scrapers-1971. Brake systems for self-propelled rubber-tired off-highway equipment manufactured after January 1, 1972 **shall** meet the applicable minimum performance criteria set forth in the following Society of Automotive Engineers Recommended Practices: Self-Propelled Scrapers..... SAE J319b-1971. {see 1926.602(a)(4)}

Audible alarms. {see 1926.602(a)(9)}

(i) - All bidirectional machines, such as rollers, compactors, front-end loaders, bulldozers, and similar equipment, **shall** be equipped with a horn, distinguishable from the surrounding noise level, which **shall** be operated as needed when the machine is moving in either direction. The horn **shall** be maintained in an operative condition.

(ii) - No employer **shall** permit earthmoving or compacting equipment which has an obstructed view to the rear to be used in reverse gear unless the equipment has in operation a reverse signal alarm

The safety requirements, ratios, or limitations applicable to machines distinguishable from the surrounding noise level or an employee signals that it is safe to do so. {see 1926.602(b)(3)}

Excavating and other equipment or attachment usage covered in Power Crane and Shovel Associations Standards No. 1 and No. 2 of 1968, and No. 3 of 1969, **shall** be complied with, and **shall** apply to cranes, machines, and attachments under this part. {see 1926.602(b)}

Lifting and hauling equipment (other than equipment covered under Subpart N of this part). {see 1926.602©}

Industrial trucks **shall** meet the requirements of 1926.600 and the following: {see 1926.602(c)}

(i) - Lift trucks, stackers, etc., **shall** have the rated capacity clearly posted on the vehicle so as to be clearly visible to the operator. When auxiliary removable counterweights are provided by the manufacturer, corresponding alternate rated capacities also **shall** be clearly shown on the vehicle. These ratings **shall not** be exceeded.

(ii) - No modifications or additions which affect the capacity or safe operation of the equipment **shall** be made without the manufacturer's written approval. If such modifications or changes are made, the capacity, operation, and maintenance instruction plates, tags, or decals **shall** be changed accordingly. In no case **shall** the original safety factor of the equipment be reduced.

(iii) - If a load is lifted by two or more trucks working in unison, the proportion of the total load carried by any one truck **shall not** exceed its capacity.

Powered industrial truck operator training. Note: The requirements applicable to construction work under this paragraph are identical to those set forth at §1910.178(l) of this chapter. {see 1926.602(d)}

The previous regulations cover vehicles on the typical construction site. Now we will discuss the prevention measures for workzones.

Traffic workzones will always have serious hazards. Each year construction workers are struck and killed when drivers of motor vehicles cross into the workzone.

## STUCK-BY HAZARD

Unfortunately, many motorists tend to be distracted and may be speeding while driving through a work zone. Once a motorist crosses into the workzone, their car becomes a deadly weapon.

The MUTCD sets the practices that must be used to keep workers safe while in workzones. Both workers and employers must adhere to this manual for the safety of all workers and motorists.

In an effort to control injuries and fatalities in workzones, many states have increased the penalties for traffic violations when motorists are stopped in traffic workzones. This effort is intended to make motorists pay more attention and drive safer. When motorists are paying closer attention to their driving and the work going on, you are safer.

The MUTCD requires the use of traffic control devices. The purposes of traffic control devices are to promote highway safety and to notify road users of what is ahead. The traffic control devices ultimately provide for your safety.

Physical barriers are one type of traffic safety device that serve a dual purpose. They protect workers from vehicle traffic while guiding the motorist through the workzone. A physical barrier will prevent drivers from entering the zone where they can strike you.

Physical barriers can only protect workers if they separate the worker and the traffic. To protect workers while they are being placed traffic must be stopped or re-routed to keep motorists out of the work zone.

Other traffic control devices, such as the use of cones and flaggers are also covered in the MUTCD.

## CONCLUSION

This chapter has highlighted only some of the struck-by hazards and their controls commonly found on construction sites.

You, as a worker, must take this information and use it. It is your choice to work in a safe or unsafe manner. If you encounter an unsafe condition, you must make the choice to work safely. If you cannot correct the situation, tell a supervisor who can help.

Don't take short cuts.

Keep yourself safe so you can go home to the ones you love!

## CHAPTER 4

# CAUGHT-IN HAZARDS

### INTRODUCTION

This chapter provides an overview of caught-in hazards typically found at construction sites. It will help you recognize and prevent these hazards at your worksite.

A caught-in hazard exists anytime a worker can get any part of his body caught in or in between objects. For example, you are in a hurry, not paying attention and you close your finger in the truck door. Your finger is now caught in the truck between the door and the doorframe. While this type of injury is painful, it would not be fatal.

Here is an example of a fatal caught-in accident. A worker is not wearing a seatbelt while operating a forklift. The forklift tips and rolls over. Since the worker doesn't have a seatbelt on, he is thrown and the forklift lands on top of him. The worker is caught between the forklift and the ground.

Each year a surprising number of workers die from being caught-in between materials, trenches, and machinery. These seemingly simple accidents were responsible for 387 deaths in the year 2004. Nearly one third, or 109, of those fatalities happened in the construction industry. According to the latest Bureau of Labor Statistics, during 2004 there were 5,703 occupational fatalities. This means that approximately 7% of all occupational deaths are a result of being caught-in between materials, trenches or machinery.

The following sections will discuss common caught-in hazards, their prevention and OSHA requirements. Remember, this book does not include every hazard or all regulations.

Section I - Hazards; this section will focus on the hazards caused by:

- Cranes and Heavy Equipment;
- Tools and Equipment;
- Material Handling; and
- Trenches and Excavations.

## CAUGHT-IN HAZARDS

Section II - Hazard Prevention; this section will focus on the prevention of caught-in hazards. The following will be discussed:

- Guarding Moving Equipment/Parts;
- Barricades;
- Proper Material Handling; and
- Shielding/Trench Boxes.

## SECTION I - HAZARDS

### CRANES AND HEAVY EQUIPMENT

Working around heavy equipment and cranes exposes you to serious caught-in hazards.

Cranes, excavators and other heavy equipment that have rotating superstructures are especially hazardous. The superstructures of these types of heavy equipment have the ability to rotate 360 degrees. When the equipment rotates, it can create caught-in hazards. If you are standing between the equipment and an immovable object, such as a wall, when the superstructure rotates, you can be caught between the two objects. Never place yourself between a piece of heavy equipment and an immovable object.

The entire swing radius, or the area where the body of the machine can rotate, must be blocked from worker access. Never walk in this area. If you do, you are exposing yourself to a hazardous condition.

If you are standing between the superstructure and the tracks, you can be caught between them when the crane rotates.

Many fatalities have occurred when workers, who were standing too close to cranes, were caught-in between the tracks and the body of the crane.



Other types of equipment that have moving or rotating parts can create serious caught-in hazards. For instance, the arm of a backhoe or excavator can pin you between a building, a stack of materials, a trench wall, or any other immovable structure. Or a rotating auger can grab your clothing and pull you into it.

Workers must always be aware of their surroundings when working on a construction site near heavy equipment. When approaching equipment be sure the operator can see you and be sure to signal to them that you are near by. Never approach heavy equipment unless you know that the operator can see you. The operator should turn off the equipment before allowing you to approach.

## TOOLS AND EQUIPMENT

Workers can also get caught-in machinery and tools. Belts, pulleys, gears, rollers, rotating shafts and other moving parts can be very hazardous. Clothing, jewelry, gloves and body parts can get caught-in moving parts.

Guards are used on machinery and tools to prevent you from coming in contact with moving parts. For your safety, never remove guards from machinery or tools. If the guards have been removed, replace them or replace the entire tool. Never use equipment that is missing guards or other protective devices. Always replace guards after servicing equipment or tools.

## CAUGHT-IN HAZARDS

Many times, employees will bypass a guard by holding it in an open position. Although this is a very common practice it is extremely unsafe and has resulted in numerous injuries to workers. Never bypass the safety guards on tools.

Gloves, loose clothing and jewelry create serious caught-in hazards. These items can get caught in moving parts of machines and tools. As the glove, clothing or jewelry is pulled into the machine, your body may be pulled in with it.

For example, if you are wearing gloves and the finger of the glove gets caught in between the gears, your fingers and hand will be pulled into the gears as well.

Never allow gloves, loose clothing or dangling jewelry to get near moving parts. It is best to not wear jewelry or loose clothing when working near these pieces of equipment.

Air compressors are used frequently on construction sites. Many times the guards have been removed exposing workers to caught-in hazards. If you get a finger or hand caught in between the belt and pulley, you will be injured and may even break a bone or two. If you get clothing caught in the pulley, your clothing can draw other parts of you into the belt and pulleys causing greater injuries.

You can also find caught-in hazards when servicing machinery. Never place your hands or body near moving machinery such as gears, pulleys, or other devices. Always turn off equipment before servicing and ensure that the equipment cannot be restarted by someone else.



## MATERIAL HANDLING

Workers are exposed to caught-in hazards while handling materials. On construction sites, massive amounts of materials, including lumber, steel, brick, and blocks, are moved on and off the site. Caught-in hazards exist when materials are moved by hand or by machines - such as forklifts and cranes.

Anytime materials are moved, either by hand or by mechanical means, you need to use caution. Manual material handling may expose you to crushed fingers or toes when you place the materials on your hands or feet. These injuries can be minor such as bruising or major such as broken bones and amputation.

Materials being moved by machines expose workers to greater hazards. When moving materials by machine, the injuries can be more severe since the materials have a mechanical force behind them. Be careful to never place yourself between a load and an immovable object.

If you do, you can be crushed between a pallet of materials and a wall or other structure, be caught under loads that have been set down, or be caught under a fallen load.

Additionally, never walk under a load or between a load and a structure.

Stored materials present more caught-in hazards. Improperly stacked materials may shift and fall on you or other workers. Make sure all materials are properly stacked and stored to reduce the hazard of them falling on and trapping workers.

When stacking materials you may be caught between the materials themselves or between the materials and another object.

Sometimes the materials that are being moved are structural, such as steel and pre-fabricated walls. These materials tend to be larger, weigh more and have additional hazards. We will focus only on the caught-in hazards.

As these structural pieces are being placed, you may be exposed to a caught-in hazard such as pinching your finger between two pieces of steel or a greater hazard such as when you place your entire body between two objects.



When placing pre-fabricated walls or forms, ensure that all panels or structures are properly braced and supported to keep the wall or form from toppling over and causing severe injury or death to workers.

Basically, anytime you are moving or storing materials, you are at risk. Never place yourself between the materials and any other object. The result may be a fatal caught-in injury.

## TRENCHES AND EXCAVATIONS

Trenches and excavations present serious caught-in hazards. Although used interchangeably in this guide, “trenches” and “excavations” are not the same:

- Excavation - any man-made cut, cavity, trench, or depression in an earth surface formed by earth removal.
- Trench - a narrow excavation made below the surface of the ground. In general, the depth is greater than the width, but the width of a trench is not greater than 15 feet.

Trenches and excavations are particularly dangerous areas to work in. When a hole is dug, the earth’s natural response is to fill it. That may sound odd, but that is what happens. As dirt and rocks and other materials are removed from the hole, the sides will start to cave in and fill the hole from the bottom up. If you are in the hole, you may be caught-in the dirt and buried.

Anytime you are working in a trench or other excavation, you must be protected from being caught in a cave-in.

A cave-in happens when dirt or rocks separate from the sides of the excavation and falls or slides into the excavation.

Cave-ins may be caused by different factors, but the results are the same. The worker is trapped or buried in the excavation and will be seriously injured or killed.

While working in a trench or excavation, workers are exposed to a cave-in when there is no protection to prevent the soil from collapsing into the trench or there is no safe area inside the excavation. A system to protect the workers must be installed. There are many ways of protecting workers in excavations and trenches, such as trench boxes and shielding. The details for these protection systems will be covered in the prevention section of this guide.

Once a protection system is put in place, workers must remain inside the protected area in order to be protected. Once you step outside the trench box or shield, you are no longer protected. The protection system must extend to the top of the excavation. If the trench box or shield does not reach the top, there is the possibility that dirt and rock materials could fall over the top and trap the worker.

As work in the excavation or trench moves, the protection must move with the work. A trench box will offer you no protection if it is behind you.

Cave-ins are not the only caught-in hazards in a trench or excavation. The work going on in a trench may also create a hazard. For instance, when laying pipe in a trench, a caught-in hazard exists because workers can get caught between the pipe and the trench walls.

Anything being placed into the trench or excavation may be a hazard, including the protection system. Workers must be careful while installing the protection system so they are not caught between the trench walls and the protection system.

Not many workers realize that water in trenches or excavations can be very dangerous and create caught-in hazards. The water can soften the soil and cause it to collapse. Workers must never work inside an excavation where water has accumulated or is accumulating unless it is controlled by using pumps or other equipment. The equipment used to control water must also be inspected by a competent person.

## CAUGHT-IN HAZARDS

A safe means of entering and exiting a trench or excavation is also required. Workers must be able to get out of a trench or excavation quickly and safely.



## SECTION II - HAZARD PREVENTION

To be safe on the job, you must recognize the hazards around you and make every effort to avoid and reduce them. The previous section showing various caught-in hazards was used to help you recognize hazards on the job. Hazard recognition is the first step in having a safe workplace. But you must do more. Once you recognize the hazard, you must do something about it. By controlling or eliminating the hazard, you have made the workplace safer.

Remember, safety starts with you. You need to have a willing, positive attitude towards safety in the workplace. You have people depending on you everyday and they expect you to come home alive and well. Practicing safety on the job will allow you to go home to the ones you love.

In the following section we will focus on the methods used to control caught-in hazards.

Caught-in hazards can be found in many different areas of construction work. For this reason it is important to plan your work and look at the possible hazards every day. As the work progresses, the hazards will change. Also, specific activities will have hazards that you will have to deal with individually.

Prevention is the key to reducing caught-in injuries and fatalities. You have seen examples of caught-in hazards and now we will focus on how to prevent or correct the hazards. We will focus on:

- Guarding Moving Equipment/Parts
- Barricades
- Proper Material Handling
- Shielding/Trench Boxes

## GUARDING MOVING EQUIPMENT/PARTS

Machine guarding is one way to prevent caught-in hazards. Hand and power tools that have moving parts must be guarded. Always make sure the guards are in place and properly positioned before use. If guards must be removed to perform maintenance or servicing on the equipment, make certain the equipment is turned off and in a safe position before working on it.

The regulations for guarding hand and power tools can be found in 29 CFR 1926.300.

Condition of tools. All hand and power tools and similar equipment, whether furnished by the employer or the employee, shall be maintained in a safe condition. {see 1926.300(a)}

Guarding. {see 1926.300(b)}

When power operated tools are designed to accommodate guards, they shall be equipped with such guards when in use. {see 1926.300(b)(1)}

Belts, gears, shafts, pulleys, sprockets, spindles, drums, fly wheels, chains, or other reciprocating, rotating or moving parts of equipment shall be guarded if such parts are exposed to contact by employees or otherwise create a hazard. Guarding shall meet the requirements as set forth in American National Standards Institute, B15.1-1953 (R1958), Safety Code for Mechanical Power-Transmission Apparatus. {see 1926.300(b)(2)}

## CAUGHT-IN HAZARDS

"Types of guarding." One or more methods of machine guarding shall be provided to protect the operator and other employees in the machine area from hazards such as those created by point of operation, ingoing nip points, rotating parts, flying chips and sparks. Examples of guarding methods are - barrier guards, two-hand tripping devices, electronic safety devices, etc. {see 1926.300(b)(3)}

"Point of operation guarding." {see 1926.300(b)(4)}

(i) - Point of operation is the area on a machine where work is actually performed upon the material being processed.

(ii) - The point of operation of machines whose operation exposes an employee to injury, shall be guarded. The guarding device shall be in conformity with any appropriate standards therefore, or, in the absence of applicable specific standards, shall be so designed and constructed as to prevent the operator from having any part of his body in the danger zone during the operating cycle.

(iii) - Special hand tools for placing and removing material shall be such as to permit easy handling of material without the operator placing a hand in the danger zone. Such tools shall not be in lieu of other guarding required by this section, but can only be used to supplement protection provided.

(iv) - The following are some of the machines which usually require point of operation guarding:

- (a) - Guillotine cutters.
- (b) - Shears.
- (c) - Alligator shears.
- (d) - Powered presses.
- (e) - Milling machines.
- (f) - Power saws.
- (g) - Jointers.
- (h) - Portable power tools.
- (i) - Forming rolls and calendars.

"Exposure of blades." When the periphery of the blades of a fan is less than 7 feet above the floor or working level, the blades shall be guarded. The guard shall have openings no larger than 1/2 inch. {see 1926.300(b)(5)}

"Guarding of abrasive wheel machinery - exposure adjustment." Safety guards of the types described in paragraphs (b)(8) and (9) of this section, where the operator stands in front of the opening, shall be constructed so that the peripheral protecting member can be adjusted to the constantly decreasing diameter of the wheel. The maximum angular exposure above the horizontal plane of the wheel spindle as specified in paragraphs (b)(8) and (9) of this section shall never be exceeded, and the distance between the wheel periphery and the adjustable tongue or the end of the peripheral member at the top shall never exceed 1/4 inch. (See Figures I-1 through I-6.) {see 1926.300(b)(7)}

**Note** - these figures are not included in this guide. They can be found on the web at [www.osha.gov](http://www.osha.gov).

Personal protective equipment. Employees using hand and power tools and exposed to the hazard of falling, flying, abrasive, and splashing objects, or exposed to harmful dusts, fumes, mists, vapors, or gases shall be provided with the particular personal protective equipment necessary to protect them from the hazard. All personal protective equipment shall meet the requirements and be maintained according to Subparts D and E of this part. {see 1926.300(c)}

Exception: This paragraph does not apply to concrete vibrators, concrete breakers, powered tampers, jack hammers, rock drills, and similar hand operated power tools. {see 1926.300(d)(5)}

The regulations for guarding abrasive wheels and tools are found in 29 CFR 1926.303.

Guarding. {see 1926.303(b) }

Grinding machines shall be equipped with safety guards in conformance with the requirements of American National Standards Institute, B7.1-1970, Safety Code for the Use, Care and Protection of Abrasive Wheels, and paragraph (d) of this section. {see 1926.303(b)(1)}

"Guarding design." The safety guard shall cover the spindle end, nut, and flange projections. The safety guard shall be mounted so as to maintain proper alignment with the wheel, and the strength of the fastenings shall exceed the strength of the guard, except: {see 1926.303(b)(2)}

## CAUGHT-IN HAZARDS

(i) - Safety guards on all operations where the work provides a suitable measure of protection to the operator, may be so constructed that the spindle end, nut, and outer flange are exposed; and where the nature of the work is such as to entirely cover the side of the wheel, the side covers of the guard may be omitted; and

(ii) - The spindle end, nut, and outer flange may be exposed on machines designed as portable saws.

Use of abrasive wheels. {see 1926.303(c)}

Floor stand and bench mounted abrasive wheels, used for external grinding, shall be provided with safety guards (protection hoods). The maximum angular exposure of the grinding wheel periphery and sides shall be not more than 90 deg, except that when work requires contact with the wheel below the horizontal plane of the spindle, the angular exposure shall not exceed 125 deg. In either case, the exposure shall begin not more than 65 deg. above the horizontal plane of the spindle. Safety guards shall be strong enough to withstand the effect of a bursting wheel. {see 1926.303(c)(1) }

Floor and bench-mounted grinders shall be provided with work rests which are rigidly supported and readily adjustable. Such work rests shall be kept at a distance not to exceed one-eighth inch from the surface of the wheel. {see 1926.303(c)(2) }

Cup type wheels used for external grinding shall be protected by either a revolving cup guard or a band type guard in accordance with the provisions of the American National Standards Institute, B7.1-1970 Safety Code for the Use, Care, and Protection of Abrasive Wheels. All other portable abrasive wheels used for external grinding, shall be provided with safety guards (protection hoods) meeting the requirements of paragraph (c)(5) of this section, except as follows: {se 1926.303(c)(3)}

(i) - When the work location makes it impossible, a wheel equipped with safety flanges, as described in paragraph (c)(6) of this section, shall be used;

(ii) - When wheels 2 inches or less in diameter which are securely mounted on the end of a steel mandrel are used.

Portable abrasive wheels used for internal grinding shall be provided with safety flanges (protection flanges) meeting the requirements of paragraph (c)(6) of this section, except as follows: {see 1926.303(c)(4)}

- (i) - When wheels 2 inches or less in diameter which are securely mounted on the end of a steel mandrel are used;
- (ii) - If the wheel is entirely within the work being ground while in use.

When safety guards are required, they shall be so mounted as to maintain proper alignment with the wheel, and the guard and its fastenings shall be of sufficient strength to retain fragments of the wheel in case of accidental breakage. The maximum angular exposure of the grinding wheel periphery and sides shall not exceed 180 deg. {see 1926.303(c)(5)}

When safety flanges are required, they shall be used only with wheels designed to fit the flanges. Only safety flanges, of a type and design and properly assembled so as to ensure that the pieces of the wheel will be retained in case of accidental breakage, shall be used. {see 1926.303(c)(6)}

All employees using abrasive wheels shall be protected by eye protection equipment in accordance with the requirements of Subpart E of this part, except when adequate eye protection is afforded by eye shields which are permanently attached to the bench or floor stand. {see 1926.303(c)(9)}

Regulations for woodworking tools are found in 29 CFR 1926.304.

Guarding. All portable, power-driven circular saws shall be equipped with guards above and below the base plate or shoe. The upper guard shall cover the saw to the depth of the teeth, except for the minimum arc required to permit the base to be tilted for bevel cuts. The lower guard shall cover the saw to the depth of the teeth, except for the minimum arc required to allow proper retraction and contact with the work. When the tool is withdrawn from the work, the lower guard shall automatically and instantly return to the covering position. {see 1926.304(d) }

Personal protective equipment. All personal protective equipment provided for use shall conform to Subpart E of this part. {see 1926.304(e)}

## CAUGHT-IN HAZARDS

Other requirements. All woodworking tools and machinery shall meet other applicable requirements of American National Standards Institute, 01.1-1961, Safety Code for Woodworking Machinery. {see 1926.304(f)}

"Radial saws." {see 1926.304(g)}

The upper hood shall completely enclose the upper portion of the blade down to a point that will include the end of the saw arbor. The upper hood shall be constructed in such a manner and of such material that it will protect the operator from flying splinters, broken saw teeth, etc., and will deflect sawdust away from the operator. The sides of the lower exposed portion of the blade shall be guarded to the full diameter of the blade by a device that will automatically adjust itself to the thickness of the stock and remain in contact with stock being cut to give maximum protection possible for the operation being performed. {see 1926.304(g)(1)}

"Hand-fed crosscut table saws." {see 1926.304(h)}

Each circular crosscut table saw shall be guarded by a hood which shall meet all the requirements of paragraph (i)(1) of this section for hoods for circular ripsaws. {see 1926.304(h)(1)}

"Hand-fed ripsaws." {see 1926.304(i)}

Each circular hand-fed ripsaw shall be guarded by a hood which shall completely enclose the portion of the saw above the table and that portion of the saw above the material being cut. The hood and mounting shall be arranged so that the hood will automatically adjust itself to the thickness of and remain in contact with the material being cut but it shall not offer any considerable resistance to insertion of the material to the saw or to passage of the material being sawed. The hood shall be made of adequate strength to resist blows and strains incidental to reasonable operation, adjusting, and handling, and shall be so designed as to protect the operator from flying splinters and broken saw teeth. It shall be made of material that is soft enough so that it will be unlikely to cause tooth breakage. {see 1926.304(i)(1)}

The hood shall be so mounted as to insure that its operation will be positive, reliable, and in true alignment with the saw; and the mounting shall be adequate in strength to resist any reasonable side thrust or other force tending to throw it out of line.

Mechanical power-transmission apparatus, such as belts, pulleys, and rotating shafts, must also be guarded. Those regulations are found in 29 CFR 1926.307.

Here are a few things that you need to remember to keep safe when working near rotating and moving parts:

- Never remove safety guards.
- Never use equipment with rotating or moving parts that is not guarded.
- Never wear loose clothing or jewelry that can get caught in moving parts.

Any tool or piece of equipment that has moving parts can be a caught-in hazard. Rotating shafts, gears, belts and pulleys, and other moving parts can catch your fingers, gloves, clothing or other body parts. When you get something caught in a moving part, it can cause crushing injuries, amputations, and even death.

## BARRICADES

Some pieces of equipment do not and can not have guards to protect workers from moving parts. In these situations, you need to do something else to protect workers. You may need to guard those moving parts by distance. For example, an auger does not have a guard, but you can protect yourself by keeping a safe distance from the hazard.

When working near equipment that can't be guarded in the traditional way, such as cranes, augers, and excavators, you must use other means to keep workers safe. You must identify the unsafe area near the equipment and use barricades to protect workers.

29 CFR 1926.550 states that the superstructures of cranes must be guarded.

Accessible areas within the swing radius of the rear of the rotating superstructure of the crane, either permanently or temporarily mounted, shall be barricaded in such a manner as to prevent an employee from being struck or crushed by the crane. {see 1926.550(a)(9)}

## CAUGHT-IN HAZARDS

The key is to keep workers safe and out of the hazardous area.

Barricades that are used to protect workers must always be maintained in a good condition. When a barrier falls, comes loose, or is damaged in any way, it must be repaired immediately. If the crane or other piece of heavy equipment moves, the barricade must be moved also.

The barricades are used as a physical and visual deterrent to keep workers away from the hazardous area. The barricades must be constructed so workers cannot cross them. They also must be visible from a distance so workers can change their path if necessary.

Remember, a barricade may be the only thing that prevents a worker from being caught-in a crane or other piece of heavy equipment.

## PROPER MATERIAL HANDLING

Proper material handling includes both the storage and moving of materials.

When materials are being stored they must be stored in a manner to prevent them from falling. 29 CFR 1926.250 has the regulations for storage.

All materials stored in tiers shall be stacked, racked, blocked, interlocked, or otherwise secured to prevent sliding, falling or collapse. {see 1926.250(a)(1)}

Maximum safe load limits of floors within buildings and structures, in pounds per square foot, shall be conspicuously posted in all storage areas, except for floor or slab on grade. Maximum safe loads shall not be exceeded. {see 1926.250(a)(2)}

Aisles and passageways shall be kept clear to provide for the free and safe movement of material handling equipment or employees. Such areas shall be kept in good repair. {see 1926.250(a)(3)}

Material storage. {see 1926.250(b)}

Material stored inside buildings under construction shall not be placed within 6 feet of any hoist way or inside floor openings, nor within 10 feet of an exterior wall which does not extend above the top of the material stored. {see 1926.250(b)(1)}

Bagged materials shall be stacked by stepping back the layers and cross-keying the bags at least every 10 bags high. {see 1926.250(b)(4)}

Structural steel, poles, pipe, bar stock, and other cylindrical materials, unless racked, shall be stacked and blocked so as to prevent spreading or tilting. {see 1926.250(b)(9)}

Housekeeping. Storage areas shall be kept free from accumulation of materials that constitute hazards from tripping, fire, explosion, or pest harborage. Vegetation control will be exercised when necessary. (see 1926.250(c))

Caught-in hazards also exist when materials are moved around the construction site. When materials are moved overhead from one location to another there are two types of hazards that occur – struck-by and caught-in. (The struck-by hazards are not covered in this module.) Caught-in hazards occur when you are caught between the load and an immovable object. When a load is placed on a foot, it may be crushed or even amputated. Your whole body may also be caught between a load and a wall or other structure.

29 CFR 1926.251 contains the regulations for rigging equipment for material handling. This standard has the regulations for alloy steel chains, wire ropes, natural rope, and synthetic fiber, synthetic webbing and shackles and hooks. The general requirements are listed below.

General. {see 1926.251(a)}

Rigging equipment for material handling shall be inspected prior to use on each shift and as necessary during its use to ensure that it is safe. Defective rigging equipment shall be removed from service. {see 1926.251(a)(1)}

Rigging equipment shall not be loaded in excess of its recommended safe working load, as prescribed in Tables H-1 through H-20 in this subpart, following 1926.252(e) for the specific equipment. {see 1926.251(a)(1)}

Rigging equipment, when not in use, shall be removed from the immediate work area so as not to present a hazard to employees. {see 1926.251(a)(3)}

## CAUGHT-IN HAZARDS

Special custom design grabs, hooks, clamps, or other lifting accessories, for such units as modular panels, prefabricated structures and similar materials, shall be marked to indicate the safe working loads and shall be proof-tested prior to use to 125 percent of their rated load. {see 1926.251(a)(4)}

Scope. This section applies to slings used in conjunction with other material handling equipment for the movement of material by hoisting, in employments covered by this part. The types of slings covered are those made from alloy steel chain, wire rope, metal mesh, natural or synthetic fiber rope (conventional three strand construction), and synthetic web (nylon, polyester, and polypropylene). {see 1926.251(a)(5)}

Inspections. Each day before being used, the sling and all fastenings and attachments shall be inspected for damage or defects by a competent person designated by the employer. Additional inspections shall be performed during sling use, where service conditions warrant. Damaged or defective slings shall be immediately removed from service. {see 1926.251(a)(6)}

Mechanical material handling is used every day to move massive amounts of materials. Using mechanical means to move materials is not a hazard in itself. The hazards arise when you place yourself between the load and something that doesn't move. That's when you get caught between the load and an immovable object.

Here are some things to remember:

- Use a tag line when lifting loads.
- Stay a safe distance from the load. Never work under the load.
- Place loads a safe distance from the other workers.
- Use caution when handling materials either by hand or by mechanical means.
- Never place yourself between materials and an immovable object.

## SHEILDING AND TRENCH BOXES

Several caught-in hazards exist in trenching and excavation work.

Workers can be caught between the walls of the excavation or trench and materials or equipment and they can also be caught in a cave in.

Before performing any excavation work all employees must be trained:

- To recognize the potential hazards found when working in or around excavations and trenches; and
- How to protect themselves by eliminating those hazards.

When excavation work is taking place a competent person must be present. The competent person is designated by the company to identify potential hazards and has the authority to correct those hazards.

The competent person constantly inspects the trench or excavation and determines the safest way to perform the work.

To protect workers from a cave-in, protective systems must be put in place anytime an excavation is greater than 5 feet deep. The protective system can be a manufactured trench box or shielding. Both shielding and trench boxes are designed to provide workers with a safe place to work by preventing the dirt and rocks from cave-ins to trap or bury them.

Trench boxes or shields are structures that are placed in a trench and are 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.

Shoring systems are structures that support the sides of an excavation and which is designed to prevent cave-ins. Benching and sloping prevents the sides of the trench from collapsing onto workers inside the trench.

Once workers begin working in a trench or excavation, they must have a safe means to enter and exit. Anytime an excavation is 4 foot or greater in depth, a ladder, ramp, a stairway or other safe means of getting in and out must be provided. Access to the top must be placed so workers do not have to travel more than 25 feet to get to them.

When using a ladder you must still follow ladder safety procedures:

- inspect the ladder before use

## CAUGHT-IN HAZARDS

- position the ladder with 3' extended over the edge
- secure the ladder so that it will not slip

The regulations for excavations are found in Subpart P of 29 CFR 1926.650-652. Some of those standards are listed below.

Surface encumbrances. All surface encumbrances that are located so as to create a hazard to employees shall be removed or supported, as necessary, to safeguard employees. {see 1926.651(a)}

Access and egress - {see 1926.651©}

Structural ramps. {see 1926.651(c)(1)}

(i) - Structural ramps that are used solely by employees as a means of access or egress from excavations shall be designed by a competent person. Structural ramps used for access or egress of equipment shall be designed by a competent person qualified in structural design, and shall be constructed in accordance with the design.

(ii) - Ramps and runways constructed of two or more structural members shall have the structural members connected together to prevent displacement.

(iii) - Structural members used for ramps and runways shall be of uniform thickness.

(iv) - Cleats or other appropriate means used to connect runway structural members shall be attached to the bottom of the runway or shall be attached in a manner to prevent tripping.

(v) - Structural ramps used in lieu of steps shall be provided with cleats or other surface treatments on the top surface to prevent slipping.

Means of egress from trench excavations. A stairway, ladder, ramp or other safe means of egress shall be located in trench excavations that are 4 feet or more in depth so as to require no more than 25 feet of lateral travel for employees. {see 1926.651(c)(2)}

Exposure to vehicular traffic. 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. {see 1926.651(d)}

Exposure to falling loads. No employee shall be permitted underneath loads handled by lifting or digging equipment. Employees shall be required to stand away from any vehicle being loaded or unloaded to avoid being struck by any spillage or falling materials. Operators may remain in the cabs of vehicles being loaded or unloaded when the vehicles are equipped, in accordance with 1926.601(b)(6), to provide adequate protection for the operator during loading and unloading operations. {see 1926.651(e)}

Protection from hazards associated with water accumulation. {see 1926.651(h)}

Employees shall not work in excavations in which there is accumulated water, or in excavations in which water is accumulating, unless adequate precautions have been taken to protect employees against the hazards posed by water accumulation. The precautions necessary to protect employees adequately vary with each situation, but could include special support or shield systems to protect from cave-ins, water removal to control the level of accumulating water, or use of a safety harness and lifeline. {see 1926.651(h)(1)}

If water is controlled or prevented from accumulating by the use of water removal equipment, the water removal equipment and operations shall be monitored by a competent person to ensure proper operation. {see 1926.651(h)(2)}

If excavation work interrupts the natural drainage of surface water (such as streams), diversion ditches, dikes, or other suitable means shall be used to prevent surface water from entering the excavation and to provide adequate drainage of the area adjacent to the excavation. Excavations subject to runoff from heavy rains will require an inspection by a competent person and compliance with paragraphs (h)(1) and (h)(2) of this section. {see 1926.651(h)(3)}

Stability of adjacent structures. {see 1926.651(i)}

## CAUGHT-IN HAZARDS

Where the stability of adjoining buildings, walls, or other structures is endangered by excavation operations, support systems such as shoring, bracing, or underpinning shall be provided to ensure the stability of such structures for the protection of employees. {see 1926.651(i)(1)}

Excavation below the level of the base or footing of any foundation or retaining wall that could be reasonably expected to pose a hazard to employees shall not be permitted except when: {see 1926.651(i)(2)}

(i) - A support system, such as underpinning, is provided to ensure the safety of employees and the stability of the structure; or

(ii) - The excavation is in stable rock; or

(iii) - A registered professional engineer has approved the determination that the structure is sufficiently removed from the excavation so as to be unaffected by the excavation activity; or

(iv) - A registered professional engineer has approved the determination that such excavation work will not pose a hazard to employees.

Sidewalks, pavements and appurtenant structures shall not be undermined unless a support system or another method of protection is provided to protect employees from the possible collapse of such structures. {see 1926.651(i)(3)}

Protection of employees from loose rock or soil. {see 1926.651(j)}

Adequate protection shall be provided to protect employees from loose rock or soil that could pose a hazard by falling or rolling from an excavation face. Such protection shall consist of scaling to remove loose material; installation of protective barricades at intervals as necessary on the face to stop and contain falling material; or other means that provide equivalent protection. {see 1926.651(j)(1)}

Employees shall be protected from excavated or other materials or equipment that could pose a hazard by falling or rolling into excavations. {see 1926.651(j)(2)}

Protection shall be provided by placing and keeping such materials or equipment at least 2 feet 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.

Inspections. {see 1926.651(k)}

Daily inspections of excavations, the adjacent areas, and protective systems shall be made by a competent person for evidence of a situation that could result in possible cave-ins, indications of failure of protective systems, hazardous atmospheres, or other hazardous conditions. An inspection shall be conducted by the competent person prior to the start of work and as needed throughout the shift. Inspections shall also be made after every rainstorm or other hazard increasing occurrence. These inspections are only required when employee exposure can be reasonably anticipated. {see 1926.651(k)}

Where the competent person finds evidence of a situation that could result in a possible cave-in, indications of failure of protective systems, hazardous atmospheres, or other hazardous conditions, exposed employees shall be removed from the hazardous area until the necessary precautions have been taken to ensure their safety.  
{see 1926.651(k)(2)}

Protection of employees in excavations. {see 1926.652(a)}

Each employee in an excavation shall be protected from cave-ins by an adequate protective system designed in accordance with paragraph (b) or (c) of this section except when: {see 1926.652(a)(1)}

(i) - Excavations are made entirely in stable rock; or

(ii) - Excavations are less than 5 feet in depth and examination of the ground by a competent person provides no indication of a potential cave-in.

Protective systems shall have the capacity to resist without failure all loads that are intended or could reasonably be expected to be applied or transmitted to the system. {see 1926.652(a)(2)}

Design of sloping and benching systems. The slopes and configurations of sloping and benching systems shall be selected and constructed by the employer or his designee and shall be in accordance with the requirements of paragraph (b)(1); or, in the alternative, paragraph (b)(2); or, in the alternative, paragraph (b)(3); or, in the alternative, paragraph (b)(4), as follows: {see 1926.652(b)}

## CAUGHT-IN HAZARDS

Allowable configurations and slopes. {see 1926.652(b)(1) - Option (1)}

- (i) - Excavations shall be sloped at an angle not steeper than one and one-half horizontal to one vertical (34 degrees measured from the horizontal), unless the employer uses one of the other options listed below.
- (ii) - Slopes specified in paragraph (b)(1)(i) of this section, shall be excavated to form configurations that are in accordance with the slopes shown for Type C soil in Appendix B to this subpart.

Determination of slopes and configurations using Appendices A and B. Maximum allowable slopes, and allowable configurations for sloping and benching systems, shall be determined in accordance with the conditions and requirements set forth in appendices A and B to this subpart. {see 1926.652(b)(2) - Option (2)}

Designs using other tabulated data. {see 1926.652(b)(3) - Option (3)}

- (i) - Designs of sloping or benching systems shall be selected from and in accordance with tabulated data, such as tables and charts.
- (ii) - The tabulated data shall be in written form and shall include all of the following:
  - (A) - Identification of the parameters that affect the selection of a sloping or benching system drawn from such data;
  - (B) - Identification of the limits of use of the data, to include the magnitude and configuration of slopes determined to be safe;
  - (C) - Explanatory information as may be necessary to aid the user in making a correct selection of a protective system from the data.
- (iii) - At least one copy of the tabulated data which identifies the registered professional engineer who approved the data, shall be maintained at the jobsite during construction of the protective system. After that time the data may be stored off the jobsite, but a copy of the data shall be made available to the Secretary upon request.

Design by a registered professional engineer.

{see 1926.652(b)(4) - Option (4)}

(i) - Sloping and benching systems not utilizing Option (1) or Option (2) or Option (3) under paragraph (b) of this section shall be approved by a registered professional engineer.

(ii) - Designs shall be in written form and shall include at least the following:

- (A) - The magnitude of the slopes that were determined to be safe for the particular project;
- (B) - The configurations that were determined to be safe for the particular project;
- (C) - The identity of the registered professional engineer approving the design.

(iii) - At least one copy of the design shall be maintained at the jobsite while the slope is being constructed. After that time the design need not be at the jobsite, but a copy shall be made available to the Secretary upon request.

Design of support systems, shield systems, and other protective systems. Designs of support systems, shield systems, and other protective systems shall be selected and constructed by the employer or his designee and shall be in accordance with the requirements of paragraph (c)(1); or, in the alternative, paragraph (c)(2); or, in the alternative, paragraph (c)(3); or, in the alternative, paragraph (c)(4) as follows: {see 1926.652©}

Designs using appendices A, C and D. Designs for timber shoring in trenches shall be determined in accordance with the conditions and requirements set forth in appendices A and C to this subpart. Designs for aluminum hydraulic shoring shall be in accordance with paragraph (c)(2) of this section, but if manufacturer's tabulated data cannot be utilized, designs shall be in accordance with appendix D. {see 1926.652(c)(1) - Option (1)}

Designs Using Manufacturer's Tabulated Data.

see 1926.652(c)(2) - Option (2)}

## CAUGHT-IN HAZARDS

(i) - Design of support systems, shield systems, or other protective systems that are drawn from manufacturer's tabulated data shall be in accordance with all specifications, recommendations, and limitations issued or made by the manufacturer.

(ii) - Deviation from the specifications, recommendations, and limitations issued or made by the manufacturer shall only be allowed after the manufacturer issues specific written approval.

(iii) - Manufacturer's specifications, recommendations, and limitations, and manufacturer's approval to deviate from the specifications, recommendations, and limitations shall be in written form at the jobsite during construction of the protective system. After that time this data may be stored off the jobsite, but a copy shall be made available to the Secretary upon request.

Designs using other tabulated data. {see 1926.652(c)(3) - Option (3)}

(i) - Designs of support systems, shield systems, or other protective systems shall be selected from and be in accordance with tabulated data, such as tables and charts.

(ii) - The tabulated data shall be in written form and include all of the following:

(A) - Identification of the parameters that affect the selection of a protective system drawn from such data;

(B) - Identification of the limits of use of the data;

(C) - Explanatory information as may be necessary to aid the user in making a correct selection of a protective system from the data.

(iii) - At least one copy of the tabulated data, which identifies the registered professional engineer who approved the data, shall be maintained at the jobsite during construction of the protective system. After that time the data may be stored off the jobsite, but a copy of the data shall be made available to the Secretary upon request.

Design by a registered professional engineer.  
{see 1926.652(c)(4) - Option (4)}

(i) - Support systems, shield systems, and other protective systems not utilizing Option 1, Option 2 or Option 3, above, shall be approved by a registered professional engineer.

(ii) - Designs shall be in written form and shall include the following:

(A) - A plan indicating the sizes, types, and configurations of the materials to be used in the protective system; and

(B) - The identity of the registered professional engineer approving the design.

(iii) - At least one copy of the design shall be maintained at the jobsite during construction of the protective system. After that time, the design may be stored off the jobsite, but a copy of the design shall be made available to the Secretary upon request.

Materials and equipment. {see 1926.652(d)}

Materials and equipment used for protective systems shall be free from damage or defects that might impair their proper function. {see 1926.652(d)(1)}

Manufactured materials and equipment used for protective systems shall be used and maintained in a manner that is consistent with the recommendations of the manufacturer, and in a manner that will prevent employee exposure to hazards. {see 1926.652(d)(2)}

When material or equipment that is used for protective systems is damaged, a competent person shall examine the material or equipment and evaluate its suitability for continued use. {see 1926.652(d)(3)}

If the competent person cannot assure the material or equipment is able to support the intended loads or is otherwise suitable for safe use, then such material or equipment shall be removed from service, and shall be evaluated and approved by a registered professional engineer before being returned to service.

Installation and removal of support – {see 1926.652(e)}

General. {see 1926.652(e)(1)}

## CAUGHT-IN HAZARDS

(i) - Members of support systems shall be securely connected together to prevent sliding, falling, kick outs, or other predictable failure.

(ii) - Support systems shall be installed and removed in a manner that protects employees from cave-ins, structural collapses, or from being struck by members of the support system.

(iii) - Individual members of support systems shall not be subjected to loads exceeding those which those members were designed to withstand.

(iv) - Before temporary removal of individual members begins, additional precautions shall be taken to ensure the safety of employees, such as installing other structural members to carry the loads imposed on the support system.

(v) - Removal shall begin at, and progress from, the bottom of the excavation. Members shall be released slowly so as to note any indication of possible failure of the remaining members of the structure or possible cave-in of the sides of the excavation.

(vi) - Backfilling shall progress together with the removal of support systems from excavations.

Additional requirements for support systems for trench excavations. {see 1926.652(e)(2)}

(i) - Excavation of material to a level no greater than 2 feet (.61 m) below the bottom of the members of a support system shall be permitted, but only if the system is designed to resist the forces calculated for the full depth of the trench, and there are no indications while the trench is open of a possible loss of soil from behind or below the bottom of the support system.

(ii) - Installation of a support system shall be closely coordinated with the excavation of trenches.

Shield systems – {see 1926.652(g)}

General. {see 1926.652(g)(1)}

(i) - Shield systems shall not be subjected to loads exceeding those which the system was designed to withstand.

(ii) - Shields shall be installed in a manner to restrict lateral or other hazardous movement of the shield in the event of the application of sudden lateral loads.

(iii) - Employees shall be protected from the hazard of cave-ins when entering or exiting the areas protected by shields.

(iv) - Employees shall not be allowed in shields when shields are being installed, removed, or moved vertically.

Additional requirement for shield systems used in trench excavations. Excavations of earth material to a level not greater than 2 feet below the bottom of a shield shall be permitted, but only if the shield is designed to resist the forces calculated for the full depth of the trench, and there are no indications while the trench is open of a possible loss of soil from behind or below the bottom of the shield. {see 1926.652(g)(2)}

## CONCLUSION

This Chapter has highlighted only some of the caught-in hazards and their controls commonly found on construction sites.

You, as a worker, must take this information and use it. It is your choice to work in a safe or unsafe manner. If you encounter an unsafe condition, you must make the choice to work safely. If you cannot correct the situation, tell a supervisor who can help.

Don't take short cuts.

Keep yourself safe so you can go home to the ones you love!

## GLOSSARY OF TERMS

**accepted engineering practices** - means those requirements which are compatible with standards of practice required by a registered professional engineer.

**aluminum Hydraulic Shoring** - means a pre-engineered shoring system comprised of aluminum hydraulic cylinders (crossbraces) used in conjunction with vertical rails (uprights) or horizontal rails (wales). Such system is designed specifically to support the sidewalls of an excavation and prevent cave-ins.

**ampacity** - maximum amount of current a wire can carry safely without overheating.

**amperage** - strength of an electrical current, measured in amperes.

**ampere (amp)** - unit used to measure current.

**anchorage** - a secure point of attachment for lifelines, lanyards or deceleration devices.

**appliances** - utilization equipment, generally other than industrial, normally built in standardized sizes or types, which is installed or connected as a unit to perform one or more functions.

**arc-blast** - explosive release of molten material from equipment caused by high-amperage arcs.

**arcing** - luminous electrical discharge (bright, electrical sparking) through the air that occurs when high voltages exist across a gap between conductors.

**AWG - American Wire Gauge** - measure of wire size.

**barricade** - an obstruction to deter the passage of persons or vehicles.

**bell-bottom pier hole** - means a type of shaft or footing excavation, the bottom of which is made larger than the cross section above to form a belled shape.

## GLOSSARY OF TERMS

**benching (Benching system)** - means a method of protecting employees 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.

**body belt (safety belt)** - a strap with means both for securing it about the waist and for attaching it to a lanyard, lifeline, or deceleration device.

**body harness** - straps which may be secured about the employee in a manner that will distribute the fall arrest forces over at least the thighs, pelvis, waist, chest and shoulders with means for attaching it to other components of a personal fall arrest system.

**bonding** - the permanent joining of metallic parts to form an electrically conductive path which will assure electric continuity and the capacity to conduct safely any current likely to be imposed.

**bonding jumper** - conductor used to connect parts to be bonded.

**branch circuit** - the circuit conductors between the final overcurrent device protecting the circuit and the outlet(s).

**buckle** - any device for holding the body belt or body harness closed around the employee's body.

**cabinet** - an enclosure designed either for surface or flush mounting, and provided with a frame, mat, or trim in which a swinging door or doors are or may be hung.

**cave-in** - means the separation of a mass of soil or rock material from the side of an excavation, or the loss of soil from under a trench shield or support system, and its sudden movement into the excavation, either by falling or sliding, in sufficient quantity so that it could entrap, bury, or other wise injure and immobilize a person.

**center of gravity** - the point on an object at which all of the object's weight is concentrated. For symmetrical loads, the center of gravity is at the middle of the load.

**circuit** - complete path for the flow of current.

**circuit breaker** - over-current protection device that automatically shuts off the current in a circuit if an overload occurs.

- a) (600 volts nominal, or less.) A device designed to open and close a circuit by nonautomatic means and to open the circuit automatically on a predetermined overcurrent without injury to itself when properly applied within its rating.
- b) (Over 600 volts, nominal.) A switching device capable of making, carrying, and breaking currents under normal circuit conditions, and also making, carrying for a specified time, and breaking currents under specified abnormal circuit conditions, such as those of short circuit.

**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** - 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.

**conductor** - material in which an electrical current moves easily.

**connector** - a device which is used to couple or connect parts of the personal fall arrest system and positioning device systems together.

**controlled access zone (caz)** - an area in which certain work (e.g., overhand bricklaying) may take place without the use of guardrail systems, personal fall arrest systems, or safety net systems and access to the zone is controlled.

**cross braces** - mean the horizontal members of a shoring system installed perpendicular to the sides of the excavation, the ends of which bear against either uprights or wales.

**current** - movement of electrical charge.

**dangerous equipment** - equipment which, as a result of form or function, may be hazardous to employees who fall onto or into such equipment.

## GLOSSARY OF TERMS

**deceleration device** - any mechanism, such as a rope grab, rip-stitch lanyard, specially-woven lanyard, tearing or deforming lanyards, automatic self-retracting lifelines/lanyards, etc., which serves to dissipate a substantial amount of energy during a fall arrest, or otherwise limit the energy imposed on an employee during fall arrest.

**deceleration distance** - the additional vertical distance a falling employee travels, excluding lifeline elongation and free fall distance, before stopping, from the point at which the deceleration device begins to operate. It is measured as the distance between the location of an employee's body belt or body harness attachment point at the moment of activation of the deceleration device during a fall, and the location of that attachment point after the employee comes to a full stop.

**de-energize** - shutting off the energy sources to circuits and equipment and depleting any stored energy.

**disconnecting means** - a device, or group of devices, or other means by which the conductors of a circuit can be disconnected from their source of supply.

**disconnecting (or isolating) switch** - (Over 600 volts, nominal.) A mechanical switching device used for isolating a circuit or equipment from a source of power.

**double-insulated** - equipment with two insulation barriers and no exposed metal parts.

**energized (live, "hot")** - similar terms meaning that a voltage is present that can cause a current, so there is a possibility of getting shocked.

**excavation** - means any man-made cut, cavity, trench, or depression in an earth surface, formed by earth removal.

**exposed** - (As applied to live parts.) capable of being inadvertently touched or approached nearer than a safe distance by a person. It is applied to parts not suitably guarded, isolated, or insulated.

**faces or sides** - means the vertical or inclined earth surfaces formed as a result of excavation work.

**failure(1)** - load refusal, breakage, or separation of component parts. Load refusal is the point where the ultimate strength is exceeded.

**failure(2)** - means the breakage, displacement, or permanent deformation of a structural member or connection so as to reduce its structural integrity and its supportive capabilities.

**fault current** - any current that is not in its intended path.

**fixed wiring** - permanent wiring installed in homes and other buildings.

**flexible wiring** - cables with insulated and stranded wire that bends easily.

**free fall** - the act of falling before a personal fall arrest system begins to apply force to arrest the fall.

**free fall distance** - the vertical displacement of the fall arrest attachment point on the employee's body belt or body harness between onset of the fall and just before the system begins to apply force to arrest the fall. This distance excludes deceleration distance, and lifeline/lanyard elongation, but includes any deceleration device slide distance or self-retracting lifeline/lanyard extension before they operate and fall arrest forces occur.

**fuse** - over-current protection device that has an internal part that melts and shuts off the current in a circuit if there is an overload.

**GFCI** - **ground fault circuit interrupter** - a device that detects current leakage from a circuit to ground and shuts the current off

**ground** - physical electrical connection to the earth.

**grounded** - connected to earth or to some conducting body that serves in place of the earth.

**.ground fault** - loss of current from a circuit to a ground connection.

**ground potential** - voltage a grounded part should have; 0 volts relative to ground.

**guarding** - covering or barrier that separates you from live electrical parts.

## GLOSSARY OF TERMS

**guardrail system** - a barrier erected to prevent employees from falling to lower levels.

**handrail** - a rail used to provide employees with a handhold for support.

**hazardous atmosphere** - means an atmosphere which by reason of being explosive, flammable, poisonous, corrosive, oxidizing, irritating, oxygen deficient, toxic, or otherwise harmful, may cause death, illness, or injury.

**hole** - a gap or void 2 inches or more in its least dimension, in a floor, roof, or other walking/working surface.

**infeasible** - means that it is impossible to perform the construction work using a conventional fall protection system (i.e., guardrail system, safety net system, or personal fall arrest system) or that it is technologically impossible to use any one of these systems to provide fall protection.

**insulation** - material that does not conduct electricity easily.

**job-made ladder** - a ladder that is fabricated by employees, typically at the construction site, and is not commercially manufactured.

**kickout** - means the accidental release or failure of a cross brace.

**lanyard** - a flexible line of rope, wire rope, or strap which generally has a connector at each end for connecting the body belt or body harness to a deceleration device, lifeline, or anchorage.

**leading edge** - the edge of a floor, roof, or formwork for a floor or other walking/working surface (such as the deck) which changes location as additional floor, roof, decking, or formwork sections are placed, formed, or constructed. A leading edge is considered to be an "unprotected side and edge" during periods when it is not actively and continuously under construction.

**leakage current** - current that does not return through the intended path, but instead "leaks" to ground.

**lifeline** - a component consisting of a flexible line for connection to an anchorage at one end to hang vertically (vertical lifeline), or for connection to anchorages at both ends to stretch horizontally (horizontal lifeline), and which serves as a means for connecting other components of a personal fall arrest system to the anchorage.

**location** -

- (a) **damp location.** Partially protected locations under canopies, marquees, roofed open porches, and like locations, and interior locations subject to moderate degrees of moisture, such as some basements.
- (b) **dry location.** A location not normally subject to dampness or wetness. A location classified as dry may be temporarily subject to dampness or wetness, as in the case of a building under construction.
- (c) **wet location.** Installations underground or in concrete slabs or masonry in direct contact with the earth, and locations subject to saturation with water or other liquids, such as locations exposed to weather and unprotected.

**lock-out** - applying a physical lock to the energy sources of circuits and equipment after they have been shut off and de-energized.

**low-slope roof** - means a roof having a slope less than or equal to 4 in 12 (vertical to horizontal).

**lower levels** - those areas or surfaces to which an employee can fall. Such areas or surfaces include, but are not limited to, ground levels, floors, platforms, ramps, runways, excavations, pits, tanks, material, water, equipment, structures, or portions thereof.

**mechanical equipment** - all motor or human propelled, wheeled equipment used for roofing work, except wheelbarrows and mop carts.

**milliampere (milliamp or mA)** - 1/1,000 of an ampere.

## GLOSSARY OF TERMS

**neutral** - at ground potential (0 volts) because of a connection to ground.

**opening** - a gap or void 30 inches or more high and 18 inches or more wide, in a wall or partition, through which employees can fall to a lower level.

**open sides and ends** - the edges of a platform that are more than 14 inches away horizontally from a sturdy, continuous, vertical surface (such as a building wall) or a sturdy, continuous horizontal surface (such as a floor), or a point of access.

**OSHA** - **O**ccupational **S**afety and **H**ealth **A**dministration - Federal agency in the U.S. Department of Labor that establishes and enforces workplace safety and health regulations.

**outlet** - a point on the wiring system at which current is taken to supply utilization equipment.

**over-current protection device** - device that prevents too much current in a circuit.

**overhand bricklaying and related work** - the process of laying bricks and masonry units such that the surface of the wall to be jointed is on the opposite side of the wall from the mason, requiring the mason to lean over the wall to complete the work. Related work includes mason tending and electrical installation incorporated into the brick wall during the overhand bricklaying process.

**overload** - too much current in a circuit.

**personal fall arrest system** - a system used to arrest an employee in a fall from a working level. It consists of an anchorage point, connectors, a body belt or body harness and may include a lanyard, deceleration device, lifeline, or suitable combinations of these. As of January 1, 1998, the use of a body belt for fall arrest is prohibited.

**platform** - a work surface elevated above lower levels. Platforms can be constructed using individual wood planks, fabricated planks, fabricated decks, and fabricated platforms.

**point of access** - all areas used by employees for work related passage from one area or level to another. Such open areas include doorways, passageways, stairway openings, studded walls, and various other permanent or temporary openings used for such travel.

**portable ladder** - a ladder that can be readily moved or carried.

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

**power** - amount of energy used each second, measured in watts.

**PPE** - **personal protective equipment** (eye protection, hard hat, special clothing, etc.).

**protective system** - means a method of protecting employees from cave-ins, from material that could fall or roll from an excavation face or into an excavation, or from the collapse of adjacent structures. Protective systems include support systems, sloping and benching systems, shield systems, and other systems that provide the necessary protection.

**qualified** - one who, by possession of a recognized degree, certificate, or professional standing, or who by, extensive knowledge, training and experience, has successfully demonstrated his/her ability to solve or resolve problems related to the subject matter, the work or the project.

**qualified person** - someone who has received mandated training on the hazards and on the construction and operation of equipment involved in a task.

**ramp** - means an inclined walking or working surface that is used to gain access from one point to another, and is constructed from earth or from structural materials such as steel or wood.

**rated load** - the manufacturer's specified maximum load to be lifted by a hoist or to be applied to a scaffold or scaffold component.

## GLOSSARY OF TERMS

**receptacle** - a receptacle is a contact device installed at the outlet for the connection of a single attachment plug. A single receptacle is a single contact device with no other contact device on the same yoke. A multiple receptacle is a single device containing two or more receptacles.

**receptacle outlet** - an outlet where one or more receptacles are installed.

**registered professional engineer** - means a person who is registered as a professional engineer in the state where the work is to be performed. However, a professional engineer, registered in any state is deemed to be a "registered professional engineer" within the meaning of this standard when approving designs for "manufactured protective systems" or "tabulated data" to be used in interstate commerce.

**resistance** - material's ability to decrease or stop electrical current.

**riser height** - the vertical distance from the top of a tread to the top of the next higher tread or platform/landing or the distance from the top of a platform/landing to the top of the next higher tread.

**roof** - the exterior surface on the top of a building. This does not include floors or formwork which, because a building has not been completed, temporarily become the top surface of a building.

**roofing work** - the hoisting, storage, application, and removal of roofing materials and equipment, including related insulation, sheet metal, and vapor barrier work, but not including the construction of the roof deck.

**rope grab** - a deceleration device which travels on a lifeline and automatically, by friction, engages the lifeline and locks so as to arrest the fall of an employee. A rope grab usually employs the principle of inertial locking, cam/level locking, or both.

**safety belt** - a device, usually worn around the waist which, by reason of its attachment to a lanyard and lifeline or a structure, will prevent a worker from falling.

**safety-monitoring system** - a safety system in which a competent person is responsible for recognizing and warning employees of fall hazards.

**scaffold** - any temporary elevated work platform (supported or suspended) and its supporting structure (including points of anchorage, used for supporting employees or materials, or both).

**self-retracting lifeline/lanyard** - a deceleration device containing a drum-wound line which can be slowly extracted from, or retracted onto, the drum under slight tension during normal employee movement, and which, after onset of a fall, automatically locks the drum and arrests the fall.

**sheeting** - means the members of a shoring system that retain the earth in position and in turn are supported by other members of the shoring system.

**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. Additionally, shields can be either pre-manufactured or job-built in accordance with 1926.652(c)(3) or (c)(4). Shields used in trenches are usually referred to as "trench boxes" or "trench shields."

**shocking current** - electrical current that passes through a part of the body.

**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.

**short** - low-resistance path between a live wire and the ground, or between wires at different voltages (called a fault if the current is unintended).

**signs** - are the warnings of hazard, temporary or permanently affixed or placed, at locations where hazards exist.

**signals** - are moving signs, provided by workers, such as flaggers, or by devices, such as flashing lights, to warn of possible or existing hazards.

**sloping (sloping system)** - means a method of protecting employees from cave-ins by excavating to form sides of an excavation that are inclined away from the excavation. The angle of incline required to prevent a cave-in varies with differences in such factors as the soil type, environmental conditions of exposure, and application of surcharge loads.

**snap hook** - a connector comprised of a hook-shaped member with a normally closed keeper, or similar arrangement, which may be opened to permit the hook to receive an object and, when released, automatically closes to retain the object. Snap hooks are generally one of two types:

- The locking type with a self-closing, self-locking keeper which remains closed and locked until unlocked and pressed open for connection or disconnection; or
- The non-locking type with a self-closing keeper which remains closed until pressed open for connection or disconnection. As of January 1, 1998, the use of a non-locking snap hook as part of personal fall arrest systems and positioning device systems is prohibited.

**stable rock** - means natural solid mineral material that can be excavated with vertical sides and will remain intact while exposed. Unstable rock is considered to be stable when the rock material on the side or sides of the excavation is secured against caving-in or movement by rock bolts or by another protective system that has been designed by a registered professional engineer.

**stair rail system** - a vertical barrier erected along the unprotected sides and edges of a stairway to prevent employees from falling to lower levels. The top surface of the stair rail system may also be a handrail.

**steep roof** - a roof having a slope greater than 4 in 12 (vertical to horizontal).

**structural ramp** - means a ramp built of steel or wood, usually used for vehicle access. Ramps made of soil or rock are not considered structural ramps.

**support system** - means a structure such as underpinning, bracing, or shoring, which provides support to an adjacent structure, underground installation, or the sides of an excavation.

**switches -**

- (a) **general-use switch.** A switch intended for use in general distribution and branch circuits. It is rated in amperes, and it is capable of interrupting its rated current at its rated voltage.
- (b) **general-use snap switch.** A form of general-use switch so constructed that it can be installed in flush device boxes or on outlet box covers, or otherwise used in conjunction with wiring systems recognized by this subpart.
- (c) **isolating switch.** A switch intended for isolating an electric circuit from the source of power. It has no interrupting rating, and it is intended to be operated only after the circuit has been opened by some other means.
- (d) **motor-circuit switch.** A switch, rated in horsepower, capable of interrupting the maximum operating overload current of a motor of the same horsepower rating as the switch at the rated voltage.

**tabulated data** - means tables and charts approved by a registered professional engineer and used to design and construct a protective system.

**tags** - are temporary signs, usually attached to a piece of equipment or part of a structure, to warn of existing or immediate hazards.

**tag-out** - applying a tag that alerts workers that circuits and equipment have been locked out.

**toeboard** - a low protective barrier that will prevent the fall of materials and equipment to lower levels and provide protection from falls for personnel.

**tread depth** - the horizontal distance from front to back of a tread (excluding the nosing, if any).

## GLOSSARY OF TERMS

**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 m). If forms or other structures are installed or constructed in an excavation so as to reduce the dimension measured from the forms or structure to the side of the excavation to 15 feet (4.6 m) or less (measured at the bottom of the excavation), the excavation is also considered to be a trench.

**trench box** - see "shield".

**trench shield** - see "shield".

**trip** - automatic opening (turning off) of a circuit by a GFCI or circuit breaker.

**uprights** - means the vertical members of a trench shoring system placed in contact with the earth and usually positioned so that individual members do not contact each other. Uprights placed so that individual members are closely spaced, in contact with or interconnected to each other, are often called "sheeting."

**unprotected sides and edges** - any side or edge (except at entrances to points of access) of a walking/working surface, e.g., floor, roof, ramp, or runway where there is no wall or guardrail system at least 39 inches high.

**voltage** - measure of electrical force.

**Wales** - means horizontal members of a shoring system placed parallel to the excavation face whose sides bear against the vertical members of the shoring system or earth.

**walking/working surface** - any surface, whether horizontal or vertical on which an employee walks or works, including, but not limited to, floors, roofs, ramps, bridges, runways, formwork and concrete reinforcing steel but not including ladders, vehicles, or trailers, on which employees must be located in order to perform their job duties.

**walkway** - a portion of a scaffold platform used only for access and not as a work level.

**warning line system** - a barrier erected on a roof to warn employees that they are approaching an unprotected roof side or edge, and which designates an area in which roofing work may take place without the use of guardrail, body belt, or safety net systems to protect employees in the area.

**watertight** - so constructed that moisture will not enter the enclosure.

**weatherproof** - so constructed or protected that exposure to the weather will not interfere with successful operation. Rainproof, raintight, or watertight equipment can fulfill the requirements for weatherproof where varying weather conditions other than wetness, such as snow, ice, dust, or temperature extremes, are not a factor.

**wire gauge** - wire size or diameter (technically, the cross-sectional area).

**work area** - that portion of a walking/working surface where job duties are being performed.

## REFERENCES

### ANSI

#### **American National Standards Institute**

- <http://www.ansi.org>

### Cranes and Heavy Equipment

**OSHA Standard:** 29 CFR 1926 Subpart N - Cranes, Derricks, Hoists, Elevators, and Conveyors

- [http://www.osha.gov/Publications/Const\\_Res\\_Man/index.html](http://www.osha.gov/Publications/Const_Res_Man/index.html)

### Electrical

**OSHA Standard:** 29 CFR 1926 Subpart K - Electrical

- [http://www.osha.gov/Publications/Const\\_Res\\_Man/index.html](http://www.osha.gov/Publications/Const_Res_Man/index.html)

### Fall Protection

**OSHA Standard:** 29 CFR 1926 Subpart M

- [http://www.osha.gov/Publications/Const\\_Res\\_Man/index.html](http://www.osha.gov/Publications/Const_Res_Man/index.html)

### Material Handling

**OSHA Standard:** 29 CFR 1926 Subpart H - Materials Handling, Storage, Use, and Disposal

- [http://www.osha.gov/Publications/Const\\_Res\\_Man/index.html](http://www.osha.gov/Publications/Const_Res_Man/index.html)

**OSHA Standard:** 29 CFR 1926 Subpart J - Welding and Cutting

- [http://www.osha.gov/Publications/Const\\_Res\\_Man/index.html](http://www.osha.gov/Publications/Const_Res_Man/index.html)

### Personal Protective Equipment

**OSHA Technical Links - Construction:** Personal Protective Equipment

- [www.osha-slc.gov/SLTC/constructionppe/index.html](http://www.osha-slc.gov/SLTC/constructionppe/index.html)

**OSHA Standard:** 29 CFR 1926 Subpart E

- [http://www.osha.gov/Publications/Const\\_Res\\_Man/index.html](http://www.osha.gov/Publications/Const_Res_Man/index.html)

## **Tools and Equipment**

**OSHA Standard:** 29 CFR 1926 Subpart V - Power Transmission and Distribution

- [http://www.osha.gov/Publications/Const\\_Res\\_Man/index.html](http://www.osha.gov/Publications/Const_Res_Man/index.html)

## **Stairways and Ladders**

**Overview for Subpart X** - Stairways and Ladders

- [www.osha-slc.gov/Publications/Const\\_Res\\_Man/1926sub-x-overview.html](http://www.osha-slc.gov/Publications/Const_Res_Man/1926sub-x-overview.html)

**OSHA Standard:** 29 CFR 1926 Subpart X

- [http://www.osha.gov/Publications/Const\\_Res\\_Man/index.html](http://www.osha.gov/Publications/Const_Res_Man/index.html)

## **Scaffolds**

**Construction Safety and Health Outreach Program** - Scaffolding

- [www.osha-slc.gov/doc/outreachtraining/htmlfiles/scaffreg.html](http://www.osha-slc.gov/doc/outreachtraining/htmlfiles/scaffreg.html)

**OSHA Standard:** 29 CFR 1926 Subpart L

- [http://www.osha.gov/Publications/Const\\_Res\\_Man/index.html](http://www.osha.gov/Publications/Const_Res_Man/index.html)

## **Tools and Equipment**

**OSHA Standard:** 29 CFR 1926 Subpart I - Tools - Hand and Power

- [http://www.osha.gov/Publications/Const\\_Res\\_Man/index.html](http://www.osha.gov/Publications/Const_Res_Man/index.html)

## **Trenches and Excavations**

**OSHA Standard:** 29 CFR 1926 Subpart P - Excavations

- [http://www.osha.gov/Publications/Const\\_Res\\_Man/index.html](http://www.osha.gov/Publications/Const_Res_Man/index.html)

## **US Department of Labor**

- [www.dol.gov](http://www.dol.gov)