

Roofing Industry Fall Protection From A to Z



Worker Injuries in the Construction Industry

In 2012, the private construction industry experienced 775 fatal work injuries. Two hundred and eighty of the 775 deaths were caused by falls.

Occupational Safety and Health Administration (OSHA) Standards

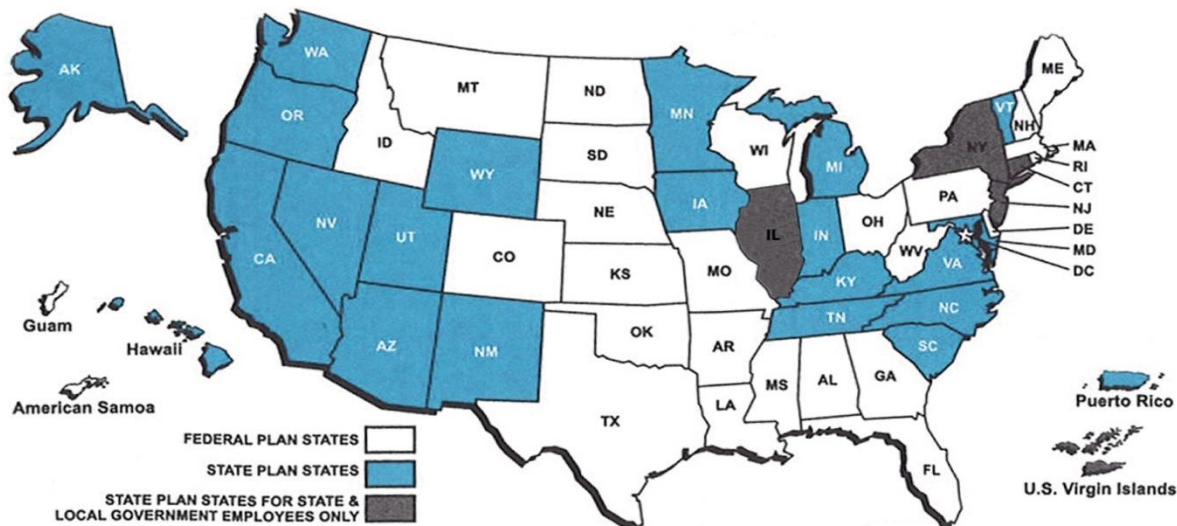
In carrying out its duties, OSHA is responsible for developing legally enforceable standards. It is the responsibility of employers to become familiar with standards applicable to their companies and ensure workers have and use fall-protection equipment when required.

Workers must comply with all rules and regulations that apply to their actions and conduct.

Where OSHA has not developed specific standards, employers are responsible for following the Occupational Safety and Health (OSHA) Act's general duty clause, which states each employer "shall furnish ... a place of employment which is free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees."

OSHA's federal standards for construction are published in the Code of Federal Regulations (CFR). They are collected in Title 29 of the CFR (29 CFR), Part 1926.

OSHA-approved State Plans



States can develop and operate, under OSHA guidance, their own safety and health plans. There are currently 22 states and jurisdictions operating complete state plans (covering the private sector and state and local government workers) and five—Connecticut, Illinois, New Jersey, New York and the Virgin Islands—that cover public workers only.

States with OSHA-approved occupational safety and health programs must set standards that are at least as effective as the federal standards. Many state plan states adopt standards identical to federal standards.

Falls From Roofs

Roofing work can be dangerous even under the best conditions. High elevations, unprotected roof edges and steep slopes all pose fall risks. Those risks may be increased by other factors, such as wind and wet surfaces; equipment misuse or failure, particularly involving ladders; and unsafe behavior on the part of workers.

Weather Conditions

Throughout the year, rain and wind can create hazardous conditions. Rain can make surfaces extremely slippery, especially on steep-slope roofs. High winds can make it easy to lose one's footing. In winter, snow, frost and ice can be treacherous, sometimes creating slick patches that are not readily apparent to the eye. Frozen hands and feet can make even the most adept worker clumsy. For all these reasons, it's a good idea to monitor weather conditions closely so you can suspend activity if necessary.



Equipment Use and Maintenance

There is no room at work sites for faulty equipment. It is important to report and remove any damaged or broken equipment promptly.

In terms of falls, the piece of equipment posing the single greatest risk to worker safety is a misused or damaged ladder. Ladders need to be checked daily and always kept in good condition. Additionally, the setup and maintenance requirements described in 29 CFR 1926.1053 must be followed at all times.

Worker Behavior



You must take responsibility for making your workplace safe. Take the time to do the job right; shortcuts can lead to disaster. Ultimately, you are responsible for your own well-being. Although your employer risks a hefty fine for fall-protection violations, you risk even more, namely, pain, injury and even death.

Furthermore, many states have toughened their worker's compensation requirements. If it is determined the underlying cause of an injury was preventable employee misconduct, such as horseplay or substance abuse, the claim can be denied. You have nothing to gain and everything to lose by disregarding fall-protection safety.

Changing behavior so people work safely requires an ongoing process of training and reinforcement. Regardless of the experience you have, safety never must be taken for granted. In the roofing industry, complacency can be deadly. A roofing worker who has a bad attitude or is fatigued, under the influence of drugs or alcohol, or careless about safety must change his or her behavior—before it kills him or her or someone else.

Fall-protection Training and Follow-up

In recent OSHA reports, nearly 90 percent of fatal falls happen when no fall-protection system is in place. Other falls occur when fall-protection systems are used improperly. Proper use of PFA systems, securing of ladders, observing correct procedures for scaffold setup, and guarding and covering skylights and other roof holes all are essential elements of a safe work environment that reduces fall exposures.

In a separate OSHA study involving 99 fall-related fatalities, it was found virtually all the deaths could have been prevented by the use of guardrails, PFA systems, safety nets, covers or other means to reduce employee exposure to the hazard. Proper training and use of fall-protection measures can save

lives. An effective job hazard analysis may help you assess the risks posed by specific tasks performed at the particular job-site and select appropriate methods to reduce or eliminate those risks.

Roof Slope

OSHA defines a low-slope roof as a roof having a slope of less than or equal to 4 inches of vertical rise for every 12 inches horizontal length (4:12) (1926.500(b)—definitions). This is important because the OSHA definition is used as a basis for implementing low-slope fall-protection measures, such as warning-line systems and safety monitors.

Requirements of Federal Fall-protection Standards

Under Title 29 CFR Subpart M, Fall Protection, 1926.500-503, employers must assess a workplace to determine whether the surfaces on which workers are to work have the strength and structural integrity to safely support workers. Workers are not permitted to work on those surfaces until their employer has determined the surfaces have the requisite strength and structural integrity to support the workers. Once the employer has determined a surface is safe for workers, the employer must select one of the fall-protection options listed for the work operation if a fall hazard is present.



Federal construction rules set a uniform threshold height of 6 feet and greater for worker exposures that demand fall-protection. This means employers must protect their workers from fall hazards whenever an affected worker is 6 feet or more above the ground or a lower level.

Protection also must be provided for construction workers who are exposed to the hazard of falling into dangerous equipment or through roof holes or openings such as skylights. In most instances, skylight domes or glazing do not have the requisite strength to support a worker and to withstand an impact.

Workers without fall protection

Under the standard, employers are able to select fall-protection measures compatible with the type of work being performed. Fall-protection generally can be provided through use of guardrail systems, safety-net systems, PFA systems, positioning devices and warning lines, among others.

Requirements are prescribed for specific fall hazards as follows:

Controlled Access Zones—1926.502(g)

A controlled access zone is a work area designated and clearly marked in which certain types of work may take place without the use of conventional fall-protection systems: guardrail, personal fall-arrest or safety-net to protect the workers working in the zone. It is a limited provision applicable to just a few types of construction work and ordinarily not applicable to roofing work.

Controlled access zones are used to keep out workers other than those authorized to enter work areas from which guardrails have been removed. When there are no guardrails, masons are the only workers allowed in controlled access zones.

Controlled access zones, when created to limit entrance to areas where leading edge work and other operations are taking place, must be defined by a control line or other means that restrict access. Control lines shall consist of ropes, wires, tapes or equivalent materials, and supporting stanchions, and each must be:

- Flagged or otherwise clearly marked at not more than 6-foot intervals with high-visibility material
- Rigged and supported in such a way that the lowest point (including sag) is no less than 39 inches from the walking or working surface and the highest point is not more than 45 inches—or more than 50 inches when overhand bricklaying operations are being performed—from the walking or working surface
- Strong enough to sustain stress of not less than 200 pounds
- Extend along the entire length of the unprotected or leading edge and shall be approximately parallel to the unprotected or leading edge
- Connected on each side to a guardrail system or wall.



When control lines are used, they shall be erected not less than 6 feet or more than 25 feet from the unprotected or leading edge except when precast concrete members are being erected. In the latter case, the control line is to be erected no less than 6 feet or more than 60 feet or half the length of the member being erected, whichever is less, from the leading edge.

Controlled access zones when used to determine access to areas where overhand bricklaying and related work are taking place are to be defined by a control line erected not less than 10 feet or more than 15 feet from the working edge. Additional control lines must be erected at each end to enclose the controlled access zone. Only workers engaged in the overhand bricklaying or related work are permitted in the controlled access zones.

On floors and roofs where guardrail systems are not in place before the beginning of overhand bricklaying operations, controlled access zones must be enlarged as necessary to enclose all points of access, material handling areas and storage areas.

On floors and roofs where guardrail systems are in place but need to be removed to allow overhand bricklaying work or leading edge work to take place, only that portion of the guardrail necessary to accomplish that day's work shall be removed.

Fall-Protection Systems Criteria and Practices

Covers—1926.502(i)

Covers must be able to support at least twice the weight of workers, equipment and materials that may be imposed on the cover at any one time. Covers located in roadways and vehicular aisles must be able to support at least twice the maximum load of the largest vehicle to which the cover might be subjected. To prevent accidental displacement resulting from wind, equipment or workers' activities, all covers must be secured. All covers shall be color-coded or bear the marking "HOLE" or "COVER."



Guardrail Systems—1926.502(b)

If an employer chooses to use guardrail systems to protect workers from falls, the systems must meet certain criteria.

Top rails and midrails of guardrail systems must be at least $\frac{1}{4}$ of an inch nominal diameter or thickness to prevent cuts and lacerations. If wire rope is used for top rails, it must be flagged at not more than 6-foot intervals with high-visibility material. Steel and plastic banding cannot be used as top rails or midrails. Manila, plastic or synthetic rope used for top rails or midrails must be inspected as frequently as necessary to ensure strength and stability.

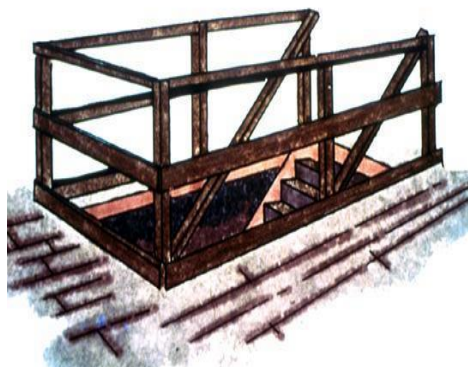
The top edge height of top rails or (equivalent) guardrails must be 42 inches plus or minus 3 inches (39-45 inches) above the walking or working level. When workers are using stilts, the top edge height of the top rail or equivalent member must be increased an amount equal to the height of the stilts.

Screens, midrails, mesh, intermediate vertical members or equivalent intermediate structural members must be installed between the top edge of the guardrail system and the walking and/or working surface when there are no walls or parapet walls at least 21 inches high. When midrails are used, they must be installed at a height midway between the top edge of the guardrail system and the walking or working level. When screens and mesh are used, they must extend from the top rail to the walking and/or working level and along the entire opening between top rail supports. Intermediate members, such as balusters, when used between posts, shall not be more than 19 inches apart.



Other structural members, such as additional midrails and architectural panels, shall be installed so there are no openings in the guardrail system more than 19 inches.

aThe guardrail system must be capable of withstanding a force of at least 200 pounds applied within 2 inches of the top edge in any outward or downward direction. When the 200 pounds test is applied in a downward direction, the top edge of the guardrail must not deflect to a height less than 39 inches above the walking or working level.



Midrails, screens, mesh, intermediate vertical members, solid panels and equivalent structural members shall be capable of withstanding a force of at least 150 pounds applied in any downward or outward direction at any point along the midrail or other member. Toeboards must withstand 50 pounds.

Guardrail systems must be surfaced to protect workers from punctures or lacerations and prevent clothing from snagging.

The ends of the top rails and midrails must not overhang terminal posts except where such an overhang does not constitute a projection hazard.

When guardrail systems are used at hoist areas, a chain, gate or removable guardrail section must be placed across the access opening between guardrails sections when hoisting operations are not taking place.

At holes, guardrail systems must be set up on all unprotected sides or edges. When holes are used for the passage of materials, the hole must not have more than two sides with removable guardrail sections. When the hole is not in use, it must be covered or provided with guardrails along all unprotected sides or edges.

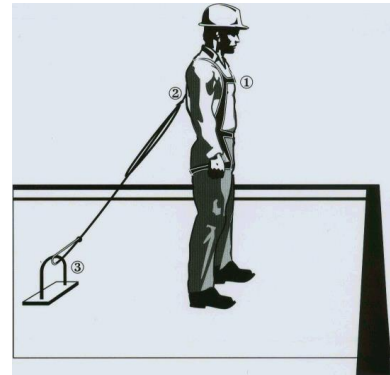
If guardrail systems are used around holes that are used as access points (such as ladderways), gates must be used or the point of access must be offset to prevent falls into the hole.

If guardrails are used at unprotected sides or edges of ramps and runways, they must be erected on each unprotected side or edge.

PFA Systems—1926.502(d)

There are many regulatory requirements regarding the strength of PFA system components, including connectors, lanyards and lifelines, harnesses and anchorages.

- Straps have to be made of synthetic fiber.
- Locking snap hooks are required and must attach to a body harness at the D-ring in the center of the back.
- The anchorage must support 5,000 pounds per employee attached. Anchorages cannot be connected to platforms, guardrails or hoists.



If a PFA system is used for fall protection, it must do the following:

- Limit maximum arresting force on an employee to 1,800 pounds when used with a body harness
- Be rigged so an employee can neither free fall more than 6 feet or contact a lower level
- Bring a worker to a complete stop and limit maximum deceleration distance an employee travels to 3 ½ feet

- Have sufficient strength to withstand twice the potential impact energy of an employee free-falling a distance of 6 feet or the free-fall distance permitted by the system, whichever is less.

The use of a body belt is not acceptable as part of a PFA system. The use of a body belt as a positioning system is acceptable and is regulated under 1926.502(e).

PFA systems must be inspected before each use for wear, damage and other deterioration. Defective components must be removed from service. D-rings and snap hooks must have a minimum tensile strength of 5,000 pounds.

Snap hooks must be sized to be compatible with the component to which they will be of locking. Unless a snap hook is a locking type and designed for the following connections, it must not be engaged:

- Directly to webbing, rope or wire rope
- To another one
- To a D-ring to which another snap hook or other connector is attached
- To a horizontal lifeline
- To any object incompatible in shape or dimension relative to the snap hook, thereby causing the connected object to depress the snap hook keeper and release unintentionally

OSHA considers a hook to be compatible when the diameter of the D-ring to which the snap hook is attached is greater than the inside length of the snap hook when measured from the bottom (hinged end) of the snap hook keeper to the inside curve of the top of the snap hook. Therefore, no matter how the D-ring is positioned or moved (rolled) with the snap hook attached, the D-ring cannot touch the outside of the keeper and press it open.

Use of non-locking snap hooks is prohibited. On suspended scaffolds or similar work platforms with horizontal lifelines that may become vertical lifelines, the devices used to connect to a horizontal lifeline must be capable of locking in both directions.

Horizontal lifelines must be designed, installed and used under the supervision of a qualified person as part of a complete PFA system that maintains a safety factor of at least two (capable of supporting at least twice the weight expected to be imposed upon it). Lifelines must be protected against being cut or abraded.

Self-retracting lifelines and lanyards that automatically limit free-fall distance to 2 feet or less must be capable of sustaining a minimum tensile load of 3,000 pounds applied to the device with the lifeline or lanyard in the fully extended position.

Self-retracting lifelines and lanyards that do not limit free-fall distance to 2 feet or less rip stitch lanyards. Lanyards must be capable of sustaining a minimum tensile load of 5,000 pounds applied when the lifeline or lanyard is fully extended.

Ropes and straps (webbing) used in lanyards, lifelines and strength components of body belts and body harnesses must be made of synthetic fibers.





Anchorage must be designed, installed and used under the supervision of a qualified person as part of a complete PFA system that maintains a safety factor of at least two. Anchorages used to attach PFA systems must be independent of any anchorage being used to support or suspend platforms and be capable of supporting at least 5,000 pounds per person attached.

Lanyards and vertical lifelines must have a minimum breaking strength of 5,000 pounds.

Positioning Device Systems—1926.502(e)

Positioning device systems using body belts or harnesses are to be set up so a worker can free-fall no more than 2 feet while supported on an elevated or vertical surface. They must be secured to an anchorage capable of supporting at least twice the potential impact load of an employee's fall or 3,000 pounds, whichever is greater. Requirements for snap hooks, D-rings and other connectors used with positioning device systems must meet the same criteria as those for PFA systems.

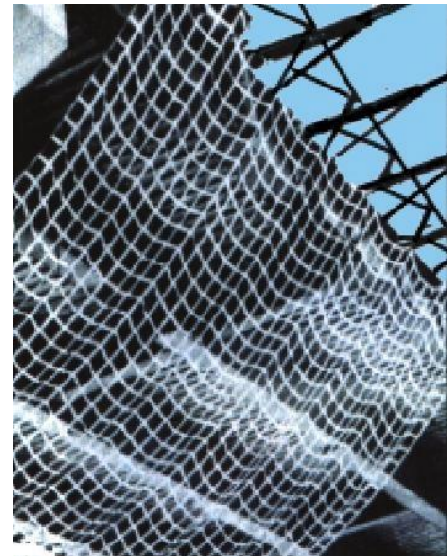
Safety-Net Systems—1926.502(c)

Safety nets must be installed as close as practicable under the walking or working surface on which employees are working and never more than 30 feet below such levels. Defective nets may not be used. Safety nets must be inspected at least once per week for wear, damage and other deterioration.

The maximum size of each safety net mesh opening may not exceed 36 square inches or be longer than 6 inches on any side, and the openings, measured center-to-center, of mesh ropes or webbing may not exceed 6 inches. All mesh crossings must be secured to prevent enlargement of the mesh opening.

Each safety net or section must have a border rope for webbing with a minimum breaking strength of 5,000 pounds. Connections between safety nets panels must be as strong as integral net components and be spaced no more than 6 inches apart.

Safety nets must be installed with sufficient clearance underneath to prevent contact with the surface or structure below.



Safety nets must extend outward from the outermost projection of the work surface as follows:

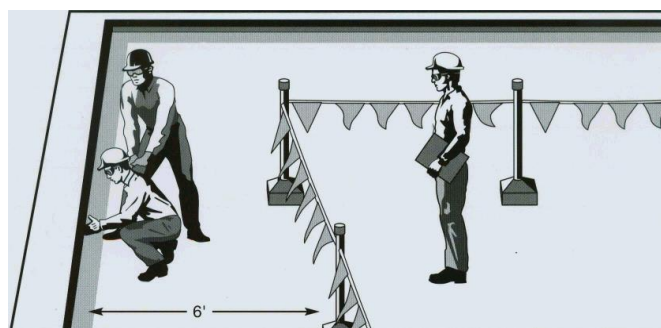
| Vertical distance from working level to horizontal plane of net surface | Minimum required horizontal distance of outer edge of net from edge of working surface |
|--|---|
| Up to 5 feet | 8 feet |
| More than 5 feet up to 10 feet | 10 feet |
| More than 10 feet | 13 feet |

Safety nets must be capable of absorbing an impact force of a drop test of a 400-pound bag of sand 30 inches in diameter dropped from the highest walking and/or working surface at which workers are exposed, but not from less than 42 inches above that level.

Items that have fallen into safety nets, including materials, scrap, equipment and tools, must be removed as soon as possible and at least before the next work shift.

Low-slope Roofs—1926.501(b)(10)

In addition to the typical guardrail systems, safety net systems and PFA systems on low-slope roofs, workers performing roofing work can be protected by a combination of a warning-line system and another fall-protection system (usually a safety-monitoring system). Warning-line systems can never be used alone because they must be set up 6 feet from the edge of the roof. Whenever workers have to work outside the warning line, one of the other systems must be in place. If a roof is 50 feet or less in width, a safety-monitoring system alone is permitted without warning lines.



Note this is a "roofing-only" exception to the conventional fall-protection systems of guardrails, safety nets and PFA systems.

Steep-slope Roofs—1926.501(b)(11)

Each worker on a steep-slope roof with unprotected sides and edges 6 feet or more above a lower level must be protected by either guardrail systems with toeboards, a safety-net system, or a PFA system.

Warning-line Systems—1926.502(f)

Warning-line systems consist of ropes, wires or chains, and supporting stanchions are set up as follows:

- The lowest point, including sag, must be no less than 34 inches from the walking and/or working surface and the highest point is no more than 39 inches from the walking and/or working surface.
- Stanchions, after being rigged with warning lines, must be capable of resisting, without



tipping over, a force of at least 16 pounds applied horizontally against the stanchion 30 inches above the walking and/or working surface perpendicular to the warning line and in the direction of the floor, roof, or platform edge.

- The rope, wire or chain must have a minimum tensile strength of 500 pounds and after being attached to the stanchions must support the load applied to the stanchions as prescribed.
- The warning line must be attached to each stanchion in such a way that pulling on one section of the line between stanchions will not result in slack being taken up in the adjacent section before the stanchion tips over.
- The line must be flagged at not more than 6-foot intervals with high-visibility material.

Warning lines must be erected around all sides of a work area. When mechanical equipment is being used, the warning line must be erected no less than 6 feet from the roof edge parallel to the direction of mechanical equipment operation and no less than 10 feet from the roof edge perpendicular to the direction of mechanical equipment operation.

When mechanical equipment is not being used, the warning line must be erected not less than 6 feet from the roof edge.

Workers outside the warning lines must be protected by guardrails, PFA systems, safety nets or safety monitors.

Safety-monitoring Systems—1926.502(h)

Employers must assign a competent person to monitor the safety of workers when a warning-line system or safety-monitoring system is used and the employer must ensure a safety monitor is:

- Competent in the recognition of fall hazards
- Capable of warning workers of fall hazard dangers and detecting unsafe work practices
- Located on the same walking or working surfaces of the workers and can see them
- Close enough to work operations to communicate orally with workers and has no other duties to distract from the monitoring function

Mechanical equipment may not be used or stored in areas where safety-monitoring systems are being used to monitor workers engaged in roofing operations on low-sloped roofs.

No worker, other than one engaged in roofing work (on low-slope roofs) or one covered by a fall-protection plan shall be allowed in an area where a worker is being protected by a safety-monitoring system.

All workers must be instructed to promptly comply with fall-hazard warnings issued by safety monitors.

Hoist Areas—1926.501(b)(3)



Each worker in a hoist area shall be protected from falling 6 feet or more by guardrail systems or PFA systems. If guardrail systems (or chain gate or guardrail) or portions thereof must be removed to facilitate hoisting operations, such as during the landing of materials, and a worker must lean through the access opening or out over the edge of the access opening to receive or guide equipment and materials, that worker must be protected by a PFA system.

Holes—1926.501(b)(4)

PFA systems, covers or guardrail systems must be erected around holes (including skylights) that are more than 6 feet above lower levels.

Leading Edges—1926.501(b)(2)

OSHA defines a leading edge as the edge of a floor, roof or formwork for a floor or other walking or working surface (such as a deck) that changes location as additional floor, roof or formwork sections are placed, formed or constructed.

Each worker who is constructing a leading edge 6 feet or more above lower levels must be protected by guardrail systems, safety-net systems, or PFA systems. If an employer can demonstrate that it is infeasible or creates a greater hazard to implement these systems, he or she must develop and implement a fall-protection plan that meets the requirements of 29 CFR 1926.502(k).

Protection From Falling Objects—1926.502(j)

When guardrail systems are used to prevent materials from falling from one level to another, any openings must be small enough to prevent passage of potential falling objects. No materials or equipment except masonry and mortar may be stored within 4 feet of working edges. Excess mortar, broken or scattered masonry units, and all other materials and debris must be kept clear of the working area by removal at regular intervals.

During roofing work, materials and equipment must not be stored within 6 feet of a roof edge unless guardrails are erected at the edge, and materials piled, grouped or stacked near a roof edge must be stable and self-supporting.

Canopies—1926.502(j)(8)

When used as protection from falling objects, canopies must be strong enough to prevent collapse and penetration by any objects that may fall onto them.

Toe boards—1926.502(j)(2), (3), and (4)

When toe boards are used as protection from falling objects, they must be erected along the edges of the overhead walking and/or working surface for a distance sufficient to protect persons working below. Toe boards must be capable of withstanding a force of at least 50 pounds applied in any downward or outward direction at any point along the toe board. Toe boards must be a minimum of 3 ½ inches from their top edge to the level of the walking and/or working surface, have no more than ¼ of an inch clearance above the walking and/or working surface, and be solid or have openings no larger than 1 inch.



Toe board
at least 3½
inches high

Where tools, equipment or materials are piled higher than the top edge of a toeboard, paneling or screening must be erected from the walking and/or working surface or toe board to the top of a guardrail system's top rail or midrail for a distance sufficient to protect workers below.

Training—1926.503

Employers must provide a training program that teaches workers who might be exposed to fall hazards to recognize such hazards and minimize them. Workers must be trained in the following areas:

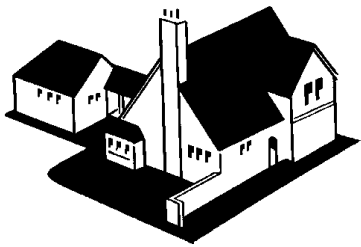
- The nature of fall hazards in the work area

- The correct procedures for erecting, maintaining, disassembling and inspecting fall-protection systems
- The use and operation of controlled access zones and guardrail, PFA systems, safety-net, warning-line and safety-monitoring systems
- The role of each worker in the safety-monitoring system when the system is in use
- The limitations on the use of mechanical equipment during the performance of roofing work on low-slope roofs
- The correct procedures for equipment and materials handling and storage and the erection of overhead protection
- Workers' role in fall-protection plans
- The OSHA fall-protection standards

Employers must prepare a written certification that identifies the worker trained and date the training. The employer or trainer must sign the certification record. Retraining also must be provided when necessary.

Residential Construction—1926.501(b)(13)

The conventional fall protection required by OSHA for construction activities on steep-slope roofs (slopes greater than 4:12) includes guardrails, safety nets and PFA systems (29 CFR 1926.501(b)(11). For residential construction under 501(b)(13), a contractor would have to find conventional fall-protection



methods are “infeasible or create a greater hazard” and develop a written plan to use other fall-protection methods.

However, OSHA Instruction STD 3-0.1A, “Interim Fall Protection Compliance Guidelines for Residential Construction,” issued Dec. 8, 1995, identified certain residential construction tasks that may be performed without the use of conventional fall protection provided the employer followed the provisions of the instruction. OSHA did a plain language revision of STD 3.1 in 1999 and renumbered the instruction STD 03-00-001. The value of the instruction is that it

relieved residential contractors from obligation to show infeasibility or greater hazard when electing to use alternative fall-protection methods, such as roofing slide guards, set out in the instruction in lieu of conventional fall protection.

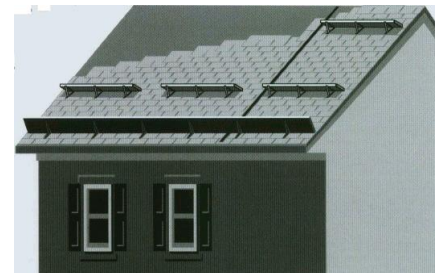
However, OSHA cancelled STD 03-00-001 effective June 16, 2011. After that date, to use alternative fall-protection methods in residential construction, employers have to develop a written fall-protection plan under 29 CFR 1926.502(k).

A prerequisite for instituting an effective plan under that regulation is that a contractor finds conventional fall protection is infeasible or creates a greater hazard. The written plan must then comply with all the elements listed under 502(k) for fall-protection plans.

It is possible that, under current OSHA rules, fall-protection plans compliant with section 502(k) may be developed for residential roofing projects relying on the original slide guard rules set out in instruction STD 03-00-001.

Roofing Slide Guards

Roofing slide guards are roof jacks or brackets with 2-inch by 6-inch (nominal) or larger planking supported by the jack or bracket. Under federal OSHA rules, slide guards may not be used as a sole means of fall protection except when an employer has developed a written fall-protection plan for residential jobs when conventional fall protection is determined to be not possible or created a greater hazard.



Chicken Ladders

Crawling boards, or chicken ladders, must extend all the way from the ridge to the eaves and be secured with ridge hooks. Boards must be at least 10 inches wide and 1 inch thick with cleats of 1 inch by 1½ inches. The cleats must be the same width as the boards and spaced at equal intervals of no more than 24 inches. The nails that hold them in place must be driven all the way through. Additionally, a lifeline or another device that can be used as a handhold must be strung next to each chicken ladder.

Ramps, Runways and Other Walkways—1926.501(b)(6)

Workers using ramps, runways and other walkways must be protected by guardrail systems against falling 6 feet or more.

Wall Openings—1926.501(b)(14)

Each worker on, at, above or near wall openings (including those with chutes attached) where the outside bottom edge of the wall opening is 6 feet or more above lower levels and the inside bottom edge of the wall opening is less than 39 inches above the walking and/or working surface must be protected from falling by the use of either a guardrail system, safety-net system or PFA system.

Falling Objects—1926.502(j)

Protection from falling objects can be accomplished in one of three ways:

1. Toe boards, screens or guardrails can be used to prevent objects from falling from higher levels.
2. Canopies can be put up. These canopies must be strong enough to prevent objects from breaking or ripping through.
3. Barricades can be erected on the ground to keep workers out of the area where objects may fall.

Dangerous Situations

Workers have a right to seek safety and health on the job without fear of punishment. That right is spelled out in Section 11(c) of the OSH Act. Workers should notify their employer immediately if they believe a fall-protection system is set up incorrectly or equipment is improper or defective. If an employer is not responsive, they should call (800) 321-OSHA (6742)—complaints will go immediately to the nearest OSHA area or state office for follow-up.

To further protect workers, the Whistleblower Protection Program protects workers against:

- Being fired or laid off
- Being blacklisted
- Demotion
- Being denied promotion or overtime
- Pay reduction
- Reassignment
- Benefits denial

Rescue: Responding to Arrested Fall Emergencies

OSHA Standard

The OSHA construction standard states simply an "... employer shall provide for prompt rescue of employees in the event of a fall or shall assure that employees are able to rescue themselves." 29 CFR 1926.502(d)(20).

- What is meant by prompt rescue? The OSHA standard does not specify, and the agency is silent on specific issues in interpreting the standard. OSHA notes that rescue must happen before a worker suffer further injury.
- Rescue should be addressed in a company's safety program as part of a fall-protection plan. Safety professionals describe post-fall rescue as a pre-planned event. Workers should be trained in available rescue equipment and specific techniques along with the hazards of rescue.

As with any emergency, a call to 911 should be the first step those on the scene take in rescuing a fallen worker. But the responsibility for rescue is not complete with that 911 call. Employers should ensure that their rescue plan identifies specific strategies for rescue.



According to one safety expert, second or third injuries or fatalities are not uncommon as a result of *unplanned* attempts to rescue. And the fact is many rescue personnel are not trained in high-angle rescue. High-angle rescue is a mountaineering term for rescue from sloped surfaces at height, but in construction it generally refers to urban and structural rescue performed at great heights. Lack of training in high-angle rescue makes an employer's rescue plan even more important.

Arresting Force

OSHA requires fall-protection equipment to limit arresting force on a fallen worker to 1,800 pounds or less. Injury may result when impact force is applied to the body. Improperly deployed fall-arrest equipment that increases free-fall distance to more than 6 feet, such as a rope grab with too much lifeline slack, can increase forces substantially when arresting a fall. As an example, a 220-pound weight dropped 6 feet produces more than 3,000 pounds of force. As force increases, the likelihood of more severe injury increases.

Suspension Trauma

The critical focus should be the health implications of suspension trauma and how to minimize or eliminate its effects. Suspension trauma is caused by orthostatic incompetence, which also is called orthostatic intolerance. Ortho comes from a Greek word meaning *straight* (for example, an orthodontist straightens teeth) and static means *fixed* or *stationary*. Orthostatic incompetence results from being in a straight position without movement for a period of time.

We've all heard about what can happen to people standing motionless for some time. For example, in a school or military assembly, people can faint because of a lack of blood flow to the brain. That condition is self-correcting when a person falls over; he or she usually quickly revives because his or her legs, heart and brain are on the same level and blood is returned to the heart.

When someone is suspended in a fall-protection harness the blood continues to accumulate in the lower extremities. Research has shown suspension trauma can occur as long as the legs don't move and are lower than the heart. This is a serious condition that can be life-threatening. Gravity causes blood to pool in the legs, and because the legs are no longer moving to help move blood back to the heart, the heart speeds up to get sufficient blood to the brain. The straps of a harness also may exert force on the veins in the legs, impairing blood flow.

Each person's tolerance for hanging suspended is different, but the dangerous effects of suspension trauma can occur quickly after a worker is hanging in a harness. Many experts agree that unconsciousness can result in less than 30 minutes. Some resources even say that suspension for more than five minutes can be dangerous. That's why rescue operations must be planned and put into effect immediately after a fall.

Suspension trauma issues may be complicated because a fallen worker also may have other injuries such as broken bones, head or neck trauma or severe cuts and may have lost consciousness at the time of the fall. Suspension trauma risk will be more severe in these instances and is especially serious when the worker has lost consciousness or is completely motionless.

What are signs of suspension trauma?

- Fainting
- Shortness of breath
- Nausea
- Dizziness
- Sweating
- Hot flushes
- Paleness
- Narrowing of field of vision or loss of vision
- Increased heart rate



Rescue

Rescue has two basic elements:

1. Delaying orthostatic shock
2. Bringing the fallen worker to a supporting surface

Prepare the Crew

Ordinarily, the greater the number of workers at a job site where a worker has fallen, the easier it will be to bring the worker to safety. This may involve something as simple as several workers using the fallen worker's lifeline to pull him up to the level or deck from which he has fallen. Generally, it will be quicker and simpler to bring a fallen worker up rather than lower him.



It is critical rescuers are protected by PFA equipment while attempting the rescue of a fallen worker.

Equipment that is already on the job site can provide the simplest rescue method. Ladders, personnel lifts and scaffolds are capable of being moved easily and set up quickly to assist in or accomplish the rescue. Limited additional training is needed for workers rescuing a crew member using this type of equipment because they already should be well-versed in its use and setup.

Pulleys, winches and descending devices also may be used in a specialized worker training in setup and use of such equipment before equipping crews with any devices.

A brake tube uses rope friction—the rope wraps around the brake suspended worker. Brake-tube systems are relatively inexpensive. A brake-tube system will lower a suspended worker from any height and lowers faster than winch or pulley systems.

Because they're small and inexpensive, you can set up brake-tube than one worker at a site. A brake-tube system requires a rope the working height plus 20 feet as a safety margin. The difficulty with brake-tube systems and similar descending devices is the need to disconnect the primary lifeline to allow descent.



rescue, but should be done

tube—to lower a worker and easy to set up. It has no

systems for more than twice as long as with brake-tube systems from the initial or

It is important during any rescue that workers never cut lanyards or lifelines to which fallen workers are connected. The lanyard or lifeline tension from the weight of the worker should be released by rescue procedures and/or equipment. Arrest systems then may be disconnected only when a worker is at a point of safety.

Self-rescue Options

In some instances, a fallen worker may be required to rescue himself or herself without any assistance from others. This may occur because of the remoteness of the jobsite or work areas within the project site and/or absence of other crew members to assist either because others have fallen in the same incident or the worker is operating as a one-person crew. With appropriate equipment and training, a fallen worker may be able to reach a supporting surface. But this should never be the only rescue option. Workers also should be trained in a variety of self-rescue techniques.

Self-rescue may be the ability merely to relieve suspension trauma because that often is the most critical condition that can bring about death when a worker is hanging. Naturally, for a worker to attempt a self-rescue, the fall must not have been so severe as to render him or her unconscious or severely injured. Some self-rescue tools and techniques include:

- **Cellular telephones/Two-way radios**—These often will be the only rescue option a worker may have. Serious injury may not allow a worker to attempt other rescue methods, and all he or she can do is call for help. To ensure a workers' cellular phones or radios are accessible, workers should be instructed to place them in a securable pocket as close to the chest as possible. Lower pockets may not be within easy reach while hanging, and open pockets may allow a phone to fall out during the fall or arrest. Cloth or metal snaps securing the phone to the outside of work clothes may be dislodged by the action of the harness against the body during fall arrest.
- **Self-rescue lanyard**—Manufacturer makes a lanyard that deploys a synthetic ladder from the lanyard's soft pack end that attaches at the rope grab. The fallen worker can use the ladder for suspension-trauma relief or can climb to safety if the ladder length is sufficient.
- **Suspension trauma straps and slings**—These are adjustable straps that attach to the lower webbing or the side D-rings of a harness. A fallen worker adjusts the strap to form a loop under him or her that is above the level of his or her feet. He or she then can pull himself or herself up by grasping the lifeline or lanyard and step into the strap relieving pressure on his or her legs.
- **Lifeline loop and prussic loops**—Both of these are used to relieve suspension trauma but may be a little more difficult to implement in the field after a fall. Use of a lifeline loop simply requires the fallen worker to grab the trailing portion of his or her lifeline that



should be hanging next to him or her. Then, he or she ties a loop in the lifeline at approximately knee or waist level that is large enough to accommodate one or both feet.



A bowline is a good knot for this because it will not slip or tighten and trap the feet. A worker can use the loop to stand in, similar to the straps or ladder described earlier, to take his weight off of the harness somewhat.

Prussic loops are thinner pieces of rope or webbing that a worker would carry in a pouch on a harness. The ropes are tied to form a circle about 12-18 inches in diameter. A fallen worker would attach one or more loops to the lifeline by encircling the lifeline with a few wraps of the loop leaving a large loop exposed in which he or she could then place his foot. The loop holds tight to the lifeline and supports his or her weight.

- **Foot wrap**—This is a suspension trauma relief technique that also may be used for limited self-rescue situations. It involves wrapping the trailing end of the fallen worker's lifeline from the inside of his or her foot around to the outside and bringing it on top of that foot. Then, the worker places his or her other foot on top of the line crossing over the top of the foot. He or she can then stand on it while holding the lines together at about chest level.

With some maneuvering, the worker can take pressure off a rope grab enough to move it slowly either up or down on the lifeline. By repeating the process several times, a worker can lower or raise himself or herself while still remaining connected to the lifeline.

If self-rescue is impossible, or prompt rescue cannot be performed, it's critical for a fallen worker to pump his or her legs frequently to activate the muscles and reduce the risk of blood pooling. Footholds can be used to alleviate pressure and provide support for muscle pumping.



Post-rescue Actions

First Aid

There is not a large amount of research available about proper first-aid treatment for victims of suspension trauma, and information that may be found often is conflicting. Emergency responders should be summoned immediately when a fall occurs. Once a fall victim is at a safe location, restoring proper blood flow to the body will be a main concern. Any arrested fall with suspension, even for a brief time, demands transport to the emergency room for assessment by medical professionals.

Maintaining the victim's airway is critical during transport. Stopping any blood loss also will be a priority for first aid.

Fully reclining a rescued worker is often not recommended. The release of pooled blood from the lower extremities can lead to cardiac arrest and cause death. A sitting position on the ground with the legs flat to the ground and perpendicular to the spine is considered more favorable. This is thought to be beneficial to reduce the surge of pooled blood back to the heart, which may be detrimental for a number of reasons.



If oxygen is available at the site, administer it to the victim and do not let the victim lie flat or stand up. This position should be maintained during transport to the hospital.

Equipment Out of Service

OSHA requires that PFA equipment that has been subjected to "impact loading"—subjected to forces like those during a fall—must be immediately removed from service and not be used again until inspected by a competent person and determined to be undamaged and suitable for reuse (29 CFR 1926.502(d)(19)). Ordinarily, this applies to the harness, lanyard, lifeline, anchorage and their component parts. At a minimum, the harness and lanyard will need to be discarded as a result of impact loading.

Rescue Protocol

- DO practice and review strategies for rescue in the fall-protection portion of the safety program.
- DO call 911 immediately to alert emergency medical responders when a fall occurs.
- DO assess available equipment on the job site that could be used for rescue.
- DO keep all rescuers tied off to appropriate anchor points during the course of the rescue operation.
- DO implement measures to relieve suspension trauma.
- DO administer first aid to a fallen worker once he or she is in a safe area.
- DO transport a rescued worker to the nearest emergency medical facility for assessment by medical personnel.
- DO remove all fall arrest-equipment from service after it has been impact loaded by a fall.
- DO NOT cut lanyards, lifelines or harnesses of a fallen worker.

Glossary

Anchorage – A secure point of attachment for lifelines, lanyards or deceleration devices.

Body belt – A strap with means for securing it around the waist and attaching it to a lanyard, lifeline or deceleration device.

Body harness – Straps that may be secured about the person in a manner that distributes the fall-arrest forces over at least the thighs, pelvis, waist, chest and shoulders with means of attaching the harness to other components of a personal fall-arrest system.

Connector – A device used to couple (connect) parts of personal fall-arrest system or positioning device system.

Controlled access zone – A work area designated and clearly marked in which certain types of work (such as overhand bricklaying) may take place without the use of conventional fall-protection systems—guardrail, personal arrest or safety net—to protect the workers in the zone.

Deceleration device – Any mechanism—such as a rope, grab, rip stitch lanyard, specially woven lanyard, tearing or deforming lanyards and automatic self-retracting lifelines/lanyards—that serves to dissipate a substantial amount of energy during a fall arrest or otherwise limits the energy imposed on an employee during fall arrest.

Deceleration distance – The additional vertical distance a falling person travels, excluding lifeline elongation and free-fall distance, before stopping from the point at which a deceleration device begins to operate.

Guardrail system – A barrier erected to prevent workers from falling to lower levels.

Hole – A void or gap 2 inches or more in the least dimension in a floor, roof or other walking and/or working surface.

Lanyard – A flexible line of rope, wire rope or strap that 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 and/or working surface (such as a deck) that changes location as additional floor, roof, decking or formwork sections are placed, formed or constructed.

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) that serves as a means for connecting other components of a personal fall-arrest system to the anchorage.

Low-slope roof — A roof having a slope less than or equal to 4:12 (vertical to horizontal)

Opening — A gap or void 30 inches or more high and 18 inches or more wide in a wall or partition through which workers can fall to a lower level.

Personal fall-arrest (PFA) system— A system including but not limited to an anchorage, connectors, and a body belt or body harness used to arrest an employee in a fall from a working level. As of Jan. 1, 1998, the use of a body belt for fall arrest is prohibited.

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 backward.

Rope grab — A deceleration device that travels on a lifeline and automatically, by friction, engages the lifeline and locks to arrest a fall.

Safety-monitoring system — A safety system in which a competent person is responsible for recognizing and warning workers of fall hazards.

Self-retracting lifeline/lanyard — A deceleration device containing a drum-wound line that can be slowly extracted from, or retracted onto, the drum under minimal tension during normal employee movement and, after onset of a fall, automatically locks the drum and arrests the fall.

Snap-hook — A connector consisting of a hook-shaped member with a normally closed keeper or similar arrangement that may be opened to permit the hook to receive an object and, when released, automatically, closes to retain the object.

Steep-slope roof — A roof having a slope greater than 4:12 (vertical to horizontal).

Toe board — A low protective barrier that prevents material and equipment from falling to lower levels and protects personnel from falling.

Unprotected sides and edges — Any side or edge (except at entrances to points of access) of a walking and/or working surface (floor, roof, ramp runway) where there is no wall or guardrail system at least 39 inches high.

Walking or 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 reinforced steel. Does not include ladders, vehicles, or trailers on which workers must be located to perform their work duties.

Warning-line system — A barrier erected on a roof that warns workers they are approaching an unprotected roof side or edge and designates an area in which roofing work may take place without the use of guardrail, body belt or safety-net systems to protect workers in the area.

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