

ROADWAY SAFETY+

Fall Hazards and Prevention For Road Building

Trainee Booklet



ARTBA

An ARTBA Work Zone Safety Consortium Awareness Program

Fall Hazards and Prevention

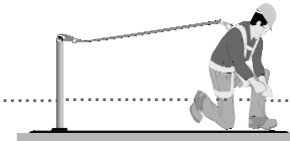
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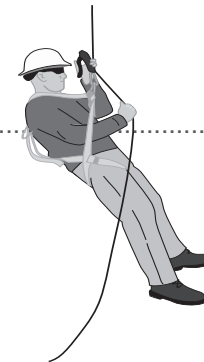
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Introduction

Fall protection was #1 on the OSHA (Occupational Safety and Health Administration) Top 10 list of the most cited violations for three years in a row.

According to OSHA, 8,241 fall protection citations were issued in 2014.

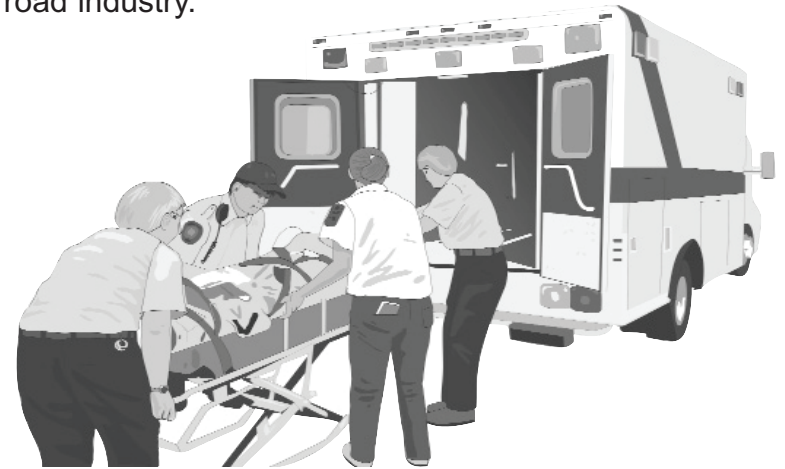
Now, more than ever, all road contractors and workers must learn how to implement comprehensive fall protection programs.

Fall Hazards and Prevention

Fall Hazards

Do Road Workers Fall on the Job?

Falls are the second most common accident in the road industry.



Road industry data:

- Falls lead to 20% of all insurance claims in the road industry.
- 4 to 5 road workers die from falls each year.

Falls are the leading cause of death in construction.

Falls took the lives of 699 construction workers in 2013 alone. The majority of these fatal falls (82%) were falls to a lower level. Of the lower level falls, about 25% were from 10 feet or less while 75% were from heights of 11 feet and higher (with 55% falling between 11 and 29 feet and 20% falling 30 feet or more).

Fatal fall cases:

- A 45-year old road worker fell 70 feet to his death from the Mount Hope Bridge in Connecticut.
- Two road workers, ages 53 and 63, fell 90 feet to their deaths from a bridge near Montgomery AL.
- A 34-year old road worker fell 60 feet to his death from a bridge across Lake Washington, Seattle.



Many more road workers are injured, even disabled, in falls.

Where Do Falls Happen?

There are 3 main categories of falls in the road industry.

- Falls on the same level.
- Falls from equipment.
- Falls from elevations.

Why Do Falls Happen?

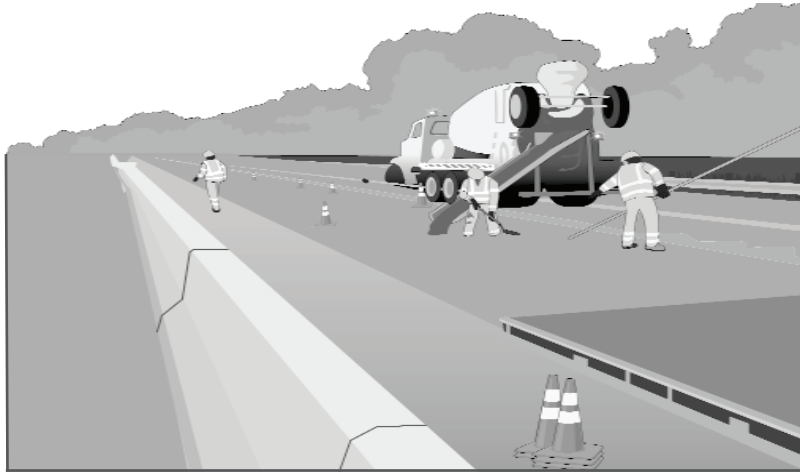
Some happen on the same level.

- Tripping over materials or debris (housekeeping).
- Falling on hills or embankments.
- Stepping in holes and walking on irregular ground.
- Stumbling while carrying loads that block vision.
- Slips or trips in muddy, wet, and/or icy conditions.
- Improper footwear.



How Do We Prevent Falls on Same Level?

Follow 6 basic best practices.



- Use footwear with ankle support and soles that grip.
- If possible, avoid walking on muddy, wet, or icy surfaces.
- Don't carry heavy loads. Use hauling equipment.
- Fill in, cover and mark, or barricade holes in ground.
- Practice good housekeeping.
- Include walking routes in the Internal Traffic Control Plan (ITCP).

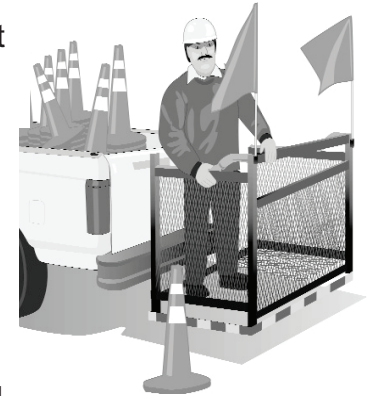
A very important way to prevent falling yourself is to maintain good physical strength and conditioning.

Fall Hazards and Prevention

Why Do Falls Happen?

Some happen from equipment.

- Not facing ladders/equipment when going up/down.
- Not using hand grabs/rails when going up/down.
- Steps, ladders not clear and defect free.
- Platform not provided or not properly guarded.
- Seatbelts, restraints not used.



How Do We Prevent Falls from Equipment?

Follow 5 basic best practices.

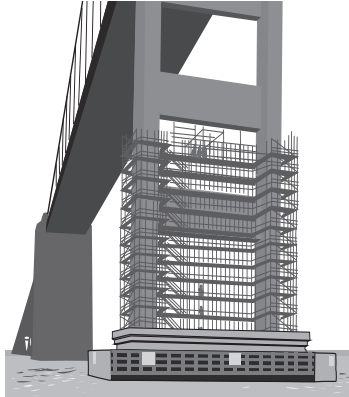
- Use handrails.
- Always use 3-point contact.
- Make sure steps and ladders are clear and defect-free.
- Do not ride on equipment except in provided seats.
- Use seatbelts or restraints for riding in cars, trucks, personnel carriers.



Why Do Falls Happen?

Some happen from elevations.

- Off bridges.
- Off formwork.
- Off scaffolds.
- Off aerial lifts.
- Off excavation rims.



Most fatal falls are from elevations. Falls from elevations often cause the most serious injuries.

How Do We Prevent Falls from Elevations?

Follow 6 basic best practices.

- Plan for 100% fall protection.
- Develop a written fall protection plan written by a *Qualified Person*.
- Select and use proper fall protection systems.
- Train workers in fall protection.
- Enforce and evaluate the fall protection program.
- Use modular erection to avoid work at heights on forms.

The following sections cover requirements and methods for preventing falls from elevations in road work.

Fall Hazards and Prevention

Fall Prevention: Basics

What Are Falls from Elevations?

Falls from elevations are falls from levels that are 6 feet or more above a lower level.

For work 6 feet or more above a lower level,* OSHA requires fall protection. (*Exceptions to this requirement include scaffold platforms, which require fall protection at 10 feet or more above a lower level.)

Workers exposed to falls from elevations must be covered by a fall protection program developed by a *Qualified Person*.



'Qualified Person'

"... one with "proven knowledge, skill, experience, training, certification, or professional standing to solve or resolve problems related to the subject matter, the work, or the project."

What OSHA Standards Are Applicable?

OSHA Subpart	Situation	Requirements	OSHA Standards
Subpart E Personal Floatation Device (PFD)	*Working over water where there is a hazard of drowning	All situations require a PFD	1926.106(a)
	*Where a personal fall arrest system (PFAS) is used 100% of the time and no drowning hazard	All situations do not require a PFD	1926.106(a) 1926.501(b)
	*Where safety nets are used for fall protection	All situations require a PFD	1926.106(a)
Subpart L Scaffold Fall Protection Requirements	Scaffolding	10 ft (3.0 m)	1926.451(g)
	Suspended scaffolding of any type	10 ft (3.0 m)	1926.451(g)(1)(i)&(ii)
Subpart M Fall Protection Requirements	Aerial lifts - NOTE: personal fall protection must satisfy criteria in 1926.502(d) & (e)	All situations	1926.453(b)(2)(v)
	**Leading edges on bridge decks	6 ft (1.8 m)	1926.501(b)(2)
	Bridge decks, unprotected sides and edges	6 ft (1.8 m)	1926.501(b)(1)
	Holes/floor (bridge deck) openings 2" and greater	6 ft (1.8 m)	1926.501(b)(4)
	Formwork and reinforcing steel	6 ft (1.8 m)	1926.501(b)(5)
	Ramps, walkways, and runways	6 ft (1.8 m)	1926.501(b)(6)
	Working above dangerous equipment	All situations	1926.501(b)(8)
**Precast concrete erection	6 ft (1.8 m)	1926.501(b)(12)	
Subpart Q Concrete & Masonry Requirements	Implement hazard (must be guarded)	Any exposure	1926.701(b)(1)
	General Requirements	15 ft (4.6 m)	1926.760(a)(1)
***Subpart R Steel Erection	Connectors	15 ft (4.6 m) to 30 ft (9.2 m)	1926.760(b)
	Controlled Deck Zone	15 ft (4.6 m) to 30 ft (9.2 m)	1926.760(c)
	Fall Protection Systems	Varies	See App. G

Fall Hazards and Prevention

Who Must Know the OSHA Standards?

Management and the fall protection *Competent Person* must know the OSHA standards in detail.

Competent person means "one who is capable of identifying existing and predictable hazards in the surroundings or working conditions ... and who has authorization to take prompt corrective measures to eliminate them."

The fall protection *Competent Person* must:

- Be responsible for implementing the fall protection plan.
- Have absolute authority over the fall protection plan.
- Have unquestioned authority to stop work and correct all fall hazards.
- Oversee documented inspections where fall protection measures are used.
- Keep maintenance records, incident reports, accident investigation records, and employee training records.
- Prepare to train employees by acquiring/developing a training program.



All employees exposed to fall hazards should be trained in OSHA standard requirements.

What Is a Fall Protection Plan?

A fall protection plan is a plan to control fall hazards written by a *Qualified Person* (see definition on page 7).

The steps in developing a plan include:

- Perform *fall hazard analysis* to determine areas of risk and methods of engineering out hazards.
- Select fall protection system(s).
- Identify rescue equipment.
- Obtain/develop worker training program.
- Describe how the plan will be enforced and evaluated.

Download fact sheet on *Sample Fall Protection Plan*.

<https://www.workzonesafety.org/training-resources/fall-prevention-fact-sheets/>

What Training Is Required?

Workers exposed to fall hazards must be trained by a *Competent Person*. At a minimum, workers must learn:

- Nature of the fall hazards in the work area.
- Correct procedures for erecting, maintaining, disassembling, inspecting fall protection systems.
- Use and operation of guardrail systems, PFAS, safety nets, and other protections.
- OSHA fall protection standard.



A *Competent Person* must keep records of all training.

Fall Hazards and Prevention

What Is Fall Protection?

Fall protection includes training, procedures, rules, and specialized equipment.

Two categories of *conventional* fall protection equipment are used in road work:

- Fall *prevention* systems that prevent a fall.
EXAMPLES: guardrails and personal fall restraint.
- Fall *arrest* systems that stop a fall after it happens.
EXAMPLES: safety nets and personal fall arrest (PFAS).

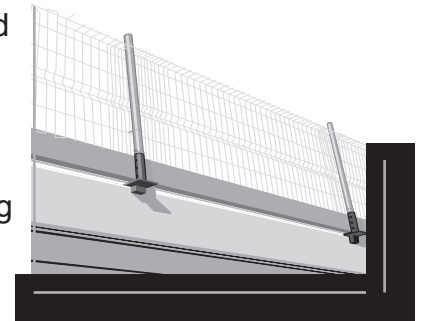
What Are Guardrails?

Guardrails are barriers erected to prevent workers falling.

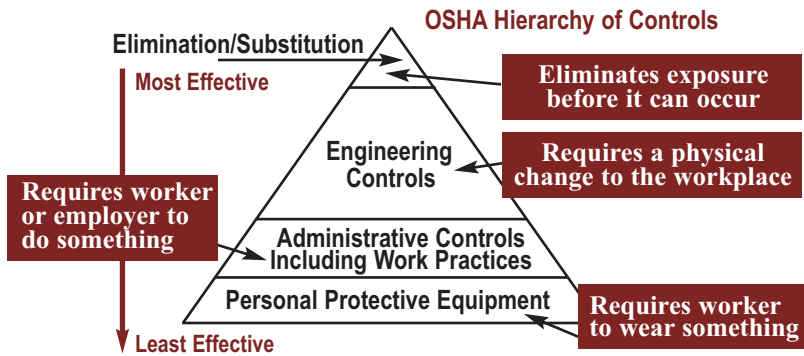
Guardrails may be cable, metal, plastic, or wood.

Guardrails are an engineering control (see *Hazard Control Methods* on page 12).

After guardrails are installed, workers do not have to do anything to operate them. So guardrails are classified as *passive* fall prevention.



Highway guardrails may or may not meet OSHA requirements.



What Is Personal Fall Restraint?

A Personal Fall Restraint System (PFRS) acts as a leash to prevent a worker falling.

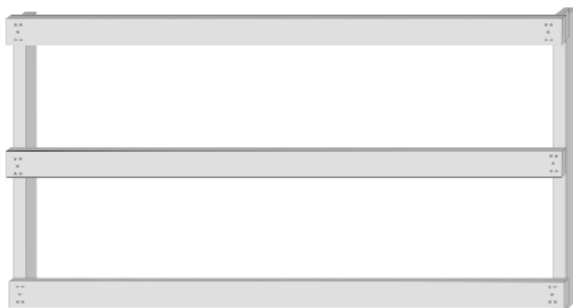
PFRS is "... composed of ... a body harness along with an anchorage, connectors and other necessary equipment. The other components typically include a lanyard and may also include a lifeline and other devices."
[OSHA Subpart R 1926.751]

What Are Guardrail Requirements?

Guardrails must meet OSHA's basic specifications.

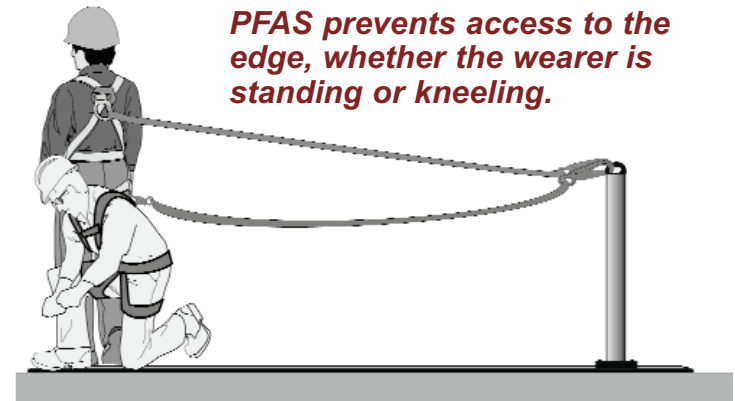
A standard guardrail consists of:

- Top rail
 - Must be 39" to 45" above the working surface.
 - Must withstand at least 200 pounds of force.
- Midrail midway between top rail and working surface
 - Must withstand 150 of force.
- Toeboard
 - Must be minimum 3.5" high.
 - Must withstand 50 pounds of force.



PFRS is an *active* fall prevention system because the worker must actively operate it after installation.

PFRS is classified as personal protective equipment (PPE) in the OSHA *Hazard Control Methods* hierarchy (see page 12).



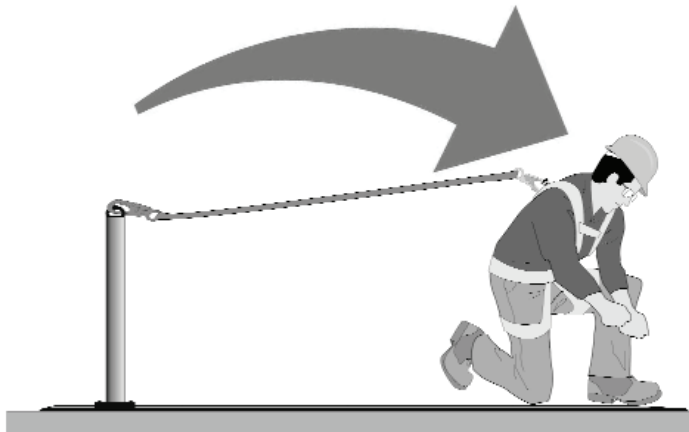
PFRS prevents access to the edge, whether the wearer is standing or kneeling.

Use PFRS only when it is set up so that no free fall is possible.

What Are PFRS Requirements?

Personal fall restraint systems must meet OSHA's basic specifications.

- Fall arrest system components shall be used in fall restraint systems and shall conform to the criteria in Subpart M §1926.502 (PFRS is defined in Subparts R and CC. PFRS is not mentioned at all in Subpart M.).
 - Body harness
 - Connectors
 - Lanyard or lifeline. Line length should not exceed the distance of the anchor from the edge minus <12 inches.



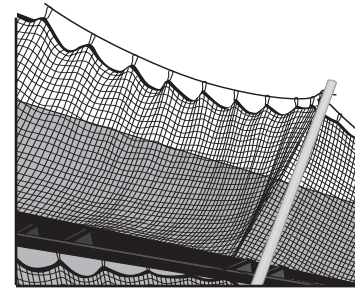
- Anchorage must be located to prevent any access to an edge.
- Anchorage height must be correct for the line length.

Fall Hazards and Prevention

Fall Arrest: Advanced

What Are Safety Nets?

Safety nets are fall *arrest* systems. Safety nets are hung beneath/around work areas to catch workers. Safety nets do not *prevent* falls.



Safety nets are an engineering control (see *Hazard Control Methods* on page 12).

After safety nets are properly installed, they provide 100% fall protection. Workers have no responsibilities other than to be alert to changes that reduce effectiveness. That is why safety nets are classified as *passive* fall protection.

What Are Safety Net Requirements?

A safety net must be installed:

- As close as practicable under working surface.
- No more than 30 feet below working surface.

Safety components are:

- Net mesh
- Support cables
- Mounting brackets
- Outriggers
- Cantilever arms
- Various adapters

A Competent Person must inspect safety nets on a frequent/regular basis to ensure continuing effectiveness.

What Is PFAS (Personal Fall Arrest System)?

PFAS is *active* fall protection designed to catch a falling worker. PFAS does not prevent falls. It reduces their impact.

A personal fall arrest system must:

- Be rigged so that a worker can never free-fall more than 6 feet and cannot hit any lower level.
- Limit maximum arresting force on a worker to 1,800 pounds.
- Bring a worker to a complete stop and limit the maximum deceleration distance to 3½ feet.
- Have enough strength to withstand twice the potential impact energy of a worker free falling a distance of 6 feet or the free fall distance permitted by the system, whichever is less.



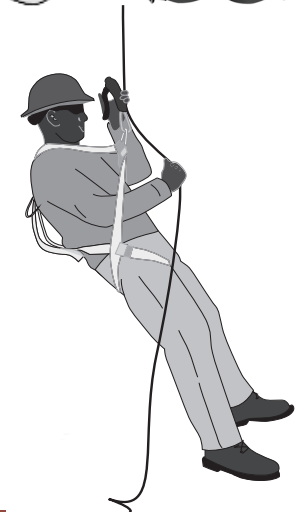
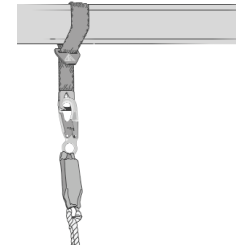
The PFAS must hold a fallen worker safely until rescue can be completed.

Fall Hazards and Prevention

What Are the Parts of a PFAS?

A PFAS has 4 main components (A-B-C-D):

- **A = Anchor**
 - Secure point to attach lifeline, lanyard, deceleration device, and/or rescue equipment.
 - Must support at least 5,000 pounds per worker.
- **B = Body harness**
 - Shoulder straps, retainer, waist strap, thigh straps, sub-pelvic support, adjustment buckles.
- **C = Connectors**
 - D-ring typically located between shoulder blades.
 - Locking carabiners or snap hooks.
- **D = Descent / rescue devices**
 - To retrieve or lower fallen worker.

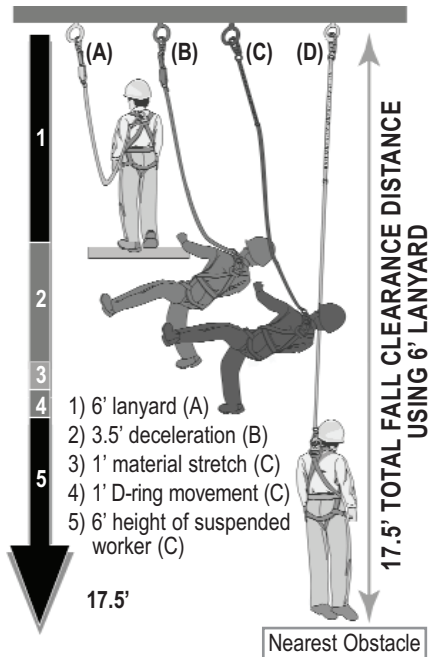


How Do We Choose PFAS Lanyards?

To select the proper PFAS lanyard, first calculate the **TOTAL FALL CLEARANCE DISTANCE**. This is the vertical distance from the anchor to the nearest lower obstruction (e.g., structural member or the ground).

Primary factors include:

- 1 Lanyard length – typically 3' to 6'
- 2 Deceleration distance of energy absorber in shock-absorbing or shock-pack lanyard
- 3 Estimated materials stretch
- 4 Estimated D-ring movement
- 5 Height of suspended worker



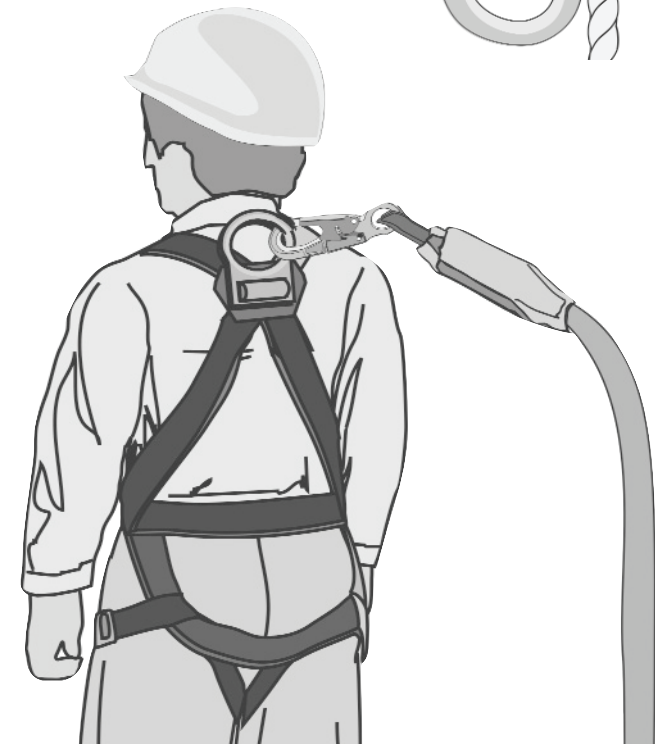
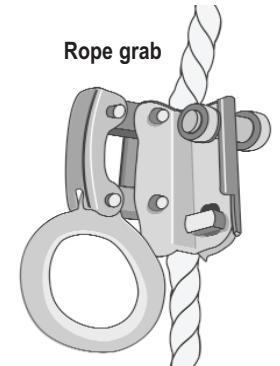
Lanyard Specifications

Lanyards must display approval by the American National Standards Institute (ANSI) or the American National Standards Institute/American Society of Safety Engineers (ANSI/ASSE). Lanyards meeting the specifications of ANSI A10.32, ANSI/ASSE Z359.1 or ANSI/ASSE Z359.13 are permitted in the construction industry. ANSI/ASSE Z359.1 and Z359.13 are more stringent and more comprehensive than the ANSI A10.32.

Fall Hazards and Prevention

Optional factors:

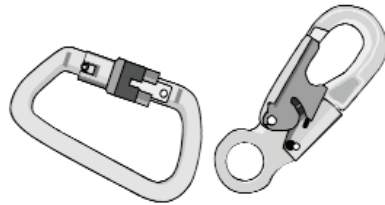
- **Vertical lifeline:** calculation should include rope grab slip and lifeline stretch.
- **Horizontal lifeline:** include displacement and lifeline stretch.
- **Anchor below D-ring level:** control arresting force by calculating a larger shock-pack.



How Do We Choose PFAS Connectors?

A connector must be suited to the connection being made. For example:

- Snap hooks and carabineers are best for vertical or horizontal lifelines.
- Web loops are suitable for wrapping around beams.
- Scaffold hooks are good for anchors of convenience, such as rebar.
- Ascender/descender devices may be the correct connector when connecting to a lifeline.



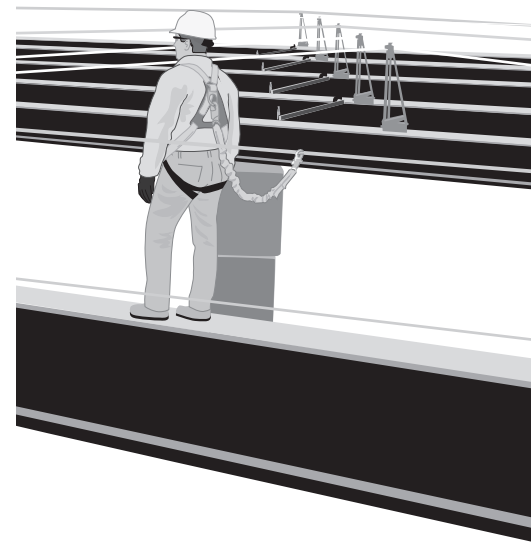
Personal fall arrest system components must be inspected by the user prior to each use and by a Competent Person on a regular schedule. Defective components must be removed from service.

Connector Specifications

All acceptable snap hooks or carabineers have a kilo-Newton (kN) rating engraved into the spine. Since 2007, the newest ANSI (American National Standards Institute) standard requires all fall protection hardware to have a minimum 16 kN (3,600 pounds) rating for the gate and 22.5 kN, (5,000 pounds) tensile load. In addition, the stamp should include: year of manufacture and ID, part number, load rating for major axis, load rating for gate and – for non-integral connectors – the ANSI Z359.1(07). Although OSHA stopped requiring the construction industry to meet ANSI 2007 in 2010, it is industry best practice to follow this standard.

Fall Hazards and Prevention

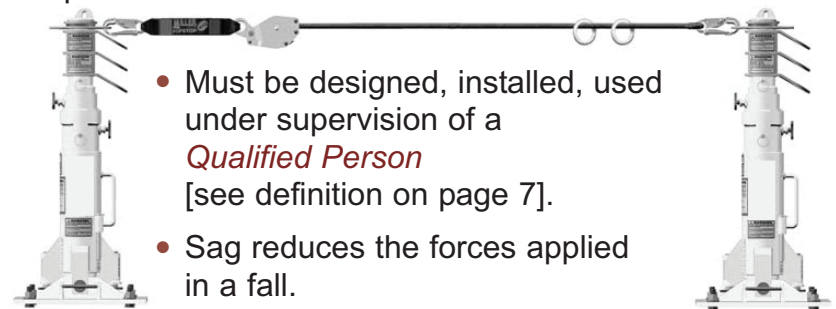
What Are Horizontal Lifelines?



A horizontal lifeline is a lifeline anchored at both ends. Features include:

- May be temporary or permanent.
- Enables flexible movement.
- Ensure 100% fall protection.

Installation and use of a horizontal lifeline requires expertise. The horizontal lifeline:



- Must be designed, installed, used under supervision of a **Qualified Person** [see definition on page 7].
- Sag reduces the forces applied in a fall.
- Sag increases the **TOTAL FALL CLEARANCE DISTANCE** [see page 18].
- Sag impacts the location of a worker after a fall as connector migrates to center of the line.

What Are Self Retracting Lifelines (SRLs)?

An SRL is a deceleration device. Components include:

- Drum-wound line extracted/retracted from/onto a drum under slight tension.
- Drum locks automatically in a fall.



The advantages of an SRL include:

- Reduces free fall. An SRL requires <2' to arrest fall if the anchor is at 0° above the worker.
- Reduces risk of hitting the ground or other objects
- Makes rescue easier. A fallen worker may self-rescue using the pulley system attached near an SRL anchorage point and the built-in raise/lower options.
- Reduces tangles and trips.

The limitations of an SRL include:

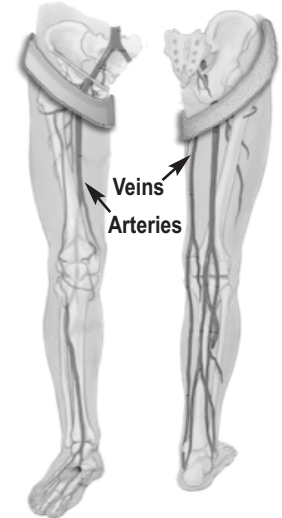
- Limited horizontal distance for work from anchor.

Fall Hazards and Prevention

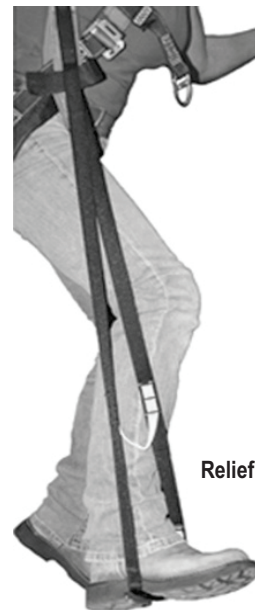
What Is Suspension Trauma?

Suspension trauma is *orthostatic shock* from hanging in harness. It happens because:

- Harness straps act like *tourniquets* on the veins in the backs of the legs.
- Straps prevent used (deoxygenated) blood returning to the heart to become oxygenated.



Suspension trauma can be *fatal* in as little as 10 minutes (typically 15 to 40 minutes).



To reduce risk of suspension trauma:

- A fallen worker should stand in relief straps or on structural member.
- The onsite rescue team should bring equipment such as a ladder, an aerial lift, etc.

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The company must have a plan to rescue the suspended worker in less than 5 minutes.

- The company must have a rescue plan written by a *Qualified Person* and a *Competent Person* must train workers in the plan.
- Rescuers must take care in handling a fallen worker to avoid post-rescue death caused by the heart's inability to tolerate an abrupt increase in the flow of carbon dioxide-saturated blood from the legs.
- Do not put the rescued worker in a horizontal position – whether conscious or not.
- Place rescued worker in the 'W' position for at least 30 minutes.
- Inform the Emergency Medical Service (EMS) team how long the worker was suspended and ensure the EMS team know how to treat suspension trauma.



Download fact sheets on *Preventing Suspension Trauma* and *Sample Fall Rescue Plan*.

<https://www.workzonesafety.org/training-resources/fall-prevention-fact-sheets/>