Module 3: Hierarchy of Controls

Terminal Learning Objective:

- Discuss hierarchy of controls for fall hazards

Hierarchy of Fall Hazard Control

Once fall hazards are identified, they need to be addressed. Fall hazard mitigation should be considered in the following order:

1. Elimination of fall hazards
2. Prevention of Falls
3. Control of falls

Elimination of fall hazards is the first, and best, line of defense against falls from heights. If the hazard is eliminated, and the employee does not have to perform work at heights, there is no more fall hazard.

Prevention of fall hazards is the second line of defense, and should be used when it is not possible to eliminate the hazard. Examples include changes to the physical work area, such as adding stairs, guardrails, and barriers to prevent the employee from being directly exposed to the fall hazard.

Control of fall hazards is the last line of defense, and should be used only when elimination and prevention of fall hazards cannot be utilized. Fall controls include use of fall protection such as safety nets or harnesses, and fall arrest systems. These controls reduce the risk of injury if a fall happens.

Use of Control of fall hazards has several disadvantages, as opposed to Elimination or Prevention methods. First, although they reduce the risk of injury, Control methods do not prevent falls. An employee who falls may still experience some type of injury. Second, Control methods rely on the employee to utilize them correctly in order to work properly. If the employee is not properly trained, for example, the controls may not work the way they were intended.

Eight Step Approach to Fall Protection:

The following eight step approach focuses on actual or potential fall hazards that may be anticipated and also allows an evaluation strategy of using fall elimination or prevention before considering fall protection.

Step 1: Determine if walking/working surfaces are structurally safe

Step 2: Conduct a fall hazard assessment

Step 3: Eliminate the need for fall protection, if possible

Step 4: Select the appropriate type of fall protection system

Step 5: Develop rescue/retrieval procedures

Step 6: Develop an equipment inspection, maintenance and storage program

Step 7: Provide fall protection training

Step 8: Monitor the fall protection program

Step 1: Determine if walking/working surfaces are structurally sound

Make sure that the walking/working surface has the strength and structural integrity to safely support all employees and their equipment.

- Consider older buildings or buildings with wooden roofs
- Consider during demolition work

Employees should not be permitted to work on building roofs and other walking/working surfaces until the employer has determined that the surfaces are structurally sound. Generally, an engineer would need to make this determination. Sometimes it can be determined by engineering records of the building.

Step 2: Conduct a Fall Hazard Assessment

Fall hazards exist on any walking or working surfaces. When many workers are working at various levels of elevation, there is a greater risk of serious injuries from falls. A fall hazard assessment is used to identify and evaluate physical fall hazards. Consider fall hazards such as working near unguarded edges, roofing on a steep pitch, lack of safe access, working on a slippery surface, or any others previously discussed.

The hazard assessment should be conducted by the Assigned Fall Protection Competent Person. The Competent person should include employees, managers, and supervisors in the analysis of fall protection hazards, and should also review:

- Previous inspections
- OSHA 300 logs and accident reports
- Safety Committee minutes

Including employees and supervisors in the hazard assessment is essential. People who actually do the work have valuable input on where and when fall protection is necessary, and often have very good ideas about how to eliminate or better prevent fall hazards. Also, it is important to make sure that everyone doing the work is part of the safety process.

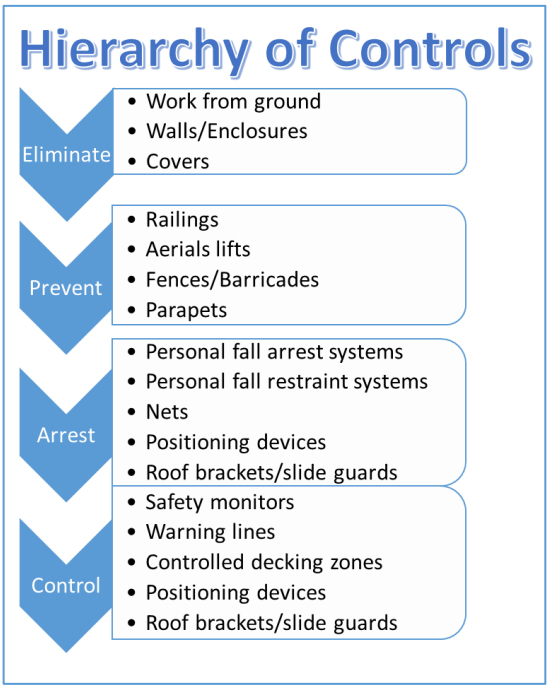
The steps for conducting the Fall Hazard Assessment should include:

1. Determine which specific jobs, activities, or areas expose employees to fall hazards.
2. Determine the type of work to be performed.
3. Determine if employees will be exposed to any of the following:
    - ☐ Unprotected sides and/or edges
    - ☐ Leading edges
    - ☐ Floor holes
    - ☐ Wall openings
    - ☐ Hoisting areas
    - ☐ Slippery surfaces
    - ☐ Formwork or reinforcing steel
    - ☐ Ramps, runways, and other walkways
    - ☐ Portable ladders
    - ☐ Stairways
    - ☐ Excavations
    - ☐ Working above dangerous equipment
    - ☐ Obstructions (materials)
    - ☐ Overhead bricklaying and related work
    - ☐ Roofing work-low pitch roof
    - ☐ Roofing work-steep pitch roof
    - ☐ Skylights
    - ☐ Precast concrete erection
    - ☐ Aerial lifts
    - ☐ Scaffolds
4. Determine how frequently the work will be performed.
5. Determine if workers require horizontal and/or vertical movement
6. Determine the number of workers from each trade that will be exposed to each fall hazard
7. Determine the type of walking/working surface
8. Determine the distance to lower levels
9. Determine if the edge of the building or the working surface is protected by a guardrail system or parapet wall. If yes, is it adequate?
10. Determine if employees could be exposed to other types of health and or safety hazards. Can it affect selection or use of fall protection systems?

Step 3: Eliminate the need for fall protection wherever possible

If the hazard assessment identifies fall hazards, the next step is to determine if the fall hazard(s) can be eliminated through engineering controls and/or alternative work methods. Options to consider include:

- Redesigning the process or job task
- Work at lower heights
- Use equipment that prevent falls
  - Platforms with fall protection
  - Guardrails
- Use tool extensions and work from ground level
- Lower equipment and tools to ground level
- Use appropriate aerial lifts
- Designing buildings and other walking/working surfaces to eliminate or reduce exposure.



Step 4: Select the Appropriate Type of Fall Protection System

If the need for fall protection cannot be eliminated, the next approach is to select the appropriate fall protection system.

There are three main types of fall protection used in construction. These types are called conventional fall protection because they are the most widely used. They are also the most reliable types of fall protection:

- Guardrails
- Personal fall arrest systems (PFAS) with harness and lifeline
- Safety Nets

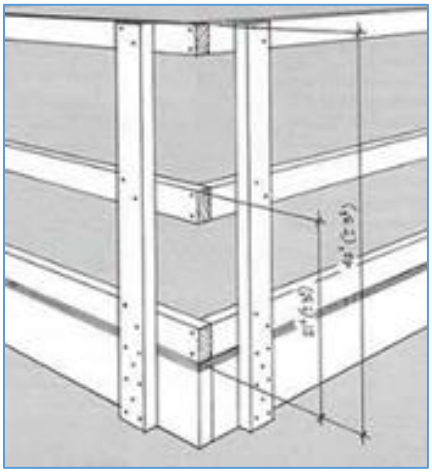
There are several other types of fall protection that can be used in specific situations:

- Positioning devices
- Fall restraint systems
- Safety monitoring systems
- Warning line systems (for flat roofs)
- Controlled access zones
- Covers for floor holes

When considering types of fall protection, consider the following:

- ☐ The distance to lower levels
- ☐ The types of activities requiring fall protection and the specific requirements of each activity
- ☐ The specific types of equipment and components needed with each fall protection system
- ☐ How much vertical and horizontal movement employees will need to perform each activity
- ☐ Environmental conditions (i.e. wind, rain, extreme heat/cold) in which fall protection equipment will be used
- ☐ The potential difficulty of using fall protection systems to perform normal and/or non-routine job activities
- ☐ The need for anchorage points of suitable design and strength
- ☐ The presence of chemical, electrical, and welding hazards
- ☐ How employees will access the system
- ☐ How employees will recover or be rescued from fallen positions
- ☐ The presence of sharp or rough surfaces and edges

Guardrails



A **Guardrail** is a barrier that prevents workers from falling to lower levels. There are specific OSHA requirements for the **height, strength,** and **design** of a guardrail. If a guardrail is not constructed to meet these requirements, then it is illegal. It is also unsafe and may not be able to protect a worker from falling and sustaining serious injury or death.

A guardrail consists of these parts:

- Top rail that is 42 inches (plus or minus three inches) above the base
- Mid rail (or a mesh, screen, or plywood panel, or vertical slats)
- Toe board
- Stanchions, or posts

A guardrail must be strong enough to **withstand a force up to 200 pounds** applied to the top rail in an outward or downward direction.

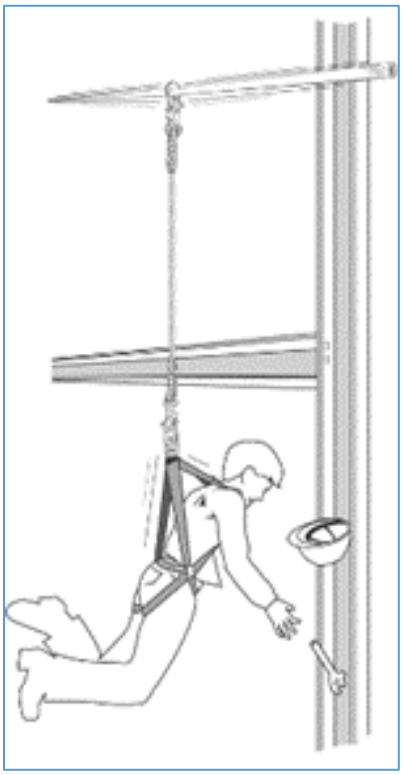
A guardrail can be made of **wood** (for example 2 X 4's), **steel pipe**, or **angle iron**. All parts of the guardrail must be free of splinters or nails that could cause lacerations or snag clothing.

The top rail and midrail may also be **tensioned wire rope at least ¼ inch in diameter**. The wire rope must have high visibility warning flags at least every 6 feet.

If a standard guardrail is used to protect a floor opening such as a **hoist way** or **ladder way**, there can be a removable top rail section (or chain) that must be put in place when the opening is not in use.

Personal Fall Arrest Systems (PFAS)

A **personal fall arrest system- PFAS** is designed to **protect you after you fall,** by **stopping you before you fall too far,** and **before you hit anything below.**

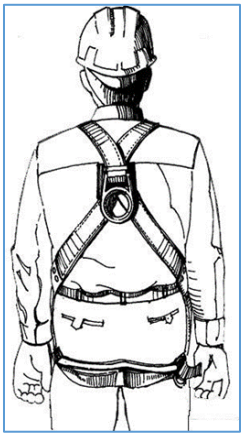


A personal fall arrest system consists of these components:

- Full body harness (Not just a safety belt!)
- Lanyard or lifeline
    - Snap hook and other connectors
    - Anchorage
    - Deceleration device

If a worker using a PFAS falls too far, or stops too quickly, the worker will be seriously injured even if the worker doesn't hit the ground or anything else. In order for a personal fall arrest system to protect the person using it, it must comply with these specifications:

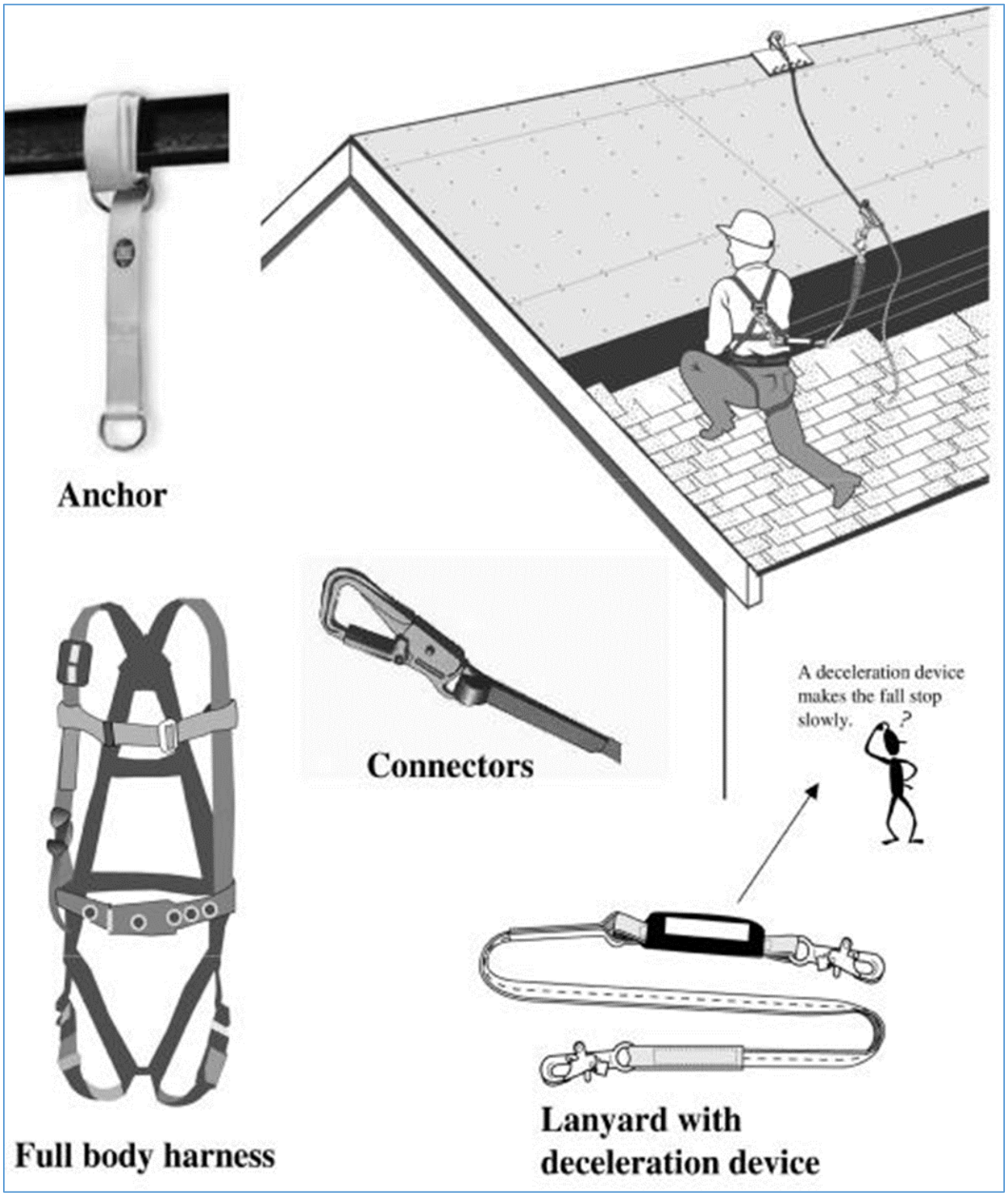
- Allow no more than 1,800 pounds of force on the worker when the fall stops
- Never allow the worker to "free fall" more than 6 feet
- Once deceleration begins (and free fall ends), stop the worker completely within 3 ½ feet
- Be strong enough to withstand twice the maximum energy created by the worker during free fall.



Safety belts may not be used in place of a harness in a personal fall arrest system. The belt does not distribute the force of a fall. All of the force would be exerted on the waist and stomach area. This could result in serious internal injuries, a broken back, or death.

Safety belts are allowed for fall restraint systems and positioning device systems, which are discussed later in this manual.

Personal Fall Arrest System Components



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Components of a Personal Fall Arrest System

Anchorage	An anchorage must be designed, installed, and used under the supervision of a qualified person. Workers have died because they attached their lifeline to a pipe, or "two by four" that was not strong enough to support the force of their fall. The anchorage must be (a) specifically designed for fall protection, or (b) a structural element that a qualified person has verified is strong enough. An anchorage must be strong enough to withstand the falling force of as many workers as are connected to it. This means that it must have a strength of 5,000 pounds for each worker.
Full body harness	A full body harness has straps that pass over the shoulders, cross the chest, and pass around the legs. These straps distribute the force of impact over a large part of the body, and for that reason the full body harness provides greater protection than a safety belt. This is why using safety belts with PFAs is prohibited.
Lanyard or Lifeline	Lanyards and lifelines must have a cable attached that certifies that they have a strength of 5000 pounds. Webbing, ropes and straps that are used in lanyards, lifelines and harnesses must be made of synthetic materials such as nylon, Kevlar or dacron. They cannot be made of natural fibers like manila, cotton or hemp.
Self retracting lanyards and lifelines	Self retracting lanyards and lilfelines have a locking device that works the same way as the locking device on automobile shoulder belts. When the lanyard or lifeline un-reels rapidly, the locking device stops it from going farther.
Snap hooks	Snap hooks must be designed so that they cannot un-hook if they are twisted. This means that they must be double-locking.
Inspection	Carefully inspect your harness and all other parts of your PFAS every time before you put it on. Look for cuts or burns to the harness webbing and the lanyard. Make sure the connectors work properly. Any damage might kill you.

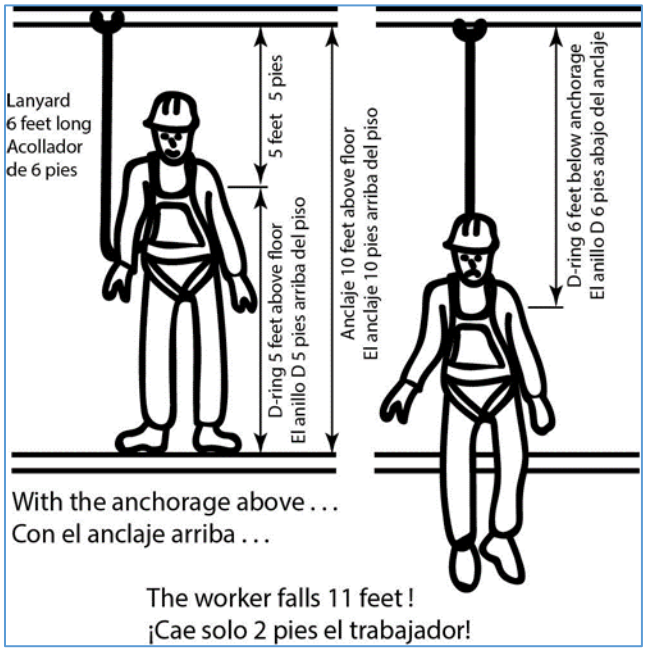
If your harness or other PFAS component is damaged, don't use it!

How far will you fall?

Remember that a personal fall arrest system (PFAS) **does not prevent you from falling. It's purpose is to stop you *after* you fall.** The further you fall, the greater the force on your body when the PFAS stops you. That is why the **PFAS must be rigged so that you can free fall no more than 6 feet.**

How far you fall depends on where your safety line or lanyard is anchored. **The best anchor point is one that is above your head.**

To understand fall distances, it is helpful to think in terms of how far the D ring on your harness drops between the beginning and the end of your fall.



Consider this:

In the second drawing, the worker fell 11 feet. What if the floor he was working on was only 9 feet above the floor below?

What if there was a machine or other object resting on the floor below?

What if, while falling, the worker swung sideways and struck a wall or other object?

Safety Net Systems

Safety nets are often used to protect workers beneath bridges or other high structures. They are sometimes also used around buildings with open sided floors.

Safety nets must be installed as close as practicable under the work surface, but **never more than 30 feet below.** There must be **sufficient clearance** below so that a falling worker does not hit anything below the net.

The net must **extend far enough away from the working surface** that a falling worker **will not fall beyond the edge of the net.**

Vertical distance from work surface to horizontal plane of net	Horizontal distance from edge of work surface to outer edge of net
Up to 5 feet	**8 feet**
More than 5 feet up to 10 feet	**10 feet**
More than 10 feet	**13 feet**

A safety net must have safe openings that cannot be larger than 36 square inches. The openings must not be longer than 6 inches on any side, and the center to center distance of the openings must not exceed 6 inches. Mesh crossing must be secured so that the openings do not enlarge.

The border rope of a net must have a breaking strength of 5,000 pounds. If a net is composed of more than one panel, use connections between that are as strong as the net, and spaced no more than 6 inches apart.

There are specific OSHA requirements for drop tests to make sure that the net is strong enough to catch a falling worker without the net breaking or tearing.

Inspect nets at least once a week for wear and damage, including damage to supporting lines and connection points. Do not use a defective net.

If tools or materials fall into the net, remove them immediately so that these items cannot injure a falling worker.

Positioning Device Systems

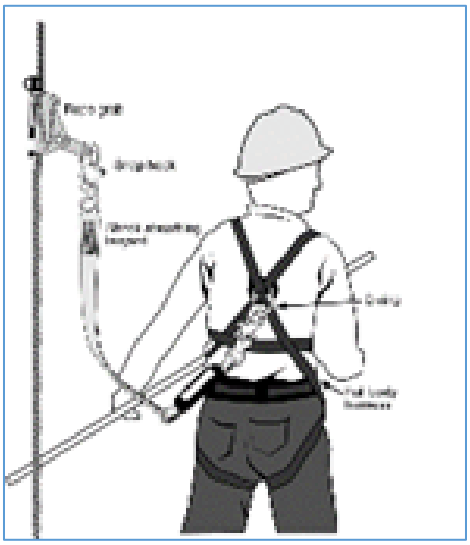
A **positioning device** is a **body belt** or **body harness** rigged to allow a worker to be supported on a **wall, concrete form** or **rebar structure,** and be able to **work with both hands free** while leaning away from the structure.

The body belt or body harness must be rigged so that if the worker's feet slip, the worker can free fall no more than 2 feet. If there is a possibility of free falling more than 2 feet, then the worker also needs to have a personal fall arrest system.

Full body harnesses are often designed with D-rings on each side of the waist belt so that the harness can be used both as a PFAS and as a positioning device.

The requirements for the strength of the components of a positioning device are similar or identical to provisions for PFAS components.

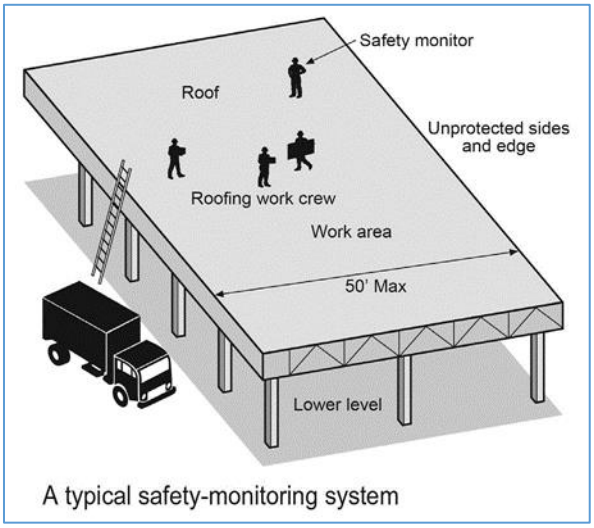
Fall Restraint System



A **fall restraint system** uses a body belt or body harness with a lanyard or lifeline, and anchorage. It may look like a PFAS, but it is not the same. A fall restraint system is rigged so that the worker cannot fall any distance at all. In other words, the fall restraint system is a tether that prevents the worker from going past the point at which the worker could fall.

Safety Monitoring System for Low Slope Roofs

A **safety monitoring system** is a fall protection option that **can only be used for flat or low slope roofing work.** A low-slope roof has a **pitch of 4 to 12 or less**.



A typical safety-monitoring system

The employer must designate a **competent person** to be a **safety monitor.** The **responsibility of the safety monitor** is to:

- Be competent to recognize fall hazards, and recognize when a worker is in danger of falling.
- Be on the same working surface as the workers and be able to see them.
- Be close enough to the workers to be able to speak with them.
- Pay close attention to the safety of the workers on the roof.
- Warn workers if they are close to the edge or other fall hazard.
- Not engage in any other activity while acting as the safety monitor.

The employer must make sure that:

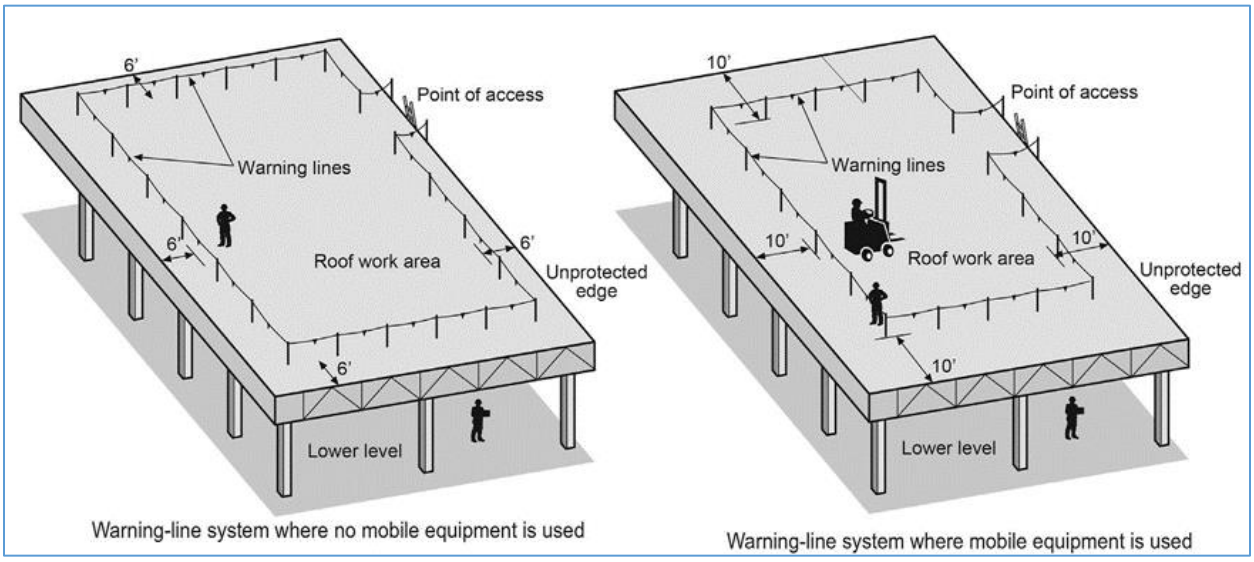
- No vehicles or mechanical equipment is used or stored in the safety monitoring area.
- No worker or other person enters the safety monitoring area unless they are engaged in the work being done.
- All workers in the safety monitoring area have been instructed to immediately comply with the fall hazard warnings given by the safety monitor.

Warning Line System for Flat Roofs

A **warning line system** uses a line of **rope, wire** or **chain**, supported by **stanchions**, placed around the work area on a **flat roof.** The warning line must be erected **around all sides of the work area,** and must be **at least 6 feet from any roof edge.** If mechanical equipment operates in a direction perpendicular to a roof edge, then the warning line on that side must be **at least 10 feet from the edge.**

Only workers engaged in the work are allowed inside the area marked by the warning line. These workers are **allowed to work without conventional fall protection.**

The warning line must have a **strength of 500 lbs.** It must have **high visibility flags every 6 feet.** The lowest point of the line must be between 34 and 39 inches above the roof surface.



Controlled Access Zone

A **controlled access zone** can be used for overhand brick laying, leading edge work, and the erection of precast concrete.

The controlled access zone **must be defined by a control line** or barrier that restricts access. **Only workers engaged in the work** are allowed in the controlled access zone. They are permitted to work **without conventional fall protection.**

The control line must be parallel to the unprotected side or leading edge, extend along the entire length of the side or edge, and be connected on each end to a guardrail system or wall.

Control lines can be **rope, wire,** or **tape,** with a **strength of at least 200 lbs.** They must be supported with **stanchions,** and have **high visibility flags every six feet.** Lines must hang **between 39 and 45 inches above the working surface.**

For **leading edge work,** the control line must be set up **at least 6 feet and no more than 25 feet** from the unprotected leading edge.

During **precast concrete erection** the control line must be **at least 6 feet and no more than 60 feet or half the length of the member being erected, whichever is less,** from the leading edge.

For **overhand bricklaying** the control line must be erected **at least 10 feet and no more than 15 feet** from the working edge.

Step 5: Developing Rescue/Retrieval Procedures

Whenever workers are exposed to fall hazards, the employer must have an emergency plan for what to do if a worker does fall. This means thinking in advance about what might happen, deciding in advance what to do, and having all necessary rescue equipment available.

When employees use a personal fall arrest system, employers must provide for prompt rescue in case of a fall or make sure that employees can rescue themselves. Some important points to consider:

- Know who you will call if you need to rescue a worker who fell. Some fire departments are trained in "technical rescue". Other fire departments don't have this training. Before work begins, the employer should check with the fire department to make sure they can perform this type of rescue. If they can't, the employer needs to come up with another rescue plan.
- Train rescuers in rescue techniques and practice rescue attempts.
- Ensure available equipment is readily available, such as retrieval winches. This should be specific for the job being performed.
- Have a plan to communicate with coworkers, other contractors onsite, and outside services.
- Have a cell phone to call 911. Even if the local fire department is not going to perform rescue, the person who fell will need to be checked on by emergency medical responders. Also, at least one person onsite should be certified in first aid and CPR.
- Make sure all workers know the address of the worksite so that the person making the call can provide correct information to the 911 operator.
- Understand the danger of suspension trauma.

Suspension Trauma

All the cells in the human body produce small amounts of toxic and acidic materials, which are picked up by the blood stream, carried to the kidney, filtered into the urine, and excreted by the bladder. This is a normal process, and it works because blood is constantly flowing.

When a worker falls and is suspended by the harness, the leg straps limit or completely stop the circulation of blood to the legs. While the worker remains suspended, toxic and acidic substances build up in the blood that is trapped in the legs. These substances can reach a dangerous level in just a few minutes. Then, when the worker is freed from the harness, the charge of contaminants in the blood from the legs is also liberated, and may be sufficient to cause cardiac arrest when it reaches the heart.

It is critically important to rescue a suspended worker immediately.

Sometimes, it is possible to purchase a harness that has stirrups attached. If the worker is able to remove the stirrups after they fall, and place their feet in the stirrups, it may be possible to reduce the risk of suspension trauma.

Step 6: Develop an equipment inspection, maintenance, and storage program.

All fall protection equipment comes with written instructions from the manufacturer. Make sure you read the instructions, and save them. These instructions describe how to inspect, use, maintain, and store the equipment.

Visually inspect ALL equipment, including harnesses, lanyards, and other connectors, before each use. Look for:

- Cuts, tears, rips, snags, punctures, abrasions, mold, or stretching
- Alterations or additions that might effect the system's efficiency. (Alterations and additions are not allowed unless the manufacturer has approved it).
- Damage caused by acids, corrosives, or other chemicals.
- Distorted hooks or faulty hook springs.
- Cracked, broken, or deformed D-ring, carabiners, grommets, or snaphooks.
- Loose, damaged or non-functioning mountings and parts.
- Wearing or any internal deterioration in the ropes.
- Appearance of colored indicator threads as described by the manufacturer.
- Indication that the equipment has been involved in a fall. If so, have it checked by a Competent Person.
- Color fading possibly indicating UV exposure.

In addition, periodic inspections by a Competent Person must be performed to look for wear, damage or corrosion as part of the safety inspection program.

Defective equipment must be immediately taken out of service and tagged or marked as unusable. Even better, destroy it.

Basic care of the equipment will prolong the durable life and will contribute toward the performance of its vital safety function. Proper storage and maintenance after use are as important as the pre-use inspections.

Clean off dirt, corrosives, or other contaminants.

Storage areas should be clean, dry, and free from fumes or corrosive substances. Store synthetic materials away from sunlight and extreme temperatures which could degrade the materials. Color fading may indicate UV damaging exposure.

Step 7: Provide Fall Protection Training

Employers are required to provide fall protection training to workers who might be exposed to fall hazards. Training must include how to recognize fall hazards, how to minimize these hazards, and how to prevent falls.

The training must be provided by a Competent Person who is qualified in the following areas:

- The nature of fall hazards in the work area
- The correct procedures for erecting, maintaining, disassembling, and inspecting the fall protection systems to be used
- The use and operation of controlled access zones, guardrails, personal fall arrest, safety net, warning line and safety monitoring systems, and other protection to be used.
- The role of each worker in the safety monitoring system when the system is used.
- 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.
- The role of all employees in fall protection plans
- OSHA's fall protection requirements.

Employers are responsible for documenting in writing that all employees exposed to fall hazards have been trained. The written certification must include:

- The name of the employee(s)
- Date(s) of training
- Signature of the trainer or the employer

Training must be provided whenever:

- Employees are assigned to work where fall hazards exist
- Responsibilities change or new methods are used
- There is a new fall hazard
- The fall protection program is inadequate
- Additional training is necessary (for example, if procedures aren't being followed)
- Employees have not acquired or retained adequate understanding.

The OSHA standard does not specify the required length or format of the training program. Both classroom instruction and hands-on training on the use of the equipment should be included.

Step 8: Monitor the Fall Protection Program

Continuously monitor the effectiveness of the program to ensure that the required elements are being followed by supervisors and employees at the jobsite.

The following are suggested ways to monitor a fall protection program:

- Conduct periodic inspections to ensure that employees are properly using fall protection
- Take immediate corrective action including the use of disciplinary action when deficiencies are observed
- Conduct a formal audit of the entire fall protection program at least once a year
    - Document and communicate the results of the audit to everyone
    - Compare the results with previous audits
- Conduct periodic inspections of equipment storage areas
- Require employees to notify their supervisor if they have any problems with the use and/or maintenance of their equipment
- Require employees to notify their supervisor if they are involved in any fall incident/accident
    - Promptly and thoroughly investigate the incident
    - Document the incident
    - Determine why the incident happened
    - Identify and implement a corrective action to prevent the incident from happening again.
- Hold managers and supervisors accountable for their crew.

<u>Reward your efforts-promote your fall protection plan!</u>

Managers, supervisors, and other staff personnel need to actively promote the proper use of fall protection equipment and encourage employee involvement and support of the program.

Some suggestions for promoting a fall protection program are:

- Provide positive feedback to employees who use fall protection correctly
- Display posters and distribute information sheets to reinforce the importance of fall protection
- Conduct safety meetings and tailgate meetings, and talk about fall protection
- Respond in a timely manner to suggestions for improving the program or selection of equipment
- Encourage union representatives and safety committee members to actively support the program
- Collect and distribute “success stories” about injuries prevented by the use of fall protection
- Formally recognize employees, supervisors, and all involved!