Working at Heights: Fall Protection Series

HIGHLIGHTS:

- No industry is free from fall hazards
- Maintaining balance is essential to task performance
- Establishing safe work procedures
- Personal fall arrest equipment
- Controled access zones
- Harness suspension trauma

No matter the industry, business or location, it's hard to imagine a workplace that does not have the need for people to work at heights from time to time. For some, the activity may be a rare or incidental part of normal procedures; for others, working off the ground is how their normal operations are carried out.

Nonetheless, all face the challenge of assuring that workers who leave the ground to do their jobs can complete it efficiently and come back down without harm.

This seven-part series is assembled to support risk reduction from falling associated with working at heights. Click on any of the topics listed in the contents table to reach that topic, or scroll down to read the content in sequence.

Spotlight on Research

If people had perfect balance in every body position and on any walking/working surface, there would be little need for fall protection. Since that is not the case, the value of considering human capability in how working at heights is designed, planned and managed cannot be overstated.

In a recent research project at the Liberty Mutual Research Institute for Safety[1], perceived effects of changes in body posture on balance were investigated. Responses from the group of workers surveyed revealed that Ratings of Perceived Balance (RPB) were significantly affected by posture changes. These responses suggest that the effects are compounded by being tired or when change in the position of the head happens quickly.

Maintaining balance is essential to task performance. It relies on processing sensory information from what we see, the motion of our head in space, and where our body parts are relative to each other. The input is integrated to make possible the very complex muscle interactions that allow us to stand, walk and climb without falling. In most healthy individuals, this all happens automatically without conscious thought, but postural changes can affect all three sensory inputs and may make maintaining balance more challenging.

Many tasks conducted at elevations involve overhead work, requiring significant change in the position of the head before moving on to the next task location. Slips and missteps when descending ladders are a common and frequent cause of worker falls.

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Some simple practices were revealed in the survey responses that may help workers maintain balance at crucial points in their work.

Maintaining Balance

- When working off the ground, design activities so that significant posture changes are minimized. For example, select tools and preassemble installations as much as possible at floor level workstations.
- Plan frequent rest breaks to minimize the effects of fatigue.
- Instruct workers to pause for about five seconds with their head in a neutral position, particularly after working overhead. This will help regain equilibrium and balance before starting to climb down from an elevated work area.
- Instruct workers to keep their eyes on the path as they descend ladders, watching where their feet are placed, not looking at the location of the next task they will do.

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Part I: Preventing the Fall

The Liberty Mutual Research Institute for Safety has produced the Workplace Safety Index annually since 2000. It ranks the leading event types that result in serious disabling injury claims by people at work. *Falls to a Lower Level* has been in the top five most costly—around 10% of the injuries and over $5 Billion—each year since the study began.

No industry segment is free from fall hazards and falls from elevations are among the most costly construction accidents. Most falls from heights occur when an employee loses their balance while performing a common task at the perimeter of an open deck or floor opening. These falls occur not because the hazard wasn't recognized, but because adequate protective measures were not taken to prevent the fall.

Controlling falls requires addressing site, human and equipment-related issues.

Providing effective fall protection for construction workers includes the following:

1. Identifying and assessing the fall hazard.
2. Selecting appropriate fall protection controls.
3. Properly constructing, installing and implementing controls.
4. Establishing and enforcing safe work procedures.
5. Training workers in the use and maintenance of the fall protection system.

1. Identifying the Hazard

Every walking and working surface should be free of slip and trip hazards. Federal safety regulations include a broad requirement for keeping working areas, passages and stairs free from the accumulation of materials that constitute tripping hazards. In addition, regulations require fall protection on walking and working surfaces with an unprotected side or edge of 4 ft (6 ft for construction) or more above a lower level. Protection may also be needed for hazards below elevated surfaces, such as uneven ground, rebar or conduit, and energized conductors or machinery, as they represent hazards to someone working above who may fall onto them.

2. Selecting Appropriate Controls

The nature of the work generally dictates which type of fall protection system is best. Employers should select the most effective and efficient measures based on the hazards, site conditions and work methods.

When physical conditions or construction methods make prevention impractical, other forms of protection must be used. Various systems are discussed in this fall protection series.

3. Properly Constructing, Installing and Implementing Controls

Guardrails

Physical barriers can be used to prevent a fall. Guardrail systems may be constructed of any material that meets ANSI[1] strength requirements. Most commonly used are dimension lumber, pipe or wire rope. **Table 1.** lists key specifications.

Top Rail	Mid Rail	Toeboard
42±3 in. from walking/working surface. The rail cannot sag below 39 in. when a 200 lb force is applied.	Horizontal member half way between walking/working surface and the top rail, or	1x4 lumber installed with a gap of not more than ¼ in. from walking/working surface.
Withstand without failure a 200 lb force applied outward or downward on the rail.	Screen or panel fitted between top rail and walking surface, or	Withstand a 50 lb force.
	Vertical members not more than 19 in. apart.	
	Withstand a 150 lb force.	

Table 1.

Hoisting and material-landing areas should be carefully planned to minimize the need for railing removal. Alternate protection is needed for employees who handle loads at the edge where the railing is sagged or removed.

Floor Openings

Openings in a floor, deck or platform greater than 1 in. (2 in. for construction), at its smallest dimension, must be protected. While guardrails and other barricades may be used, a hole cover is the most common protection. A cover must withstand twice the maximum anticipated load and be secured against accidental displacement. The contractor must highlight the fact that this is a cover by attaching a sign, painting it with a specific color paint or painting the word *Cover or Hole* on the cover.

4. Establishing Safe Work Procedures

Housekeeping

Sweeping work areas, passageways and stairs is a simple, yet effective way to eliminate fall hazards. Slips and trips can result in a little embarrassment or a serious injury. The body's reaction while attempting to regain balance at the onset of a slip or trip can result in an awkward body posture that exacerbates the injury.

Foreign substances on the floor, such as oil and water, will reduce the coefficient of friction, causing the surface to be more slippery than expected.

Establish a policy for regular cleaning of work areas, passageways and stairs. "Broom clean" is an appropriate standard for most conditions. In addition, develop a method to identify and promptly clean up liquid spills.

5. Training Workers

Employers must train their employees to recognize fall hazards and the procedures needed to control them. A competent person should train all employees, including supervisors, when fall hazards exist.

The systems discussed in this reference note are passive, meaning that once installed, they do not require an employee to wear, fit or connect anything. Every employee needs to know that they cannot remove guard rails or covers without providing alternate protection. Fall protection that has been altered or removed must be reported to the supervisor so it can be replaced or repaired.

Employers must maintain a current, written certification record to document each worker's fall protection training. The record should include the worker's name, training date and the trainer's signature. Retraining is necessary when there are changes in the system or workplace, when a worker fails to recognize or avoid fall hazards, or when workers do not demonstrate the proper skills for using fall protection equipment effectively.

Additional Fall Protection Resources

OSHA 29 CFR 1910.23, Guarding Floor and Wall Openings and Holes.

OSHA 29 CFR 1926.501, Duty to Have Fall Protection.

OSHA 29 CFR 1926.502, Fall Protection Systems Criteria and Practices.

Part II: Fall Arrest Systems

Guard rails, barricades and covers that prevent falls are not always practical. In some cases a fall arrest system is needed to protect the worker. The equipment discussed in this reference note does not prevent the fall but is used to arrest a falling employee before they strike a lower level.

The key to using this equipment properly is to keep the free fall as short as possible so that arresting forces will not result in injury.

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Personal Fall Arrest Equipment

A personal fall arrest system consists of a body harness, lanyard, connecting hardware and an anchor. Safety belts have been prohibited for fall arrest since January 1, 1998.

The personal fall arrest system must:

1. Limit the maximum arresting force on a worker to 1,800 pounds;
2. Be rigged so a worker cannot free fall more than 6 feet, nor contact any lower level;
3. Decelerate a worker to a complete stop in a maximum of 3.5 feet; and
4. Have sufficient strength to withstand twice the potential impact energy of a worker free falling six feet or the free fall distance permitted by the system, whichever is less.

The harness attachment point (rear dee-ring) should be located between the user's shoulder blades, per the manufacturer's instructions. The anchor should be above the harness' rear dee-ring with the connection point as nearly overhead as possible to reduce swing. Never connect a personal fall arrest system to a guardrail!

Lanyards are available in a variety of lengths. They should be selected and rigged to achieve the shortest free fall. In no case should they be rigged to allow a free fall of more than six feet. Follow the fall arrest equipment manufacturer's instructions. Snaphooks must be of the locking type. Do not engage snaphooks directly to webbing, rope, wire rope, each other, a dee-ring to which another snaphook or connector is attached, a horizontal lifeline or any incompatibly shaped object. All system hardware should be capable of withstanding a tensile loading of 5,000 pounds.

Horizontal lifelines give workers horizontal mobility while connected. The lifeline and anchor points should be designed by and used under the direction of a qualified person. They must be able to support 5,000 pounds per person attached.

A vertical lifeline allows mobility in the vertical direction, such as on a roof or scaffold, and is designed to support only one person. The employee must exercise care if they move horizontally, such as on a sloped roof, because in a fall they will swing back to a point under the anchor with enough force to cause a serious injury if an obstruction is encountered. Also, the vertical drop may be excessive depending on how far away from the vertical plane of the anchor they have moved, which may cause them to hit the lower level.

Self-retracting lifelines allow mobility while limiting free fall to 2 feet or less. The snaphook is connected directly to the harness' rear dee-ring. A lanyard is not needed when using a self-retracting lifeline. Swing fall is also a concern with these devices as is the rubbing of the rope/web over a sharp edge during a fall arrest. Pre-planning following the manufacturer's instructions can limit these exposures.

Prior to each use, inspect the system and its components for wear, damage and deterioration. Remove any component that is found damaged or has been subjected to impact loading.

Total Fall Distance (TDF)

TFD can be calculated as follows: **FFD + DD + HEFF + VEL + SF**

FFD = Free Fall Distance. This is determined by the length of the lanyard and location of anchor selected by the user.

DD = Deceleration Distance. The lanyard's manufacturer will provide this information on the label. It cannot exceed 3.5 feet.

HEFF = Harness Effects. The stretch of the harness and rear dee-ring above the employee's feet after the fall. From a practical standpoint, use the height of the employee.

VEL = Vertical Elongation. This additional length is the result of the elastic properties of the lifeline, cross arm strap or other connectors in the system.

SF = Safety Factor. A safety factor to handle unknowns, typically one to three feet.

Example

A 5 foot 9 inch employee is using a harness with 6 foot lanyard.

The anchor is directly above the employee, 7 feet above the deck.

Measuring the rear dee-ring, we find it is 5 feet above the walking surface. We will use this dee-ring as our reference point.

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FFD	Lanyard length minus difference between anchor height and rear dee-ring height or 6 ft – (7 ft – 5 ft).	4.00 ft.
DD	Assume DD for a shock absorbing lanyard is 3.5 ft.	3.50 ft.
HEFF	Use employee's height.	5.75 ft.
VEL	Zero, since they are connected directly to an anchor.	0.00 ft.
SF	Assigned by the competent person as 2 ft.	2.00 ft.
	Calculated Total Fall Distance	15.25 ft.

Does the total fall distance meet regulations?

Is the free fall is less than 6 feet? Yes.

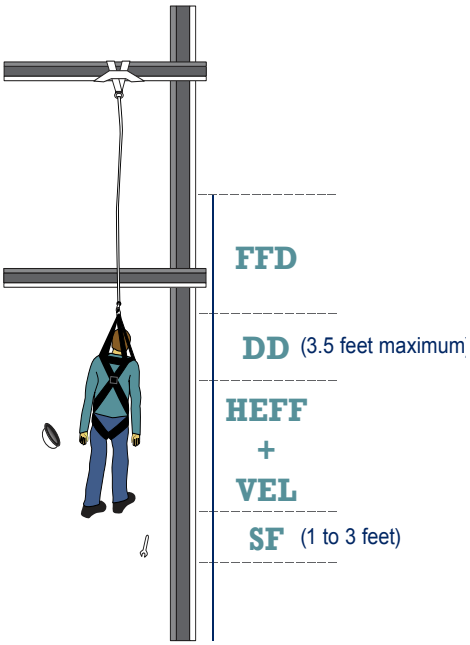
Is the deceleration distance 3.5 feet or less? Yes.

Is there an obstruction or lower level within 15.25 feet of the work area? Measure up 15.25 feet from the closest obstruction. If that point is at or below the anchor point, this is okay. If the point is above the anchor point, the lanyard length or anchor location has to be changed.

If the anchor selected was at the worker's feet, FFD would then be 6 feet – (0 – 4.5) or 6 + 4.5 which equals 10.5 feet. This would yield a total distance of 21.75 feet, which is not acceptable.

As a rule of thumb, the anchor should be as high or higher than the employee's rear dee-ring. This is the only way to keep the free fall distance equal to or less than the length of the lanyard when using a fixed length or shock-absorbing lanyard.

Every employee exposed to a fall should be trained in calculating total fall distance.



Rescue

Establish a rescue protocol prior to using any fall arrest system. Obtain and have available an aerial lift, crane suspended personnel platform or similar device to rescue an employee hanging from their personal fall arrest equipment. If you anticipate using municipal services, contact the agency to determine their willingness, capabilities and training. The rescue plan is discussed in more detail in Part VII: Rescuing Suspended Employees.

Safety Nets

Structures with atriums and high bays, bridges and large vessels/boilers are examples of locations that are not easily safeguarded by railings. Safety nets do provide an alternative to guardrail systems, but place the erection crew in danger of falling during their installation.

Safety nets should be installed as close as practical to the walking/working surface, but in no case more than 30 feet below the working surface. The net will stretch when arresting a fall so it is necessary to verify there is sufficient clearance from any obstruction or surface below the net.

The table below shows the minimum distance that a safety net should extend outward from the edge of the work surface for various installation heights.

Minimum Net Extension from Work Surface Edge

Potential Fall Distance:	Safety Net Should Extend:
Less than 5 ft	8 ft beyond edge
5 to 10 ft	10 ft beyond edge
More than 10 ft	13 ft beyond edge

Perform a drop test after initial installation, whenever the net is moved, following any major repair and at least every 6 months. Clear nets of debris at least once per shift. An engineer may certify the net's strength in lieu of the drop test. Inspect safety nets weekly for wear, damage and deterioration.

Training

Employers must provide a training program that teaches workers to recognize fall hazards and the procedures needed to control them. All employees, including supervisors, need to be trained by a competent person.

Workers who will be using personal fall arrest systems should know how to don the equipment, identify an appropriate anchor, connect to an anchor, estimate free fall distance and inspect their equipment. They should know self-rescue procedures and techniques and be aware of the rescue plan.

Employers must maintain a current, written certification record to document each worker's fall protection training. The record should include the worker's name, date trained and the trainer's signature. Retraining is necessary when there are changes in the system or workplace, when a worker fails to recognize or avoid fall hazards or when the worker does not demonstrate the proper skills for using fall protection equipment.

Supervision

Supervision of employees exposed to fall hazards cannot be overstressed. Unsafe acts must be corrected immediately upon observation or discovery. Nothing undermines safety policies and training quicker than a supervisor who observes an unsafe act and says nothing. Because nothing was said, the supervisor has non-verbally told the employee and others that it is alright to ignore or bypass safety. Supervisors must speak up immediately to correct any unsafe act.

Federal Regulation

29 CFR 1910.66 App C.

29 CFR 1926, Subpart M, Fall Protection.

Part III: Specialty Operations

The fall prevention and fall arrest systems discussed in this series should be the primary methods used to protect employees from falling.

The methods described in this section provide options when other methods are impractical due to job conditions, environment or work methods. The term impractical is used here to mean technically infeasible rather than concerning cost considerations. These methods may be considered for specific work reasons such as leading edge work, precast erection, overhand brick laying or roof work.

Controlled Access Zones

A controlled access zone is a work area designated and clearly marked where leading edge work, precast erection or overhand brick laying may take place without the use of a conventional fall protection system. Controlled access zones are intended to restrict access to workers other than those authorized and trained to perform the work.

The zone should be delineated with control lines (chain, rope or wire rope) that have a breaking strength of at least 200 pounds. Rig and support the control lines so that they are no lower than 39 inches and no higher than 45 inches. Mark lines at least every 6 feet with high-visibility material.

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Erect control lines no closer than 6 feet and no farther than 25 feet from the unprotected edge. The control line should run parallel to and extend the entire length of the exposed edge, and should be connected on each side to a guardrail system or wall.

Exception: when erecting precast concrete members, place control lines no closer than 6 feet and no farther than 60 feet, or half the length of the panel being erected, whichever is less.

A controlled access zone is less reliable than guardrails or fall arrest equipment, and should be used when these methods are infeasible. Alternate methods such as scaffolding or aerial lifts should be investigated. Pre-planning this work may allow an anchorage to be added to the panels so that self-retracting lifelines can be used.

Training and supervision should be increased when a controlled access zone is employed.

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Roof Work: Warning Line Systems

Warning line systems mark off an area on a flat or low-sloped roof (a pitch of 4:12 of less) where roofers may work without guardrails, safety nets or personal fall-arrest equipment. A warning line system consists of rope, wire rope or chain, with supporting stanchions that form a perimeter system to warn workers when they approach the unprotected roof edge.

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

> **Note:** As indicated in the titles of both the warning lines and safety monitoring paragraphs, these options are only available for contractors performing roofing work. These options can not be used by mechanical or other trades working on a roof who must use fall protection or personal fall arrest equipment.

The stanchions supporting the warning line should be capable of resisting a force of 16 pounds applied horizontally against the stanchion without tipping. Rig and support the warning line so that it is neither lower than 34 inches nor higher than 39 inches. The warning line should have a minimum tensile strength of 500 pounds. Mark the line at least every 6 feet with high-visibility material.

Make sure the warning line forms a complete enclosure. The lines must extend to the access point and material landing area if they are closer than 6 feet to the roof edge. Supervision is critical to be sure the system is complete (sections not removed), not sagging, and to ensure that no work is done outside the warning line without a safety monitor.

Roof Work: Safety Monitoring

A safety monitor is a competent person who monitors the activities and safety of employees on the roof and is responsible for warning them if they appear to be unaware of a fall hazard or are acting in an unsafe manner. A safety monitor may be used in conjunction with warning line systems for low-sloped roof work or alone on roofs 50 feet or less in width. The safety monitor must have no other duties and must be situated on the same level, in visual sight of employees and close enough to communicate verbally. There should be no mechanical equipment used or stored in areas where a safety monitor is employed.

When work is conducted in two or more widely separated areas, multiple safety monitors are needed. Safety monitoring is the least reliable of all methods of fall prevention. In order to be effective, all employees must be well trained and the safety monitor must be conscientious in the application of his or her duties. More reliable methods such as guardrails, catch platforms, aerial lifts and fall arrest systems should be used in lieu of a safety monitor wherever practical.

Training

Employers must provide training that teaches employees to recognize fall hazards and the procedures used to protect themselves. All employees, including supervisors, need to be trained by a competent person.

Employers must maintain a current, written certification record to document each employee's fall protection training. The record should include the employee's name, date trained and the trainer's signature. Retraining is necessary when there are changes in methods or work site, when an employee fails to recognize or avoid fall hazards or when an employee does not demonstrate the proper skills for using fall protection equipment effectively.

Supervision

Supervision of employees exposed to fall hazards cannot be overstressed. Unsafe acts must be corrected immediately upon observation or discovery. Nothing undermines safety policies and training quicker than a supervisor who observes an unsafe act and says nothing. Because nothing was said, the supervisor has non-verbally told the employee that it is alright to ignore or bypass safety. Supervisors must speak up immediately to correct the unsafe act.

Part IV: Equipment for Elevating Personnel

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This section discusses tools we can use to get employees closer to their work by using ladders, scaffolding or suspended devices.

In most cases, using fall protection equipment on portable ladders is impractical because of the lack of anchorage points. The accepted fall protection method involves proper ladder setup and use.

Common accidents involving ladders include:

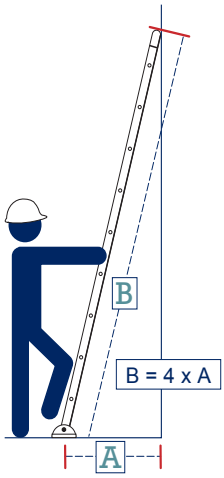
- Using a ladder too short for the job.
- A user slipping or missing a step/rung when descending.
- A ladder being knocked over when struck by equipment or people.
- A stepladder falling when the user sits on or straddles the top step.

Working on step, straight or extension ladders involves a few simple principles.

Stepladders

- Set ladder on a solid level surface, never on a scaffold.
- Fully open ladder and lock the spreader bars.
- Face the ladder while climbing using the three-point technique. Both hands must be free of tools and materials.
- Keep your belt buckle within the ladder's side rails, do not overreach.
- Do not climb or stand on the top or second step from the top.
- Do not climb the back side of the ladder.
- Be sure that only one person at a time is on the ladder.
- Keep steps dry and free of slippery substances.
- Never use the ladder when it is folded.

Straight and Extension Ladders



- Set the ladder at the proper angle, 4:1 (75.5º).
- Set ladder on a level surface. Ladder levelers are available to attain equal side rail support on uneven ground.
- Erect ladder so that the top rails sit equally against the surface. Do not rest a rung against a corner or rounded surface.
- Secure the ladder from movement.
- Face the ladder while climbing using the three-point technique. Both hands must be free of tools and materials.
- Keep your belt buckle within the ladder's side rails, do not overreach.
- Consider using a ladder stabilizer to increase the ladder's resistance of slipping sideways at the top.
- When resting against a vertical surface, climb no higher than the third rung from the top.

- Keep rungs dry and free of slippery substances.
- Have another employee hold the ladder when climbing to the top for the first time, in order to secure it.
- Extend the ladder at least three feet over a higher level when using the ladder to access that level.

To prevent falls from a ladder make sure it is in good repair and use it according to the manufacturer's instructions. Remember to practice the three-point technique when climbing and descending.

Scaffolds

Federal safety regulations require fall protection when over 4 ft general industry or 10 ft construction. Given the surfaces a scaffold can be set on and the debris that can accumulate under a scaffold, erecting guardrails at 4 ft makes good sense. Typically, a top rail, mid rail and toeboard can be used to prevent most falls from scaffolds.

Some of the most common ways to prevent falls from scaffolds are:

- Fully deck the working platform.
- Install guardrails on back side and both ends.
- Install guardrails on the ends of any bracket-supported planks.
- Provide an opening in guardrail to access platform from ladder.
- Erect scaffold so it is 14 in. or closer to the work face.
- Never use a single plank set between two support elements in lieu of a properly erected and guarded scaffold.

Extreme care must be used when employing fall arrest equipment on a scaffold. The scaffold frames are typically not designed to function as an anchor point. When fall arrest equipment is used, a qualified person must ensure that adequate anchor points are available and marked. Consult the scaffold manufacturer for erection and dismantling procedures in order to minimize fall exposures.

Aerial Lifts

Aerial lifts can be divided into two groups for the purpose of fall protection. The first group consists of equipment with a platform that moves vertically only, such as a scissors lift. These are designed to resist tipping when used on a level surface and come equipped with a guardrail system. So long as the guardrails are installed and the entry gate is closed, no additional fall protection is needed as long as a few procedures are followed:

- Work only from the platform. Do not stand on the guardrails, materials or ladders setup on the platform.
- Use the lift on a surface level to within the manufacturer's recommendations.
- Do not travel with the lift elevated, especially if the floor has holes or is debris covered.
- Stay within the manufacturer's capacity rating.

The second group consists of equipment that has an extensible or telescoping boom that allows the platform to reach out horizontally from the base.

In addition to the items discussed above for scissor lifts:

- Wear a safety harness attached to anchor points designated by the manufacturer. The connecting lanyard should be as short as practical and still allow movement within the platform.
- Never tie-off outside the platform.

Powered Industrial Trucks

Fork trucks are intended to move materials but can also be used to raise employees, as long as the working platform mounted on the forks is designed for that purpose.

The platform must be:

- Equipped with standard guardrails
- Secured to the forks
- Used only on a level surface
- Stationary – the fork truck cannot travel with employees elevated

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Part V: Suspended Devices for Elevating Personnel

When people work on platforms that are suspended from above, selection and preparation of equipment and the people that use it are critical. This section discusses considerations for suspended devices.

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Suspended Scaffolds

Suspended scaffolds are defined in 29 CFR 1926.452. Scaffolds that are suspended from a structure should be equipped with guardrails and require that workers use a full body harness and lanyard tied to an independent lifeline. Guardrails provide protection during normal use of the equipment and the independent system provides protection should the scaffold suspension fail. While there are a few exceptions to the double protection requirement (multi-tiered suspended scaffolds), the redundancy of an independent lifeline system has proven its worth countless times.

Crane Suspended Work Platforms

Suspended platforms can hang from an overhead structure or be suspended from a crane. Gone are the days when employees could be hoisted on a crane's headache ball. Federal regulations call for all lifting methods to be evaluated and rejected before use of a crane is considered. There are many elements to consider when performing a lift. ANSI standard B30.23, Personnel Lifting Systems, was developed to provide guidance.

There are three elements to consider when lifting workers by crane: the crane, platform and operating procedures.

Crane

The following are important points to consider when lifting workers:

- Functioning boom angle indicator.
- Device on telescoping boom to clearly indicate the boom's extended length.
- Accurate determination of load radius made before lift.
- Positive acting anti two-block device.
- Live boom capabilities removed.
- Power lowering engaged.
- Hook that can be positively closed.
- All inspections are current.
- Capacity of at least twice the maximum intended load. (The load being the weight of the platform, employees, tools and materials.)

Platform

When workers are performing tasks on a suspended platform, consider these points.

- Platform designed by qualified engineer or qualified person.
- Welded by qualified welder.
- Suspension designed to minimize tipping.
- Strong enough to handle its own weight plus five times maximum intended load.
- Standard guardrail system.
- Mesh or panel from floor to mid rail.
- Interior grab rail around the entire perimeter.
- Inward swinging access gate (if installed) with positive latching device.
- No sharp objects on interior.
- Manufacturer's plate conspicuously posted indicating weight of platform and rated load or maximum intended load.
- Overhead protection, if needed, due to any overhead exposures.
- Wire rope bridle connected so load is evenly distributed to each leg.

- Rigging not used for any other purpose.
- Wire rope eyes fabricated with thimbles.
- Sling legs connected to master link.
- Master link connects to crane, via hook or shackle.

Operating Procedures

- Crane set up to within one percent of level
- Set up on firm footing.
- Outriggers deployed, if equipped.
- Perform a trial lift without personnel aboard, but loaded to anticipated weight:
  - Immediately prior to actual work
  - A single trial lift may be performed at one time to all locations that will be reached from a single setup position
  - Repeated whenever crane is moved
- After trial lift and prior to hoisting personnel:
  - Hoist platform a few inches high and hold, then inspect platform for the following:
    - properly balanced
    - hoist ropes free of kinks
    - multiple part lines not twisted
    - primary attachment centered over platform
    - no rope slack on drums or sheaves
  - Inspect hoisting system to ensure trial lift did not damage system. Correct any defects discovered.
- Platform loading does not exceed its rated load.
- Only enough people on platform to do the work.
- Tools secured against displacement.
- Only enough materials necessary to do the work, and evenly distributed on the platform.
- Platform not used for hoisting tools or materials alone, when not lifting personnel.
- Pre-lift meeting:
  - Held prior to lift
  - Attended by crane operator, signal person(s), lift director and employees being lifted
  - Repeated for new crane positions and newly assigned employees to the operation
- Crane operator work practices:
  - Slow, controlled speed. Not more than 100 fpm.
  - All brakes engaged when in a stationary position.
  - Land or secure platform before exiting or entering.
  - Use tag line.
  - No simultaneous lifts on other hoists.
  - Crane operator to remain at controls when the platform is occupied.
  - Remain in continuous sight and communication with the signal person.
  - Discontinue lift during dangerous weather conditions.
- Platform occupants' work practices:
  - Wear fall arrest equipment.
  - Connect lanyard to:
    - lower load block
    - overhaul ball, or

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- structural member within platform
- nothing outside the basket

- Traveling the crane is prohibited except by portal, tower and locomotive cranes, or where employer demonstrates no less hazardous way.
  - Restricted to fixed track or runway.
  - Travel limited to load radius of boom during lift.
  - Boom parallel to direction of travel.
  - Conduct trial lift for traveling.
  - Check air pressure is operating a rubber-tired crane.

Part VI: Fall Protection Program

A fall protection program that provides policies and procedures to address employee fall hazards should be a part of a company's safety program.

Consider the following when developing your fall protection program.

1. **Goals and Objectives:** Develop a statement that discusses the expected results and why a fall protection program is important to the company and all its employees.
2. **Responsibilities:** Assign responsibilities by job title.
3. **Preplanning:** Formalize a procedure to identify fall conditions/hazards associated with anticipated means and methods before work begins. Once identified, look for ways to eliminate the hazard. If elimination is not practical, mitigate the exposure by changing means and methods or introduce protective equipment.
4. **Selection and Application:** Evaluate and select devices and equipment based on hazards and compatibility with other equipment currently in use.
5. **Training:** Train all personnel, including those in supervisory roles. Training is important for communicating expectations and providing knowledge so everyone can meet their responsibilities.
6. **Inspection and Maintenance:** Specify requirements and methods for inspection, and specify storage and removal criteria for fall protection equipment.
7. **Rescue:** Develop a plan for rescuing suspended employees. Specify methods, equipment and training of designated responders as appropriate.
8. **Enforcement:** Outline enforcement procedures for lack of use and misuse of equipment, unsafe acts and exposures by others.
9. **Subcontractors:** Establish key criteria that all subcontractors must follow, integrate them into your subcontractor contracts and define means to enforce the contract.
10. **Accident Investigation:** Document a method for investigating accidents, handling near-miss situations and sharing results of lessons learned.
11. **Program Audit:** Establish a method for periodically evaluating the program's effectiveness and a means for making changes and/or updates as needed.

Part VII: Rescuing Suspended Employees

Falls from heights are a serious source of loss in many industries. In manufacturing and retail operations, falls may be a continuous and recognized danger. In construction and maintenance operations, however, they may constitute a short-term hazard that occurs in unpredictable locations.

While training and procedures to avoid and protect against falls are improving, the means and methods to rescue an employee who has fallen and is suspended in their personal fall arrest equipment have not been well addressed.

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In the report *Harness Suspension: Review and Evaluation of Existing Information,*[1] Paul Seddon uses the term "harness suspension trauma." This report compiled results and findings of studies that addressed falls in caving, construction and mountaineering. Harness suspension trauma is a specific example of the condition orthostatic shock while suspended, which results from the body being held in an upright position with little or no leg movement. The effect of this position is venous pooling, which is an accumulation of blood in the veins of the legs due to the force of gravity. The circulatory system is secondarily affected by this pooling because the volume of blood circulated to the heart is reduced. Effects of this reduced blood flow can include loss of consciousness and death.

Death can also occur after the rescue if the victim is placed in a horizontal position. Blood that has accumulated in the lower extremities suddenly reenters and overstrains the heart.

Various factors can worsen the degree of risk while suspended (Sheehan, 2000).[2]

These include:

- The inability of the person to move their legs to assist circulation
- Dehydration
- Hypothermia
- Shock
- Fatigue
- Degree of inclination of the body
- Unconsciousness

A 1987 US Air Force/OSHA[3] study of prolonged motionless suspension concluded that the average amount of time test subjects could hang motionless in a full-body harness before experiencing nausea, tingling or numbness was 14.4 minutes. This time is dramatically lower in a safety belt, at 1.6 minutes. It should be noted that this study only looked at the suspension, it did not consider the forces on the body resulting from arresting the fall.

Specific advice for handling the victim of a fall/suspension incident is offered in the article "Rescuing People who have Fallen and First Aid Following Suspension in a Safety Harness."[4]

> "Everybody who is suspended in a safety harness runs the risk of shock and unconsciousness due to blood flow insufficiency. Unconsciousness can become life threatening after only a few minutes. Shock, caused by a lack of blood flow, is due to the blood accumulating in the lower parts of the body as a result of the musculature of the legs relaxing and the so-called "muscle pump" stopping.
>
> In order to maintain this function in good order, the victim of a fall must be made to keep his or her legs moving. In this way, blood circulation can be activated and the accumulation of blood in the legs prevented. The victim of a fall must be released from the suspended situation as quickly as possible.
>
> ***Important!*** *The accident victim must never be laid down after being rescued from the suspended position, not even in the stable side position.* The victim should be positioned with the upper body very well raised, i.e. in a seated, or possibly squatting or crouched posture. All restrictive belts and clothing should be unfastened and a doctor called immediately.
>
> Laying the victim down horizontally can be life threatening. Blood that has accumulated in the legs flows abruptly into the heart creating a risk of heart failure due to overstrain. Transfer to a horizontal posture should take place only gradually. Continuous monitoring of the respiration and circulation is necessary. In the event of unconsciousness, air passages should be kept open."
>
> ***(Lieblich and Rensing, 1997)***

Solutions

Consider these elements for preplanning a rescue:

- Identify one or more qualified persons to oversee fall protection/rescue exposures.
- Identify potential fall from height situations.
- Select appropriate protective measures, with the first choice being elimination of the exposure.
- Plan for rescue at each location that fall arrest equipment is to be used.

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- Each employee should know whom to call for assistance before putting themselves in a fall from height exposure.
- Require that anyone working at height be within verbal range of another person who can raise the alarm should a fall occur.
- Identify anchorages with the appropriate capacity where fall arrest equipment will be used.
- Develop feasible rescue scenarios based on the phase of work and location of a potential fall, including detailing personnel, equipment and methods to be used.
- Obtain necessary equipment to effect the rescue scenarios.
- Train all affected employees. Each employee should know how to initiate the plan.
- Appoint a rescue commander to oversee all operations.
- While there is no definitive time for rescue, “prompt rescue” is generally considered to be less than 15 minutes. The explanatory information in ANSI Z359.2 recommends a goal of establishing contact with the fall victim within 6 minutes.
- Timeliness is critical. Be sure rescue personnel know where the rescue equipment is and how to use it.
- Assess the system suspending a fall victim. Has the structure or anchor been weakened by the fall?
- Call an Emergency Medical Technician (EMT) and an ambulance so the fall victim will receive prompt medical attention once they are rescued.
- If self-rescue is a viable method, employees should be trained in the techniques and the use of the issued equipment. Without regular training, the employer cannot be confident that self-rescue is a viable method.
- Perform scheduled periodic inspections on all rescue equipment.
- Hospitalize the fall victim, even for apparently minor symptoms.
- Limit the time a person is suspended in a vertical position This will minimize the effects of suspension trauma. It is important that rescuers consult with an emergency responder or health care professional.)
- Some authorities warn against laying the rescued worker flat. Raise the upper body in a seated, squatted or crouched posture. Laying the victim down horizontally could be life threatening.

Conclusions

Prevention is the cure. Preventing a fall eliminates the need for rescue, however, reality dictates the need to be prepared for rescue no matter how thorough the fall prevention program may be.

Self-rescue is possible in some falls but should not be counted upon as the primary method of rescue. It may be appropriate, given a nearby structure, to grab and regain firm footing, but it is not realistic to expect an employee to be able to hoist themselves back up to the working surface without assistance and additional equipment. Rebound and entanglement, impact with the structure resulting in injuries and adrenalin rush or shock may make self-rescue difficult.

A variety of rescue equipment is available that can be attached to the suspended employee allowing their lanyard to be cut or disconnected so they can be hoisted or lowered to a safe surface. Confer with your fall equipment vendor for the options they offer.

Rescue can be accomplished using an aerial lift, ladder, scaffold or suspended personnel platform. These methods, however, may not be feasible, depending on the space available to set up the equipment and the time required to accomplish the rescue.

The most common rescue method, calling 911, may not provide the support expected. Many municipalities have equipment with limited height capabilities, such as ladder trucks limited to 6 or 7 stories. In addition, large ladder trucks require a level surface and considerable space to elevate and swing. These conditions may not be available at the site of the suspended employee. While some fire departments may have responders trained in the use of ropes and similar climbing equipment, many local departments do not have that capability. Contact the local authorities before work begins to ascertain their capabilities, limitations and willingness.

In summary, the key to prompt rescue is preplanning. Leaving an employee suspended for an extended period of time may be as critical to their health as the fall itself. Identify potential exposures

early in the job. Discuss these exposures with municipal first responders, your fall protection equipment vendor and the qualified people on your staff. Some situations may require hiring a fall protection consultation firm capable of developing engineered solutions.

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Part I

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Z359.1, Safety Requirements for Personal Fall Arrest Systems, Subsystems, and Components.

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