Frequently Addressed Topics in Fall Protection

ISEA member companies collectively receive thousands of calls from employers, end-users and others asking about various aspects of fall protection. Questions cover equipment components and systems, applications of fall protection, and other considerations important to a comprehensive fall protection program. Here are some of the common topics addressed, with guidance provided by ISEA member manufacturers.

1. Anchorage strength
2. No overhead anchorage
3. Horizontal lifeline systems
4. Harness attachments
5. Self-retracting lifeline positioning
6. Twin-leg lanyards
7. Tie-back applications
8. Compatibility
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Anchorage strength

The minimum strength of the fall protection anchor structure depends on the type of system used, how the anchor structure is selected and the number of personnel attached to the anchor.

The following table describes minimum strength requirements for anchors that are either certified (those evaluated by a qualified person) or non-certified (those selected by a competent person). Definitions of “competent person” and “qualified person” and their roles in fall protection are given in OSHA regulations and in ANSI/ASSE Z359.0. There is additional discussion of these terms in the ISEA Use and Selection Guide for Personal Fall Protection Equipment.

Anchor strength values are given below are minimum static strength requirements for one attached worker. For multiple-worker systems, multiply the minimum strength values above times the number of personnel connected to the anchor.

<table>
<thead>
<tr>
<th>Fall Protection System</th>
<th>Certified Anchor</th>
<th>Non-Certified Anchor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall arrest</td>
<td>2 times max. arresting force</td>
<td>5000 lb</td>
</tr>
<tr>
<td>Work positioning</td>
<td>2 times foreseeable force</td>
<td>3000 lb</td>
</tr>
<tr>
<td>Fall restraint</td>
<td>2 times foreseeable force</td>
<td>1000 lb</td>
</tr>
<tr>
<td>Rescue</td>
<td>5 time applied load</td>
<td>3000 lb</td>
</tr>
<tr>
<td>Horizontal lifeline</td>
<td>2 times max. line load</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>

No overhead anchorage

Some work locations lack a suitable overhead anchorage for fall arrest systems. The only available anchor point may be at foot level. In the absence of an overhead anchor structure, free-fall distance will exceed the 6 foot limit imposed by regulations and specified by the fall protection equipment manufacturer.

OSHA provides for limited exemption of the 6 foot free-fall distance requirements when (a) the fall arrest system is designed for it, (b) fall arrest forces do not exceed 1,800 pounds, and (c) there is adequate clearance in the path of the fall.

ISEA manufacturers offer specially designed energy absorbers which will arrest falls with up to 12 feet of free-fall distance. Standard fall arrest lanyards and self-retracting lanyards are not intended for these applications.

When using fall arrest equipment for longer free-falls, pay special attention to the clearance requirements, which will be more than twice the clearances required when tied-off to an overhead support. Swing fall hazards are also a serious concern. Any fall arrest system with a free-fall distance greater than 6 feet should be authorized by a competent or qualified person. Check with your employer and be sure you understand the risks involved before working in conditions which may expose you to a free-fall greater than 6 feet.
Horizontal lifeline systems

Flexible horizontal lifeline systems are available either in pre-engineered kits or engineered for site-specific applications. In either case, horizontal lifeline systems for fall protection must be designed, installed and used under the supervision of a qualified person, as required by OSHA. In pre-engineered horizontal lifeline kits, the manufacturer assumes the responsibility for the engineering design of the system, the strength and performance of the components, and the methods recommended for installation.

Factory kits will include an in-line energy absorber that limits the loads transmitted to the anchor structure in a fall. When they are installed according to the manufacturers’ instructions, these systems will provide a factor of safety of at least two times the maximum anticipated line loads.

Pre-engineered systems generally require use of a personal fall arrest system that limits the maximum fall arrest loads to 900 pounds per worker attached to the lifeline. Always follow the manufacturers’ instructions for clearance, which will vary depending on such factors as the length of the life-line span and the number of personnel on the system.

What remains is the selection of suitable end-anchor structures for attachment of the horizontal lifeline system. The task of evaluating the anchor structure is the responsibility of a qualified person at the work site, based on the minimum strength requirement specified by the manufacturer.

Harness attachments

Full body harness attachment points vary depending on how the harness is to be used, as described below. Note that where reference is made to metallic rings these may be substituted with fiber loops in some harness designs.

Fall Arrest - The fall arrest attachment element is the back D-ring, located in the middle of the back between the shoulder blades when properly adjusted on the wearer.

Work Positioning - For work positioning, use D-rings at each side of the hip. The D-rings used here are designed to be used as a pair, never only one. The work positioning D-rings should be located low on the hips, forward of the body center-line when properly adjusted and under tension.

Travel Restraint - The most common point of attachment on the harness in restraint mode is the back D-ring. In some designs, an integral body belt may be incorporated with the full body harness and equipped with a restraint attachment in the center of the back at waist level.

Descent - Attachment elements for evacuation are located at the front of the harness, located between waist and chest level. They may be a single chest or waist D-ring, or they may be a pair of D-rings or fiber loops, typically mounted approximately at the waist (sometimes referred to as belay loops). These attachment elements can be used in raising or lowering the person and are often used in conjunction with a second line for back-up fall arrest connected to the back D-ring.

Evacuation - Attachment D-rings for evacuation are used as a pair, located at the top of the harness shoulder straps. They are used together with a spreader-bar for raising or lowering the person to a safe working level. Front attachment elements at the chest may also be used in evacuation.

Ladder Climbing Safety Systems - Harness attachments for use with ladder climbing safety systems are located at the front of the harness between waist and chest level. The attachment element is most often a single D-ring, but may be a pair of rings or fiber loops, for close connection to the ladder structure.
Self-retracting lifeline positioning

ISEA manufacturers recommend that self-retracting lanyards be mounted directly overhead above the area where work takes place. Limit the angle created by the lifeline during use to no more than thirty degrees from vertical to avoid a potential swing-fall hazard.

Retractable lifelines must be protected from contact with abrasive surfaces or sharp corners. If there is a potential for a fall over an edge or unguarded opening, provide padding around the edge to protect the lifeline. There are devices that are equipped with stronger lifelines and supplemental energy absorbers to reduce the possibility of damage to the lifeline in a fall over an edge.

Twin-leg lanyards

Twin-leg lanyards, or Y-lanyards, are an increasingly popular means of connection in personal fall arrest systems. They are designed to be used when moving from one anchor point to another while remaining continuously connected. They are available in a number of materials and configurations. Some have an energy absorber at the stem of the Y, while others contain an energy absorber on, or as part of, each leg of the lanyard. The nature of twin leg lanyards requires particular attention to hazards associated with their use:

- Always connect the snap hook at the stem of the Y-lanyard to your harness fall arrest attachment (back D-ring).
- Never attempt to extend the reach of the lanyard by connecting one leg to the harness and the opposite end to an anchor structure as this will generate dangerously high forces and fall distances, resulting in serious injury or death.
- Connect the unused leg of the lanyard only to approved attachment points on the harness designated by the manufacturer for this purpose. Do not "park" the unused leg on the harness hip D-rings as this could result in unfavorable loading to the body in the event of an accidental fall.
- As with any lanyard, avoid passing the lanyard between your legs, under your arms or around your neck during use.

Tie-back applications

Tie-back lanyards are designed to be wrapped around a suitable anchor structure, like a beam. These products have the advantage of eliminating a separate component for anchorage connection. Tie-back lanyards are typically used in fall arrest and are available in single leg or Y-lanyard configurations. Tie-back lanyards are generally constructed of very high-tensile, abrasion resistant webbing. They are fitted with specially designed snap hooks rated at 5,000 pounds in all directions of loading.

Manufacturers do not recommend tying the end of a fall protection lanyard back onto the lanyard material unless the product is designed for this purpose. Misuse of a conventional fall arrest or positioning lanyard connected back onto itself can result in serious injury or death.
A fall protection system is an assembly of components, each of which must be compatible with the other components in order for the whole system to function properly. Compatibility can be a complex issue and should be addressed by the competent or qualified person at your worksite, with consideration given to:

- **Compatible connections:** When connecting components of the fall protection system together, the attachment elements, such as D-rings and snaphooks, must be compatible in size, shape and strength.

- **Size of connector:** When attaching a lanyard snaphook to a steel ring on an anchorage connector, for example, the inside diameter of the ring should be larger than the snaphook gate. This reduces the possibility that the ring will load the gate in the event of an accidental fall.

- **Shape of the ring:** Circular rings have less opportunity to capture the connecting snaphook in a way that might place a side-load against the gate mechanism in a fall event.

- **Strength of the connecting elements:** Strength must be properly matched so that the weakest connection in the system is at least twice as strong as the highest anticipated load on the system. As a general rule, fall protection hardware is rated at 5,000 pounds minimum tensile strength. Some connecting components, however, may be rated to a lower strength depending on how the component is intended to be used. Always verify that each component in the fall protection system maintains a factor of safety of at least two times the maximum foreseeable load on the system.

Accidental disengagement, or burst-out, of a snaphook or carabiner can occur when the connection between the snaphook or carabiner and the connecting element is incompatible. For example, attaching a large "pelican" style snaphook to an eye-bolt or similar small diameter connection, can place unacceptable loads on the gate mechanism of the snaphook, resulting in gate failure and burst-out. Likewise, when connecting a large throat-opening snaphook or carabiner to an anchor structure, such as a ladder rung or angle iron structure, there is the potential for adverse loads bearing against the side of the gate mechanism. Be sure the connection does not put the gate in a position where it will be cross-loaded, or loaded against one side by a nearby structural element, in the event of a fall.

The gate mechanisms of snaphooks and carabiners have been significantly increased under the requirements of the new ANSI/ASSE Z359 fall protection standards. The higher-strength gate mechanisms make the task of compatibility easier than before. Nevertheless, you must take care to reduce the possibility of accidental disengagement even when working with this new hardware.

- **Do not attempt to connect two snaphooks or carabiners into the same D-ring or fiber loop.** This can cause mechanical interference between the connectors with the potential for accidental disengagement in a fall.

- **Do not connect snaphooks or carabiners together.**

- **Do not tie-off by hooking the nose of a snaphook into a hole or opening.** The snaphook or carabiner must always enclose the connecting element and the gate must always close and lock.

- **Do not tie a lanyard back onto itself unless the product is designed for this application.**

- **Refer to the instructions provided with each product before making connections.**

**Compatibility between Manufacturers** - Not every component of a fall protection system can be interchanged between manufacturers. This is true even though the components may be labeled as meeting the same fall protection equipment standards. It is recommended that the owner of the equipment consult the respective manufacturers of equipment used in their workplace to determine if the proposed match of fall protection products is compatible.
### Service life

Service life is dependent on conditions of use and not based on a fixed time scale.

Fall protection products, including components constructed with synthetic fibers, have an unlimited shelf life, so long as the product is stored in its original factory packaging in a cool, dry place away from sunlight and free of chemical vapors.

Once the equipment is in service, manufacturers recommend inspection before each use and formal inspection at least annually by a competent person other than the user according to the manufacturer’s product instructions. More frequent formal inspection may be necessary depending on the severity of the conditions of use. When inspection reveals an unsafe condition, the equipment must be removed from service and marked "UNUSABLE" until repaired or destroyed.

Manufacturers’ policy states that products may remain in service until such time as inspection reveals an unsafe condition. The service life of each product will vary, depending on many factors associated primarily with the conditions under which the product is used. In some applications, involving abrasive surfaces, exposure to harmful chemicals, heat damage, high impact forces or other conditions may limit the life of a fall protection component to a few months or less. If a component of a personal fall arrest system is exposed to the forces of arresting a fall, or equivalent forces, it should be removed from service and labeled "UNUSABLE" until destroyed.

OSHA regulations do not specify a service life for fall protection equipment. Voluntary US national consensus standards are divided on the issue. The recent ANSI Z359-2007 Fall Protection Code does not make recommendations for service life, but includes provisions for inspection before each use and formal inspection at least annually. The ANSI A10.32-04 standard for construction includes a guideline for maximum service life of 5 years, as well as requirements for inspection before each use and formal inspection by a competent person.

The ultimate responsibility for determining the service life of fall protection equipment rests with the owner’s organization. Each employer that provides personal protective equipment to their employees must make a determination when, or if, to establish a fixed service life for their equipment.

### Fall protection for heavy workers

Workers who weigh more than 310 lb, including clothing and tools, will require fall protection equipment designed especially for heavier loads. Make certain all the components in your fall protection system are qualified for workers who weigh more than 310 lb. This includes your harness, connecting lanyard or self-retracting lanyard and anchorage connector. OSHA limits the maximum arrest forces to 1,800 lb or less, regardless of the weight of the person.

ISEA manufacturers have designed and tested energy absorbers for heavy workers that comply with the OSHA force limits. However, the fall arrest distance for these heavy worker energy absorbers may be greater than standard energy absorbers, so be sure to allow for adequate clearance in the path of an accidental fall. Check the total fall arrest distance listed on the labels of your equipment. Also, consider whether workers who will use personal fall arrest equipment are healthy and fit to withstand the forces of fall arrest and post-fall suspension before working at height.

### Post-fall suspension

Medical experts caution that prolonged suspension in a full body harness is associated with a serious health risk, known as orthostatic intolerance, or “suspension trauma.” The beginning of suspension trauma can occur within a few minutes, especially if a fall protection user is suspended unconscious in a full body harness. It is therefore imperative that employers have a rescue plan in place and the means to retrieve a fallen worker quickly after an accidental fall has been arrested. OSHA regulations (29 CFR 1926.502(d)(20) call for “prompt rescue” in the event of an accidental fall. ANSI Z359-2007 Fall Protection Code recommends that contact be made with a worker within six minutes after a fall.

The onset of orthostatic intolerance can be delayed or prevented by the use of simple, portable and lightweight equipment a worker carries as part of a personal fall arrest system. ISEA manufacturers provide these products for use with a fall arrest harness that permit a conscious worker to maintain circulation in the large muscles of the legs, reducing the potential for suspension trauma until help arrives.
Fall protection applications - welding

The use of personal fall protection equipment in applications where exposure to an open flame or high-heat source, such as welding, is possible presents a special challenge. ISEA member companies have developed special fall protection equipment to use when workers are exposed to a fall hazard while welding. This equipment is typically constructed of materials that are resistant to direct contact with a welding torch and the hot slag thrown off by welding operations.

Full body harnesses are made of heat-resistant webbing with a sheath of additional heat resistant materials to protect the aramid fibers from abrasion and UV exposure. Energy absorbing lanyards are constructed with wire rope and the energy absorber covered with a heat resistant sheath to protect the internal energy-pack. Additionally, the energy absorber contains a back-up strap of high-strength material in the event of catastrophic separation of the energy absorbing webbing. Energy absorbing lanyards designed for welding applications can also be obtained for use in steel erecting applications where the only available anchor is located at foot level. These specialty products will arrest a fall of up to 12 feet while keeping fall arrest forces to below 1,800 lbf.

Lastly, compatible anchorage connector straps are available that are also constructed of high strength, flame resistant fibers for attachment to an anchor structure, such as a steel I-beam. When used together as part of a complete system for personal fall arrest, these components comply with OSHA regulations for fall arrest.

Fall protection applications - residential roofing

Residential roofing contractors rely on several products available from ISEA Fall Protection Group manufacturers. Once roof joists are placed and stable and workers are permitted to tie-off to the roof structure, there are a number of temporary and permanent roof anchors available. Most can be mounted to common roof structural materials using screws or clamps. Roofers can then connect their personal fall arrest systems, including either self-retracting lanyards or vertical lifeline (rope grab) systems. Full body harnesses are available for roofing work that incorporate back, front and side D-rings as well as integral waist belts and accessory pads for added comfort. Complete roofers kits are prepackaged with all the components needed for residential roofing fall protection.

Fall protection applications - aerial lift devices

The primary means of fall protection in aerial lift devices are the guardrails surrounding the elevated work platform, either boom lift or scissor lift. Guardrails must be installed on all sides of the work platform with gates closed and locked. When working inside the elevated work platform, the occupant must keep both feet on the floor at all times, as directed by OSHA regulations.

The ISEA Fall Protection Group recommends the use of a personal fall restraint system in aerial lift devices to protect against the hazard of ejection from the work platform.

A typical fall restraint system would consist of a body support harness with back D-ring (or D-ring located in the center of the back affixed to an integral waist belt) and an adjustable-length restraint lanyard rigged as short as practical to a restraint anchor located low in the platform interior.

ISEA also recommends a separate, independently anchored fall arrest system whenever there is a hazard of falling outside the aerial work platform. Falls outside the work platform while anchored to the platform or boom risk a swing fall hazard and encounters with hazards outside the platform, such as high voltage electrical sources, moving machinery or sharp edges.

For more information

ISEA’s Use and Selection guide for Personal Fall Protection Equipment provides practical, hands-on guidance for fall protection users and administrators in their selection, use, maintenance and inspection of fall protection equipment, plus definitions and links to OSHA regulations and relevant US and Canadian consensus standards. The guide is available for download from www.safetyequipment.org. Also on the Web site you’ll find a searchable Buyers Guide for personal protective equipment, with links to the ISEA member companies that supply fall protection equipment, systems, technologies and training.