VOSH PROGRAM DIRECTIVE: **09-052D** **Issued: 01 July 2016**

Subject **OSHA TECHNICAL MANUAL (OTM)**

Purpose **CHANGE V** adds technical information specific to fall protection in the construction industry to the OSHA Technical Manual (OTM). **CHANGE IV** adds a new Chapter 6 to Section IV to cover technical information about ethanol processing. **CHANGE IIII** updates Section II, Sampling, Measurement Methods and Instruments, Chapters 1-3 of the OSHA Technical Manual. **CHANGE II** adds Chapter 5, Noise, to Section III of the OSHA Technical Manual (15 August 2013), which provides the technical guidance to help CSHO's evaluate noise hazards in the workplace. **CHANGE I** renumbers this Directive from the 02 series [Compliance Instructions] to the 09 series [Program Operations, Analysis and Evaluation] and transmits to field personnel OSHA's new Table of Contents and updated Chapters 1 through 4 of Section II of the OSHA Technical Manual (OTM) on Sampling, Measurement Methods and Instruments (24 June 2008). All other OTM chapters remain in effect and unchanged.

This Program Directive is an internal guideline, not a statutory or regulatory rule, and is intended to provide instructions to VOSH personnel regarding internal operation of the Virginia Occupational Safety and Health Program and is solely for the benefit of the program. This document is not subject to the Virginia Register Act or the Administrative Process Act; it does not have general application and is not being enforced as having the force of law.

Scope This directive applies to all VOSH personnel.

References
CHANGE V: OSHA Notice: TED 01-00-015 (14 April 2016);
CHANGE IV: OSHA Instruction TED 01-00-015 (28 April 2015);
CHANGE III: OSHA Notice 13-03 (TED 01) (11 February 2014);
CHANGE II: OSHA Notice 13-03 (TED 01) (15 August 2013); and
CHANGE I: OSHA TED 01-00-015 (20 January 1999); 08-05 (TED 01) (24 June 2008)

Cancellation VOSH PD 09-052C (15 June 2015)

Action Directors and Managers shall assure that the procedures set forth in the OSHA Technical Manual are followed during inspections and consultative visits.

Effective Date 01 July 2016

Expiration Date Not Applicable.

C. Ray Davenport
Commissioner

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E-attachments: **CHANGE V:** OSHA Notice TED-01-00-015 (14 April 2016):

CHANGE IV: OSHA Instruction TED 01-00-015 (28 April 2015)
http://www.osha.gov/dts/osta/otm/otm_iv/otm_iv_5.html

CHANGE III: OSHA Notice 13-03 (TED 01) (11 February 2014)
http://www.osha.gov/dts/osta/otm/otm_ii/otm_ii_1.html

http://www.osha.gov/dts/osta/otm/otm_ii/otm_ii_2.html

http://www.osha.gov/dts/osta/otm/otm_ii/otm_ii_3.html

CHANGE II: OSHA Notice 13-03 (TED 01) (15 August 2013)
http://www.osha.gov/dts/osta/otm/new_noise/index.html

CHANGE I: OSHA Technical Manual, OSHA Instruction TED 01-00-015 [TED 1-0.15A] (20 January 1999)
http://www.osha.gov/dts/osta/otm/otm_toc.html

When the guidelines, as set forth in this Program Directive, are applied to the Department of Labor and Industry and/or to Virginia employers, the following federal terms, if and where they are used, shall be considered to read as below:

Federal Terms	VOSH Equivalent
OSHA	VOSH
Federal Agency	State Agency
Agency	Department
Regional Administrator	Assistant Commissioner
Area Director	Regional Director VOSH Program Director
Area Office/Regional Office	Regional Director
Regional Solicitor	Attorney General or VOSH Division of Legal Support (DLS)
Office of Statistics	VOSH Research and Analysis
29 CFR	VOSH Standard
Compliance Safety and Health Officer (CSHO) and/or Industrial Hygienist	CSHO
OSHA's Cincinnati Training Center (CTC)	VOSH's Applicable State Contract Vendor

OSHA Directives:	***VOSH Program Directives:***
CPL 02-00-150, OSHA Field Operations Manual (FOM) (04/22/11)	02-001G, VOSH Field Operations Manual (FOM) (10/01/13) or its successor

Summary

This chapter (Section V (Construction Operations), Chapter 4), provides technical information for Compliance Safety and Health Officers (CHSOs) to evaluate fall hazard assessment and abatement methods in the construction industry. The content is based on currently available research publications, OSHA standards, and consensus standards.

The chapter is divided into three main sections. Following the introduction, the first section focuses on fall prevention, effective methodologies, and related equipment. The second section describes fall protection strategies and specific types of equipment. The third section describes how to assess fall hazards conceptually, visually, and mathematically. The three sections are followed by five appendices: Appendix A presents fall protection standards and references for scaffolds and related equipment; Appendix B lists the most significant OSHA standards relevant fall protection in construction; Appendix C lists and describes different fall protection anchors; Appendix D lists and describes lanyards, harnesses, deceleration devices, and related equipment; and Appendix E lists all references and resources. The final two sections are the references and a glossary.

Significant Changes

This is a new OTM chapter, therefore, there are no significant changes.

Fall Protection in Construction

Introduction

This chapter provides technical information about fall hazards and protection methods. The information is intended to help prepare OSHA compliance officers to conduct inspections and investigations. For convenience, links are provided to applicable OSHA standards throughout this chapter. This chapter does not cover all OSHA requirements for fall prevention/protection methods, and is not intended to serve as a comprehensive guide for developing compliant fall protection programs.

Although fall hazards are common at construction worksites, fall-related injuries and fatalities are preventable. Fall hazards can be addressed in two main ways:

Fall prevention: preventing workers from falling by using engineering controls (e.g., guardrails and hole covers) or restraint systems.

Fall arrest/rescue: preventing injury during and after a fall by using personal fall arrest systems (PFAS) or safety nets and having an effective rescue plan in place.

Recognizing fall hazards and planning to control them before work begins is critical for determining the best methods and equipment for protecting workers during construction activities at heights.

Emergency response planning will identify necessary emergency response training and critical resources (e.g., trained on-site fall arrest rescue team and rescue equipment).

A number of OSHA standards contain provisions for protecting workers from falls. In the construction industry, applicable standards include:

- 29 CFR 1926.500–.503: Fall Protection;
- 29 CFR 1926.760: Steel Erection;
- 29 CFR 1926.954: Electric Power Transmission and Distribution; and
- 29 CFR 1926.1423: Cranes and Derricks.
- *16VAC25-145, Safety Standards for Fall Protection in Steel Erection, Construction Industry (Virginia Unique standard), http://law.lis.virginia.gov/admincode/title16/agency25/chapter145/*

Refer to Appendix B for a more complete list of OSHA standards on fall protection.

OSHA-approved state occupational safety and health plans may have different standards, but those standards must be at least as effective as federal OSHA requirements. More information about state plans is available on the OSHA website.

I. Fall Prevention

I.A. Guardrail Systems

A guardrail system can be used as a barrier installed to prevent workers from falling off a work surface edge to a lower level. Guardrail systems can be used on many work surfaces, including rooftops, platforms, mezzanines, balconies, scaffolds, incomplete decked floors, catwalks, observation platforms, mobile work surfaces and ladderway points of access. Figure 1 shows a temporary guardrail system for a walkway (see 29 CFR 1926.500; 29 CFR 1926.502(b)).

Figure 1. Guardrail system.

Guardrails can also be used to keep workers from falling into holes or openings in decking or floors (see 29 CFR 1926.501(b)(4)(i); 29 CFR 1926.502(b); Figure 2).

Guardrails are typically constructed using:

- Upright supports attached to the working surface;
- A horizontal top rail connected to the supports;
- One or more midrails running parallel to the top rail; and
- Toeboards when necessary to protect workers below from falling objects.

Figure 2. Guardrails used around an opening.

(See 29 CFR 1926.501(c)(1); 29 CFR 1926.502(b); 29 CFR 1926.502(j).)

Effective guardrail systems will have at a minimum:

- A surface that is smooth and free from burrs to prevent punctures and lacerations and to prevent snagging of clothing (see 29 CFR 1926.502(b)(6)).
- Toprails and midrails that are at least ¼ inch in diameter (see 29 CFR 1926.502(b)(9)).
- Strength to withstand at least 200 pounds applied within 2 inches of the top edge in any outward or downward direction (see 29 CFR 1926.502(b)(3)) .
- A toprail between 39 and 45 inches from the working level, raised as necessary to account for workers using stilts or otherwise working in an elevated location above the work surface (see 29 CFR 1926.502(b)(1)).

- Midrails (or equivalent structural members) that withstand at least 150 pounds of force in the downward or outward direction (see 29 CFR 1926.502(b)(5)).
- A midrail, mesh, screen, or equivalent intermediate structural members installed between the guardrail system top edge and the walking/working surface when there is no wall or parapet wall at least 21 inches high (see 29 CFR 1926.502(b)(2)).
- Intermediate members (such as balusters), when used between posts, that are not more than 19 inches apart (see 29 CFR 1926.502(b)(2)(iii)).
- Flags made of high visibility material every 6 feet if wire rope is used for top rails (see 29 CFR 1926.502(b)(9)).

Effective guardrail systems **will not have**:

- Guardrails that deflect to lower than 39 inches above the working surface when 200 pounds of pressure are applied in a downward direction (see 29 CFR 1926.502(b)(4)).
- Toprails and midrails that overhang terminal posts to constitute a projection hazard (see 29 CFR 1926.502(b)(7)).

Basic guardrail components come in a variety of materials and configuration options. It is common for employers to use material available or produced at the worksite. Upright supports may be made from wood, formed metal, pipe, or composites. Wire rope is sometimes used for the top rails and midrails.

Table 1 provides guidelines as a starting point for designing guardrail systems. However, the guidelines do not provide all the information necessary to build a complete system. The components of a guardrail system must still be designed and assembled in such a way that the completed system meets all applicable requirements.

Workers installing or removing guardrails must be protected using other forms of fall protection whenever the guardrail systems are not attached securely to a stable structure.

Table 1 – Guardrail Component Strength Indicators

Material	**Strength** (minimum criteria)	**Posts** (minimum criteria)	**Top Rail** (minimum criteria)	**Intermediate Rail** (minimum criteria)
Wood guardrails	1,500 lb-ft/in^2 fiber (stress grade) construction lumber	2 inch × 4 inch (nominal) lumber	2 inch × 4 inch (nominal) lumber	1 inch × 6 inch (nominal) lumber
Pipe guardrails	N/A	1.5 inch diameter (schedule 40 pipe)	1.5 inch diameter (schedule 40 pipe)	1.5 inch diameter (schedule 40 pipe)

Structural steel guardrails	N/A	2 inch × 2 inch × 3/8 inch	2 inch × 2 inch × 3/8 inch	2 inch × 2 inch × 3/8 inch
Spacing	N/A	All material: no more than 8 feet apart (on centers)	N/A	N/A

N/A = not applicable.

lb-ft/in^2 = pound-foot per square inch. Adapted from 29 CFR 1926 Subpart M, Appendix B.

I.A.1. Temporary Guardrails

Premade or job-made guardrails can be used as temporary guardrails while more permanent structures are being installed or when the work is transient or in a space not intended as a permanent work area. For example, temporary guardrails can be used while constructing a wall, completing floor decking, or replacing a roof (see Figure 4). These guardrails are often constructed from reusable materials or premade guardrail system components as shown in Figure 4 (see 29 CFR 1926.502(b)).

Figure 3. Temporary guardrails.

Premade guardrails are particularly susceptible to damage if not handled properly when disassembled and stored. Specific handling instructions are typically included in the manufacturer's recommended procedures for disassembling and storing the guardrail components. If railing components are bent, broken, or missing, the guardrail may not be effective. Damage is more likely to occur if the components are dropped when disassembled, transported in vehicles, or stored in areas not protected from conditions that could cause corrosion or distortion.

I.A.2. Guardrails for Scaffolds, Aerial Lifts, and Scissor Lifts

Scaffolds, aerial lifts, and scissor lifts can pose similar fall hazards. Guardrails, possibly in combination with additional types of fall protection systems (e.g., PFAS or restraint system), may be used to address these hazards. (see 29 CFR 1926.451(g)(1); 29 CFR

Figure 4. Temporary guardrails.

1926.453(b)(2)(v); 29 CFR 1926.954(b)(3)(iii)(A)).

For information on fall protection for scaffolds and lifts see:

Appendix A (chart describing fall protection for various types of scaffolds and related equipment)

Safety and Health Topics - Scaffolding

Scaffolding eTool

A Guide to Scaffold Use in the Construction Industry, OSHA 3150 (revised 2002), www.osha.gov/Publications/osha3150.pdf; 29 CFR 1926.452(j)(3)&(4)

OSHA PowerPoint: Scaffolding
www.osha.gov/dte/library/scaffolds/scaffolding/scaffolding.ppt

OSHA's Fall Protection Campaign

OSHA Publications – Fall Prevention/Protection

I.A.3. Stairrails and Handrails

I.A.3.i. Stairrails

A stairrail system is a vertical barrier that runs along the unprotected side edge of a stairway to prevent workers from falling to lower levels (see Figures 5 and 6). The top surface of the stair rail system may be used as the handrail (see 29 CFR 1926.1050(b); 29 CFR 1926.1052(c)(7)).

Figure 5. Stairrail System

I.A.3.ii. Handrails

Effective handrails provide an adequate handhold for workers to grasp to prevent them from falling (see Figure 6 and 29 CFR 1926.1052(c)(1), (c)(9)).

Effective handrails are 30 to 37 inches high and meet the guardrail strength requirements (i.e., able to withstand 200 pounds of weight applied within two inches of the top edge in any downward or outward direction at any point along the top edge) (see 29 CFR 1926.1052(c)(5), (c)(6)).

Effective temporary handrails have a minimum clearance of 3 inches between the handrail and walls, stair rail systems a minimum clearance of 3 inches between the handrail and walls, stair rail systems, and other objects (see 29 CFR 1926.1052(c)(11).

For additional information see OSHA's booklet on Stairways and Ladders - A Guide to OSHA Rules (OSHA 3124-12R) 2003.

Figure 6. Stairrail System with handrail.

I.B. Hole Covers

A hole is a gap or void 2 inches or more in its least dimension in a floor, roof, deck, or other walking/working surface (see 29 CFR 1926.500(b); 29 CFR 1926.501(b)(4); 29 CFR 1926.751; 29 CFR 1926.754(e)(2)(ii)) that is hazardous because:

- workers can fall through the hole (see 29 CFR 1926.501(b)(4)(i));
- the hole's design can create a trip hazard (see 29 CFR 1926.501(b)(4)(ii);
- objects can fall through the hole and injure workers below (see 29 CFR 1926.501(b)(4)(iii)).

Workers are protected from the hazards associated with holes by the use of covers, personal fall protection or guardrail systems (see 29 CFR 1926.501(b)(4)(i)).

The following types of holes are commonly found at construction worksites:

- Holes cut (or constructed) in floors to receive equipment or ducts and for future access points (e.g., openings for stairs that will be installed later);
- Holes cut in roofs in preparation for installing skylights, ventilation units, and other features or equipment;

Figure 7. Hole cover.

- Excavations for pits, wells, or shafts (e.g., caissons);
- Excavations or cuts in roadways.

I.B.1. Effective Hole Covers

Covers are strong protective surfaces used on walking/working surfaces or roadways to prevent workers from falling through a hole (see Figure 7).

Covers for permanent holes are typically built for a specific purpose (e.g., permanent access points, manhole covers, and trap doors) and are only effective when they are properly designed and secured in place.

Covers for temporary holes are often constructed on work sites with reusable materials, most commonly using plywood and steel plates. For example, to cover large holes in a road, hinged steel plate covers can be used. Other options for covers include grates designed to support weight, custom boxes to cover a hole with an elevated lip or partially installed equipment, and temporary trapdoors.

Effective hole covers are:

- Large enough to provide appropriate overlap to prevent workers from falling through.
- Strong enough to support at least twice the anticipated weight imposed by the heaviest load (see 29 CFR 1926.502(i)(1), (i)(2)).
- Left in place over the hole until access is needed.
- Inspected periodically to identify deterioration.
- Secured (see 29 CFR 1926.502(i)(3)) and do not create trip hazards.
- Clearly marked as hole covers (see 29 CFR 1926.502(i)(4)).

The following materials lack the strength necessary to prevent a worker from falling through a hole (see 29 CFR 1926.502(i)(1), (i)(2)):

- Cardboard;

- Tarps;
- Materials not intended to bear the anticipated load (e.g., plastic or glass);
- Loose materials that could separate (e.g., unsecured two-by-four planks);
- Damaged materials (e.g., deteriorating wood, a bent metal plate);
- Drywall or particle board; and
- Chicken wire or other fencing material.

I.B.2. Plywood Hole Covers

Heavy plywood is a common choice for covering temporary holes in floors and roofs (see Figure 9), but plywood strength and durability can vary. Some materials, including plywood scraps from shipping crates or similar scrap products, do not have structural value or span ratings, making it hard to know if they are strong enough. In addition, strength information on the plywood is occasionally covered with paint.

Figure 9. Plywood hole cover.

I.B.2.i. Plywood Strength

Several factors determine and measure plywood strength. In the United States, two groups provide the most commonly used plywood rating systems: APA–The Engineered Wood Association (formerly the American Plywood Association and Douglas Fir Plywood Association) and the Timber Engineering Company (TECO). CSHOs should refer to these organizations for detailed information.

The hole size and the expected load weight are considered when determining if the plywood is effective for use as a hole cover (see 29 CFR 1926.501(b)(4); 29 CFR 1926.502(i)(1), (i)(2)).

I.B.2.ii. Plywood Durability

Plywood is susceptible to damage over time from exposure to water, traffic, and heavy loads that may reduce its strength. Some indicators of reduced- strength plywood may include cracks, chips, a warped appearance, a worn surface, de-lamination, and water stains. Expected damage after exposure to water depends on whether the plywood is exterior-grade or interior-grade. The binding agents (i.e., adhesive) used to adhere interior-grade plywood layers degrade more rapidly in a moist environment than do the binders used in exterior-grade plywood. For specific cases, SLTC, in conjunction with the U.S. Forest Service Products Laboratory, can evaluate plywood strength degradation.

When workers are using hauling equipment, the weight of the equipment and its load is concentrated into the smaller area that contacts the ground (e.g., the load in a wheelbarrow will concentrate where the wheel hits the ground – an area of just a few inches in size). Commonly used routes for hauling these loads will experience additional wear and tear to the flooring. Adding a protective layer to the floor along these routes is one way to prevent damage to the flooring from concentrated loads. Typical protective layers may include liquid latex compounds, penetrating oils, sheet plastics, and interlocking membranes.

I.B.2.iii. Plywood Cover Size and Orientation

The plywood cover's size and orientation can affect the cover's overall effectiveness. Plywood covers rest on the hole edges that are supported through the joists. The following are indications that a plywood cover's size and orientation will generally keep workers from falling through a hole:

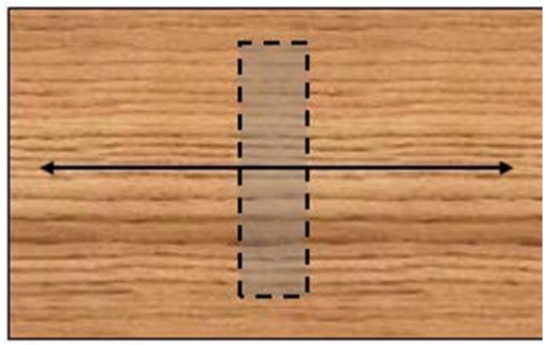


Figure 10. Plywood orientation relative to hole orientation and strength axis.

- The plywood piece is larger than the hole size so that it is possible to cover the hole with the shortest panel side overlaying the longest unsupported hole dimension.

- The panel overlaps the supporting surfaces around the hole far enough for needed support.

- The panel is positioned with the strength axis (grain direction) running along the shortest unsupported hole dimension (Figure 10 above).

I.C. Warning or Marking Systems

I.C.1. Warning Line Systems

A warning line system is a barrier erected on a flat or low- sloped roof to warn workers that they are approaching an unprotected roof side or edge (see 29 CFR 1926.500(b); 29 CFR 1926.501(b)(10); Figure 11). A warning line system includes a line (rope, wire, or chain) and supporting stanchions (see 29 CFR 1926.502(f)(2)).

Warning lines are not engineered to physically prevent or arrest falls and may not be used in all situations. On flat or low-sloped roofs, warning lines are used in conjunction with conventional fall protection or a safety monitoring system (see 29 CFR 1926.501(b)(10)).

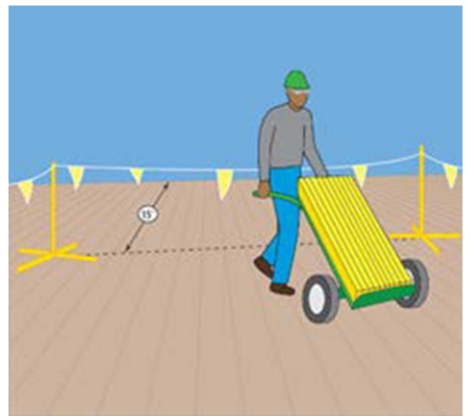


Figure 11. Warning line system for non-roofers.

Workers are not allowed in the area between the warning line and the unprotected edge, except during roofing work (see 29 CFR 1926.502(f)(3)). Any employee performing roofing work between the warning line and the roof edge must be protected using another form of fall protection.

I.C.2. Safety Monitoring Systems

A safety monitoring system uses a competent person as a safety monitor who can recognize and warn workers of fall hazards (see 29 CFR 1926.500(b); 29 CFR 1926.502(h)(1)). Safety monitoring systems are typically used as part of fall protection plans during precast concrete erection work, leading edge work, and residential construction work when conventional fall protection is infeasible or would create a greater hazard and alternative measures (such as scaffolds, ladders, or vehicle mounted work platforms) are not used (see 29 CFR 1926.501(b)(2), (b)(12), (b)(13); 29 CFR 1926.502(k)(6), (k)(8)). Also, when conducting roofing work on a flat or low sloped roof that is 50 feet or less in width, a safety monitoring system may be used as a stand alone fall protection technique (see 29 CFR 1926.501(b)(10)).

Only workers engaged in low-sloped roofing work and workers performing the specific job tasks covered by a fall protection plan are allowed in an area where workers are being protected by a safety monitoring system (see 29 CFR 1926.502(h)(3)). The worker designated as the safety monitor may not perform other job tasks that could take attention away from the monitoring function (see 29 CFR 1926.502(h)(1)(v)).

I.C.3. Access Zoning

I.C.3.i. Controlled Access Zones (CAZs)

A controlled access zone is a clearly marked, designated work area where certain work (e.g., overhand bricklaying) may take place without conventional fall protection systems (see 29 CFR 1926.500(b)). Controlled access zones are used to keep out workers other than those authorized to enter a work area (see 29 CFR 1926.502(g)).

Situations where CAZs are used:

- Overhand bricklaying and related work (see 29 CFR 1926.501(b)(9));
- Leading edge work (see 29 CFR 1926.501(b)(2); 29 CFR 1926.502(k)(7));
- Residential construction (see 29 CFR 1926.501(b)(13); 29 CFR 1926.502(k)(7)); and
- Precast concrete erection (see 29 CFR 1926.501(b)(12); 29 CFR 1926.502(k)(7)).

In overhand bricklaying and related work, CAZs can be used provided that workers are not reaching more than 10 inches below the walking or working level they are on (see 29 CFR 1926.501(b)(9)).

CAZs may be used for leading edge work, precast concrete work, and residential construction work only as part of a fall protection plan when conventional fall protection is infeasible or creates a greater hazard (see 29 CFR 1926.501(b)(2)(i), (b)(12), (b)(13); 29 CFR 502(k)).

I.C.3.ii. Controlled Decking Zones (CDZs)

***NOTE: The use of controlled decking zones (CDZ) is prohibited in Virginia.* (16VAC25-145-40.A)**

A controlled decking zone is a clearly marked work area used during steel erection while workers are initially installing decking at the leading edge of the work area (see 29 CFR 1926.751; 29 CFR 1926.760(c); 29 CFR 1926 Subpart R Appendix D).

I.C.3.iii. Control Lines Used in a CAZ

Control lines are used to demark CAZs.

- 29 CFR 1926.502(g)(1) describes the general requirements for control lines in CAZs.
- 29 CFR 1926.502(g)(2) describes the control line requirements where overhand bricklaying and related work are taking place.
- 29 CFR 1926.502(g)(3) describes control lines physical requirements.

I.D. Fall Restraint Systems and Positioning Devices

Fall restraint systems prevent the user from falling *any* distance. To determine the force needed to restrain a worker, consideration is given to the force that would be generated by the worker walking, leaning, or sliding down the working surface. OSHA has no specific standards for restraint systems, however, at a minimum, fall restraint systems should have the capacity to withstand at least 3,000 pounds of force or twice the maximum expected force that is needed to restrain the worker from exposure to the fall hazard.

Positioning devices are specialized systems that hold workers in place on an elevated vertical surface (such as a wall) allowing them to keep both hands free to work while leaning into the system (see 29 CFR 1926.500(b)). When the worker leans back, the system is activated (supporting the worker's body weight). Positioning devices limit free falls to two feet or less (see 29 CFR 1926.502(e)(1)).

II. Fall Arrest Systems

Fall arrest systems are designed to prevent or reduce injuries when a worker falls from an elevated height.

II.A. Safety Net Systems

Safety net systems (see Figures 12 and 13) are an option when workers are working at elevated heights with hazardous vertical drops (see Table 2). Safety net systems are commonly used during work on bridges and large structures. The nets are available in various sizes and materials, including materials resistant to ultraviolet deterioration.

Table 2. Safety Net System Dimensions	
Vertical Distance from Working Level to Horizontal Plane of Net	**Minimum Required Horizontal Distance of Outer Edge of Net from Edge of Working Surface**
Up to 5 feet	8 feet
More than 5 feet, up to 10 feet	10 feet
More than 10 feet, up to 30 feet	13 feet
More than 30 feet	Safety net not permitted as fall protection
See 29 CFR 1926.502(c)(1), (c)(2)	

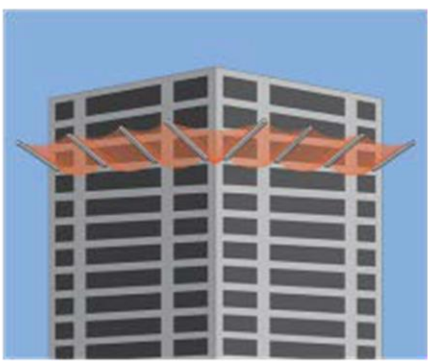


Figure 12. Safety net system.

Figure 13. Safety net system.

II.B. Personal Fall Protection Equipment for Personal Fall Arrest Systems

A PFAS is a system with components that work together to protect workers when they fall from elevated heights. PFAS components include an anchorage, connectors, and a full-body harness, and may include a shock-absorbing lanyard, a retractable lifeline, and/or a deceleration device (see 29 CFR 1926.500(b)).

PFAS components will be marked by the manufacturer with pertinent information specific to the equipment, such as warnings, serial/model number, capacity, and the materials used to make the component (see Figure 14). Information (e.g., proper use, maintenance, inspection) about fall protection components is typically provided in equipment manuals.

Although some components may look the same, they may not be interchangeable if they are from different manufacturers or from different equipment series made by the same manufacturer.

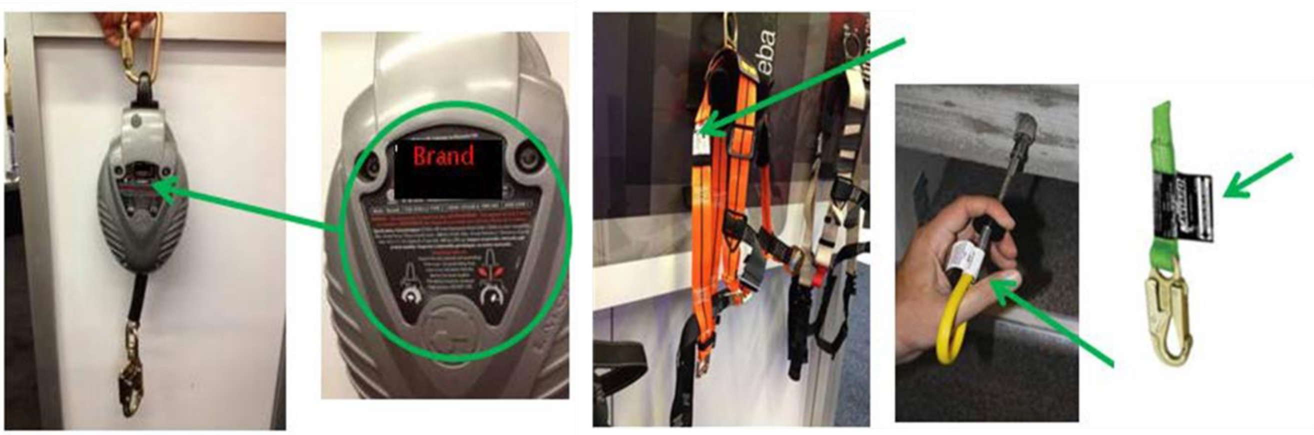


Figure 14. Examples of manufacturers' labels for various types of fall protection equipment.

II.B.1. Component Compatibility

Personal fall protection system effectiveness relies on component compatibility. Often, components are supplied together as a set. Using non-compatible fittings can lead to damage and system failure (see 29 CFR 1926.502(d)(5)).

A compatibility assessment should be performed when using fittings from different manufacturers or different product lines from the same manufacturer. This includes assessing the way fittings connect to each other and confirming with the manufacturer(s) that the fittings can be used together safely.

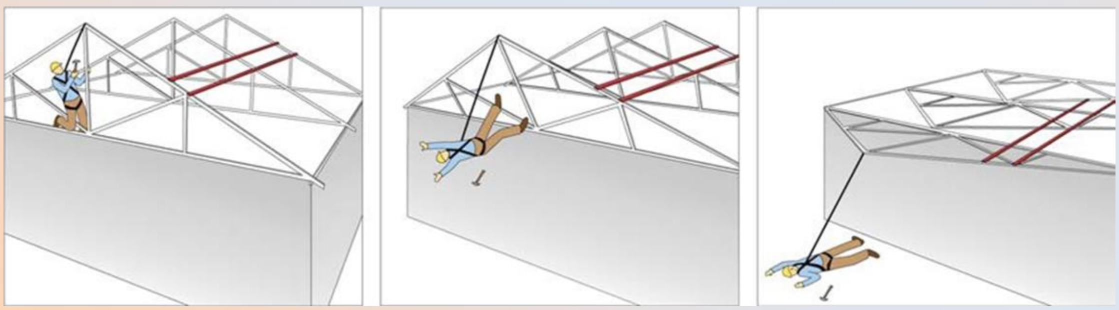
For additional information see:

Many factors can contribute to a workers' risk of falling from an elevated work area. Examples include precarious work positions, excessive leaning or reaching, improper work practices, unstable structures, trip hazards, slippery surfaces, and distractions.

When guardrails are not an option, personal fall protection equipment is helpful in some situations, but only when properly selected, worn, and attached to an adequate anchor point.

A personal fall arrest system was not a good choice in this case. In the illustration below, the trusses were not fully installed, braced and sheathed, so they did not form a sufficiently strong anchor point. The structure collapsed when it received the sudden force of the falling worker.

The fall hazard could have been eliminated by pre-assembling the truss sections (groups of several trusses) on the ground or using special devices that serve as temporary bracing for fall arrest equipment.



Compatibility of Personal Fall Protection System Components, OSHA Safety and Health Information Bulletin, www.osha.gov/dts/shib/shib092203.html.

II.B.2. Anchorage

Anchorage systems normally include, at a minimum, a building structure and an anchorage device to which the worker will tie off (see Appendix C).

Anchors are fixed to a strong structural member. Anchors are not effective if they are attached to weak materials. Certain structural members may not be strong enough to hold the sudden weight imposed by a falling worker. The anchorage manufacturer should provide instructions on anchor installation (see 29 CFR 1926.502(d)(15); 29 CFR 1926.1423(g)).

Many anchors are removed when they are no longer needed. Other anchors are designed to be left in place for future use (e.g., repeated servicing), or are covered over during the job (e.g., with roofing shingles), or are cut flush with the surrounding surface (e.g., concrete bolt-style anchor protruding from a wall). Appendix C provides fall protection anchor examples.

(See 29 CFR 1926 Subpart M, Appendix C(II)(h), Tie-off considerations)

II.B.3. Lanyards

A lanyard is a flexible rope, wire rope, or strap which generally has a connector at each end for connecting the body belt or body harness to a deceleration device, lifeline, or anchorage point (see 29 CFR 1926.500(b)). Some manufacturers offer adjustable length lanyards. Effective lanyards are maintained in a clean, intact condition, and inspected prior to each use for wear, tear, and any obvious distortion or signs that the fall arrest (energy-absorbing) system has been activated (see 29 CFR 1926.502(d)(21)).

Inspecting a lanyard involves beginning at one end and continuing to the opposite end. During an inspection, the lanyard is slowly rotated so that its entire circumference is checked. Spliced ends require particular attention.

Lanyards used for personal fall protection are not to be used for hoisting materials. Equipment used for hoisting is not suitable for use in a fall protection system (see 29 CFR 1926.502(d)(18)).

II.B.3.i. Deceleration Device

A deceleration device is a mechanism (e.g., tearing or deforming lanyards) that serves to dissipate energy during a fall to limit the energy and stress imposed on a worker during a fall. Deceleration occurs over a maximum distance of 3.5 feet (see 29 CFR 1926.502(d)(16)(iv)). Deceleration devices vary widely. Examples include:

- **Self-retracting lanyard.** A self-retracting lanyard/lifeline contains a drum-wound line which can be slowly extracted or retracted. The lanyard extends as necessary to allow the worker to move about the work area, but retracts as necessary to maintain slight tension, preventing the line from becoming slack. The drum is under slight tension during normal worker movement and automatically locks the drum when the line is extracted too rapidly (see 29 CFR 1926.500(b)).

  Self-retracting lanyards and lifelines that limit free fall to two feet or less need to sustain, at a minimum, 3,000 pounds applied to the device with the lanyard in the fully extended position (see 29 CFR 1926.502(d)(12)).

  Self-retracting lanyards that do not limit free fall to two feet or less need to sustain, at a minimum, 5,000 pounds applied to the device with the lanyard in the fully extended position (see 29 CFR 1926.502(d)(13)).

  Some retractable lifelines provide a deceleration (energy-absorbing) function. These lifelines can include a feature that slows the fall over a distance of up to 3.5 feet (see 29 CFR 1926.502(d)(16)(iv)).

- **Rip-stitch lanyards.** A rip-stitch lanyard has extra webbing incorporated into the lanyard. The extra webbing is stitched into place and folded lengthwise along the lanyard. During a fall, the weaker stitching allows the folded webbing to pull away at a controlled speed, slowing the fall.

- **Shock-absorbing lanyards.** The webbing in a shock-absorbing lanyard is designed to stretch as it receives the worker's falling weight. The stretching action breaks the fall in a controlled manner.
- This is not an all-inclusive list of lanyards. OSHA expects that emerging lanyard technology will continue to improve safety in the workplace.

II.B.4. Vertical and Horizontal Lifelines

A lifeline is a component consisting of a flexible line for connection to an anchorage at one end to hang vertically (vertical lifeline) or for connection to anchorages at both ends to stretch horizontally (horizontal lifeline), and which serves as a means for connecting other components of a PFAS to the anchorage (see 29 CFR 1926.500(b)).

Vertical lifelines remain connected to a set anchorage point while the lanyard moves with the worker. If the worker falls, the clip locks (cable grab) to the lifeline and stops the worker from falling further. When vertical lifelines are used each worker generally needs to be attached to a separate lifeline (see 29 CFR 1926.502(d)(10)).

Vertical and Horizontal Lifelines

Lifelines function as an extension of an anchorage system, allowing an employee to move up and down (vertical lifeline) or back and forth (horizontal lifeline) across a work area. A sliding fitting (rope grab or shuttle) connects to the line and a lanyard connects the worker's harness to that sliding fitting.

Vertical lifelines require active participation by the worker, who must often reposition the rope grab when moving to a new position.

Horizontal lifelines require special attention during design and installation to: (1) limit the distance the worker can fall (a greater sag in the line can mean a farther fall); and (2) minimize the forces on the connectors at the anchorage (a greater sag in the line can mean lower forces on the anchorage connectors at either end). A qualified person must supervise the horizontal lifeline's design, installation, and use (see 29 CFR 1926.502(d)(8)).

Depending on their geometry and sag angle, horizontal lifelines may be subjected to greater loads than the impact load imposed by an attached component. When the horizontal lifeline's sag is less than 30 degrees, the impact force imparted to the lifeline by an attached lanyard is greatly amplified. For reference, a 15-degree sag angle amplifies the force approximately 2:1. A 5 degree sag angle amplifies the force approximately 6:1. See 29 CFR 1926 Subpart M Appendix C for more information.

When a horizontal lifeline is used for multiple tie-offs, if one worker falls, the lifeline's movement may cause other workers to fall.

OSHA is aware of emerging fall protection technology, such as pre-manufactured horizontal lifelines, that will continue to improve workplace safety.

For additional information see OSHA's Fall Protection – It's a Snap: Fall Protection Information.

II.B.5. Full-Body Harnesses

Harnesses include shoulder straps and leg straps, a sub-pelvic assembly, adjustable buckles or fasteners, and one or more D-rings to connect to a lanyard.

The dorsal D-ring (between the worker's shoulder blades) is used with a fall arrest system. D-rings in other positions are sometimes included for use with ladder safety devices. For this reason, some harnesses come with D-rings on the front, sides, and lower back.

A safe and effective harness will fit (i.e., be the correct size) and is adjusted so that all straps are snug (see Figure 15). Dangling leg straps or arm straps are signs that the harness is not being worn correctly. The sub-pelvic assembly transfers the forces during a fall or suspension to the worker's sub-pelvic region.

Although adjustable, some models come in different sizes and may be gender specific. See OSHA's Fall Protection – It's a Snap: Fall Protection Information.

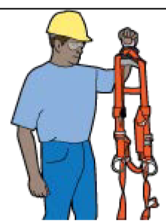
				
Inspect	Position back D-ring between shoulder blades	Buckle up legs	Buckle up front	Adjust so the harness fits snuggly and D-ring remains in the correct position

Figure 15. Simple steps to fitting a full body harness.

II.B.6. Body Belts

A body belt is a wide band that buckles around the hips with means both for securing it about the waist and for attaching it to a lanyard, lifeline, or deceleration device. Body belts serve as positioning devices that position a worker so the person can perform a job safely in a vertical work position. Body belts are designed to hold a worker in place and reduce the possibility of a fall (see 29 CFR 1926.502(e); 29 CFR 1926 Subpart M Appendix D).

II.B.7. Ladder Safety Devices

Ladder safety devices or systems are used to climb fixed ladders. The system includes a body harness, carabiner, carrier rail, and safety sleeve. Ladder safety devices are available as a cable (i.e., vertical lifeline) or fixed rail system (see Figure 16 and 29 CFR 1926.1053(a)(18), (a)(22), (a)(23)).

The worker wears a body harness attached to the system by a carabiner. The system uses a cable/safety sleeve, shuttle, or cable grab specifically designed to attach the climber to the vertical line or rail. The cable grab or shuttle freely travels up or down the lifeline/rail as the worker ascends or descends the ladder, allowing the worker to maintain full contact with the ladder. If the worker falls, a locking cam or friction brake in the cable grab or shuttle locks onto the cable or rail and arrests the fall.

Typically, cable and fixed rail systems are permanently attached to the ladder or supporting structure. The cable (flexible carrier) or rail (rigid carrier) is attached by mountings at the top and bottom of the fixed ladder, with intermediate mountings or cable guides for added strength. Existing ladders may be retrofitted with commercially available ladder climbing systems.

A ladder climbing system should not be confused with a "climb assist" system, which consists of motorized equipment that ascends the ladder and partially bears the worker's weight. Some, but not all, climb assist systems incorporate fall protection features.

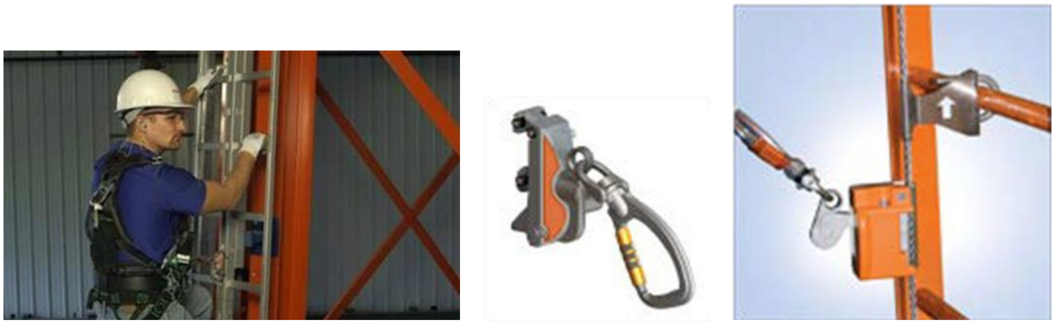


Figure 16. Ladder safety device.

II.C. Fallen Worker Rescue

An effective fallen worker rescue plan addresses the procedures, equipment, and personnel needed to ensure that a rescue proceeds quickly and efficiently when a fall occurs.

Even when a PFAS works properly, the fallen worker is still in danger. The worker's body weight places pressure on the harness straps, which can compress the veins, and cause blood to pool, in the lower extremities and reduce blood return to the worker's heart (see Figure 17). This condition is called suspension trauma, also known as harness hang syndrome. In medical terms, this results in orthostatic intolerance. If the pressure is not reduced promptly, the worker can lose consciousness within minutes. (See OSHA SHIB - Suspension Trauma/Orthostatic Intolerance www.osha.gov/dts/shib/shib032404.html)

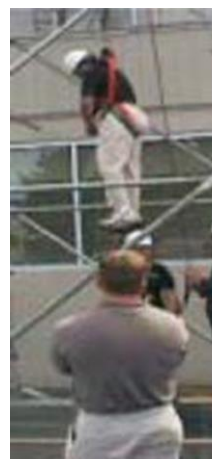


Figure 17. Worker suspended in harness prior to rescue.

See Washington Industrial Safety & Health Division's Fall Protection Responding to Emergencies.

Self-rescue and aided rescue are two techniques for rescuing a suspended worker. Rescuing the worker promptly (i.e., aided rescue) or ensuring the worker can self-rescue is imperative to preventing injury or a fatality (see 29 CFR 1926.502(d)(20)).

II.C.1. Aided Rescue

A worker who is suspended from a lifeline and cannot perform a self-rescue will need help from trained rescuers using appropriate equipment, including appropriate fall protection. Off-site emergency response personnel may rescue suspended workers, although most 911 responders are not trained in how to do so.

II.C.2. Self-Rescue

With proper personal fall protection equipment, training and practice, a fallen worker can take steps to minimize suspension trauma. Self-rescue methods allow a fallen worker to temporarily relieve pressure on the legs or in some cases to even lower himself or herself to the lower level. Self-rescue methods are discussed in detail in Washington Industrial Safety & Health Division's Fall Protection Responding to Emergencies.

III. Measurements for Assessing Fall Hazards and Controls

A few basic measurements and equations can aid in evaluating if a PFAS will be sufficient to prevent workers from contacting a lower level. This section provides information on evaluating:

- The necessary total fall clearance distance for PFASs;
- Swing fall hazards for PFASs.

III.A. Total Fall Clearance Distance for PFAS

The total fall clearance distance is the minimum vertical distance between the worker and the lower level that is necessary to ensure the worker does not contact a lower level during a fall. The total fall clearance distance is calculated *before* a decision is made to use a PFAS. If the available distance is not greater than the total fall clearance distance, it is inappropriate to use the PFAS and a fall restraint system might be used instead. Total fall clearance distance calculations are simple to perform based on several factors, including:

- Lanyard length;
- The height at which the lanyard is anchored relative to where the other end attaches to the worker's harness;
- The distance the worker will travel as the deceleration device absorbs the energy from the fall (i.e., slows it down);
- The worker's height;
- D-ring shift; and
- A safety factor.

The following variables are necessary to calculate the total fall clearance distance:

- *Free fall distance:* This is the distance the worker falls before the PFAS begins to slow the fall. When using a PFAS, this distance must be 6 feet or less and also prevent the worker from contacting a lower level (see 29 CFR 1926.502(d)(16)(iii)).

- Free fall distance varies depending on the lanyard's length and where the anchor is set relative to the back D-ring on the harness.

- *Deceleration distance:* This is the distance the lanyard stretches in order to arrest the fall. Deceleration distance must be no greater than 3.5 feet (see 29 CFR1926.502(d)(16)(iv)).

- *D-ring shift:* This is the distance the D-ring moves and the harness shifts when they support the worker's full weight. As the line tugs upwards, the harness can shift so the D-ring location is higher on the worker than it was before the fall. This shift is often assumed to be one foot, but it can vary, depending on the equipment design and the manufacturer. (See International Safety Equipment Association (ISEA), ISEA. 2015. Personal Fall Protection Equipment. Use and Selection Guide.)

- *Back D-ring height:* The D-ring height is measured as the distance between the D-ring and the worker's shoe sole while the worker is wearing the harness. This height is often standardized as five feet for six-foot-tall workers (shorter workers may also be protected using this default distance). It is necessary to adjust the back D-ring height for workers exceeding six feet. (See International Safety Equipment Association (ISEA), 2015. Personal Fall Protection Equipment. Use and Selection Guide.)

- *Safety factor:* A safety factor is an additional distance added to the total fall clearance distance to ensure there is enough clearance between the worker and the lower level after a fall. It is typically 2 feet.

The total fall clearance distance is calculated by adding these values together.

III.A.1. Calculating Total Fall Clearance Distance for Fall Arrest Systems with a Shock-absorbing Lanyard

Common assumptions:

- Deceleration distance: 3.5 feet (the maximum per OSHA requirements (see 29 CFR 1926.502(d)(16)(iv)).
- D-ring shift: 1 foot.
- D-ring height (shoe sole to point between shoulder blades): 5 feet.
- Safety factor: typically 2 feet.

The equation below shows how to add the various values in order to calculate total fall clearance distance. A fall arrest system will not protect a falling worker if the calculated clearance distance is greater than the actual distance available below the elevated work area (measured as the distance between the point at which a worker would be anchored and any lower surface).

Clearance Distance	=	**Free Fall Distance**	+	**Deceleration Distance** (lanyard/lifeline stretch/elongation)	+	**D-Ring Shift** (harness slip)	+	**Back D-Ring Height**	+	**Safety Factor**
______	=	______	+	______	+	______	+	______	+	______
Calculate		*See chart below*		*Assume 3.5 feet**		*Assume 1 foot**		*Assume 5 feet**		*Typically 2 feet*

** If actual workplace values or manufacturer specifications are available, or if circumstances dictate the need to use alternative values, use them instead.*

III.A.2. Calculating Free Fall Distance

Calculating free fall distance based on D-ring location					
D-ring ***ABOVE*** **Anchor**	Free fall distance	=	Lanyard length	+	Distance from D-ring to anchor
D-ring ***BELOW*** ***Anchor***	Free fall distance	=	Layard length	-	Distance From D-ring to anchor
D-ring ***LEVEL*** ***with anchor***	Free fall distance	=	Lanyard length		

This table applies to a worker using a shock-absorbing lanyard (e.g., ripstitch lanyard). Self-retracting lanyards typically activate, and thus limit free fall distance, within 2 feet. Refer to manufacturer specifications for activation details.

III.A.3. Examples

- **Example 1a**

  A worker is framing an attic. The worker will wear a PFAS with a 6-foot rip-stitch lanyard tied off to an anchor attached to a truss' bottom chord. He will also be standing on the same bottom chord (so the anchor will be at foot level). Calculate his total fall clearance distance.

  Free fall distance = 6-foot lanyard + 5 feet between the anchor and D-ring = 11 feet

  Answer: The free fall distance (11 feet) is greater than the 6-foot maximum free fall permitted (see 29 CFR 1926.502(d)(16)(iii)).

  No further calculations are necessary. The free fall distance can be reduced by moving the anchor above the D-ring. For example, if a section of truss has been stabilized and sheathed, the anchorage point might be moved above the worker's head.

- **Example 1b**

  A competent person sees that the trusses in the adjacent section have been installed, fastened in place, and sheathed, and are stable enough to serve as an anchorage. An anchor is installed 2 feet above the back D-ring on the worker's harness. What is the total fall clearance distance?

  Free fall distance = 6-foot lanyard – 2 feet between the anchor and D-ring = 4 feet

  Deceleration distance = 3.5 feet

  D-ring shift = 1 foot

  Back D-ring height = 5 feet

  Safety factor = 2 feet

  Answer: total necessary fall clearance distance = 4 + 3.5 + 1 + 5 + 2 = 15.5 feet. This value can then be compared to the vertical clearance actually available at the work location.

- **Example 2**

  A worker on a concrete wall is wearing a PFAS tied off to a concrete anchor strap, which is 1 foot below his D-ring. His shock-absorbing lanyard is 2 feet long. What is the total fall clearance distance?

  Free fall distance = 2-foot lanyard + 1 foot between the anchor and D-ring = 3 feet

  Deceleration distance = 3.5 feet

D-ring shift = 1 foot

Back D-ring height = 5 feet

Safety factor = 2 feet

Answer: total fall clearance distance = 3 + 3.5 + 1 + 5 + 2 = 14.5 feet. This value can then be compared to the vertical clearance actually available at the work location.

This example demonstrates that, even with a relatively short lanyard (2 feet), a fall arrest system can require considerable clearance below the elevated work area. In this case the free fall distance is 3 feet (less than OSHA's 6-foot maximum); however, the total fall distance is 14.5 feet (more than the typical space between levels in a building under construction). A falling concrete worker could come in contact with (and be injured by) any object within the space 14.5 feet below the worker's original position.

If fall protection in this configuration is used, there needs to be at least 14.5 feet of clear space below the worker. The fall protection equipment requires this much vertical distance to stop a fall and prevent the worker from falling on an object and sustaining an injury.

Where guardrails cannot be used, fall restraint is a better option than fall arrest for a work area with limited clearance below.

- **Example 3**

  A worker welding in a warehouse is using a PFAS. The system includes a 4-foot shock-absorbing lanyard that is anchored to an I-beam clamp, level with the D- ring on her upper back. What is her total fall clearance distance?

  Free fall distance = 4-foot lanyard

  Deceleration distance = 3.5 feet

  D-ring shift = 1 foot

  Back D-ring height = 5 feet

  Safety factor = 2 feet

  Answer: total fall clearance distance = 4 + 3.5 + 1 + 5 + 2 = 15.5 feet. This value can then be compared to the available vertical clearance actually available at the work location.

- **Example 4**

  A construction worker is wearing a PFAS including a 6-foot rip-stitch lanyard. He uses a strap anchor to tie off around a steel ceiling joist 4 feet above the D-ring on his back. What is the total fall clearance distance?

  Free fall distance = 6-foot lanyard – 4 feet between the D-ring and the anchor = 2 feet

  Deceleration distance = 3.5 feet

  D-ring shift = 1 foot

  Back D-ring height = 5 feet

  Safety factor = 2 feet

  Answer: total fall clearance distance = 2 + 3.5 + 1 + 5 + 2 = 13.5 feet. This value can then be compared to the vertical clearance actually available at the work location.

- **Example 5**

  The same construction worker is now using a self-retracting lanyard that activates (locks) within 2 feet if he falls. This new lanyard is connected to the same steel ceiling joist 4 feet above the D-ring on his back. What is the total fall clearance distance?

  Free fall distance = 2 feet

  This self-retracting lanyard automatically limits free fall distance to 2 feet as stated in the Example 5 problem statement (see 29 CFR 1926.502(d)(12)).

  Deceleration distance = 3.5 feet

  D-ring shift = 1 foot

  Back D-ring height = 5 feet

  Safety factor = 2 feet

Answer: total fall clearance distance = 2 + 3.5 + 1 + 5 + 2 = 13.5 feet. This value can then be compared to the vertical clearance actually available at the work location.

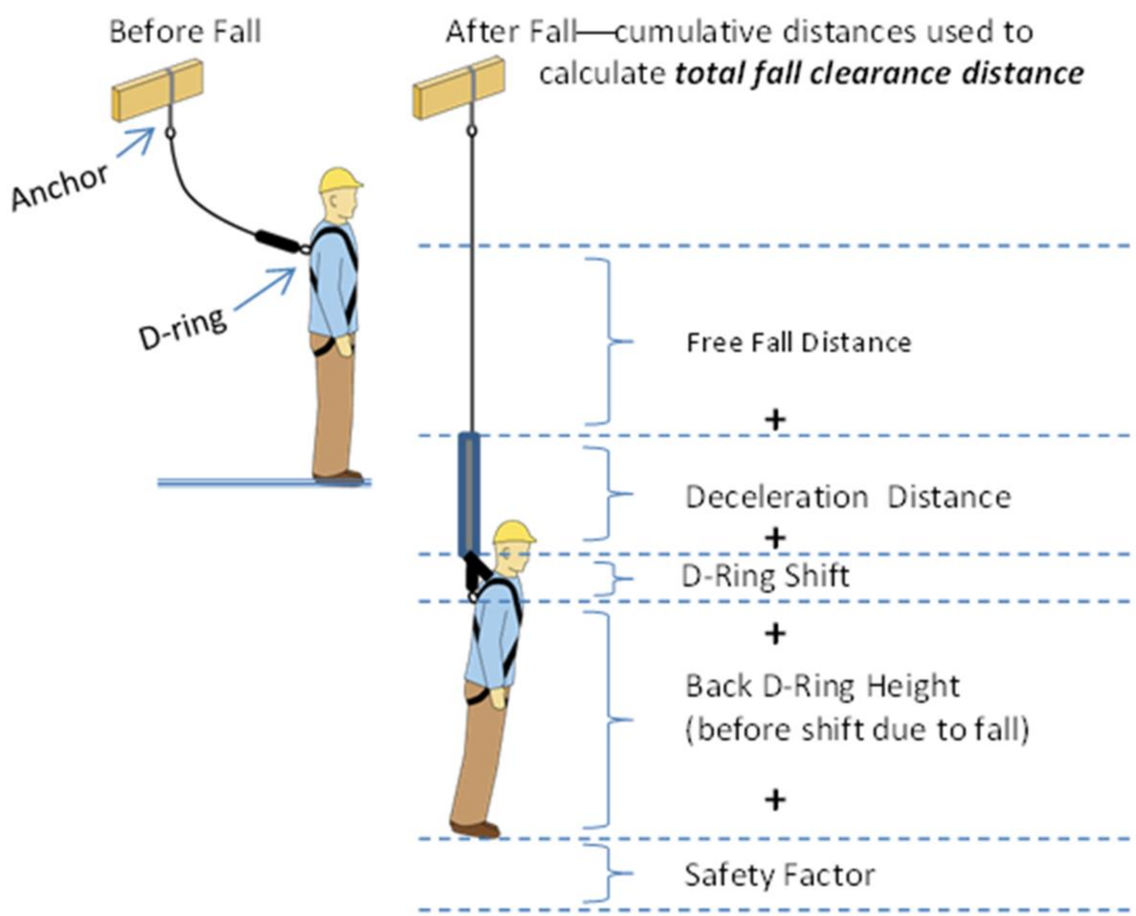


Figure 18. Total fall clearance distance -- Example with D-ring below anchor.

III.B. How to Evaluate the Swing Fall Hazard

The swing fall hazard is created by the pendulum effect, which can swing a fallen worker into a nearby surface, such as a wall or protruding beam. It is important to evaluate the swing fall hazard at any edges where a worker might fall. A worker who falls while connected to an anchor (unless it is directly overhead) will swing back and forth like a pendulum. Workers can be seriously injured if they strike objects during a swing fall. Installing the anchorage point directly above the work area (i.e., connected to an overhead attachment point with sufficient strength) will help prevent injury.

Appendix A - Fall Protection for Scaffolds and Related Equipment

Type of Scaffold or Equipment	**Fall Protection Required**
Aerial lift	Body belt (tethering, restraint system) See 29 CFR 1926.453(b)(2)(v). Personal fall arrest system or fall restraint system See 29 CFR 1926.954(b)(3)(iii)(A) (electric power transmission and distribution)
Boatswain's chair	Personal fall arrest system See 29 CFR 1926.451(g)(1)(i).
Catenary scaffold	Personal fall arrest system See 29 CFR 1926.451(g)(1)(i).
Crawling board (chicken ladder)	Personal fall arrest system, guardrail system (with a minimum 200 pound top rail capacity), or ¾ inch (1.9 centimeter) thick grab line or equivalent handhold securely fastened beside each crawling board See 29 CFR 1926.451(g)(1)(iii).
Float scaffold	Personal fall arrest system See 29 CFR 1926.451(g)(1)(i).
Ladder jack scaffold	Personal fall arrest system See 29 CFR 1926.451(g)(1)(i).
Needle beam scaffold	Personal fall arrest system See 29 CFR 1926.451(g)(1)(i).
Self-contained adjustable scaffold	**Both** a personal fall arrest system **and** a guardrail system with a minimum 200 pound top rail capacity (when the platform is supported by ropes); guardrail system only (when the platform is supported by the frame structure) See 29 CFR 1926.451(g)(1)(iv).
Single-point or two-point adjustable suspension scaffold	**Both** a personal fall arrest system **and** a guardrail system See 29 CFR 1926.451(g)(1)(ii).

Type of Scaffold or Equipment	Fall Protection Required
Supported scaffold for overhand bricklaying operations	Personal fall arrest system **or** guardrail system (with a minimum 200 pound top rail capacity) See 29 CFR 1926.451(g)(1)(vi).
All other scaffolds not specified in 29 CFR 1926.451(g)(1)(i) to (g)(1)(vi)	Personal fall arrest system **or** guardrail systems meeting the requirements of 29 CFR 1926.451(g)(4) See 29 CFR 1926.451(g)(1)(vii).

Appendix B - OSHA Standards Related to Fall Protection

This appendix lists some of the OSHA standards that apply to fall protection in construction.

Construction

29 CFR 1926.104, safety belts, lifelines, and lanyards

29 CFR 1926.105, safety nets

29 CFR 1926.451, general requirements (scaffolding)

29 CFR 1926.452, additional requirements applicable to specific types of scaffolds

29 CFR 1926.453, aerial lifts

29 CFR 1926.454, training requirements (scaffolding)

29 CFR 1926.501, duty to have fall protection

29 CFR 1926.502, fall protection systems criteria and practices

29 CFR 1926.503, training requirements (fall protection)

29 CFR 1926.760, fall protection (steel erection)

29 CFR 1926.800, underground construction

29 CFR 1926.954, electric power transmission and distribution (personal protective equipment)

29 CFR 1926.1051, general requirements (stairways and ladders)

29 CFR 1926.1052, stairways

29 CFR 1926.1053, ladders

29 CFR 1926.1060, training requirements (stairways and ladders)

29 CFR 1926.1423, cranes and derricks in construction (fall protection)

16VAC25-145, Safety Standards for Fall Protection in Steel Erection, Construction Industry (Virginia Unique standard), http://leg1.state.va.us/cgi-bin/legp504.exe?000+reg+16VAC25-145

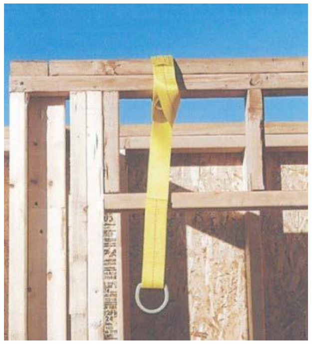
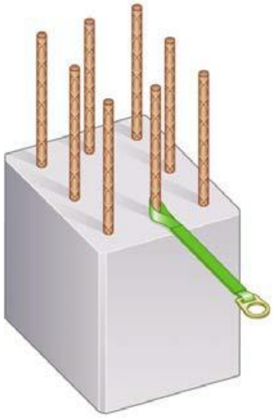
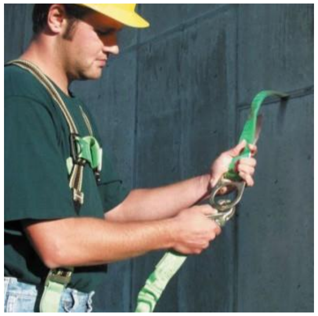
Appendix C – Examples: Fall Protection Anchors by Type

This appendix identifies various types of anchors, how they are generally used and shows an image of the anchor in use.

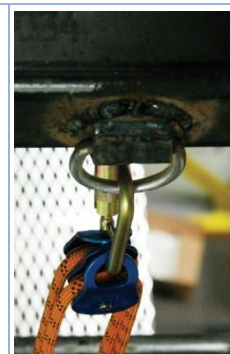
Anchor Type	Typical Use or Purpose	Illustration
Peak Anchor (One or Two D-Rings)	Typically used on a house roof after it is sheathed or fully constructed. They are typically left in place after the job is completed for future repairs.	 
Truss Anchor (including Spreaders)	Used before a structure is fully framed. A spreader is a method a qualified person may use to improve anchor point lateral stability before trusses are fully sheathed.	 
Engineered Clamp		
I-beam clamp and structural steel (vertical or horizontal beams)	The clamp adjusts to various steel beam sizes.	 

Anchor Type	Typical Use or Purpose	Illustration
Trolley beam anchor	Allows a worker to have greater access to a larger area without a longer lanyard.	
Standing seam metal roof anchor	For workers on standing seam metal roofs. This anchor clamps onto parallel seams.	
Doorway and window opening clamp	For anchoring between interior building framing or a window opening.	

Anchor Type	Typical Use or Purpose	Illustration
Top Plate Anchor	For activities near the framed wall top plate.	
Strap Anchor		
Cable anchorage sling	For use around structural steel or I-beams.	
Drop-through anchor cable	Anchor point drops through a small hole in an overhead substrate (concrete or steel).	

Anchor Type	Typical Use or Purpose	Illustration
Strap anchor (web)	For sturdy horizontal structures (e.g., beams or structural steel members). Sharp or rough edges could damage the strap.	 
Concrete Anchor		
Concrete anchor strap with D-ring	Often used by workers conducting foundation and formwork. The concrete anchor strap has a tough sleeve or wear-pad that protects it from abrasion where it contacts concrete. The strap loop slips over rebar and is left in place (with D-ring exposed) when concrete is poured. When no longer needed, the strap is cut flush with the concrete surface. Photo: a worker connects a shock-absorbing lanyard to an embedded concrete anchor strap.	 

Anchor Type	Typical Use or Purpose	Illustration
Precast hollow core concrete anchor	For workers performing activities with precast hollow concrete. Allows a single worker to tie off.	

Anchor Type	Typical Use or Purpose	Illustration
Bolt-on wall anchor	Temporary or permanent anchor point on a vertical concrete wall.	
Welded Anchor		
Welded D-ring anchor	Single D-ring temporary or permanent anchor point that is welded onto vertical structural steel.	
Weld-on anchor post	This permanent anchor point is welded onto an I-beam.	

Anchor Type	Typical Use or Purpose	Illustration
Trench Box Guardrail Anchor	For performing deep excavation. The trench box guardrail is designed with an anchor point on a post near the guardrail.	 

Anchor Type	Typical Use or Purpose	Illustration
Anchor Not Bolted or Clamped in Place		
Mobile fall protection system	Intended for a single worker using a fall arrest system. It allows quick mobility from place to place on a job site. Larger versions allow multiple workers to anchor.	
Rotating retractable anchor mast	For use on sloped residential roofs. Allows the worker greater range of motion (up to 360 degrees for some models) and helps elevate the anchor point above the worker.	
Dead weight anchor	For use on roofs where penetrating the surface is not an option. Anchorage is provided by the weight of heavy materials (e.g., concrete, steel, water bladder).	 

Anchor Type	Typical Use or Purpose	Illustration
Bolt hole anchor	For use in horizontal steel bolt holes.	
Vertical Lifeline		
Rope grab (with vertical lifeline)	Rope lifeline attaches to an anchorage at the top and hangs vertically down through the work area. Movable rope grab attaches to the rope. Lanyard connects the rope grab to workers' harness. To move up and down the work area, the worker can slide the rope grab up and down the lifeline, then relock it in place. If the worker falls, the rope grab locks onto the rope to break the fall. This system's effectiveness depends on how well the worker is trained to reposition the rope grab while moving about. The grab can slide off the end of the rope if the rope is too short, if a knot is not tied near the end of the rope, or if the grab	 

Anchor Type	Typical Use or Purpose	Illustration
	is not installed properly.	
Horizontal Lifeline	This hybrid system uses one line (firmly anchored at both ends) as the anchorage for another. This allows the worker greater lateral movement than a fixed anchor point. The components are the same as other personal fall protection systems. A deceleration device or rip-stitch lanyard can be included. In some cases, more than one worker will connect to the horizontal lifeline if approved by the manufacturer and a qualified person.	 

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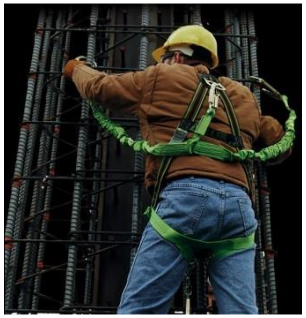
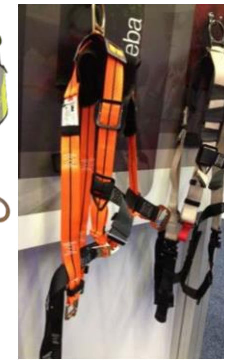
Appendix D – Examples: Lanyards, Deceleration Devices, Harnesses, and Body Belts

Device Type		Typical Use or Purpose	Illustration
Lanyard	Lanyard (typical 2-foot and 6-foot lengths)	Lanyards are available in a variety of lengths.	
	Y-lanyard (or twin-leg lanyard)	Typically used during work on cranes, rebar and steel structures, and poles. By attaching and reattaching the legs in different positions, the worker can move across the work face, remaining connected by at least one leg of the lanyard at all times.	

Device Type		Typical Use or Purpose	Illustration
Deceleration Device	Rip-stitch-style Shock Absorbing Lanyard	These typically expand by approximately 3.5 feet during deceleration, which reduces the force on the worker.	
	Stretch-type Shock-Absorbing Lanyard	These absorb force in a fall by stretching (or by a similar mechanism) on impact to provide a controlled deceleration.	
	Self-retracting lifeline (line wound on a reel in a reel-housing)	The lifeline is wound on a reel and automatically extends or retracts to take up slack in the line as the worker moves about. A sudden extension in the line activates a locking mechanism that typically includes a deceleration device. Some self-retracting lanyards can be set to restrict the distance traveled and so can also function as part of a properly designed fall	

Device Type	Typical Use or Purpose	Illustration
	restraint system.	
Body Harness	Used in personal fall protection systems. Has a D-ring on the back between the shoulders when used for fall arrest and fall restraint systems. Workers need to be fitted with the correct harness size. Available with special features such as an integrated high-visibility vest, extra D-rings (for use with positioning devices), life vest (for over-water work), or various buckle and closure styles.	  
Body Belt	In general, harnesses are preferable to body belts. Body belts may be used in limited instances (e.g., as part of a positioning device system).	 
Thimble	Thimbles provide a protective interface between the eye of a rope loop and a connector. They are used to prevent pinching or abrasion of the rope. The thimble needs to be firmly seated in the eye of the rope loop.	

Appendix E - References and Resources

29 CFR 1926 Subpart M (.500, .501, .502, and appendices)

29 CFR 1926 Subpart R and appendices

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