nsc Construction & Utilities Division

Prevention & Protection

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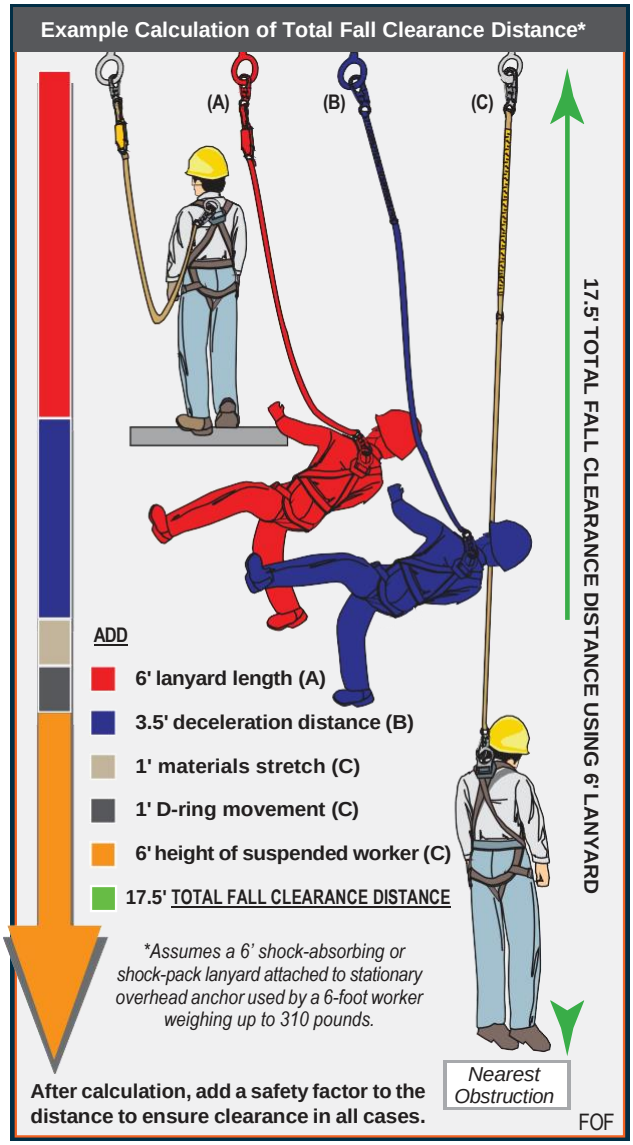
Selecting Lanyards and Connectors for Personal Fall Arrest Systems in Bridge Work

In a personal fall arrest system (PFAS), a lanyard connects a body harness to an anchor or to a horizontal or vertical lifeline. Lanyards are typically made from 3-foot to 6-foot lengths of synthetic webbing or rope, or wire rope, with attached connectors such as snaphooks, carabiners, or other devices. Lanyards may have built-in shock absorbers to reduce the impact of a fall.

Ideally, a personal fall arrest system is designed, tested, and supplied as a complete system. However, it is common practice for PFAS components to be interchanged because some parts wear out more quickly. The employer should realize that not all components are interchangeable. Proper selection of compatible PFAS components is discussed on the reverse.



Lanyard Length and Total Fall Clearance Distance

Selection of lanyards in bridge work must consider the ***total fall clearance distance*** of a potential fall. The total fall clearance distance is the vertical distance from the anchor to the nearest lower obstruction that a falling worker would impact, such as a structural member or the ground. Five basic factors make up this distance: 1) lanyard length, 2) deceleration distance of the energy absorber in a shock-absorbing lanyard or a shock-pack lanyard, 3) estimated materials stretch, 4) estimated D-ring movement, and 5) height of the suspended worker.

The illustration at left shows how these factors affect total fall clearance distance for a 6-foot worker using a 6-foot lanyard anchored overhead. Safely arresting the fall of a 6-foot worker using a 6-foot lanyard requires approximately 17.5 feet of clearance from the anchorage point to the nearest lower obstruction.

In cases where vertical lifelines or horizontal lifelines are used, calculations of total fall clearance distances must also include the slip of the rope grab plus lifeline stretch (vertical lifeline) or the displacement plus stretch of the lifeline (horizontal lifeline).

For anchorage below standing D-ring level, careful calculation and a larger shock-pack are required to control arresting force.

The required total fall clearance distance may be shortened in any setup by using a shorter lanyard (3, 4 and 5-foot lengths) or by using a self-retracting lifeline (SRL).

When selecting a lanyard for use in an aerial work platform (AWP), consult the operator's manual to determine the recommended lanyard length. It is best to use a lanyard that will restrain the worker on the AWP and will not allow the worker to fall or be catapulted over a guardrail.

Lanyard Length and Fall Force

Always select the shortest possible lanyard. The longer the lanyard, the longer the fall and the greater the fall forces. Even short falls can generate huge amounts of force. A 200-pound worker falling 10 feet is subject to 8,000 pounds of force on abrupt impact. A properly selected and installed PFAS does not *prevent* falls but greatly *reduces their impact*. Lanyards must be selected to limit free falls to no more than 6 feet and 1,800 pounds of force *[CFR 1926.502(d)(16)(ii)]*.

NOTE: Occupational Safety and Health Administration Standard 29 CFR 1926.502(d)(16)(iv) limits deceleration distance (B) to 3.5 feet. Source of other values: Introduction To Fall Protection, J. NigelEllis, Ph.D., CSP, P.E., CPE, 2012. OSHA Standard 29 CFR 1926.502(d) provides specifications for lanyards and does not directly mention ANSI or ANSI/ASSE consensus standards; however, the following OSHA webpage provides a list of various ANSI and ANSI/ASSE consensus standards relating to falls in the construction industry: https://www.osha.gov/SLTC/fallprotection/construction.html.

Lanyard Specifications

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

Compatibility of Lanyards and Connectors

Connectors on lanyards – such as snap hooks, carabiners, scaffold hooks, or web loops – should be appropriate for the connection made. While a web loop may be appropriate for wrapping around a beam, a snap hook is more often used to connect to a vertical or horizontal lifeline. Scaffold hooks, due to the larger opening, are often a better choice for anchors of convenience, such as rebar. When connecting directly to a lifeline, the connector may be an ascender/descender device.

PFAS components are often not interchangeable, whether from one manufacturer or not. In 29 CFR 1926 Subpart M Appendix C, OSHA reminds employers that they must evaluate the compatibility of all components *before* they are used to protect employees. Manufacturers issue numerous technical bulletins and educational pamphlets to aid in this evaluation.

In particular, OSHA requires employers to determine whether snaphooks are compatible with the members to which they are connected *[29 CFR 1926.502(d)(5) and 1926.502(d)(6)(v)]*.

Connector Specifications

OSHA, ANSI A10.32 and ANSI/ASSE Z359.1 all require that snaphooks and carabiners be self-closing and self-locking. Opening and releasing snap hooks requires two consecutive deliberate actions to prevent rollout and other accidental openings of the snap hook or carabiner. Both ANSI standards are compliant with OSHA 29 CFR 1926.502 requirements.

All acceptable snap hooks or carabiners have a kilo-Newton (kN) rating engraved into the spine. Since 2007, the newest ANSI standard requires all fall protection hardware to have a minimum 16 kN (3,600 pounds) rating for the gate and 22.5 kN, (5,000 pounds) tensile load (ANSI Z359.1-2007, Section 3.2.1.4.). *(A kilo-Newton equals about 225 pounds, which is a force of gravity and not static weight or mass. Force = mass times acceleration.)*

Compliant connectors are clearly stamped with strength ratings. Avoid any connectors not so marked. Dealing with reputable manufacturers and distributors helps assure acquisition of compliant connectors.

In addition to kN and/or pounds ratings, the stamp should include: year of manufacture and ID, part number, load rating for major axis, load rating for gate and – for non-integral connectors – the ANSI Z359.1(07). Although OSHA stopped requiring the construction industry to meet ANSI 2007 in 2010, it is industry best practice to follow this standard.

Inspection of Lanyards and Connectors

Personal fall arrest system components must be inspected by the user prior to each use and by a competent person on a regular schedule. Defective components must be removed from service *[OSHA 29 CFR 1926.502(d)(21)]*.