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IEEE Standard for Fall Protection for Utility Work

IEEE Power Engineering Society

Sponsored by the
Transmission and Distribution Committee

IEEE

3 Park Avenue, New York, NY 10016-5997, USA

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IEEE Standard for Fall Protection for Utility Work

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of the
IEEE Power Engineering Society

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Abstract: General recommendations for fall protection and worker protection are provided. Sufficient details of the methods, equipment, and training requirements necessary to provide minimal risk procedures for personnel working at elevated worksites are presented.
Keywords: carabineer, engineered system, fall arrester, fall arrest system, fall prevention system, fall protection program, fall protection system (hardware), total fall distance, work positioning system, worker certification

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Introduction

This introduction is not part of IEEE Std 1307-2004, IEEE Standard for Fall Protection for Utility Work.

Fall protection equipment, work methods, and training for working in elevated positions has been applied to industry in general. Utilities are a very small and specialized part of general industry and therefore require specialized climbing practices. Federal regulation proposed in 1989 caused the utility industry to realize that general industry regulations were impractical when applied to utility structures and climbing practices. This standard was developed from a trial guide established to provide fall protection applications that are specific to the utility industry.

Injuries and death from falls have long been the concern of every worker and employer whose work involves worksites at elevated locations. As data has been accumulated regarding falls, it has been recognized that falls occurred because protective equipment, regardless of how minimal or inadequate, was ignored or misused. Workers died or sustained serious injury because they were not trained to use, or simply decided they did not need to use, fall protection. Today, in most areas of the utility industry, employers have mandatory requirements regarding the use of fall protection in accordance with current accepted practice. Together, modern day equipment and training can minimize the risk of a worker falling.

This standard was written by Standards Working Group, 15.07.02 of the IEEE Engineering in the Safety, Maintenance and Operations of Lines (ESMOL) Subcommittee 15.07. It includes contributions from Subcommittee 8, Part 4, Working Rules of Accredited Standards Committee C2, National Electrical Safety Code®, (NESC®,), as well as persons from other national committees and organizations. The initial trial-use guide was reviewed, not only by electric utility organizations, but also by organizations associated with the communications, tree trimming, and structure painting industries. In accordance with the IEEE-SA Standards Board Implementation Plan for Metrics, metric units were used in the body of the document and the equivalent English units are listed as footnotes.

WARNING

Since fall prevention and protection practices for different circumstances are influenced by the nature of the circumstance, care shall be exercised when applying these practices to a specific job and location.

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IEEE Standard for Fall Protection for Utility Work

1. Overview

1.1 Scope

This standard provides general recommendations for a fall protection program for substation and generation structures and equipment, communication [including Community Antenna Television (CATV)], transmission, and distribution structures. It is not intended to include all of the proven practical methods and procedures; however, the selected recommendations covered under this standard are based on sound engineering principles, engineering safety considerations, and research into the tools, methods, practices, and training provided to and by electric power and communications workers.

This standard applies to electric distribution, transmission, and generation work, communications work (including CATV), line clearance tree trimming work (tree work performed from an aerial device or from a ladder), and structure painting. It does not include work in vaults, manholes, or other confined spaces. Requirements regarding floors and similar surfaces, stairways, guardrail systems, and scaffolding of all types are not considered in this standard.

1.2 Purpose

The purpose of this standard is to provide rules, work methods, and equipment specifications to protect employees covered under the standard from being injured by falls and provide emphasis to encourage further development in equipment, work methods, and training relating to fall protection programs used for utility work. This standard clearly differentiates between the processes of climbing to a worksite versus the actual activities at the worksite. This standard permits qualified climbers to free climb when it is safe to do so, but requires them to be attached while at the worksite.

1.3 Application

This standard is broad yet specific enough to apply to the fall protection of personnel climbing and working at a variety of elevated worksites considered for the utility industry. Since fall prevention and protection practices for different circumstances are influenced by the nature of the circumstance, care shall be exercised when applying these practices to a specific job and location.

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1.4 General considerations

The procedures presented herein are intended to clarify and enhance other national, state, and local regulations and to add specific requirements applicable to the utility industry. They are not intended to replace their respective regulations. The rules of the administrative authority shall take precedence if a conflict exists between this standard and the administrative authority's rules.

2. References

This standard shall be used in conjunction with the following publications. When the following standards are superseded by an approved revision, the revision shall apply. In case of disagreement between this standard and a referenced standard, this standard shall govern.

Accredited Standards Committee C2-2002, National Electrical Safety Code® (NESC®).[1]

ANSI A10.8-2001, American National Standard for Safety Requirements for Scaffolding.[2]

ANSI A10.14-1991, American National Standard for Construction and Demolition Operations—Requirements for Safety Belts, Harnesses, Lanyards, and Lifelines for Construction and Demolition Use.

ANSI A14.1-2000, American National Standard for Safety Requirements for Portable Wood Ladders.

ANSI A14.2-2002, American National Standard for Safety Requirements for Portable Metal Ladders.

ANSI A14.3-1992, American National Standard for Safety Requirements for Fixed Ladders.

ANSI A14.5-1992, American National Standard for Safety Requirements for Portable Reinforced Plastic Ladders.

ANSI A92.2-2002, American National Standard for Vehicle Mounted Elevating and Rotating Aerial Devices (SIA).

ANSI A92.3-1990, American National Standard for Elevating Work Platforms, Manually Propelled.

ANSI A92.5-1992, American National Standard for Elevated Work Platforms, Boom-Supported.

ANSI A92.6-2001, American National Standard for Work Platforms, Self Propelled Elevating.

ANSI Z133.1-2001, American National Standard for Safety Requirements for Tree Care Operations—Pruning, Trimming, Repairing, Maintaining, and Removing Trees, and Cutting.

ANSI Z359.1-1992 (R-1999), American National Standard for Safety Requirements for Personal Fall Arrest Systems, Subsystems, and Components.

ASTM F711-02-2003, Standard Specification for Fiberglass-Reinforced Plastic (FRP) Rod and Tube Used in Live Line Tools.[3]

[1]The NESC is available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA (http://standards.ieee.org/).

[2]ANSI publications are available from the Sales Department, American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, USA (http://www.ansi.org/).

[3]ASTM publications are available from the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, USA (http://www.astm.org/).

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ASTM F887-97a, Standard Specifications for Personal Climbing Equipment—Pole and Tree Climbers.

ASTM F914-98, Standard Test Method for Acoustic Emission for Insulated Aerial Personnel Devices.

IEEE Std 516™-2003, IEEE Guide for Maintenance Methods on Energized Power Lines.[4,5]

3. Definitions

For the purposes of this standard, the following terms and definitions apply. *The Authoritative Dictionary of IEEE Standards Terms*, Seventh Edition [B1][6] should be referenced for terms not defined in this clause.

3.1 activation distance: The distance traveled by a fall arrester or the amount of line paid out by a self-retracting lanyard from the point of onset of a fall to the activation point where the fall arrester begins to apply a braking or stopping force. This activation point is where the fall arrester engages the lifeline or, in the case of a self-retracting lanyard, where an internal brake engages. Activation distance is part of the free-fall distance experienced in a fall.

3.2 adjuster: A means to shorten or lengthen a strap, webbing, or rope.

3.3 administrative authority: The governmental authority exercising jurisdiction over application of this standard.

3.4 anchorage: A secure point of attachment to which the fall protection system is connected.

3.5 attached: A worker is connected to an anchorage when utilizing a fall protection system to prevent or arrest a fall.

3.6 belt, aerial: A single *D-ring* belt designed for attachment when a worker is in an aerial bucket or platform.

3.7 belt, line-worker's body: A belt that consists of a belt strap and D-rings, and may include a cushion section or a tool saddle.

3.8 belt, bucket: *See:* **belt, aerial.**

3.9 capacity: The combined weight for which the component is designed to be used. Combined weight includes the user's body weight and clothing, tools, and other objects borne or carried by the user.

3.10 carabineer: A connector component generally comprised of a trapezoidal or oval shaped body with a normally closed gate or similar arrangement that may be opened to permit the body to receive an object, and when released, automatically closes to retain the object. Three types of carabineers are described as follows:

a) *Locking type* (required by this standard), with a self-closing, self-locking gate that remains closed and locked until intentionally unlocked and opened for connection or disconnection.

b) *Non-locking type*, with a self-closing gate that remains closed, but not locked, until intentionally opened by the user for connection or disconnection.

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c) *Manual locking type,* with a self-closing gate that remains closed but not locked (unless purposely locked by the user) until intentionally opened by the user for connection or disconnection.

3.11 climber in training: A worker who is in training to become a qualified climber.

3.12 climbing: The vertical movement (ascending and descending) and horizontal movement to access or depart the worksite.

3.13 competent person: One who, because of training, experience, and authority is capable of identifying and correcting hazardous or dangerous conditions in the fall arrest system, or any component thereof under consideration, as well as its application and use with related equipment.

3.14 component slack distance: The distance due to the free movement between equipment components i.e., the distance obtainable when the D-ring and the attached snap hook move from the relaxed state to full tension.

3.15 deceleration distance: The additional vertical distance a falling worker travels, excluding lifeline elongation and free-fall distance, before stopping, from the point at which the energy-absorbing device begins to operate. It is measured as the distance between the location of a line-worker's body belt, aerial belt, or full-body harness attachment point at the moment of activation (at the onset of fall arrest forces) of the energy absorbing device during a fall, and the location of that attachment point after the worker comes to a stop.

3.16 detachable ladder: A sectioned ladder designed specifically for the structure it is used on and is not always left permanently installed on the structure after access is no longer required.

3.17 detachable step: An individual ladder rung or step bolt used to access structures that is typically removed from the structure after access is no longer required.

3.18 D-ring: A connector used integrally in a line-worker's body belt, aerial belt, or full-body harness as an attachment element, and in lanyards, energy absorbers, lifelines and non-permanent boom attachments.

3.19 energy (shock) absorber: A component whose primary function is to dissipate energy and limit deceleration forces that the system imposes on the body during fall arrest. Such devices may employ various principles such as deformation, friction, tearing of materials, or breaking of stitches to accomplish energy absorption. An energy absorber causes an increase in the deceleration distance.

3.20 engineered system: A fall protection system that is designed and will operate to withstand the maximum expected impact load while maintaining a specified overload capacity factor (OCF).

3.21 equipment certification: An act or process resulting in documentation that attests to product performance.

3.22 fall arrester: A device such as a rope grab that travels on a lifeline and will automatically engage the lifeline and lock so as to arrest an accidental fall of a worker.

3.23 fall arrest system: The assemblage of equipment such as a full-body harness in conjunction with a connecting means, with or without an energy-absorbing device, and an anchorage to limit the forces a worker experiences during a fall. A fall arrest system is designed to prevent a worker, in the process of a fall, from falling more than the designed fall limit.

3.24 fall clearance distance: The total fall distance plus the distances between the location of a line-worker's body belt or full-body harness attachment point under load and the nearest possible point of contact, plus the dynamic elongation.

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3.25 fall prevention system: A system, which may include a positioning system, intended to prevent a worker from falling from an elevation. Such systems include positioning device systems, guardrail, barriers, and restraint systems. Fall prevention systems are used in an attempt to prevent workers from falling from an elevation.

3.26 fall protection program: A plan intended to guard workers from injury due to falls from elevations.

3.27 fall protection system (hardware): Consists of either a fall prevention system or a fall arrest system.

3.28 flip-out: The action of a worker or test torso being unintentionally separated from the body support component during or after fall arrest. *Syn:* Fall-out

3.29 force test: A test that measures the arresting force that would be impacted on a worker during the maximum permitted free-fall.

NOTE—See 4.3.2. [7]

3.30 free-fall distance:

a) *Fall arrest*—The vertical displacement of a fall arrest attachment point on the line-worker's full-body harness between onset of the fall and just before the system begins to apply force to arrest the fall. This distance excludes deceleration distance, lifeline and lanyard elongation, but includes any energy absorbing device slide distance or self-retracting lifeline/lanyard extension before they operate and fall arrest forces occur. The component slack (D-ring slide) distance should be included in the free-fall distance.

b) *Work positioning*—The vertical displacement of the work positioning attachment point on the line worker's body belt or aerial belt between the onset of the fall and just before the worker or positioning equipment begins to retard the fall. The component slack (D-ring slide) distance should be included in the free-fall distance.

3.31 harness: A component with a design of straps that is fastened about the worker in a manner so as to contain the torso and distribute the fall arrest forces over at least the upper thighs, pelvis, chest, and shoulders with means for attaching it to other components or subsystems. *Syn:* full-body harness

3.32 jobsite: The assembly point at the structure or equipment where the workers, tools, and vehicles are assembled to perform the climbing to the worksite.

3.33 karabiner: *See:* **carabineer**.

3.34 lanyard: A flexible line of webbing, rope, wire rope, or strap that generally has a connector at each end for connecting the line-worker's body belt, aerial belt, or full-body harness to a energy absorbing device, lifeline, or, anchorage.

NOTE—Wire rope is reserved for special use only. It is required in operations where the lanyard is subject to being cut, and prohibited in the vicinity of energized facilities.

3.35 lifeline: A component consisting of a flexible line for connection to an anchorage or anchorage connector at one end to hang vertically (vertical lifeline), or for connection to anchorages or anchorage connectors at both ends to span horizontally (horizontal lifeline). Serves as a means for connecting other components of a fall arrest system to the anchorage. A lifeline serves to extend the range of the user through the slideable connection of a fall arrester in the case of a vertical lifeline, or a connector or other device in the case of a horizontal lifeline.

3.36 lineman's body belt: *See:* **belt, line-worker's body.**

[7]Notes in text, tables, and figures are given for information only, and do not contain requirements needed to implement the standard.

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3.37 maximum arrest force: The peak force measured by the test instrumentation during arrest of the test weight in the dynamic test.

3.38 overload capacity factor: The number by which a maximum load is multiplied to ensure that the system does not fail when loaded beyond the design load.

3.39 pin-on platform: A platform temporarily attached by a pin to a boom to support a worker at an elevated worksite. A pin-on platform is a device typically used to support a single worker in a standing position.

3.40 pole strap: *See:* **positioning strap.**

3.41 portable platforms: A platform temporarily installed on a pole or tower. The platforms are available in various lengths and materials. They may be fixed or may pivot. The platform may have an anchorage point for a positioning strap.

3.42 positioning strap: A strap with snap hook(s) to connect to the D-rings of a line-worker's body belt or full-body harness that helps to position the worker at the worksite.

3.43 qualified climber: A worker who, by reason of training and experience, understands the methods and has routinely demonstrated proficiency in climbing techniques and is knowledgeable of the hazards associated with climbing.

3.44 roll-out: A movement process by which a snap hook or carabineer unintentionally disengages from another connector or object to which it is coupled.

3.45 rope grab: A device that travels on a lifeline and automatically frictionally engages the lifeline and locks so as to arrest the fall of a worker.

3.46 safety strap: *See:* **positioning strap.**

3.47 self-retracting lanyard: A device that contains a drum-wound line that may be slowly extracted from or retracted onto the drum under slight tension during normal movement of the user. The line has means for attachment to the fall arrest attachment on the body support. After onset of a fall, the device automatically locks the drum and arrests the fall. The device may have integral means for energy absorption.

3.48 skates: Devices used in the climbing of flanged structures.

3.49 snap hook: A connector comprised of a hook-shaped member with a normally closed keeper or similar arrangement that may be opened to permit the hook to receive an object and, when released, automatically closes to retain the object. Two types of snap hooks are described as follows*:*

a) *Locking type,* with a self-closing, self-locking keeper that remains closed and locked until unlocked and pressed open for connection or disconnection.
b) *Non-locking type,* with a self-closing keeper that remains closed until pressed open for connection or disconnection.

3.50 strength test: A test that ensures that the fall protection system has an Overload Capacity Factor (OCF) of at least 2.0 for worker who falls the maximum free-fall distance.

NOTE—See 4.3.1

3.51 total fall distance: The maximum vertical distance between the person's fall arrest attachment point at the onset of a fall and after the fall is arrested, including free-fall distance and maximum deceleration distance. Total fall distance excludes dynamic elongation.

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3.52 transferring: The act of moving from one distinct object to another (e.g., between an aerial device and a structure).

3.53 transitioning: The act of moving from one location to another on equipment or a structure.

3.54 unqualified climber: A worker that does not meet the requirements of a qualified climber.

3.55 worker certification: The act of documenting the training and demonstrated proficiency of the worker for the task to be performed.

3.56 work positioning system: A system of equipment or hardware that, when used with a line-worker's body belt or full-body harness, allows a worker to be supported on an elevated surface, such as a pole or tower, and to work with both hands free.

3.57 worksite: The location on the structure or equipment where, after the worker has completed climbing (horizontally and vertically), the worker is in position to perform the work or task.

4. Technical requirements for a fall protection system

4.1 Introduction

The employer is responsible for eliminating or controlling recognized potential hazards by implementing a fall protection program, providing a fall protection system and ensuring the availability of tools, methods, and equipment that enable the worker to travel safely to and from the worksite.

4.2 Anchorage design strengths

4.2.1 Fall arrest systems

Anchorages to which there is fall arrest equipment attached shall be capable of supporting at least 22.2 kN[8] per person, or shall be designed, installed, and used as part of a complete fall protection system that maintains an overload capacity factor (OCF) of at least 2 (engineered system). Energy absorbing force ratings to be used in the calculations of engineered systems shall be obtained from the device manufacturer.

Demonstration has shown that energy absorbing devices can reduce the impact force to below 4.45 kN[9]. Energy absorbing lanyards are designed to slow the fall and absorb much of the energy (i.e., by tearing material or stitching) when impacted by a force.

Examples of what might be appropriate anchorages are steel/wood members or I-beams if an acceptable strap is available for connection.

WARNING

Tying off a rope lanyard or lifeline around a H-beam, I-beam, or similar support can reduce its strength as much as 70%, due to the cutting action of the beam edges. Competent persons shall be used to evaluate the suitability of such anchorages.

[8] 5000 lb.
[9] 1000 lb.

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The design limit for the OCF for multiple workers attached to the same anchorage need only be increased by a minimum factor of 0.2 for each additional worker.

Tests show that the duration of the initial shock load is so short (milliseconds) that the probability of super-imposing shocks from a simultaneous fall are extremely unlikely.

For example, using an engineered system with a 2.0 OCF and a decelerating device shock load of 4.45 kN[10], the anchorage need only support 8.90 kN[11]. Using a second worker factor of 0.2, the anchorage will support 10.68 kN[12], plus tool and equipment loads. The anchorage design shall include static and dynamic loads for conductors or equipment and work tools attached to the anchorage.

4.2.2 Positioning devices

Line worker's body belts with positioning straps are considered to be positioning devices. Positioning devices shall be secured to an anchorage capable of supporting at least twice the potential impact load of a worker's fall, or 13.34 kN[13]. Multiple worker calculations shall be in accordance with 4.2.1.

Adequate anchorages are not always available; therefore, work positioning system is used in such cases to hold a worker in position so that a fall does not occur. An anchorage is not required when using a line worker's body belt and positioning strap on a pole. Where an anchorage for the work positioning strap is available, it should be used.

4.2.3 Structures

The employer shall ensure, by test or design, that the potential fall arrest anchorages meet the minimum strength requirements.

When the work procedure does not allow attachment to the structure (i.e., barehand work), an anchorage to the work surface can be considered. The anchorage (e.g., hook ladders, insulated platforms) shall meet the same strength requirements as the structure anchorage.

4.2.4 Aerial devices

It is the employer's responsibility to verify the strength of anchorages. The employer shall ascertain that the aerial device can withstand the fall arrest forces that can be imposed on it.

Booms that have been subjected to fall arrest impact loads shall be inspected for defects.

NOTES

1—ANSI A92.2-2001, Section 4.9.5, Attachments, reads as follows: A restraint attachment, conforming to ASTM F887-97a that allows personnel to attach a positioning strap or lanyard to the ladder, platform, or boom shall be provided. Note that ANSI A92.2-1990 refers to a dated document that does not require the same tests as specified in this standard in all cases. However, the user should verify the technical points. Guardrail systems meeting ANSI A92.2-1990 will withstand 1.36 kN[14] of force.

2—ASTM F887-97a does not address attachment points or strengths of anchorages. Subclauses 15.3 and 15.4 do require a 22.2 kN[15] test for D-rings and snap hooks.

[10] 1000 lb.
[11] 2000 lb.
[12] 2400 lb.
[13] 3000 lb.
[14] 300 lb.
[15] 5000 lb.

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3—ANSI A92.2-2001 requires that hardware have a rated load of 50% yield for ductile components and a 20% yield of ultimate strength for non-metal components. There are no given strengths for fall prevention systems or fall arrest anchorages. Until values are incorporated in an ASTM standard, it is the responsibility of the employer to assure the requirements of this subclause are met.

4.2.5 Cable-supported baskets, cable carts, boatswain's chair

The use of cable carts and boatswain's chairs frequently involves situations that preclude the availability of a fall protection anchorage from a near or adjacent structure. In these situations the conductor supporting the cart or chair is the only anchorage available. It is the employer's responsibility to assure that the engineered strengths of these conductors are adequate to support the additional loads presented by the worker, equipment, the cart or chair, and the arrest of a fall with an OCF of 2.0.

Local design criteria and work practices shall dictate whether the cart/chair is used for an attachment point or whether the attachment shall be made directly to the conductor. Factors that may influence this determination include the nature of the work to be performed and the existence of mid-span attachments and obstructions.

4.3 Fall protection equipment (manufacturers' design) test parameters

Anchorages and equipment shall, as a minimum, meet the requirements of ANSI A10.14-1991, ASTM F887-97a, ANSI Z359.1-1992, or the dynamic strength and force tests specified in 4.3.1 and 4.3.2 below. These tests are necessary for an engineered system to determine the maximum anticipated forces.

4.3.1 Strength test

This test ensures that the system has an OCF of at least 2.0 for a worker who falls a maximum of 1.83 m[16] free-fall distance. It is based on a worker's weight of 113 kg[17], a force factor of 1.5, and a maximum arrest force of 11.1 kN[18]. The force factor accounts for the difference in test results of using a rigid test weight versus a non-rigid body (worker) of the same weight. That is, a rigid test weight will impact more force to a system than a human body when falling under the same conditions. A strength test shall be performed to assure an OCF of 2.0. The system shall be tested to a potential force of 22.2 kN[19]. To do this, the test weight is increased to 136 kg[20] and the fall distance increased to 2.29 m[21]. Other combinations of weights and fall distances could be used, but the 136 kg[22] and 2.29 m[23] were chosen by industry and have now been used for about 20 years. As noted above, the strength test dynamically tests for an OCF of 2.0.

This test ensures that components of the fall protection system will not fail when subjected to a 22.2 kN[24] force per worker, or to the design load of an engineered system.

4.3.2 Force test

The force test measures the arresting force that would be impacted on a worker during the maximum permitted free-fall of 1.83 m[25]. To be consistent with ISO/TC-94/SC-4, the worker's weight has been chosen as

[16] 6 ft.
[17] 250 lb.
[18] 2500 lb.
[19] 5000 lb.
[20] 300 lb.
[21] 7.5 ft.
[22] 300 lb.
[23] 7.5 ft.
[24] 5000 lb.
[25] 6 ft.

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100 kg[26]. The permitted maximum arrest forces of 8.0 kN[27] for a full-body harness is the human force limit, and a force factor of 1.4 has been applied to this value to obtain the test limit (using a rigid test weight) of 11.2 kN[28] for the full-body harness. The force factor of 1.4 rather than 1.5 (as used for the strength test) appears to be more appropriate for the weight and free-fall distance used in the force test.

4.4 Fall forces and distances

4.4.1 Fall forces

The maximum arrest force for a full-body harness shall be 8.0 kN[29].

This standard recognizes that line worker's body belts and aerial belts are not to be used as part of a fall arrest system but can be used in addition with fall arrest equipment. In the event of a fall, it is reasonable to expect when workers are using both positioning and fall arrest systems that their positioning equipment can activate prior to their fall arrest equipment activation. This standard therefore limits the forces on the line worker's body belt and aerial belt to 4.0 kN[30].

4.4.2 Free-fall distance

A fall arrest system shall be rigged such that a worker cannot free-fall more than a maximum of 1.83 m[31] (see Annex B). The component slack distance included in the free-fall distance is generally 152 mm[32].

Positioning devices attached to an anchorage shall be rigged such that a worker cannot free-fall into the device more than 0.61 m[33]. The distance may be increased if the forces listed in 4.4.1 are not exceeded and fall arrest equipment is used as work positioning equipment. In the event of a loss of footing, positioning equipment will not necessarily prevent a worker from falling, and the 0.61 m[34] maximum free-fall does not apply.

4.4.3 Deceleration distance

The deceleration distance shall not exceed 1.07 m[35] (see Annex B).

4.4.4 Total fall distance

The total fall distance shall not exceed 2.90 m[36] (see Annex B).

4.4.5 Fall clearance distance

The fall arrest system design for the equipment being used shall have a minimum fall clearance distance consisting of the total fall distance, plus the elongation distance, plus the distance from the body attachment to the nearest possible point of contact. The worker shall not contact any lower level. Lower level does not include structure bracing members or supporting vertical structures.

[26] 220 lb.
[27] 1800 lb.
[28] 2520 lb.
[29] 1800 lb.
[30] 900 lb.
[31] 6 ft.
[32] 6 in.
[33] 2 ft.
[34] 2 ft.
[35] 3.5 ft.
[36] 9.5 ft.

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There is no upper limit for the anchorage height as long as the distances in 4.4.2 and 4.4.3 are not exceeded. The anchorage for a fall arrest system is ideally above the worker's head and positioned in a manner to minimize the hazards involved (see Annex B).

Consideration for pendulum-like swing falls and the collisions they can cause as well as the ability to effect rapid self-recovery can impact the decision on the anchorage attachment height. The location of available anchorages in combination with the fall arrest system will probably cause swing falls to occur.

Note that the fall clearance distance may be limited by an obstruction or grade level, in which case the system will need to be redesigned.

5. Fall protection equipment types, inspection, and care

5.1 General

The proper application of various pieces of fall protection equipment utilized by workers while climbing, resting, and performing work from elevations is detailed and identified in this clause. On frequently climbed structures, a temporary or permanently installed cable, railing, rope, or fall prevention system may be installed for climbing and repositioning (see Clause 9).

5.2 Equipment types

5.2.1 Line-worker's body belt

A line-worker's body belt shall meet the requirements of ASTM F887-97a.

This type of belt permits work positioning and limits the exposure to falls, while the worker is using both hands to perform a work task. The line-worker's body belt, with a positioning strap or lanyard, is a fall prevention system, if there is assurance that the positioning strap or lanyard will properly interact with the structure to provide an anchorage.

5.2.2 Aerial belt (bucket belt)

Aerial belts (single D-ring belts) shall meet the requirements of ANSI A10.14-1991.

5.2.3 Harness

5.2.3.1 Full-body harness

Full-body harnesses shall meet the testing and manufacturing requirements of ANSI A10.14-1991, ASTM F887-97a and ANSI Z359.1-1992.

5.2.4 Positioning strap

Positioning straps shall meet the requirements of ASTM F887-97a. Lanyards, manufactured in accordance with 5.2.5, may be used as a positioning strap.

Positioning straps are used as a positioning device in conjunction with a body belt or full-body harness. Positioning strap components include fixed end snap hooks, adjustable end snap hooks, adjusting buckle, metal attachment clip, rivet and 45 mm[37] or wider six-ply nylon load-carrying fabric.

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Lanyards, fixed or adjustable length, may be constructed of rope or nylon webbing with a snap hook attached to both ends, or may be woven into one D-ring with a snap hook on the other end.

5.2.5 Lanyards

Lanyards shall meet the requirements of ANSI A10.14-1991 and ANSI Z359.1-1992.

5.2.5.1 Web lanyards

Knots shall not be allowed in web lanyards for any purpose. Snap hooks shall not be connected to loops made in webbing-type lanyards unless specifically designed for the purpose.

5.2.5.2 Rope lanyards

When multi-stranded rope lanyards are spliced to connect fittings, other ropes, extensions and attachments, there shall be a minimum of four (manufacturers may require five, on certain materials) tuck splices. Knots, other than the length-adjusting knot, shall not be allowed in rope lanyards for any purpose.

5.2.6 Pole and tree climbers

Pole and tree climbers shall meet the requirements of ASTM F887-97a. Pole and tree climber components include the leg irons, gaff, ankle and leg straps, and leg pads. Climber leg irons are made of steel or aluminum alloy. Climbers may be adjustable or non-adjustable and may have replaceable or non-replaceable gaffs.

5.2.7 Skates

Straps shall be fastened prior to ascending or descending a structure.

Exercise caution when ascending and descending with skates to prevent slipping due to the presence of moisture, wetness, ice, oil, or scale rust on flanges.

The climbers shall keep their knees away from the structure with their weight on their heels. The skate is released by lifting the heel and pointing the toes downward, releasing the grab of the rubber stoppers. One foot is slid up while leaning back on the alternate foot. Descending is accomplished by alternately releasing and putting weight on each skate. Leaning forward on skates can cause them to lose contact with the structure and slip.

5.2.8 Anchorage

Anchorages are attachment points for fall arrest equipment able to withstand the shock load of a falling worker. Anchorages shall not allow movement of the anchoring device or lanyard in any direction if a fall should occur. Anchorages may be eyebolts, rigging points, slings, ropes, other attachments to the structure, or a lanyard wrapped around structural members so as to limit any movement of the lanyard at the connection point.

Anchorages shall meet the technical requirements of Clause 4.

[37] 1.75 in.

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5.2.9 Energy absorber

Energy absorbers are devices designed to control the amount of shock load to the body by decelerating the workers fall. Energy absorbers may be tear-out stitching on webbing or other shock absorbing material that will control the amount of shock transmitted to the worker in the event of a fall.

Energy absorbers shall meet the testing and manufacturing requirements of ANSI Z359.1-1992.

5.2.10 Self-retracting lanyard

Self-retracting lanyards are attached to an automatic rewinding reel that quickly arrests a fall and limits the shock load to the worker. Self-retracting lanyards place less limitation on freedom of movement up to the length of their lanyard or webbing.

Self-retracting lanyards shall meet the testing and manufacturing requirements of ANSI Z359.1-1992.

5.2.11 Lifeline

Lifelines shall meet the requirements of ANSI Z359.1-1992. Lifelines shall be protected against being cut or abraded. Not more than one worker shall be attached to any one lifeline.

5.2.12 Rope grab with lifeline

There are no consensus standards for rope grabs. Rope grabs shall be designed to allow free movement along a lifeline, but lock on the lifeline if a fall occurs. Rope grabs shall be compatible with the lifeline being used.

The operation of rope grabs in dirty conditions or in inclement weather shall be considered prior to use in those environments.

5.2.13 Fixed rail, tube, or cable with slider

Fixed rail, tube, or cable with slider systems shall meet the testing and manufacturing requirements of ANSI A14.3-1992. Fixed rail, tube, or cable with slider systems shall permit the worker using the system to climb without continually having to hold, push, or pull any part of the system, leaving both hands free for climbing. The connection between the slider and the attachment point on a body belt or harness shall not exceed 229 mm[38]. These systems shall be activated within 0.61 m[39] after a fall occurs, in order to limit the descending velocity of the worker to 2.1 m/s[40] or less.

5.2.14 Aerial devices

Aerial devices shall meet the requirements of ANSI A92.2-2001, ANSI A92.3-1990, ANSI A92.5-1992, and ANSI A92.6-2001.

5.3 Inspection and care of fall protection equipment

The equipment manufacturer shall furnish inspection and maintenance program recommendations to the purchaser.

[38] 9 in.
[39] 2 ft.
[40] 7 ft/s

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The employee shall visually inspect fall protection equipment each day before use to determine that the equipment is in safe working condition. This equipment shall be inspected at least annually by a competent person. Defective equipment shall be removed from service immediately.

5.3.1 Guidelines

The employer shall develop a guide that specifies inspection and maintenance practices to be performed on all climbing and fall protection equipment used in a fall protection system, including the shelf and service lifetime, system rating, and frequency of inspection for the following components:

a) Belts
b) Straps
c) Webbing
d) Ropes
e) Hardware
f) Devices that lockup
g) Devices that lower
h) Climbing devices

Special requirements, such as low electrical conductivity, may require specific maintenance requirements (see IEEE Std 516-2003).

5.3.2 Equipment inspection

5.3.2.1 Line-worker's body belt

The following specific items of the line-worker's body belt shall be inspected to determine that:

a) Hardware has no cracks, nicks, distortion or corrosion
b) No loose or worn rivets are present
c) Waist strap has no loose grommets
d) No worn materials that could affect the safety of the user are present
e) D-rings are compatible with the snap hooks with which they are used
f) No non-approved modifications have been made to carry tools or material

See 11.3 for a discussion of roll-out. Not all D-rings are compatible with all snap hooks. The incompatibility may cause roll-out or unintentional disengagement of the snap hook from the D-ring. This incompatibility can result from multiple combinations of component shape, dimensions, and wear. Snap hooks and D-rings of different manufactures shall not be used together unless previously demonstrated to be compatible.

5.3.2.2 Harness

The following specific items of the harness shall be inspected to determine:

a) Absence or illegibility of manufacturer's markings
b) Absence of any elements affecting the equipment form, fit or function
c) Evidence of defects or damage to hardware elements including cracks, sharp edges, deformation, corrosion, chemical attack, excessive heating, alteration and excessive wear

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d) Evidence of defects in or damage to straps or ropes including fraying, misplacing, inlaying, kinking, knotting, roping, broken or pulled stitches, excessive elongation, chemical attack, excessive soiling, abrasion, alteration, needed or excessive lubrication, excessive aging and excessive wear

e) Alteration, absence of parts, or evidence of defects in, damage to or improper function of mechanical devices and connectors

5.3.2.3 Positioning strap

The following specific items of the positioning strap shall be inspected to determine that:

a) Warning center of the strap material is not exposed

b) No cuts, burns, extra holes, or excessive fraying of strap material are present

c) Rivets are properly secured

d) No cracks, burns, or corrosion is in the snap hook

5.3.2.4 Lanyards

The following specific items of the lanyard shall be inspected to determine that:

a) Warning center of the strap material is not exposed

b) No cuts, burns, extra holes, or fraying of strap material are present

c) Rivets are properly secured

d) No cracks, burns, or corrosion is in the snap hook

5.3.2.5 Pole and tree climbers

Pole climbers shall not be used if the gaffs are less than 32 mm[41] in length as measured on the underside of the gaff. Tree climbers shall not be used if the gaffs are less than 51 mm[42] in length as measured on the underside of the gaff.

The following specific items of the pole and tree climbers shall be inspected to determine:

a) Fractured or cracked gaffs or leg irons

b) Wear on stirrup and leg iron

c) Loose or dull gaffs or deformation that would affect use

d) Proper sharpening of gaffs

e) Broken straps or buckles

5.3.2.6 Skates

The user shall visually inspect skates for the following specific items:

a) Cracks, stress, and strap damage, determined prior to each use

b) Rubber stops. Rubber stops shall be turned if needed, or be replaced if turning will not furnish a good grabbing surface, or if they are loose in the saddle.

5.3.2.7 Carabineers

The following steps shall be taken when inspecting carabineers before use:

a) Verify that there is no visible damage to the carabineer

[41] 1.25 in.

[42] 2 in.

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b) Verify that there is no visible damage to the gate assembly

c) Verify smooth operation of the gate assembly

5.4 Usage rules

5.4.1 Pole and tree climbers

Pole and tree climbers shall not be worn when

a) Climbing in trees, unless specifically designed for tree work

b) Working on ladders (unless using the ladder as access to a worksite)

c) Working from an aerial device

d) Driving or riding in a vehicle

e) Walking in the vicinity of the jobsite

NOTE—Climbers may be worn on ladders, in aerial devices, or when walking, if used as part of an access system incidental to the work activity. Gaff guards should be worn until just prior to use and immediately after use.

5.4.2 Fall arrest equipment

Fall arrest equipment receiving an impact from a fall shall be removed from service and the entire system shall be inspected by a competent person. Suspect equipment shall be returned to the manufacturer for repair, shall be repaired by a competent person, or shall be destroyed. If the competent person finds no evidence of a defect, the equipment may be returned to service.

6. Methods

6.1 Introduction

This clause describes fall protection methods utilized on various structures and pieces of equipment. The design and type of structure or equipment determines the method of climbing and fall protection systems required for climbing, transitioning, transferring, resting, and working. The requirements of this clause shall apply to all types of work, including painting.

In order to utilize a fall protection system, the structures involved may require modification to accept commercially available systems. See Clause 10 to ensure the use of proper minimum electrical approach distances. See Annex C for a generalized listing of conditions that are associated with critical fall situations.

Where the structure is not equipped with a permanently installed fall protection system, other fall protection systems such as double belting, or the use of a hook, rope grab, and lifeline are available. The use of such methods can increase climber fatigue due to continually connecting and disconnecting these devices during ascent and descent. In addition, it forces the climber to focus on matters other than the primary objective, climbing. Therefore, a qualified climber may climb and change work positions without utilizing fall protection equipment.

The attachment requirements of this clause apply to all workers at an elevation greater than 1.83 m[43], unless otherwise specified. See 6.3.4 for discussion of various height requirements for fall protection.

All workers shall be attached or otherwise protected at a rest-site or worksite.

[43] 6 ft.

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Unqualified climbers shall be required to be attached or otherwise protected at all times unless otherwise permitted by this clause (see 3.43 and 3.54 for clarification).

6.2 Climbing, transitioning, and transferring

A qualified climber routinely demonstrates a proficiency in climbing techniques and is knowledgeable of the hazards associated with climbing. Utility workers who perform work on electric, communication, mechanical systems or the like, supported by the structures they must climb are keenly aware of the dangers not just in climbing, but also of the type of work they do at elevated locations.

Work performed at elevated locations requires not only vertical ascending and descending, but very often, horizontal movement as well. Accessing elevated worksites often requires the climber to make moves around, over, under or between structure members in order to gain position to perform the work. Fall protection equipment is not required to be used by qualified climbers climbing or changing location on poles, towers, or similar structures, unless conditions such as, but not limited to, ice, high winds, damaged or questionable supports or members, the design of the structure (i.e., no provisions for holding on with hands), or the presence of contaminants on the structure, could cause loss of footing.

Horizontal access to the worksite on a cross arm that requires the worker to move on his/her hands and knees or in a crawling-on action shall be performed using fall protection unless the cross arm is designed to permit the climber to use that method of climbing. Careful consideration shall be given to the method of fall protection selected for work on a horizontal cross arm so as not to expose the worker to other hazards such as electrical contact or mechanical complications.

Prior to climbing, a review of the suitability for free climbing shall be performed, as well as an inspection by the climber to determine that the structure or equipment is capable of sustaining the additional or unbalanced load to which it will be subjected. Where structures or equipment may be unsafe for climbing, they shall not be climbed until made safe by guying, or other adequate means.

6.2.1 Climbing and transitioning

6.2.1.1 Wood structures

A qualified climber equipped with a line-worker’s body belt and positioning strap may climb wood distribution, transmission, and communications poles without the use of a positioning strap while climbing or transitioning objects. A qualified climber may change work positions on wood structures without the use of a positioning strap where conditions warrant.

6.2.1.2 Guyed and self-supporting lattice structures

A qualified climber may climb and change work positions using step bolts, fixed ladders, or lattice steel members without utilizing fall protection equipment.

Activities such as bolt tightening, replacing bolts, resting, and other activities besides climbing or repositioning from one location to another, will require the qualified climber to be attached to the structure.

Structure inspection activities, where the qualified climber is in a continual climbing motion, do not require attachment.

6.2.1.3 Tubular steel, concrete, composite, and special purpose structures

A qualified climber may climb, transition objects, or change work positions without utilizing fall protection equipment.

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6.2.1.3.1 Tubular steel poles

A qualified climber shall be attached when moving horizontally on tubular arms except where climbing provisions have been provided.

6.2.1.3.2 I-Beam structures

The use of mechanical climbing aids, such as skates, does not amend the requirements of Clause 5.

6.2.1.4 Communications towers

A qualified climber may climb, transition objects, or change work positions on communications towers without utilizing fall protection equipment. Once at the worksite or in a rest position, the qualified climber shall be attached.

6.2.1.5 Substation and switching station structures and equipment

When climbing or changing positions on a substation or switching station structure, a qualified climber is required to follow the requirements of 6.2.1.1 through 6.2.1.3.

A qualified climber may free climb to the worksite on substation equipment provided that the requirements for ladders and supporting structures are met.

6.2.1.6 Ladders

6.2.1.6.1 Fixed ladders

Fixed ladders shall be used for ascending and descending where provided. Fixed rail or cable safety devices shall be used when in good condition and where available.

Individual step rungs fastened to the structure in the form of a ladder are considered to be a fixed ladder.

Fixed ladders are most commonly used on tubular steel, communication, and substation structures and in some instances on portions of lattice towers. In some instances a fixed (rail or cable) climbing attachment is mounted on the structure or ladder.

6.2.1.6.2 Temporary or portable ladders

Temporary or portable ladders shall be selected by design and experience to be of sufficient strength for application with the structure and work involved. They shall be constructed in accordance with ANSI A14.1-2001 (wood), ANSI A14.2-2000 (metal), and ANSI A14.5-1992 (fiberglass reinforced plastic). Temporary ladders made from metal or conductive materials shall not be used near energized lines or equipment except as may be necessary in specialized work where nonconductive ladders might present a greater hazard than conductive ladders. Conductive or metal ladders shall be prominently marked as conductive and all necessary precautions shall be taken when used in specialized work.

Ladder hardware shall meet the strength requirements of the ladder's component parts and shall be of a material that is protected against corrosion unless inherently corrosion resistant. Metals shall be so selected as to avoid excessive galvanic action.

The composition of the ladder depends on the type of work it is to be used with. Non-energized work affords the use of any composite ladder when no other energized facilities are in close proximity. While working on or in the vicinity of energized facilities, that ladder should be insulated or made of insulating material.

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Conductive ladders may be used in extra-high-voltage work to eliminate electric discharges due to strong electric fields.

a) Hook ladders (direct access to worksite)

Hook ladders may be used as follows:

1) *Vertical attachment.* While at the worksite position on the ladder, fall protection shall be used. Transferring to and from the ladder requires continuous attachment. To provide for greater stability, the hook ladder can be "tagged" (tied off) at the bottom to either the structure or to some ground-level fixed object (a chocked vehicle without keys in the ignition is often the only means available). Once the ladder is tagged and is firmly in place, it becomes more like a fixed device than portable and can be free climbed. To require attachment while simply ascending or descending creates a hazard in fastening and unfastening and shifts the worker's focus away from climbing. If the ladder is not tagged in a manner that does not allow swinging and rotation, then the worker shall be attached. While at the worksite position, fall protection shall be used. The fall protection system shall be used in a manner that does not permit the worker from sliding down the ladder in the event of a slip off a ladder rung. Hook ladders often are used on steel, concrete, and composite structures as well as wood poles to gain access to the fixed ladders or steps permanently installed on the structure. In some cases there may be inadequate toe space behind the ladder. In these cases it may be necessary to add spacers to the ladder mounts to obtain adequate toe space.

2) *Horizontal attachment.* While on the horizontal ladder, fall protection shall be used. Transferring to and from the ladder requires continuous attachment. The horizontal ladder can be placed in a wide range of configurations to meet the needs of the worksite. Not only does it provide access to the worksite, it also provides a platform to work from. When a ladder is used in this fashion it requires the qualified climber to pay careful attention to where the worker steps or moves.

b) Detachable ladders and steps

A qualified climber while in the process of installing or removing detachable ladders or steps on the structure shall use an appropriate fall protection system.

Detachable ladders and steps must fit into the clips or on the studs in such a fashion that they are not easily knocked loose when bumped by workers, material, or tools. After the ladders or steps are properly in place on the structure the qualified climber may climb or reposition without the use of fall protection. If the work position is on the ladder, attachment is required.

c) Self-supporting ladders (step, platform, and extension trestle)

When work is to be performed off these ladder types, care shall be taken to properly stabilize the ladder and the worker. Workers are not required to be attached to the ladder.

Ladder selection shall include the proper size and type of ladder, the proper stabilization of the ladder, and the following of basic work rules.

Fall prevention depends on the safe use of self-supporting ladders. The use of fall arrest equipment is not practical when working on self-supporting ladders. Ladders are primarily designed for access to work locations.

The climber should face the ladder, not exceed the highest permitted standing level, keep the belt buckle between the rails, and not push or pull material.

d) Non-self-supporting ladders (extension and single)

When work is to be performed off these ladder types, care shall be taken to properly stabilize the ladder and the worker. Workers are not required to be attached to the ladder.

Ladder selection shall include the proper size and type of ladder, the proper stabilization of the ladder, and the following of basic work rules.

Special precaution, such as securing the ladder to the structure or equipment, is required if the climber is transferring from the ladder.

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Fall prevention depends upon the safe use of non-self-supporting ladders. The climber should face the ladder, not exceed the highest permitted standing level, keep the belt buckle between the rails, and not push or pull material.

Ladders are primarily designed for access to work locations. When work is performed from a ladder, the climber should maintain three points of contact with the ladder, unless the ladder is secured at the top and work positioning equipment is used. It is preferable to tie the ladders firmly to the object being accessed to prevent the ladder from sliding or moving in such a manner that may cause the climber to fall. The use of fall arrest equipment is not practical when working on non-self-supporting ladders, as anchorage points are not available or would require extra climbing to establish them.

Certain of the foregoing basic rules may not apply if the ladder is secured at the top and work positioning equipment is used.

6.2.2 Transferring

6.2.2.1 Cable-supported basket, boatswain's chair, or cable cart and a structure

A qualified climber transferring to or from a supported basket, boatswain's chair, or cable cart shall be attached to the equipment and the structure while making the transfer.

6.2.2.2 Single-worker bucket aerial device

Transferring to or from a single-worker bucket shall not be permitted.

6.2.2.3 Multi-worker bucket or platform aerial device

A qualified climber may transfer to or from a multi-worker aerial device (i.e., a multiple worker single basket or platform) to a structure, conductor, aerial ladder, or cable cart, provided that it is not prohibited in writing by the manufacturer, and:

a) The basket shall be self-leveling or fixed-pin or have a locking mechanism to provide stability during transfer.

b) The transfer is made to or from the device through a door, or by a portable ladder or step solely designed for the purpose of assisting the worker over the rim of the basket or platform. Portable ladders or steps shall not extend beyond the rim of the basket or platform. Portable ladders or steps shall be removed from the basket or platform when transferring is no longer required.

c) Two or more climbers shall be available at the point of transfer. One shall remain in the basket or platform and be attached to the aerial device at all times.

d) When transferring to or from a basket or platform a climber shall 1) be attached at all times to the aerial device and to the structure or equipment while making the transfer, or 2) shall be attached to the aerial device, and prior to stepping from the floor of the basket or platform, shall detach and immediately attach to the structure or equipment.

e) When transferring to the basket or platform from the structure or equipment, the climber shall 1) be attached at all times to the structure or equipment and to the aerial device while making the transfer, or 2) be attached to the structure or equipment, and prior to stepping off the structure or equipment, detach and immediately attach to the aerial device.

f) Unattached time as permitted in item 2) of d and item 2) of e shall be kept to a minimum.

NOTE—A qualified climber wearing skates should transfer only through a door designed for that purpose.

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6.2.2.4 Pin-on platform

Transferring from a single-worker, pin-on platform is permitted. A qualified climber shall be attached at all times to the aerial device and structure or equipment while making the transfer.

6.2.2.5 Helicopter

Transferring to or from a helicopter to a conductor or structure by a qualified worker is accomplished by the platform or suspension method. The qualified worker shall be attached to the helicopter at all times when traveling between the ground and the aerial transfer point or worksite. Barehand work methods require the qualified worker to be in contact with or bonded to the conductor or energized part and insulated or isolated from conductors or objects at a different potential. Care must be taken to ensure the fall arrest system does not compromise the worker's insulated or isolated work positions.

6.2.2.5.1 Helicopter with a platform and a structure or conductor

When a qualified worker is in position to transfer to a conductor or structure, the disconnecting device of the fall arrest system shall be disconnected from the helicopter and immediately reattached to the conductor or structure being transferred to. The fall arrest system shall consist of a harness and line-worker's body belt (or equivalent) with the appropriate connecting devices. The time the qualified worker is not attached to either the helicopter, conductor, or structure during this transfer shall be kept to a minimum.

6.2.2.5.2 Suspended from a helicopter

a) Conductor

A fall arrest system consisting of a harness (or equivalent device), and the appropriate connecting devices is required when a qualified worker, suspended from a helicopter, is transferring to or from a conductor. When the worker is placed in a stable position on the conductor, the connecting device attached to the worker's harness (or equivalent) shall be attached to the conductor, and the worker shall immediately disconnect the connecting device to the helicopter. The time the worker is attached to both the helicopter and conductor shall be kept to a minimum.

b) Structure

A fall arrest system consisting of a harness (or equivalent) with the appropriate connecting devices is required when a qualified worker, suspended from a helicopter, is transferring to or from a structure. When the worker is placed in a stable position on the structure, the connecting device of the fall arrest system attached to the helicopter shall be disconnected and immediately reattached to the structure. The time the worker is not attached to either the helicopter or the structure shall be kept to a minimum.

6.3 Working at elevated locations

6.3.1 Tower erection and removal

Modern day lattice tower erection typically involves the joining of ground assembled structure sections of the tower supported by a crane or helicopter at various elevations. The sections are joined together using bolted splice plates. The crane or helicopter slowly lowers a section for attachment to a previously installed lower section in a manner that allows the suspended section to be bolted to the splice plates already installed on the lower section. Most side bracing is left unfastened on both sections at the attachment points to allow the sections to be joined together smoothly. Usually four climbers, one on each leg, are in place at the top of the lower section waiting to position the suspended section to the lower section and install the bolts. There is no place above the worker to install fall protection until after the suspended section is bolted in place and the side bracing cannot often be used because it is not yet firmly bolted in place. This is an extremely dangerous

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time for the climbers whose only escape route from trouble is to climb down the legs they are working on. To require attachment prior to having the new section minimally secured to the splice plates exposes the workers to injury should trouble develop prior to catching off the upper section. Most workers will use their positioning strap around the tower leg of the lower section while awaiting the placement of the upper section and often elect to leave it in place until the sections are bolted. Many workers fear being pinned in place by their positioning strap if the suspended section shifts or breaks free and therefore elect not to use positioning straps for the time it takes to land the upper section. This standard recognizes the danger involved at this point of the installation and similar installations and determines it is up to the individual worker to decide the safest procedure for him or her to follow. During tower removal, the qualified climber shall be required to be attached until the last bolt is ready to be removed. This requirement applies to all components of a tower, including arms.

6.3.2 Aerial devices

When working from an aerial device, workers shall be attached using a fall protection system prior to the bucket or platform being raised, and shall remain attached except as permitted in 6.2.2.3 or 6.2.2.4. The fall protection system shall consist of the following:

a) An anchorage that meets the technical requirements of Clause 4

b) One of the following:

   1) Full body harness, or

   2) If the fall protection system can be rigged in such a manner that the worker cannot free fall more than .9m[44], an aerial belt may be used

c) A connection device consisting of a lanyard with an energy absorbing device and locking snap hooks shall be used to connect the harness or aerial belt to the anchorage.

NOTES

1—Workers using an aerial device need not be qualified climbers.

2—Aerial devices may be used as the principle means to reach a suitable climbing device, such as a fixed ladder.

6.3.3 Helicopters

Qualified workers shall be attached to the helicopter at all times. The qualified worker shall attach the fall arrest system prior to leaving the ground. The fall arrest system shall remain attached until the helicopter returns to the ground unless permitted per 6.2.2.5 for transferring.

6.3.4 Substations, generating stations, and switchyards

When working at an elevation of 3.05 m[45] or more on the top of equipment such as transformers, circuit breakers, or other large equipment, fall protection is required.

Current consensus fall protection standards set varying heights for the required use of fall protection equipment. While a height of 1.22–1.83 m[46] is a common starting point for requiring the use of fall protection equipment, certain standards recognize the need, due to structure, equipment, or operational limitations, to initiate fall protection at greater heights. For example, ANSI A10.8-2001[47] requires guard rails to be installed on scaffolds exceeding 3.05 m[48] in height.

[44] 2 ft.
[45] 10 ft.
[46] 4–6 ft.
[47] Information on references can be found in Clause 2.
[48] 10 ft.

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Substation equipment, such as transformers and capacitors, does not readily accommodate permanent guard rails, nor does it provide suitable anchorages for the attachment of personal fall protection equipment. Because this type of equipment is typically less than 3.05 m[49], and because the exposure to fall protection hazards would be similar to that faced by an employee working on a scaffold less than 3.05 m[50], it is believed that a 3.05 m[51] starting height for the use of fall protection equipment is appropriate for substation equipment.

Porcelain bushings shall not be used to secure fall protection equipment, unless the required strength and method to support the fall protection equipment has been verified.

If attachment points are provided on the top surface, they shall be in accordance with Clause 4.

6.3.5 Cable carts, boatswain's chairs, etc.

Cable carts, boatswain's chairs, and similar devices shall only be used by qualified climbers who have had training on the specific device to be used.

Before a cable cart or boatswain's chair is supported from a conductor, a visual inspection shall be made of the conductor to identify any apparent physical damage or deterioration that may reduce the strength of the component. This inspection shall include the integrity of the conductor attachments at each end of the span to be traversed.

6.3.6 Portable platforms

A portable platform may be temporarily installed on a pole or tower to provide the line-worker a convenient place to stand, and to place the worker in the correct vertical and horizontal relationship to the area to be worked. The platforms may be fixed or may pivot.

To provide provisions for fall prevention and line-worker positioning, the platforms may have an auxiliary tripod or railing located to provide attachment for a positioning strap. Unless it is specifically designed to provide fall protection the auxiliary tripod or railing shall be used for positioning only and not to withstand a free fall. The line-worker will need to use the structure for anchorage.

7. Rescue and escape

7.1 General

Retrieval of a worker after a fall or escaping from an elevated position or aerial device is accomplished with available equipment. Aerial devices, cranes, hand lines, descent devices, or any other device capable of lifting or affording a path of safe travel to the worker shall be used. The equipment the employer provides to the workers for rescue and escape from hazardous situations shall be included with all the other climbing equipment inspection, maintenance, and training schedules.

[49] 10 ft.
[50] 10 ft.
[51] 10 ft.

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7.2 Rescue and escape descent devices

Descent devices shall be sized to permit the safe descent from an aerial device at the maximum distance obtainable from the bucket or platform to the surface where the worker can gain support. The rate of descent is controlled by the worker.

There are many controlled-descent devices using rope friction, rope to metal friction, or some other type of friction brake. These devices should be attached to the body harness or body belt such that the workers will have control of the descent and be able to attach and detach themselves.

7.2.1 Spiral-wrapped

There are no consensus standards for these devices.

Spiral-wrapped descent-control devices control the rate of descent by the number of wraps around a spiral-grooved rod sized for a specific rope. The rate of descent is controlled by the worker. The spiral-wrap device generally has a tie off position to lock the worker in a fixed position if the need arises for the use of both hands.

7.2.2 Figure eights

There are no consensus standards for these devices.

Figure eights (8), or firefighter rings, allow a loop of rope to be passed through one of the openings, and placed around the outside of the ring, allowing a controlled descent. The rate of descent is controlled by the worker.

As the figure eight requires tying a special knot around the ring, and a special degree of skill is required to control descent, the figure eight shall only be used by employees receiving frequent training in its use.

7.2.3 Brake-controlled

There are no consensus standards for these devices.

Brake-controlled descent devices have a cable attached to a drum with a friction brake to control the rate of descent. Most of these devices have a rate of descent that is preset by the manufacturer. Some of these devices are user-controlled up to a preset maximum rate of descent.

7.3 Rescue methods

Rescue and escape procedures shall be established that provide for the prompt rescue of a worker when working in an elevated position or in the event of a fall. These procedures shall include self-rescue techniques. Appropriate equipment shall be provided for rescue (e.g., providing the controlled descent device, means of communication, etc.).

Rescue of workers suffering trauma due to a fall is beyond the scope of this standard. Generally, public service personnel will be required to evaluate the injured worker's condition and to provide immobilization equipment, stokes/basket type litter, or other rescue equipment. When planning or executing rescue and escape measures involving energized facilities, the first consideration shall be to maintain minimum approach distances to the energized facilities.

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8. Training

8.1 General requirements

Required training may be on the job, in the classroom, or a combination of both, but it shall be conducted by a qualified climber.

Training shall be specific to the type of work being performed. Workers who may be required to use fall protection equipment shall be trained in the use of fall protection equipment and in the application limits, proper anchoring and tie-off techniques, including determination of elongation and deceleration distance, methods of use, and inspection and storage of the system components. Workers who may be required to use fall protection equipment shall become familiar with manufacturers' recommendations, reduction in strength caused by certain tie-offs, and maximum permitted free-fall distances.

Due to the variety of required climbing techniques and associated hazards in electrical and communication utility work, it is essential that each respective worker be given sufficient training to master the required skills. In addition to the worker possessing the basic physical attributes needed to perform the work, the employer shall demonstrate all the climbing techniques to be learned and explain each hazard associated with the technique.

Climbing instruction shall be presented in a way that the worker can recognize and avoid the hazardous conditions while at the same time master the art of climbing, resting, and positioning for work.

The instructor shall explain and demonstrate the use of each piece of equipment used by the worker for climbing and positioning. The worker shall become proficient in the use and care of the equipment.

8.2 Climber in training

A climber in training shall be attached at all times at elevations in excess of 1.83 m[52] or other fall protection shall be provided (i.e., safety net). Formal training programs may be established specifically to train multiple climbers under one supervisor/instructor.

Training shall be specific to the type of structure (e.g., lattice, wood, etc.) and climbing device. When the trainee successfully completes this training, the trainee shall be considered qualified for that type of structure only. Training shall include instruction in the following areas:

a) Recognition of any hazards unique to the structure to be climbed
b) Selection of the proper climbing equipment and fall protection system
c) Proper use of fall protection system
d) Climbing methods, such as:
    1) Free climbing
    2) Belting
    3) Transitioning
    4) Transferring and other climbing techniques
e) Considerations associated with energized facilities
f) Techniques for safely performing aerial rescue
g) Proper care, inspection, and maintenance of climbing equipment and fall protection systems or devices

[52] 6 ft.

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8.3 Rescue training

Workers shall be trained and shall have demonstrated proficiency in the rescue procedures relevant to the work they perform. Rescue shall be practiced by qualified climbers and others involved with climbing activities on a regular basis, and at least annually.

8.4 Climber proficiency

A worker whose job assignment requires climbing poles, towers, or other similar structures shall be deemed a qualified climber after completing the training and demonstrating proficiency in the skills required by 8.2.

8.5 Documentation

The employer shall document that each employee has been trained and has demonstrated proficiency in the elements of fall protection required by this standard. The documentation shall be retained and maintained for the duration of the employee's employment. A copy of the documentation can be given to the employee.

8.6 Retraining

The employer is responsible for assuring that a climber possesses the skill, knowledge, and physical ability necessary to perform the job safely. Employees who, in the judgment of responsible supervision, fail to demonstrate adequate skill, knowledge, or physical ability, or who have not performed climbing for one year, shall be re-qualified.

Documentation shall comply with the intent of 8.5. See 7.3.7 of ANSI Z-359.1-1992.

9. Structure design

9.1 New design

New construction of elevated structures shall incorporate into their design all the features required to safely construct, climb, and maintain them in accordance with the preceding clauses. Particular attention should be given to providing adequate anchorages, climbing space, and live work minimum approach distances. It is imperative that new designs consider the use of fall protection systems.

Specific fall protection items to be considered include fixed ladders, pole or tower steps, platforms, guard rails on platforms, structure members to aid transferring to or from step bolts, ladders, and structure members, anchorages, and fixed rail or cable systems. These design principles apply to generating stations, substations, switchyards, poles, towers and other similar structures.

The minimum electrical approach distances listed in the NESC (Rules 236 and 441), whichever is greater, shall be utilized.

Permanently installed equipment and fixtures associated with climbing shall be provided for access to the highest work location on the structure.

The principal access path will in general be continuous, except for lateral points where the design will provide for a safe transition.

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Design loads shall be required to accommodate the loads associated with the worker, the worker's tools, and the rigging loads for the work to be performed.

9.1.1 Principal access path on elevated structures

9.1.1.1 Step bolts

Step bolts shall

a) Have a minimum clear width of 115 mm[53], be firmly attached without sharp edges, and be so constructed that a climber's foot cannot slip off the ends.

b) Be vertically spaced a maximum of 153 to 457 mm[54] evenly spaced.

c) Provide a minimum toe clearance of 178 mm[55]. Where an obstruction cannot be avoided, the toe clearance may be reduced, but shall be at least 140 mm[56].

d) Be capable of supporting the intended workload [as defined for the application per the applicable ANSI standard(s)], but in no case shall the minimum design live load be less than a simple concentrated load of 271 kg[57] applied 51mm[58] from the inside face of the step bolt head.

e) Be maintained in a safe condition and, where feasible, be inspected before each use, utilizing an appropriate inspection technique. Step bolts that are bent greater than 0.26 rad[59] below the horizontal shall be removed and replaced with bolts that meet the requirements of this subclause.

If tower bracing, splice plates, etc., are within the 457 mm[60] spacing, they may be used as stepping points, provided they meet the above a, c, and d requirements. In addition the surface should be flat and level so that a worker's foot does not slide or get wedged in.

NOTE—Step bolts on lattice structures are usually located on one leg of the structure. A portable access ladder or temporary step bolts are required to reach the first step since it is located a minimum of 2.45 m[61] above the ground (NESC Rule 217A2).

9.1.1.2 Fixed ladders

Fixed ladders on elevated structures shall meet the following requirements (see ANSI A14.3-1992):

a) The spaces between steps or rungs permanently installed on poles or towers shall be uniform, except where working, standing, or access steps are required, and shall be not less than 254 mm[62] nor more than 356 mm[63] apart. Fixed ladder rungs and step rungs for poles and towers shall have a minimum diameter of 16 mm[64]. Fixed ladder rungs shall have a minimum clear width of 406 mm[65].

b) The minimum distance between obstructions behind the rungs shall be not less than 178 mm[66]. Rungs shall be corrugated, knurled, dimpled, coated with skid-resistance material, or otherwise

[53] 4.5 in.
[54] 6–18 in.
[55] 7 in.
[56] 5.5 in.
[57] 598.4 lb.
[58] 2 in.
[59] 15 degrees
[60] 18 in.
[61] 8 ft.
[62] 10 in.
[63] 14 in.
[64] 5/8 in.
[65] 16 in.
[66] 7 in.

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treated to minimize slipping, and shall be shaped such that a worker's feet cannot slip off of the end of the rungs.

c) Fixed ladders on elevated structures shall be capable of supporting their maximum intended load.

d) For public protection the fixed ladders are started 2.45–3.05 m[67] above grade level necessitating the use of temporary ladders for access.

9.1.1.3 Hook ladders (direct access to worksite)

Access to the worksite may require the use of hook ladders. Provisions shall be incorporated into the structure to accommodate such ladders, or similar ladders with various ladder support attachments.

Hook ladders provide a means of accessing facilities that are specifically installed with a predetermined clearance from the structure. They also provide convenient access for routine activities on the structure where permanent access is limited. Hook ladders can be made of wood, metal, or synthetic material (typically fiberglass).

9.1.1.4 Detachable ladders or steps

Detachable ladders or steps shall meet the following requirements:

a) Detachable ladders shall be in accordance with 9.1.1.1, and typically, the detachable ladder is comprised of a number of step bolts attached to a square or rectangular steel bar with appropriate end fittings on the ends of the bar that fit into permanently installed clips on the structure. The size and weight of the ladder is such that one worker alone can install or remove it from the structure.

b) When detachable steps or climbing devices are used, secure attachment of the step or device to the structure shall be provided. The spacing between detachable steps shall not exceed 914 mm[68] on any one side and spaced at 457 mm[69] intervals.

9.2 Retrofit existing structures

Retrofit of existing structures may create a greater exposure to falls than routine maintenance activities. Retrofitting of structures for fall protection shall be considered where structures are frequently climbed or where the possibility of a fall exists.

10. Special conditions

10.1 General

Equipment identified in this clause will have application to both energized and non-energized facilities. This includes equipment utilized by line clearance tree trimmers.

The specific requirements for devices used by tree trimmers are covered in ANSI Z133.1-2001.

Live work demands the dielectric integrity of fall protection devices be confirmed when the possibility exists of inadvertent or of planned entry inside the minimum electrical approach distance.

[67] 8–10 ft.
[68] 36 in.
[69] 18 in.

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In addition to the task of climbing, resting, and positioning at the worksite, it is imperative the fall protection method selected be compatible with the specific work being performed and/or the prevailing conditions. Many elements of a fall protection system used on de-energized work may not be suitable for energized, storm damage, or inclement weather work.

10.1.1 Selecting an energized work method

When selecting an energized work method to perform work on or near energized facilities at an elevated work position, consideration shall be given to:

a) Method of reaching the elevated position and returning to the ground
b) The fall protection system

The fall protection systems used shall not compromise the worker's insulated position. A key element to barehand work is access to the final work position. Access to the work position can be accomplished by one or more of the following:

a) Insulating aerial device
b) Insulating hot sticks
c) Nonconductive rope
d) Insulating ladder
e) Insulating platform
f) Insulating tower boom
g) Helicopter

NOTE—The basic live work methods to be considered are discussed in IEEE Std 516-2003. Fall protection equipment shall not violate electrical minimum approach distances. Refer to NESC Rule 441, for the minimum electrical approach distances for qualified workers. The minimum electrical approach distance for unqualified workers is 3.05 m[70] for phase-to-ground voltages below 50 kV and 3.05 m[71] plus 102 mm[72] for each 10 kV above 50 kV.

10.2 Clearance to energized facilities for tree trimming

When trimming trees in proximity to energized facilities, the working distance shall be in accordance with ANSI Z133.1-2001.

Fall protection devices used in these circumstances shall not reduce the minimum electrical approach distances of NESC Rule 441, for qualified workers.

10.3 Storm damage and inclement weather

10.3.1 Storm damage

Thorough inspection of suspected or visually damaged facilities shall precede any climbing or work activity. Stresses that may have exceeded design limitations require engineering evaluation. Qualified climbers shall inspect all climbing surfaces for damage to permanently attached facilities such as step bolts, rungs, working rings, attachment fixtures, and welds. In particular, the structural integrity of the anchorages for attaching work positioning and fall protection systems shall be carefully scrutinized. In addition, other hazards (trees, buildings, adjacent structures, etc.) that may fall into or affect the structure's stability shall be analyzed before work is started on the structure.

[70] 10 ft.
[71] 10 ft.
[72] 4 in.

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10.3.2 Inclement weather

Weather conditions may adversely affect qualified climbers and climbing surfaces. Prevailing local conditions (i.e., wind, ice, rain, and slippery surfaces) shall be considered in the selection of climbing methods and equipment. Actions shall be taken to minimize the effects of wet, icy, muddy, or slippery handholds and stepping surfaces (i.e., ice can be chipped, anti-slip gloves and/or boots can be worn).

When a structure has ice or snow accumulations, special care should be taken if it is necessary to climb the structure. The use of a second lanyard or pole strap should be considered. A structure should not be climbed if heavy rain or high winds are present.

11. Precautions

11.1 General

Manufacturers' recommendations shall be considered in addition to employer requirements for the inspection, care, use, and maintenance of fall protection equipment.

11.2 Positioning equipment

One hundred percent leather positioning straps, aerial belts, and line-worker's body belt buckle attachments shall not be used. Composite positioning straps that have a wear indicator and the rated strength required by this standard shall be used.

11.3 Accidental disengagement

Accidental disengagement is the sudden, unexpected release of a positioning strap snap hook from the D-ring of the line-worker's body belt, without the user directly manipulating the latch of the snap hook.

Snap hooks shall be dimensionally compatible with the member to which they are connected so as to prevent unintentional disengagement of the connection.

The possibility exists for some snap hooks to roll-out of D-rings. Attachment of mismatched or multiple snap hooks, either of the non-locking or locking type, to a single D-ring should be avoided. When multiple locking snap hooks are attached to a single D-ring, they shall be evaluated in the combination to be used. Locking snap hooks reduce the possibility for roll-out.

Snap hooks shall not be connected to each other.

The employee shall determine that all components of the fall protection system are properly engaged and that the employee is secure in the line-worker's body belt, harness, or other fall protection equipment.

11.4 Line-worker's body belt or aerial belt flip-out

The line-worker's body belt or aerial belt shall be worn in such a way as to prevent flip-out. The use of *gut straps* or *suspenders* or other methods should be used to minimize the risk that the worker will flip out.

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Annex A

(normative)

Elements of a fall protection program

A.1 Fall protection program

A fall protection program includes all of the elements required to prevent a climber from falling or, should a fall occur, to arrest the forces on the worker's body to prescribed limits. A fall protection system has the following components:

a) Qualified climber or continuous attachment

b) Inspection and care of equipment

c) Fall protection system (hardware). A fall protection system consists of three basic elements: an anchorage designed to support the loads required for a fall prevention or arrest system (including rigging and work loads); a worker's body attachment; and a means of connecting the body attachment to the anchorage.

Fall protection systems are of the following two types:

a) *Fall prevention system*

A fall prevention system prevents the worker from falling from one elevation to another elevation. Some examples of components that may be included in a fall prevention system are:

1) Anchorage

2) Tethers with body attachment

3) Harness with retractable lifeline or lanyard

4) Line-worker's body belt with positioning strap or lanyard (see NOTE below)

5) Aerial belt with lanyard

6) Railing

NOTE—Line-worker's body belts with positioning straps or lanyards are considered to be positioning devices in cases such as climbing poles. The qualified climber requirements shall be met where positioning devices do not guarantee fall prevention or protection.

b) *Fall arrest system*

A fall arrest system is designed to arrest the worker in the event of a fall. Considered in a fall arrest are the length of fall and the action of any energy-absorbing device incorporated in the system. Some examples of components that may be included in a fall arrest system are

1) Retractable lifeline or lanyard

2) Lanyard with deceleration provisions

3) Lifeline with rope grab

4) Harness

5) Anchorage

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Annex B

(normative)

Components of an arrested fall

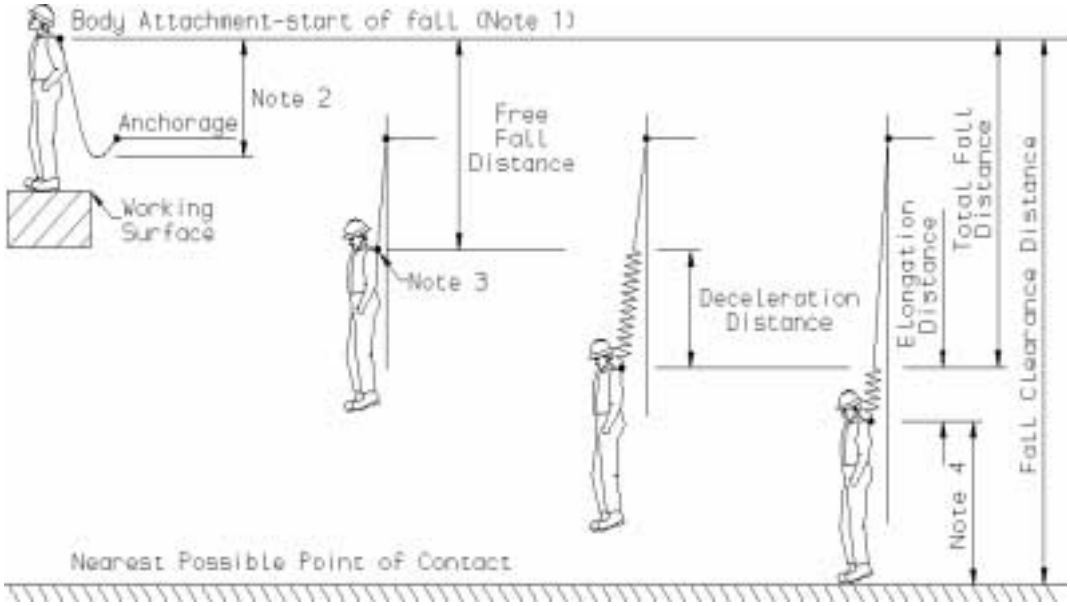


Figure 1—Components of an arrested fall

NOTES

1—The anchorage should be above the body attachment point; however, this may not always be possible, i.e., when attaching a lattice member or an aerial device. The principle shown also applies to the use of a line-worker's body belt and aerial belt.

2—The lanyard slack, and distance between the body and anchorage attachments, shall be included in the fall arrest system design for each specific use.

3—The movement of the D-ring from its slack position to deceleration on set shall be included in the free-fall distance (1.83 m[73] maximum) (see 3.30).

4—The elongation distance plus the distance from the body attachment to the nearest possible point of contact shall be included in the fall arrest system design for each specific use.

[73] 6 feet

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Annex C

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Critical fall situations

C.1 Wood structures

During work on wood poles, the following conditions described in C.1.1 through C.1.3 may be encountered and create the potential for a fall while climbing, transitioning, and changing position and/or work location. These conditions shall be addressed in the training required for qualified climbers.

C.1.1 Condition of poles

- Knots/knotholes
- Broken pole
- Weather checks
- Splinters
- Rotted outer surface
- Crooked/leaning poles
- Wet/icy conditions
- Conditions created by wood preservatives

C.1.2 Conditions on poles

- Conduits or cable attachments
- Nails/tacks
- Communication cables/wires
- Ground wires and moldings
- Signs/posters
- Pole numbers and date nails
- Insect nests
- Metering equipment
- Inadequate climbing space
- Guy wires/crossarms/other attachments

C.1.3 Climbing practices

- Ascending or descending too rapidly
- Climbing low side of pole
- Climbing too close to the pole
- Climbing through unprotected/uncovered conductors
- Improperly sharpened climbing gaffs
- Inattention while ascending or descending

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— Belting off at an improper position
— Holding onto hardware
— Standing on hardware
— Improper climbing techniques (cut-outs of climbing hooks, roll-outs on snap hooks/positioning strap)

C.2 Lattice steel structures

Items that shall be included in a climbing hazard assessment for lattice structures include:

— Moving on diagonal members during structure climbing inspections and when transitioning the bridge
— Loose or weak step bolts
— Permanent fixed ladders
— Temporary ladders
— Structure design (extended spacing between steps)
— Deterioration of step bolt or rung strength
— Weather (cold, wind, ice, wet, mud)
— Excessively rough or sharp surfaces that can catch clothing or cut the climber
— Loose steel members

C.3 Tubular steel, concrete, guyed, composite, and special purpose structures

Items that shall be included in a climbing hazard assessment for these types of structures should include:

— Permanently installed ladders and rungs
— Loose or weak step bolts
— Temporary ladders and step bolts
— Temporary platforms
— Weather (cold, wind, ice, wet, mud)

C.4 Personal clothing

The following conditions in a worker's clothing could create a potential hazard while climbing. These conditions should be addressed prior to climbing:

— Worn or loose heels/soles on climbing boots
— Loose or torn clothing
— Improper size gloves
— Holes in gloves
— Slippery type clothing (nylon, polyester, etc.)
— Grease/oil stained clothing or gloves

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Annex D

(informative)

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