

<h1>PPPL</h1>	PRINCETON PLASMA PHYSICS LABORATORY ES&H DIRECTIVES		
	ES&HD 5008 SECTION 9, CHAPTER 16 Fall Protection		
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CHAPTER 16 Fall Protection

16.1 INTRODUCTION

Accidental falls from heights are one of the leading causes of workplace deaths in the United States. In order to prevent these falls from happening, this chapter will discuss control measures that must be applied when a worker is working at heights above lower levels.

16.2 SCOPE

This chapter provides information based on OSHA regulations for protecting employees from the hazards of falling to a lower level, both during general work activities and during construction activities. This chapter does not address falls on a single level, such as from slips or tripping, which are addressed in Section 8, Chapter 9, "Housekeeping and Sanitation", and in Section 9, Chapter 9, "Office Safety" of this manual.

16.3 DEFINITIONS

Anchorage - a secure point of attachment for lifelines, lanyards or deceleration devices.

Body belt (safety belt) - a strap with means both for securing it about the waist and for attaching it to a lanyard, lifeline, or deceleration device.

Body harness (full body harness) - straps which may be secured about the employee in a manner that will distribute the fall arrest forces over at least the thighs, pelvis, waist, chest and shoulders with a connector (D-ring) for attaching it to other components of a personal fall arrest system.

Carabiner - a hardened metal ring designed to facilitate connection between components.

Connector - a device which is used to couple (connect) parts of the personal fall arrest system and positioning device systems together. A connector may be an independent component of the system, such as a carabiner, or it may be an integral component of part of the system (such as a D-ring sewn into a body harness, or a snap-hook sewn to a lanyard).

Controlled access zone (CAZ) - an area in which certain work (e.g., overhand bricklaying) may take place without the use of guardrail systems, personal fall arrest systems, or safety net systems and access to the zone is controlled.

Deceleration device - any mechanism, such as a rope grab, rip-stitch lanyard, automatic self-retracting lifelines/lanyards, etc., which serves to dissipate a substantial amount of energy during a fall arrest, or otherwise limit the energy imposed on an employee during fall arrest.

Guardrail system - a barrier erected to prevent employees from falling to lower levels.

Hole - a gap or void 2 inches or more in its least dimension, in a floor, roof, or other walking/working surface.

Lanyard - a flexible line of rope, wire rope, or strap which generally has a connector at each end for connecting the body belt or body harness to a deceleration device, lifeline, or anchorage.

Leading edge - the edge of a floor, roof, or other walking/working surface which changes location as additional floor or roof sections are placed or constructed. A leading edge is considered to be an unprotected side and edge during periods when it is not actively and continuously under construction.

Lifeline - a flexible line for connection to an anchorage at one end to hang vertically (vertical lifeline), or for connection to anchorages at both ends to stretch horizontally (horizontal lifeline), and which serves as a means for connecting other components of a personal fall arrest system to the anchorage.

Low-slope roof - a roof having a slope less than or equal to 4 in 12 (vertical to horizontal).

Opening - a gap or void 30 inches or more high and 18 inches or more wide, in a wall or partition, through which employees can fall to a lower level.

Personal fall arrest system - a system used to arrest an employee in a fall from a working level. It consists of an anchorage, connectors, a body harness and may include a lanyard, deceleration device, lifeline, or suitable combinations of these.

Positioning device system - a body belt or body harness system rigged to allow an employee to be supported on an elevated vertical surface, such as a wall, and work with both hands free while leaning.

Rope grab - a deceleration device which travels on a lifeline and automatically, by friction, engages the lifeline and locks so as to arrest the fall of an employee.

Safety-monitoring system - a safety system in which a competent person is responsible for recognizing and warning employees of fall hazards.

Self-retracting lifeline/lanyard - a deceleration device containing a drum-wound line that can be slowly extracted from, or retracted onto, the drum under slight tension during normal employee movement, and which, after onset of a fall, automatically locks the drum and arrests the fall.

Snaphook - a connector comprised of a hook-shaped member with a normally closed keeper which may be opened to permit the hook to receive an object and, when released, automatically closes to retain the object. Snaphooks must be the locking type with a self-closing, self-locking keeper which remains closed and locked until unlocked and pressed open for connection or disconnection.

Steep roof - a roof having a slope greater than 4 in 12 (vertical to horizontal).

Toeboard - a low protective barrier that will prevent the fall of materials and equipment to lower levels and provide protection from falls for personnel.

Unprotected sides and edges - any side or edge (except at entrances to points of access) of a walking/working surface, e.g., floor, roof, ramp, or runway where there is no wall or guardrail system at least 39 inches high.

Walking/working surface - any surface on which an employee walks or works, including, but not limited to, floors, roofs, ramps, bridges and runways but not including ladders, vehicles, or trailers.

Warning line system - a barrier erected on a roof to warn employees that they are approaching an unprotected roof side or edge, and that designates an area in which roofing work may take place without the use of guardrail, body belt, or safety net systems to protect employees in the area.

Work area - that portion of a walking/working surface where job duties are being performed.

16.4 RESPONSIBILITIES

- 16.4.1 Department or Division Heads are responsible for ensuring implementation of this chapter.
- 16.4.2 Line supervisors / Lead Technicians are responsible for direct implementation of this chapter. Line supervisors are tasked with determining when fall protection may be required, in consultation with Industrial Hygiene and/or Construction Safety personnel.
- 16.4.3 Industrial Hygiene (IH) is responsible for assisting in the interpretation and implementation of this chapter. Industrial Hygiene may be called upon to assist in determining when fall protection may be required, and which type of fall protection is appropriate.
- 16.4.4 Fabrication, Operations, and Maintenance (FOM) Division is responsible for assisting in the determination of mechanical strengths of anchorage points and lifelines to ensure that fall protection systems utilizing these will provide appropriate protection.
- 16.4.5 All Employees are responsible for obtaining, using and/or installing fall protection equipment when necessary.

16.5 REQUIREMENTS

- 29 CFR 1910.67 - OSHA standard for "Vehicle-mounted elevating and rotating work platforms."
- 29 CFR 1910.23 - OSHA standard for "Guarding floor and wall openings and holes."
- 29 CFR 1926.500-503 - OSHA construction standards subpart M for "Fall Protection."

16.6 PRACTICES AND PROCEDURES

- 16.6.1 Each employee on a walking/working surface with an unprotected side or edge which is 6 feet or more above a lower level in construction operations, or 4 feet or more above a lower level in all other operations, shall be protected from falling by the use of guardrail systems, safety net systems, or personal fall arrest systems.
- 16.6.2 Each employee near a floor opening to be used for hoisting shall be protected from falling by guardrail systems or personal fall arrest systems. If guardrails, chains or gates are removed to facilitate the hoisting operation, and an employee must lean through the opening, that employee shall be protected by a personal fall arrest system.
- 16.6.3 Employees must be protected from falls through holes or skylights by covers, guardrails, or personal fall arrest systems. All covers shall be labeled indicating their purpose.
- 16.6.4 Each employee at the edge of an excavation 6 feet or more in depth shall be protected from falling by guardrail systems, fences, or barricades when the excavations are not readily seen because of plant growth or other visual barrier.
- 16.6.5 All employees shall be protected from falling into or onto dangerous equipment regardless of the height.

- 16.6.6 Personnel engaged in roofing activities on low-slope ("flat") roofs shall be protected from falling by guardrails, safety nets, personal fall arrest systems; or a combination of warning line system and guardrails, safety net, or personal fall arrest; or a warning line and safety monitoring system. On roofs 50-feet or less in width, the use of a safety monitoring system alone is permitted. Preference shall be given towards requiring a "positive" fall protection system, such as guardrails or personal fall arrest systems, over reliance on a safety monitoring system whenever practical.
- 16.6.7 Work on steep roofs requires positive fall protection systems such as guardrails, safety nets, or personal fall arrest systems.
- 16.6.8 Guardrail systems shall comply with OSHA standards 29 CFR 1926.502(b) including:
- A. Top rails shall be 42 inches plus or minus 3 inches above the walking/working level. Higher rails may be allowed under certain circumstances.
 - B. Midrails, screens, mesh, balusters, or other media shall be installed between the top edge of the guardrail system and the walking/working surface when there is no wall or parapet wall at least 21 inches high.
 - 1. Midrails, when used, shall be installed at a height midway between the top edge of the guardrail system and the walking/working level.
 - 2. Screens and mesh, when used, shall extend from the top rail to the walking/working level and along the entire opening between top rail supports.
 - 3. Intermediate members (such as balusters), when used between posts, shall be not more than 19 inches (48 cm) apart.
 - 4. Other structural members (such as additional midrails and architectural panels) shall be installed such that there are no openings in the guardrail system that are more than 19 inches wide.
 - C. Guardrail systems shall be capable of withstanding, without failure, a force of at least 200 pounds applied within 2 inches of the top edge, in any outward or downward direction, at any point along the top edge.
 - D. When the 200 pound test load is applied in a downward direction, the top edge of the guardrail shall not deflect to a height less than 39 inches above the walking/working level.
 - E. Midrails, screens, mesh, etc., shall be capable of withstanding, without failure, a force of at least 150 pounds applied in any downward or outward direction at any point.
 - F. Guardrail systems shall be so surfaced as to prevent injury to an employee from punctures or lacerations, and to prevent snagging of clothing.
 - G. The ends of all rails shall not overhang the terminal posts, except where such overhang does not constitute a projection hazard.
 - H. Steel banding and plastic banding shall not be used as rails.
 - I. Top rails and midrails shall be at least one-quarter inch diameter or thickness to prevent cuts and lacerations. If wire rope is used for top rails, it shall be flagged at not more than 6-foot intervals with high-visibility material.

- J. When guardrail systems are used at hoisting areas, a chain, gate or removable guardrail section shall be placed across the access opening between guardrail sections when hoisting operations are not taking place.

16.6.9 Safety Net systems will not be covered in detail in this chapter. The use of safety nets at PPPL will require, at a minimum, approval from Industrial Hygiene.

16.6.10 Personal fall arrest systems and their use shall comply with the provisions set forth below.

- A. All components of a personal fall arrest system, including, connectors, d-rings, snaphooks, lanyards, and full body harnesses shall meet all of the requirements of the OSHA standard (29 CFR 1926.502(d)).
- B. Dee-rings and snaphooks shall have a minimum tensile strength of 5,000 pounds
- C. Only locking type snaphooks shall be used.
- D. Snaphooks shall not be engaged directly to webbing, rope or wire rope.
- E. Horizontal lifelines shall be designed, installed, and used under the supervision of a mechanical engineer, as part of a complete personal fall arrest system, which maintains a safety factor of at least two.
- F. Lanyards and vertical lifelines shall have a minimum breaking strength of 5,000 pounds.
- G. When vertical lifelines are used, each employee shall be attached to a separate lifeline.
- H. Lifelines shall be protected against being cut or abraded.
- I. Ropes and straps (webbing) used in lanyards, lifelines, and strength components of body belts and body harnesses shall be made from synthetic fibers.
- J. Anchorages used for attachment of personal fall arrest equipment shall be independent of any anchorage being used to support or suspend platforms and shall be capable of supporting at least 5,000 pounds per employee attached.
- K. Personal fall arrest systems, when stopping a fall, shall:
 - 1. be rigged such that an employee can neither free fall more than 6 feet nor contact any lower level;
 - 2. bring an employee to a complete stop and limit maximum deceleration distance an employee travels to 3.5 feet; and,
 - 3. have sufficient strength to withstand twice the potential impact energy of an employee free falling a distance of 6 feet, or the free fall distance permitted by the system, whichever is less.
- L. The attachment point of the body harness shall be located in the center of the wearer's back near shoulder level, or above the wearer's head.
- M. Body harnesses and components shall be used only for employee protection and not to hoist materials.

- N. Personal fall arrest systems and components subjected to impact loading shall be immediately removed from service.
- O. PPPL Emergency Services shall provide for prompt rescue of employees in the event of a fall or shall assure that employees are able to rescue themselves. In unusual circumstances where rescue may prove difficult, preplanning with the Emergency Services Unit will be necessary.
- P. Personal fall arrest systems shall be inspected by the user prior to each use for wear, damage, and other deterioration. Defective components shall be removed from service.
- Q. Personal fall arrest systems shall not be attached to guardrail systems, nor shall they be attached to hoists.
- R. When a personal fall arrest system is used at hoist areas, it shall be rigged to allow the movement of the employee only as far as the edge of the walking/working surface.

16.6.11 Positioning systems will not be covered in this chapter. Refer to the OSHA standard 29 CFR 1926.502(e) for information on these systems.

16.6.12 Warning lines shall be used for work on low-sloped roofs as follows:

- A. The warning line shall be erected around all sides of the roof work area.
- B. When mechanical equipment is not being used, the warning line shall be erected not less than 6 feet from the roof edge.
- C. When mechanical equipment is being used, the warning line shall be erected not less than 10 feet from the roof edge that is perpendicular to the direction of mechanical equipment operation.
- D. Points of access, materials handling areas, storage areas, and hoisting areas shall be connected to the work area by an access path formed by two warning lines, which shall be closed off when not in use.
- E. Warning lines shall consist of ropes, wires, or chains flagged at not more than 6-foot intervals with high-visibility material;
- F. The rope, wire, or chain shall be rigged and supported in such a way that it is between 34 inches and 39 inches from the walking/working surface.
- G. After being erected, stanchions shall be capable of resisting, without tipping over, a force of at least 16 pounds applied horizontally against the stanchion.
- H. No employee shall be allowed in the area between a roof edge and a warning line unless the employee is performing roofing work in that area.

16.6.13 A safety monitoring system shall only be used when guardrails and personal fall arrest systems are not feasible. When used, safety monitoring shall comply with the following provisions:

- A. A competent person shall be designated to monitor the safety of other employees and it shall be ensured that the safety monitor complies with the following requirements:
 - 1. The safety monitor shall be trained to recognize fall hazards;
 - 2. The safety monitor shall warn any personnel when it appears that the person is unaware of a fall hazard or is acting in an unsafe manner;
 - 3. The safety monitor shall be on the same walking/working surface and within visual sighting distance of any personnel being monitored;
 - 4. The safety monitor shall be close enough to communicate orally with the person;
 - 5. The safety monitor shall have NO other responsibilities that could take the monitor's attention from the monitoring function; and
 - 6. The safety monitor should be made identifiable, such as by wearing an orange "traffic" vest.
- B. Mechanical equipment shall not be used or stored in areas where safety monitoring systems are being used to monitor employees engaged in roofing operations on low-slope roofs.
- C. No employee, other than an employee engaged in roofing work or an employee covered by a fall protection plan, shall be allowed in an area where an employee is being protected by a safety monitoring system.
- D. Each person working in a controlled access zone shall be directed to comply promptly with fall hazard warnings from safety monitors.

16.6.14 Every pit and trapdoor floor opening, infrequently used, shall be guarded by a cover of standard strength and construction. While the cover is not in place, the pit or trap opening shall be constantly attended by someone or shall be protected on all exposed sides by removable standard railings.

16.6.15 For other situations where fall protection may be required, consult with Industrial Hygiene.