

PRINCETON PLASMA PHYSICS LABORATORY	ENGINEERING STANDARD	No. ES-MECH-016, Rev. 0 Page 1 of 4
Subject: Design, Construction, Determination and Inspection of Anchorages	Effective Date: June 16, 2016	Initiated: ES&H Department
	Supersedes: New	Approved: Head, Engineering and Infrastructure

Applicability: This Engineering Standard applies to all new and existing anchorages to support people that use personal fall arrest or fall restraint systems specifically body harnesses. It applies to both outdoor and indoor installations.

Introduction: This Standard provides the criteria for designing, constructing, and performing inspections of all anchorages as well as the inspection and maintenance requirements for anchorages.

Reference Documents:

29CFR1910.66, Powered Platforms for Building Maintenance of OSHA General Industry Regulations.

29CFR1926 Subpart M, Fall Protection section of OSHA Construction Industry Regulations.

29CFR1926 Subpart M App C, Non-Mandatory Guidelines for Complying with 1926.502(d).

29CFR1926.502, Fall Protection Systems Criteria and Practices section of OSHA Construction Industry Regulations.

ANSI A10.32 & Z359.0-18, Safety Requirements for Personal Fall Arrest Systems, Subsystems, and Components.

Definitions

1. Anchorage (anchor point) - a secure point of attachment for lifelines, lanyards or deceleration devices.
2. Competent Person - A person who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are hazardous to personnel and who has authorization to quickly correct the situation.
3. Qualified Person - A person with a recognized degree or professional certificate, (e.g. civil, mechanical, or structural engineering profession or Certified Safety Professional) and extensive knowledge and experience in this area, capable of doing design, analysis, evaluation and specifications.
4. Certified - Documentation that determines a criterion meets the requirements of the standard through testing or proven analytical method or both, carried out under the supervision of a qualified person.

Design and Construction Requirements:

The design and construction of anchorages must be done as follows:

1. Anchorages used for attachment of personal fall arrest or fall restraint equipment must be independent of any anchorage being used to support or suspend platforms.
2. Anchorages must be capable of supporting at least 5,000 pounds per employee attached or must be designed and used as follows:
 - a. Used as part of a complete fall arrest system that maintains a safety factor of at least two.
 - b. Used under the supervision of a qualified person.

❖ This also pertains to man lifts.

3. Anchorages shall be used appropriately and placed as high as feasible to reduce fall distance.
4. Positioning devices (or restraint systems) shall be secured to an anchorage capable of supporting at least twice the potential impact load of an employee's fall or 3,000 pounds, whichever is greater.
5. Anchorages may be integral to existing structures (e.g. structural steel, columns, rebar, or I-beams). Other locations may require the installation of temporary or permanent anchors. The following criteria must be considered for each anchor:
 - a. Criteria for Existing Structures
 - Structure must be sound and capable of withstanding a 5000 lb. static load.
 - In some cases, anchors must be installed immediately prior to use. In such cases, a registered professional engineer with experience in designing fall protection systems, or another qualified person with appropriate education and experience should design an anchor point to be installed.
 - Structure/anchor must be easily accessible to avoid fall hazards during hook-up and un-hooking.
 - Prior to tying off, a means of rescue in the event of a fall must be immediately available.
 - Structures used as anchor points must be at the worker's shoulder level or higher to limit free fall to 6 feet or less and prevent contact with any lower level.
 - It is known that during roof work anchors are typically found to be at hip height or below due to the lack of overhead structures to tie-off thereto. During roofing work, anchors shall be determined to be useable by the qualified person, if not previously identified, and the competent person shall calculate the fall distance to determine any associated hazards.
 - Choose structures for anchor points that will prevent swing fall hazards. Potentially dangerous "pendulum" like swing falls can result when a worker moves horizontally away from a fixed anchor point and falls. The arc of the swing produces as much energy as a vertical free fall.
 - Raising the height of the anchor point can reduce the angle of the arc and the force of the swing.
 - Horizontal lifelines can help maintain the attachment point overhead and limit the fall vertically.
 - Horizontal lifeline and anchor strength should be increased for each additional employee to be tied off.
 - The tautness at which a horizontal lifeline is installed greatly affects the forces at the anchorage point. It is recommended that designs of horizontal lifelines produce an angle no greater than 15 degrees at the time of a fall.
 - For these and other reasons, qualified persons must only do the design of systems using horizontal lifelines. Testing of installed lifelines and anchors prior to use is recommended.
 - Anchorages from existing masonry or wood members may be used only if the attachment point is substantial and precautions have been taken to assure that bolts or other connectors will not pull through. A qualified person shall be used to evaluate these anchorages with a focus on proper strength.
 - b. Criteria for permanent anchorages (in addition to all the criteria listed for existing structures, the following points must be considered):
 - Environmental factors and dissimilarity of materials can degrade exposed anchors.
 - The roof/structure integrity must be preserved after penetration for installation of anchors.
 - There must be compatibility of permanent anchors with employee's fall arrest equipment.
 - Permanent anchor systems that meet a 2 to 1 safety factor of at least 3,600 lb. must be certified. A qualified person must design and install these anchors. If the permanent anchor system is not certified it must meet a 5,000 lb. static load or greater.
 - Schedule recertification test.
 - Determine appropriate end life and schedule for replacement.
 - Visibly label permanent anchors via specific tags.
 - Roof anchors must be immediately removed from service and disposed of if subjected to fall arrest forces.

- Load or drop testing can be performed when the qualified or competent person determines it is necessary.
6. The anchorage should be rigid, and should not have a deflection greater than 0.04 inches when a force of 2,250 pounds is applied.
 7. Anchorages or special attachment points could be cast into the precast concrete members if sufficient preplanning and consideration of erectors' position is done before the members are cast.
 - a. The engineer who designed the member must approve any hole or other attachment.
 8. Knots shall not be used as anchor points.

Inspection Requirements:

1. Inspections before use shall verify compliance with:
 - a. The abovementioned design and construction requirements (ES-MECH-016).
 - b. OSHA and ANSI, as applicable.
2. Inspections before use shall also determine if the following are acceptable:
 - a. Metal features are free from damage such as cracks, breaks, pitting, wear, rough or sharp edges, corrosion, impact indicators, or distortion.
 - b. Inspection tags are present and fully legible.
 - c. Awareness of hazards below if a fall would occur when anchor points are selected.
3. Anchorages shall be inspected annually (or otherwise as stated by the manufacturer) and shall look for:
 - a. Damage to any component and its impact on the structural integrity
 - b. Loose connections to the structure (welds, bolts, etc.)
 - c. Condition of materials
4. Initial and annual inspections must be performed and documented by one of the following persons:
 - a. Professional Engineer (Civil, Mechanical, or Structural)
 - b. Certified Safety Professional
5. The Engineering Department will keep the records of inspections of the anchorages.
6. At any time the configuration of the anchor changes, it shall be re-inspected.

Posting Requirements:

1. Subsequent to the annual inspection, a tag shall be placed upon the anchorage.
2. The tag must be positioned in a visible position.
3. The tag should be marked with at least the year and initials of inspector or similar date and identification means.
 - a. This shall be performed yearly or at a time specified by the inspector.

Training:

1. Prior to use of an anchor, employees are required to pass the PPPL fall protection training.
2. Prior to use of an anchor, employees shall be briefed on how to inspect the tag to determine if the proper date and inspection markings are present.
3. After the construction and inspection of a *new* anchor, the qualified person or competent person shall brief the employees on the hazards associated with the anchor surroundings (i.e. fall hazards, obstructions, or the like).

Inspection of Anchorages/Anchor Points

Anchor Number: _____

Location: _____

Description: _____

Inspection Type: Prior to Initial Use Annual

Inspection Prior to Initial Use Requirements **Satisfactory**

1. Annual inspection is performed by a Professional Engineer (Civil, Mechanical, or Structural) or Certified Safety Professional
2. Verify compliance with Engineering Standard ES-MECH-016
3. Determine if the following items are acceptable:
 - Stability of connection between anchor and structural member
 - Condition of materials (signs of damage, rust, corrosion or pitting, impact indicators)
 - Free from distortion
 - Inspection tag is legible and in date
 - Free from hazards below anchorage given a fall would occur
 - Rescue plan has been considered
 - Can a worker move, climb up/down without exposure to a fall hazard?
 - Are anchorage points for self retracting lifeline systems located overhead?
 - Are anchorage points for body harness located at shoulder height?
4. Verify compliance with the following requirements:
 - The Fall Protection section of OSHA and ANSI, as applicable.

Annual Inspection Requirements

1. Annual inspection is performed by a Professional Engineer (Civil, Mechanical, or Structural) or Certified Safety Professional
2. Inspections should check for the following:
 - Structural integrity of the existing building
 - Damage to any component and its impact on the structural integrity
 - Stability of connection between anchor and structural member
 - Free from distortion
 - Condition of materials (signs of damage, rust, corrosion or pitting, impact indicators)
 - Inspection tag is legible and updated

Comments: _____

Inspection Performed by: _____ Date: _____

The Engineering Department will keep records of inspections and preventative maintenance.