



C-05 - PERMANENT FALL PROTECTION

Summary

This guideline sets a framework for establishing permanent fall protection systems on the facilities at the University of North Carolina at Chapel Hill (UNC). The intent of this document is to prevent exposure to fall hazards where possible and to protect personnel that are exposed to fall hazards at UNC.

Permanent fall prevention/protection measures must be included as an integral part of the design phase for all new construction projects and **roof** renovation/repair projects at UNC. All **walking/working surfaces** where employees are exposed to fall hazards (i.e. roof systems and floor **openings**) shall be permanently guarded or have qualified anchorages for personal fall arrest systems. Buildings that utilize powered platforms for exterior maintenance shall be provided with qualified anchorages and tie-in guides as necessary.

Governing Regulations

The North Carolina Department of Labor's Occupational Safety & Health Administration (OSHA) regulates fall protection for both General Industry and Construction. The General Industry Standards are located in the North Carolina Administrative Code (NCAC) under 13 NCAC 07F.0101 and incorporate by reference Federal OSHA 29 CFR 1910 Subpart D – Walking – Working Surfaces and 29 CFR 1910.66 (Powered Platforms for Building Maintenance). The Construction Standards are located under 13 NCAC 07F.0201 and incorporate by reference 29 CFR Subpart M, 1926.501-503 (Fall Protection). The primary objective of these standards is to prevent employees from falling from working surfaces and to provide adequate protection in the event of a fall.

The American National Standards Institute (ANSI) has set voluntary consensus standards for personal fall arrest systems, subsystems, and components which supplement the above referenced regulations (ANSI Z359.1-1992 (R1999)). The scope of this ANSI standard establishes requirements for manufacturer's design, performance, testing, and qualifications of personal fall arrest equipment. The standard also addresses requirements for user training, inspection, maintenance, and use of equipment used for personal fall arrest equipment.

In addition, ANSI and the International Window Cleaners Association (IWCA) have developed a standard governing safe window cleaning operations (IWCA I-14.1-2001).

It is important to note that compliance with ANSI/IWCA standard does not ensure compliance with the above referenced OSHA standards and vice versa.

Design Requirements

All new construction projects and renovations, alterations, or repairs to existing roof systems or roof mounted equipment must comply with the above regulations, as well as any applicable building codes. In addition, any installations or renovations of equipment that would subject personnel to fall hazards must incorporate fall protection solutions into the project design phase.

A qualified person with extensive experience in fall protection is required to plan, evaluate, design, and select the most appropriate fall prevention/protection solution. Building anchorages, tie-downs, and any other affected parts of the building shall be designed and certified by a registered Professional Engineer (PE) currently registered in North Carolina with expertise in fall protection systems.



A variety of fall protection solutions are available, and it is important to select a system based on the specific building type, roof system, or work application. It is imperative that the designers consider the continuity of the fall protection systems selected throughout campus. All fall protection systems shall be designed and installed similarly with compatible components to reduce variability in fall protection systems on campus. Users of these systems must be trained on how to properly use, inspect, and maintain the selected fall protection systems.

A complete understanding of the work procedures will enable the design team and/or qualified person to select the most appropriate fall protection system. The schematic design phase shall include consultation with affected campus maintenance personnel that are exposed to fall hazards. The purpose of this meeting will help identify specific building maintenance and/or equipment service activities required to be conducted throughout the life of the building. In addition, the design team can discuss maintenance and inspection requirements of the proposed personal fall arrest systems and identify areas of concern.

It is essential that during the design phase, the qualified person and/or contract designer gives consideration to the prevention of falls for future maintenance of the building, structure, or facility.

Considerations should include the following:

1. Safe access to or egress from any potential work area.
2. Provisions for permanent guardrail systems or edge protection such as parapets that meet the height criteria established for guardrails by OSHA.
3. Selection of materials that can withstand harsh environments.
4. Location of and safe access to equipment for maintenance purposes.
5. Identification and location of utilities that service the buildings (e.g., location of power lines, etc.)
6. Use of fall-arrest systems and devices, including the provision of suitably located permanent rooftop anchorages and field identification of all required anchorage point locations. (See Appendices A, B, & C for information on anchorages).

The primary goal of this guideline is to eliminate fall hazards where feasible. Where preventing exposure to the fall hazard is not possible, UNC shall provide the means for proper fall protection for all personnel working at elevated heights during construction, maintenance, and repair work.

Hierarchy of Controls

Control measures are not intended to be used independently and in many cases a combination of controls should be implemented to reduce exposure to fall hazards.

1. Engineering Controls

Engineering Controls that are designed to eliminate hazards are the preferred method for protecting employees from or controlling exposure to fall hazards. Examples of engineering controls used to eliminate or reduce exposure are listed below:

- a. Changing equipment or processes to control hazard (e.g. using aerial lifts to access work area)
- b. Installing screens/gutter guards to reduce frequency of exposure



2. **Passive Fall Protection Systems**

Passive Fall Protection Systems do not require operational involvement from the employee in order to be protected while performing work at elevated heights. Examples of passive systems are listed below:

- a. Installation of guardrail systems
- b. Construction of parapet walls meeting height criteria for guardrails

3. **Active Fall Protection Systems**

Active Fall Protection Systems require that employees understand when they are exposed to fall hazards and have a working knowledge of the fall protection system available for their protection. Active systems begin with a qualified anchorage point and have components connected to the worker (body harness, lanyard, self-retracting lifeline, rope grab, etc). Proper training in the use of active systems is essential for an effective fall protection system.

4. **Personal Fall Arrest Systems (PFAS)**

Personal Fall Arrest Systems (PFAS) are considered active systems and shall be incorporated into the building design when elimination of the fall hazard or a passive system is not feasible. Examples of PFAS are listed below:

- a. Fixed point anchors certified as an attachment point for workers that work locally
- b. Horizontal Lifeline (HLL) systems to serve as an anchorage attachment for continuous fall protection

PFAS shall provide secure anchorages to arrest a fall while preventing the users from free falling more than six (6) feet. Anchorages must be easily accessible from the roof access in order to avoid fall hazards during connection to the fall protection system. Systems shall provide uninterrupted access to the entire length of the structure without having to disconnect from the system to pass through intermediate support points. All PFAS shall be capable of supporting at least two (2) workers at a time. All essential components shall be designed and tested as part of the system in order to provide a complete and fully operational fall arrest system.

Specific Requirements

Fall protection must be provided for each employee working on elevated surfaces 4 feet above a lower level or whenever there is a possibility of falling onto dangerous equipment or into a hazardous environment, or where there are impalement hazards present. The listed examples are not all inclusive.

1. **Skylights**

Every skylight shall be guarded by a standard skylight screen or a fixed standard railing on all exposed sides. Skylight screens must be capable of withstanding a load of at least 200 lbs applied perpendicularly at any one point on the screen. In addition, screens must be constructed and mounted such that when subjected to ordinary loads they will not deflect downward and break the glass below the screen.

2. **Flat or Low Slope Roof Systems**

Employees engaged in work on low slope roofs shall be protected from unprotected edges of the roof by one or more of the following methods:

- a. Approved Guardrail System or parapet wall meeting OSHA height criteria
- b. Safety Net System
- c. Employee use of a fall-restraint or fall-arrest system



3. Steep Slope Roof Systems

Employees engaged in work on steep slope roof shall be protected from falling from all unprotected edges of the roof by one or more of the following methods:

- a. Employee use of a positioning devices, fall-restraint, or personal fall-arrest system (e.g. PFAS or HLL)

Additional Requirement Notes

1. Warning lines and safety monitor systems are prohibited on steep slope surfaces exceeding a 4 to12 pitch.
2. Mechanical equipment shall be placed only in areas where employees are protected by a warning-line system, fall restraint, or fall arrest systems.
3. The anchorage connectors and all components of fall arrest systems must be made of stainless steel or other corrosion resistant materials and comply with all sections of ANSI Z359.1.
4. A laminated reduced roof plan showing all fall protection system locations, anchor load ratings, number of authorized users that may attach to the system at one time, date of initial certification, and name of registered professional engineer who certified anchorages shall be posted at every roof access.
5. A logbook shall be maintained on site with a thorough description of certification and inspection procedures. The certification test and inspection results shall be entered into the logbook and signed and dated by the competent person.
6. Fall protection design shall consider prompt rescue procedures in the event an employee is subjected to a fall using a fall arrest system. Emergency contact information and rescue procedures shall be laminated and posted at all roof access points.
7. The certified fall arrest system must be marked on the as-built drawings with the PE seal.
8. Personal Fall Arrest Systems shall
 - a. be rigged such that an employee can neither free fall more than six (6) feet or contact a lower level.
 - b. limit the maximum arresting force on an employee to 1800 pounds when used with a full body harness
 - c. bring an employee to a complete stop and limit the maximum deceleration travel distance to 42 inches.
 - d. have sufficient strength to withstand twice the potential impact energy of an employee free falling six_(6) feet or the free fall distance permitted by the system, whichever is less.
9. Fall arrest equipment subjected to an impact load shall be immediately removed from use and/or tagged



Appendix A - Requirements for Anchorage Design, Certification, and Identification

- a. Anchorages shall be designed and installed under the supervision of a Professional Engineer (PE) in North Carolina and in strict accordance with the manufacturer's instructions. The PE shall have significant experience in designing fall-protection systems. If there is a need to devise an anchor point from existing structural members such as beams, rafters, or columns, a PE shall be used to evaluate these anchorages. It is recommended that a structural engineer independent of the fall protection company evaluate and certify the structural integrity of the building.
- b. Qualified anchorages used for personal fall arrest shall be: 1) independent of any anchorage used to support or suspend equipment or platforms, and 2) capable of supporting 5,000 pounds per employee attached or designed, installed, and used under the supervision of a qualified person as part of a complete fall-arrest system which maintains a safety factor of at least two.
- c. The forces generated by arresting a fall; total loading; and impact on the structural members should be calculated in order to determine the optimal safe location and how to properly tie-off to qualified anchorages.
- d. Only a P.E. shall certify the structural integrity of the anchorages. Anchorage conditions should be field verified by a qualified person.
- e. Before initial use, the anchorage assemblies and fall arrest equipment shall be successfully load tested at the rated load and documentation provided to UNC. The load test shall be prescribed, defined, and certified by a registered PE. Elastic deformation of the test anchorage or anchorage connector may be determined by theoretical calculations performed and certified by a PE.
- f. A laminated reduced roof plan showing all fall protection system locations, anchor load ratings, number of authorized users that may attach to the system at one time, date of last inspection, and name of registered professional engineer who certified anchorages shall be posted at every roof access.



Appendix B - Inspection and Re-Certification of Anchorages

- a. Fall arrest, positioning, and restraint equipment shall be inspected by the user before each use and annually by a competent person in accordance with the manufacturer's instructions. Workers are not qualified to inspect anchor points; however, they shall be trained to pay special attention to any cracks developing around the anchor points or if the anchor points are unstable or loose. End users shall not tie-off to unsafe anchorages and they must bring it to the attention of the competent person if such a situation exists. Questionable anchorages must be immediately tagged or labeled "Do Not Use" until recertification can be performed.
- b. Anchorages that show signs of degradation during the inspection shall be reviewed by a qualified person to determine if recertification testing is required. If it is determined that testing is necessary, then a PE shall develop a non-destructive test procedure and certify the results.
- c. A preventative maintenance program shall be developed for fall protection systems to include recertification requirements of permanent anchorages which should not exceed a five-year frequency.
- d. Anchorage Recertification depends on the design, type, location, and the size of the structural member to which the anchorage is attached. The environment and weather conditions also contribute to how often anchorages should be inspected and recertified. The type and frequency of recertification shall be determined by the manufacturer or the PE who designed the fall protection system.
- e. The recertification of anchorage connectors shall be done by the manufacturer's representative or a qualified person under the supervision and direction of a PE.
- f. Any component of a fall arrest system subjected to an impact load shall immediately removed from service and not used again for employee protection until it has been recertified as stated above.



Appendix C - Guide to Selecting Safe Anchorages for Fall Protection Systems

- a. The strength of a personal fall-arrest system depends on its subsystems and components, as well as how the system is attached to the anchorage point. Such attachment shall not significantly reduce the strength of the system, including the structural members such as beams, column, or any rigid structures.
- b. All components and sub-components of the selected fall-arrest system shall be compatible with each other and constructed of stainless steel, galvanized steel, or other materials with a corrosive resistant finish. All surfaces shall be smooth to prevent damage to interfacing parts of the system.
- c. When planning and selecting a point of anchor location, take into consideration the accessibility and ease of securing to it.
- d. Select the point of anchor as high as possible. This will minimize the freefall distance and total fall distance and will prevent any contact with an obstruction of the ground below.
- e. The point of anchorage shall be located in such a way to minimize swinging the worker (pendulum-like motion) that can occur during a fall. The farther away in a horizontal direction a worker moves from a fixed tie off point, the greater is the swinging angle if a fall should occur. If any obstruction exists in the path of the swing fall, the force generated by such a fall is the same as the force in a vertical fall. The maximum angle of swing away from the point of anchor should not be more than 30 degrees.
- f. Always specify the number of authorized users that are allowed to attach to a specific anchorage point.
- g. The diameter of the anchorage eye, tieback, or eyebolt shall be compatible to the snap hook or carabiner attachment. If an eyebolt is selected as a point of anchor, it should be rated along its axis. Eyebolt strength is greatly reduced if the force is applied at an angle to the eyebolt axis.
- h. When tying off to a beam or column, do not attach the anchorage connection to a hole in the beam unless evaluated by a PE, because the forces generated by a fall may weaken the beam structure. Do not drill a hole for tying off. This attachment will compromise the structural integrity of the beam. If anchorage connectors are not available, the most favorable way to tie off is to wrap an anchor strap around the beam or column or use a designed beam clamp.
- i. Do not tie a knot in the anchorage connection.
- j. Take into consideration the impact of shear forces and the bending motion at the supports and also the distribution of forces beyond the supports onto other structural members.
- k. When selecting the point of anchor in a column, take into consideration the impact of fall forces due to axial loading and bending stresses.



Appendix D - Fall Protection Post Job Submittals

- a) The qualified person/contract designer and the installation contractor shall ensure that documentation of anchorage certification and annual recertification requirements are provided to UNC prior to the system being put into use.
- b) Detailed user instructions for the fall arrest system must be printed and provided to UNC. User instructions shall include at least the following:
 - a. manufacturer's name, address, and telephone number
 - b. manufacturer's user instructions for part and model number
 - c. statement of manufacturer's intended use and purpose
 - d. description of proper methods and limitations on use
 - e. printed information or illustrations of fixed equipment markings
 - f. description of detailed inspection/recertification procedures for fall arrest system
 - g. criteria for failing inspections and determining unusable equipment
 - h. procedures for maintenance and repair requirements (who is authorized to make adjustments and repair to equipment).
 - i. Appropriate warnings regarding altering, misusing, and limitations of equipment
- c) Submit reduced shop drawings illustrating the fall protection system to be affixed at all roof accesses.
- m) Submit manufacturer warranty information and documentation that the system was installed in accordance with manufacturer's instructions.



Appendix E - Definitions

Active fall protection systems are made up of components and systems that require some manipulation by the worker to make the protection effective.

Anchorage means a secure point of attachment for lifelines, lanyards or deceleration devices and at a minimum must meet the design loads outlined in the applicable OSHA regulations.

Body harness means 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 means for attaching it to other components of a personal fall arrest system.

Competent Person is one who by way of training or expertise is knowledgeable of applicable standards, is capable of identifying workplace hazardous or dangerous conditions relating to the specific operation, is designated by the employer and has the authority to take corrective actions.

Engineering Controls are methods to reduce exposure to potential hazards either by isolating the hazard or by removing it from the work environment.

Guardrail system means a barrier erected to prevent employees from falling to lower levels and shall consist of a top rail, intermediate rail, toe board and posts and shall have a vertical height of 42" from upper surface of top rail to the floor. The anchoring of posts and framing of members for railings of all types shall be of such construction that the completed structure shall be capable of withstanding a load of at least 200 pounds applied in any direction at any point on the top rail, with a minimum of deflection.

Lanyard means 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.

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

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

Opening means a gap or void measuring 12 inches or more in its least dimension, in any floor, platform, pavement, or yard, through which persons may fall; such as a hatch, stair, or ladder opening, pit, or manhole.

Parapet Wall is a low wall along the edge of a roof or balcony

Passive fall protection systems consist of components and systems that do not require any action on the worker's part.

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



Positioning device system means a 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.

Qualified Person is one with a recognized degree or professional certificate and extensive knowledge and experience in the subject field who is capable of design, analysis, evaluation and specifications in the subject work, project, or product.

Registered Professional Engineer is one who is licensed and has professional experience in the practice of design and installation of permanent fall protection systems and is familiar with all applicable codes and standards.

Rated Load is the combined weight of the employee, tools, equipment, materials that the device is designed to support.

Rope grab means 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. A rope grab usually employs the principle of inertial locking, cam/level locking, or both.

Roof means the exterior surface on the top of a building. This does not include floors or formwork, which, because a building has not been completed, temporarily becomes the top surface of a building.

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

Self-retracting lifeline/lanyard means a deceleration device containing a drum-wound line which 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.

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

Unprotected sides/edges means 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 42 inches high.

Walking/working surface means any surface, whether horizontal or vertical on which an employee walks or works, including, but not limited to, floors, roofs, ramps, bridges, runways, formwork and concrete reinforcing steel but not including ladders, vehicles, or trailers, on which employees must be located in order to perform their job duties.

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

