

01 35 20 .02 Roof Fall Protection and Prevention

Part 1 – General

1. Purpose

- a. The Pennsylvania State University Office of Physical Plant, in its continued dedication to safety, has developed the following minimum standards to improve fall protection and prevention through proper planning, design, construction and maintenance. These standards are intended to provide guidance and direction on how to provide safe roof access, remove fall hazards, prevent access to fall hazards, restrict movement at fall hazards and/or provide the proper fall arrest equipment as well as assist in the proper selection, care, and use of fall protection equipment. It is Penn State's goal to provide 100% protection on all roofs, with a preference for passive protection.

2. Applicability

- a. Any project which proposes to add, remove, or modify any portion of the roofing system or roof-top serviceable equipment, including new construction.
 - i. Old Main Building is exempt from the requirements of this design standard. Fall protection methods will be determined by the Fall Protection Management Team.

3. Definitions

- a. Active Fall Protection Systems - Active fall protection systems are dynamic and require the use of special personal protective equipment, training, as well as active participation by the individual. Common Active systems on campus include Life Lines and Anchor Points.
- b. Addition (as stated in IEBC) – an extension or increase in floor area, number of stories, or height of a building or structure.
 - i. Fall protection requirements to be the same as required for new construction.
- c. Fall Hazard
 - i. Where distance exceeds 30 inches as described in 1015.2 and 1015.6 of the IBC.
 - ii. Other locations: where distance to adjacent lower level exceeds 48 inches.
- d. Fall Protection Management Team (FPMT) – The Pennsylvania State University Office of Physical Plant has established a team of individuals including members from Environmental Health and Safety, OPP Safety, Design Services, Planning Design & Properties, Work Control Center, Project Management and Commonwealth Services to establish, maintain and uphold Fall Protection and Prevention Standards.
- e. Feasible – Relates to these factors: cost justification (installation cost, training, personal fall arrest equipment cost, inspection cost, etc), status of personnel utilizing structure (employee, student, public, etc.), structural capabilities, and aesthetics. Final determination made by the Fall Protection Management Team.
- f. Passive Fall Protection Systems - A “passive” fall protection system refers to a system that is non-dynamic, stationary, and does not move, adapt, or change when in or out of use. Passive systems do not require the use of personal protective equipment or active participation from individuals occupying the roof. Common Passive systems on campus include parapets and guardrails.
- g. Path of Travel - The route, whether clearly designated or not with pavers/pads/matting, from the roof access location, along a logical walking path a person would take, to serviceable equipment locations, including paths between serviceable equipment locations, and to other rooftop destinations such as penthouses or enclosures.
- h. Serviceable Equipment - Means such equipment requiring servicing from the roof level such as solar array/structures, green roofs, HVAC, fan units, exhaust units, air handlers etc.
 - i. The roof surface, roof drains, gutters, cameras/security cameras, antennas, cell towers and equipment on the roof that can be entirely serviced from beneath the roof level, are not considered serviceable equipment.
- i. Sloped Roof - for the purposes of this design standard a Sloped Roof is considered a roof having a slope greater than 4 in 12.

4. Reference Standards

- a. The following codes and regulations and their appendices, as amended, are hereby incorporated by reference:
 - i. IBC requirements (current edition)
 1. 1011.12 Stairway to Roof
 - ii. OSHA
 1. 1910.23 (Fixed Ladders)
 2. 1910.25 (Stairs)
 3. 1910.28 (Duty to have fall protection and falling object protection).
 4. 1910.29 (Guardrails)
 5. 1910.140 (Personal Fall Protection Systems)
 - iii. Penn State Roofscape Design Guide. See OPP Design and Construction standard 01 05 10.01.
 - iv. Penn State University Ladder Detail. See OPP Design and Construction standard 01 35 20.02.
 - v. Where discrepancies exist between the above requirements/codes/regulations and this document, this document shall take precedence.

5. Design Reviews and Submittals

- a. All projects with scope as described in the Applicability paragraph above require review with the Fall Protection Management Team early in design and again during construction document phase as follows:
 - i. Step 1: Project team shall familiarize themselves with all relevant standards and develop both passive and active fall protection approaches.
 - ii. Step 2: The Project Leader shall request an initial review meeting with the University Architect attended by design team, Project Leader, and campus representative. The purpose of this meeting is to explain the project scope to the University Architect, identify anticipated fall protection issues, possible solutions and ensure the design team understands the standards so there is adequate time to develop an approvable fall protection strategy for the project. The University Architect will either recommend the project proceed to a presentation to the Fall Protection Management Team (Step 3) or recommend a second architectural review with comments (repeat Step 2). Design team shall provide meeting minutes in eBuilder.
 - iii. Step 3: The Project Leader shall request to be added to an upcoming monthly Fall Protection Management Team meeting. The presentation to the Fall Protection Management Team shall be attended by the design team, Project Leader and campus representative. The purpose of this presentation is to ensure the fall protection strategy is agreed to by all stakeholders and to give the design team direction on specific conditions associated with the project. Depending on the status of the project (early design vs late Construction Documents), the FPMT will either recommend follow-up meetings repeating Steps 2 and/or 3 or approval with comments. Design team shall provide meeting minutes in eBuilder.
- b. Presentation Content
 - i. Site plan showing conditions around the building, changes in grade, lawn and paved areas, trees, building entrances etc.
 - ii. Roof plan(s) identifying the areas of work, excluded work areas, roof access, distance to grade and surrounding roof planes, 15-foot distance from roof edge and proposed fall protection approach. Identify both serviceable and non-serviceable mechanical equipment, noting sides of the serviceable equipment that need the access.
 - iii. Views (renderings, photos or photo simulations) of the building taken from grade showing rooftop equipment and proposed passive systems at various angles. Supporting documentation such as key plans and building elevations can be helpful. The proposed serviceable equipment and passive systems may be simulated as shown in Figure 1.
 - iv. Clearly identify deviations from the standard (if any) and provide justification for the approach.



Figure 1 – Before and after passive fall protection simulation

Part 2 - Requirements

1. General Requirements

- a. All roof surfaces and/or impacted material require testing for hazardous materials before removal or penetration.
- b. Passive fall protection systems such as parapet walls and/or guardrails integrated with the design of the building, are preferred in all situations to minimize the need for personal fall arrest systems, and the associated expenses, inspection, maintenance, personal protection equipment and training of such systems. Active systems proposed for new construction are considered a deviation from the standard.
- c. All projects must consider how roofs are accessed, the condition of the access system, whether the access system is up to current standards, and if a better location or type would minimize hazards and/or improve aesthetics. Roof access options in order of preference:
 - i. Elevator or direct access from man door
 - ii. Interior stairs to man door
 - iii. Interior stairs to oversized roof hatch.
 - iv. Fixed ladder to roof hatch
 - v. Exterior fixed ladder
 - vi. In certain instances, permanent exterior ladders may not be appropriate such as at canopies or single-story buildings with infrequent access. For these conditions, the team may consider access with a portable ladder and installation of a portable ladder anchor or access from a lift. Review required by FPMT.
 - vii. Ships ladders and alternating tread devices are not permitted.
- d. Planning Design & Properties – University Architect shall be consulted regarding the architectural design and finishes of passive fall protection systems as well as location and finish of access systems.

2. Project Requirements

- a. New construction (i.e., new building construction) including additions
 - i. 100% protection required.
 - ii. To minimize the frequency of rooftop access, all serviceable equipment shall be located inside the building or outside the building at ground level.
 - iii. Hatches, elevators, interior stairs leading to roof man door, and pathways to serviceable equipment shall be located 15 feet or further from any roof edge.
 - iv. Passive fall protection systems such as parapet walls and/or guardrails shall be installed along all rooftop edges. Parapet walls or guardrails shall comply with all applicable design standards referenced herein.
 1. Canopies and special architectural elements may be excluded if no serviceable equipment is present, subject to review and approval of the Fall Protection Management Team. Active protection may still be required.

- v. Sloped roofs preferably have permanent anchor points installed to protect 100% of the roof surface. Review required by Fall Protection Management Team.
- vi. Penthouse roofs require roof access and fall protection.
- b. Roof replacement, including partial roof replacement, at an existing building:
 - i. Passive protection is required for all serviceable equipment and/or travel paths less than 15' from the roof edge included in the work area.
 - 1. For equipment and pathways within 15 feet of the roof edge, consideration should be given to relocating the equipment or changing it to be serviceable from below to eliminate the condition requiring passive fall protection.
 - ii. Active fall protection systems shall be provided for all remaining roofs that are included in the proposed roof replacement work area.
 - iii. Sloped roofs preferably have permanent anchor points installed to protect 100% of the roof surface. Review required by Fall Protection Management Team.
- c. All other roof modifications, including but not limited to new or replacement serviceable equipment installations, and retrofit of existing roofs with the sole purpose of providing fall protection:
 - i. Proposed new or replacement serviceable equipment and related walking path should be located 15 feet or further from any roof edge.
 - ii. Passive protection is required for all serviceable equipment and/or travel paths less than 15' from the roof edge.
 - iii. Temporary/movable fall protection systems (i.e., portable railing, carts) may be utilized if a roof is scheduled for replacement within five (5) years or as determined appropriate by the Fall Protection Management Team. No temporary systems may be constructed without consulting the Fall Protection Management Team and written approval from the Project Leader.
 - 1. Existing temporary railings encountered near a project area shall be reviewed by the Fall Protection Management Team.

3. Technical Requirements

a. Roof Access

i. Stairs

- 1. Stairs to unoccupied roofs three or fewer stories above grade plane shall be provided in accordance with OSHA 1910.25, but in no cases steeper than 45 degrees from the horizontal. Other notable requirements include:
 - 1) 1910.25(b)(2) - Vertical clearance above any stair tread to any overhead obstruction is at least 6 feet, 8 inches (203 cm), as measured from the leading edge of the tread. Note: this requirement includes the framing for the roof hatch opening, not the hatch itself.
 - 2) 1910.25(c)(2) - Have a maximum riser height of 9.5 inches (24 cm).
 - 3) 1910.25(c)(3) - Have a minimum tread depth of 9.5 inches (24 cm).
 - 4) 1910.25(c)(4) - Have a minimum width of 22 inches (56 cm) between vertical barriers.
- 2. Stairs to unoccupied roofs four or more stories above grade plane shall be provided in accordance with IBC 1011.12.
- 3. Inability to accommodate a stair shall be reviewed by the FPMT.

ii. Fixed Ladder Access

- 1. Fixed ladder access shall be provided in accordance with OSHA 1910.23.
- 2. Fixed ladders over 24 feet shall be equipped with ladder safety system.
 - 1) Rigid rail design is required for the ladder safety system.
 - 2) Trolleys or shuttles shall be in a secured, labeled box at the bottom of the ladder.
- 3. Fixed roof access ladders over four (4) feet high must have guardrails at the top that extend a minimum of six (6) feet on each side and a self-closing swing gate. Alternative configurations that provide the same level of protection and reduce the visual impact, such as angled "chute" arrangements will be considered by the Fall Protection Management Team.
- 4. Fixed ladders shall be provided with a locking rod.

5. Fixed ladders and associated railings shall be concealed from view as much as possible.
6. For full details pertaining to fixed ladder installations refer to the Penn State University - Ladder Detail.

iii. Portable Ladder Access

1. Portable ladder locations should have a fixed tie-off point to secure the ladder at the top and firm, level ground at the bottom, preferably a concrete pad, located away from a pedestrian path.
2. Building materials that meet a portable ladder should be durable and able to resist the load of the ladder and personnel using it.
3. Personnel must be able to access a passive or active fall protection system from the ladder. Locate within 1-2 feet of the ladder tie-off on the right-hand side.

iv. Roof Hatch or Scuttle

1. All roof hatches and scuttles shall be protected in accordance with OSHA 1910.28. Mill finish aluminum systems are preferred and bright painted finishes are discouraged. Refer to Figure 2.
2. All roof hatches and scuttles accessed from stairs shall:
 - 1) Be sized to maintain the minimum headroom clearance and easy step-over condition at transition from top tread of stair to roof. See Figure 3. *Note: an oversized roof hatch will be required.*
 - 2) Be at least 30 inches wide.



Figure 2

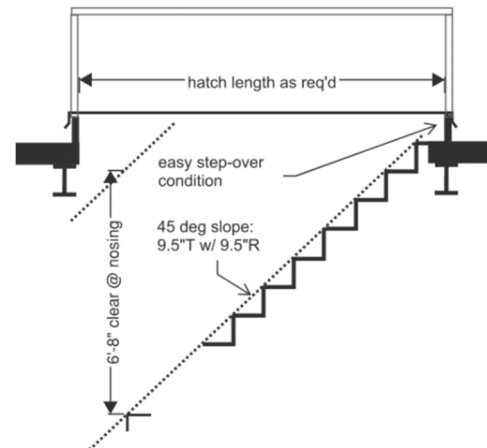


Figure 3

3. All roof hatches and scuttles accessed from fixed ladders shall:
 - 1) Be sized for the equipment or tools to be carried up to the roof, but in no case smaller than three (3) feet by three (3) feet.
 - 2) Open at least 70 degrees from horizontal if the hatch is counterbalanced.
 - 3) Be equipped with a means of assistance for transition from access ladder onto rooftop (i.e., Ladder safety post, grab bar, folding post, etc.).
 - 4) Be equipped with lift assist feature which is shock or spring activated.
 - 5) Be able to be secured (locked).
4. Switched electric lighting shall be provided beneath the roof deck adjacent to the hatch.

b. Passive Fall Protection Systems

i. Parapet design criteria

1. Parapet walls shall measure forty-two (42) inches from top of finished roof grade at the roof edge, be compatible with adjacent building materials and comply with all reference standards. Consideration should be given to exceed 42 inches to accommodate varying thickness of roof insulation and future increases in roof insulation thickness.

ii. Guardrail/Screen wall design criteria

1. Guardrails must comply with all applicable reference standards.
 2. Guardrails shall be a minimum of forty-two (42) inches in height as measured from the top of finished roof grade with spacing in accordance with current IBC.
 3. Where guardrails are visible from street level, they shall be designed to blend in or be otherwise minimally visible. Consideration should be given to how guardrails can also be configured as screen walls to block the view of equipment. Consider sight lines, nearby building massing, materials, and color.
 4. Guardrails where required shall extend six (6) feet beyond edge of serviceable equipment and roof access ladders.
 5. Materials to be considered included mill finish aluminum, stainless steel, and hot-dipped galvanized steel. To minimize maintenance, painted materials are discouraged. No wood material shall be used.
- c. Active Fall Protection Systems
- i. Anchor point design criteria
 1. Anchor points must comply with OSHA design standards found in 1910.140.
 2. Anchor point quantity, spacing and load rating shall be designed to ensure two workers can work concurrently at the same location. It is the responsibility of the design professional to provide supporting calculations regarding load ratings.
 - ii. Horizontal Lifeline design criteria
 1. Shall be designed in accordance with all applicable codes, regulations, and manufacturers' specifications.
 2. Horizontal Lifelines shall be designed to allow for "pass through" system. Those designed for use with a Y-lanyard are not acceptable.
 3. Lifeline shuttles or trolleys must be detachable type.
 - 1) Provide two (2) trolleys at each access point per lifeline.
 - 2) Provide storage unit near roof access point should none exists with adequate capacity.
 4. Consideration should be given to maintain visibility of lifeline while minimizing trip hazards due to snow fall, nearby equipment nearby, etc. Consult Fall Protection Management Team.
 5. Products in order of preference where an existing system is not already in place:
 - 1) DBI/SALA - https://www.3m.com/3M/en_US/p/c/b/dbi-sala/
 - 2) MSA Latchways - <https://us.msasafety.com/roof-fall-protection>
 - 3) Other products or protection for special conditions to be reviewed by FPMT
- d. Marking and Signage
- i. Approved tie off locations shall be marked with stamped stainless-steel tag including, but not limited to, the following information: building number, tie off sequential number, and rating (maximum number of people allowed to hook to). Tags may be secured on structural members, adjacent to tie off, or wire connected to loop.
 - ii. Roof Protection Diagram – see requirements below.
- e. Skylights and sloped Glazing
- i. New and replacement skylights shall be fall protection rated.
 - ii. Skylights that are not fall protection rated shall be protected per OSHA Section 1910.28(b)(3)(i).
 - iii. New sloped glazing and framing shall each withstand a load of at least 200 pounds applied perpendicularly at any one area of the glass.
4. Close-out and As-Builts
- a. At a minimum, as-built drawings shall include, but are not limited to the precise location of all fall protection features with design criteria and identifying information.
 - b. Contractor shall provide log of tie off sequential number and information with general description of location.

- c. Roof Protection Diagram – The design professional shall provide a diagram (CAD drawing, ‘as-built’) to the Project Leader of each roof section that Penn State will post on roof which includes, but is not limited to, the following:
 - i. Locations of all fall protection features.
 - ii. Load rating for each fall protection feature, if applicable.
 - iii. Maximum number of people permitted on each anchor point, where applicable.
 - iv. Type of personal protection equipment required at each fall protection feature (i.e., connection devices/lanyard/retractable lanyard, etc.).
- 5. O&M from Designers
 - a. Manufacturer’s maintenance and inspection requirements must be provided by the designer prior to final payment.
 - b. Warranty information must be provided by the designer prior to final payment.

End of Document

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