



# Building Design Elements for Enhanced Fall Protection for Construction and Maintenance Personnel: An NRCA Perspective

## INTRODUCTION

According to the Bureau of Labor Statistics, 969 construction workers were killed on the job during 2008 in the private construction industry in the U.S. Three-hundred-thirty-two of those fatalities, nearly 35 percent, involved workers who were killed in falls. Of those 332 fatalities, 98 fell from roofs and 64 fell from ladders. Another 52 deadly falls were from scaffolds and staging. Every year, falls also produce a large number of crippling injuries.

In addition, direct costs of workplace falls are estimated by the Liberty Mutual Workplace Safety Index to be more than \$11 billion per year in the U.S. with indirect costs related to falls much more difficult to determine but likely as significant. Also significant is the fact buildings' interiors are mandated by codes to protect building occupants from falls from balconies, walkways and stairwells. Design of life-safety requirements currently stops below the roof level, and rooftops ordinarily are designed as "unoccupied" spaces. However, it is the more responsible design approach to treat a rooftop as space that will have frequent worker and public presence. This will be even more critical as vegetative roof systems, roof-mounted photovoltaic systems, decorative lighting and other emerging rooftop technologies place workers on rooftops throughout a building's life and formerly restricted-access areas are opened to additional maintenance personnel and public traffic.

To address these issues at the building design phase, NRCA created this document to elevate the level of safety and improve the standard of care for construction and maintenance personnel *during* the construction process and make rooftops safer for people who maintain roof systems, roof-mounted equipment and exterior walls *after* a construction project is complete. It is NRCA's hope that a collaborative effort among industry stakeholders can develop ways to reduce roofing-related injuries and deaths.

## NRCA RECOMMENDATIONS

The following items are desirable when designing structures to provide fall-prevention measures. NRCA realizes not all recommendations can be implemented on existing structures but should be designed into new construction projects. The items listed provide the safest possible environment for construction and maintenance personnel. NRCA's goal is to partner with the National Institute for Occupational Safety and Health (NIOSH) and other agencies and organizations to further safety-in-design initiatives and save lives by discussing and implementing these recommendations.

Design and installation of parapet walls, permanent guardrails and fixed anchor points require professional engineering tailored to the specific installation. Regular inspection and maintenance of fall-protection components must be incorporated into the overall design and implementation process.

Flashings for all the recommended items (where applicable) can be found in the construction details in The NRCA Roofing Manual.

Requirements for many fall-protection systems and components can be found in OSHA Construction Industry Regulations, 29 CFR 1926.500-503 and ANSI/ASSE Z359.1-2007 Fall Protection Code.

### Perimeter Fall Protection

*Parapet walls*—Corresponding to the Occupational Safety and Health Administration's (OSHA's) definition of an "unprotected side or edge" in 29 CFR 1926.500(b), NRCA recommends designers incorporate into their designs parapet walls at a minimum of 39 inches above a finished roof surface at all outside roof perimeters or edges. Parapets for public access areas may require additional structural or design elements under the applicable building code.

*Guardrails*—NRCA recommends designers incorporate into their designs fixed, permanent guardrails with midrails where no parapet wall exists or the structural design or aesthetics do

not allow installation of parapet walls. Guardrails may be attached to a building's exterior walls or the interior structure if feasible. Guardrails for worker protection should be a minimum of 39 inches above the finished roof surface and include midrails.



*A permanent guardrail and parapet protects a rooftop terrace.*

*Fixed anchor points for fall-protection devices*—Where aesthetics are paramount and parapet walls or guardrails are not desirable, engineered, fixed (permanently anchored to the facility structure or structural roof deck) anchor points should be designed and installed to provide a readily available fixed anchor for personal fall-protection equipment. These systems typically are installed at the time of installation of the structural components affording a protective system for roof deck installation, roofing work, HVAC installation and other work. Careful consideration must be given to anchor locations to allow convenient worker tie-off for complete rooftop fall-protection coverage.



*Assorted fall-protection anchors designed for permanent installations*

## Roof Access

*Interior roof access*—Penthouse access is preferred with permanent stairs and door access onto a roof at a location at least 10 feet from roof edges or skylights. The door should be oriented to direct access away from roof edges. Another access preference is a fixed interior ladder with an inclined design, similar to ships ladders, or an OSHA-compliant safety cage on vertical fixed ladders 12 feet tall or higher. Interior ladders should have adjacent rope and pulley assemblies to provide safe means to get tools and equipment from the floor to a roof. Interior roof hatchway and doorway areas should be illuminated to provide sufficient light to operate locks and latches.

*Roof hatches*—NRCA recommends designers incorporate into their designs roof hatch installations a minimum of 10 feet from roof perimeters. Hatch orientation should direct traffic away from a roof edge or perimeter (hinge side of a hatch toward the closest roof edge). Hatches equipped with inclined or ships ladders are preferred over fixed vertical access ladders. Interior roof hatchway areas should be illuminated to provide sufficient light to operate locks and latches.



*Ships ladder access to roof hatch*

*Guardrails at roof hatches*—NRCA recommends designers incorporate into their designs fixed, permanent guardrails adjacent to roof access hatches to provide stable hand-hold to access roofs.



*Roof hatches with permanent guardrails*

*Exterior access*—An external steel staircase is the preferred means of access if interior access by penthouse, hatch or other means is not available. Exterior fixed ladders should have an OSHA-compliant safety cage that must meet or exceed OSHA regulations where ladders are 12 feet tall or higher. Ladders should have solid platforms at their highest points, handrails and rungs on both sides of parapet walls where applicable. The bottom rung of ladders should be no greater than 18 inches above a finished roof surface. Ladders should be securely anchored to elevation and/or parapet walls. Exterior access ladders also should be a minimum of 10 feet from adjacent roof edges or perimeters to provide a safe access environment.



*Exterior staircase and fixed ladders for roof access*

## Roof Skylights

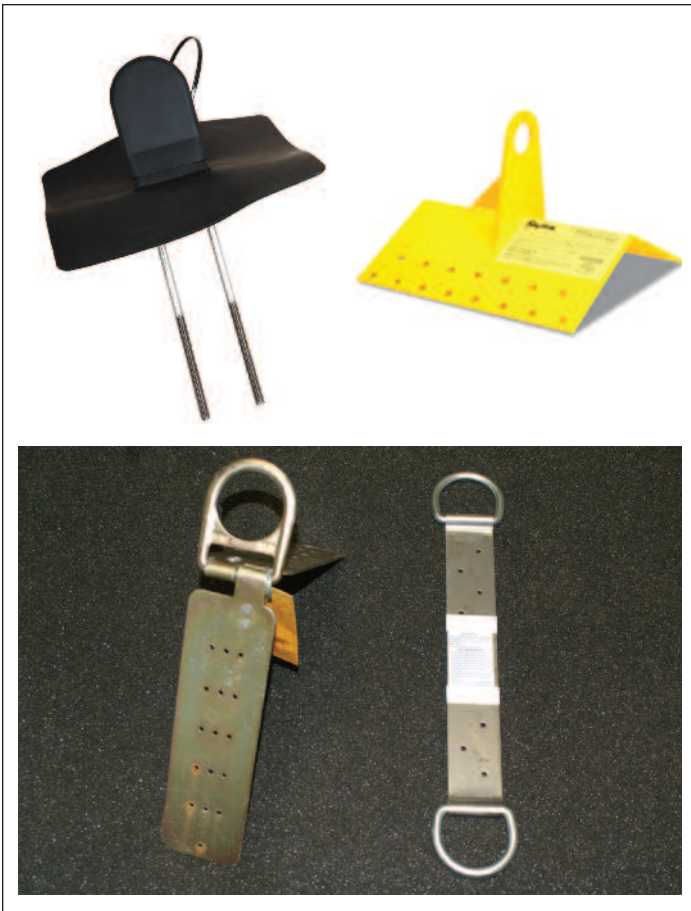
*Grates at skylights*—NRCA recommends designers incorporate into their designs a minimum 6- by 6-inch metal grid welded into the structural framing for skylight openings. Such a grid should be capable of supporting twice the maximum intended load to provide fall prevention before and after a skylight is installed and also may serve a dual purpose as a component of burglar protection for the building. If large skylights are present or an interior grate is not desirable, exterior metal grates or structural glass panels for the skylight in combination with fixed anchor points adjacent to skylight curbs are recommended.



*Exterior and interior skylight fall protection*

## Steep-slope Fall Protection

*Fixed anchor points in steep-slope assemblies*—Engineered, fixed (permanently anchored to a facility structure) anchor points should be designed and installed at or near the ridge of steep-slope roof systems to provide a readily available fixed anchor for personal fall-protection equipment. For steep-slope mansard roof systems, fixed anchor points should be installed on the adjacent low-slope roof system and anchored permanently to the structure or structural roof deck. NRCA also recommends permanent, fixed anchor points around chimneys for maintenance purposes.



*Fall-protection anchors designed for permanent steep-slope installations*

## Roof Hoist Conditions

*Permanent equipment hoist*—When materials and equipment are frequently hoisted to a roof surface for maintenance, service or repair work, a permanent equipment hoist with guardrail and gate is recommended. Such a system may include engineered, fixed (permanently anchored to a facility structure) hoist supports; fixed guardrails with an inside-swinging gate; and a permanent, engineered fixed anchor point for attaching personal fall-arrest systems for personnel working at hoists.



*Integrated guardrails for permanent equipment hoist*

## CONCLUSION

There are many initiatives in the construction industry to improve safety for construction and maintenance personnel. Design in new construction is the responsibility of architects and engineers. The responsibility for design in roof system restoration and replacement projects may fall on the aforementioned entities but also on building owners, roof consultants or roofing contractors. Obviously, all these partners in the construction industry are stakeholders in designing for safety.

During a building's life cycle, many individuals may use the roof for maintaining mechanical equipment, inspections, modifications, etc., and each employer remains responsible for providing fall protection for his or her workers. Implementation of these recommendations will benefit all workers on rooftops, not just professional roofing contractors and their employees.

Roofing contractors bear the responsibility of providing personal protective equipment and appropriate training to their personnel for fall prevention, but the U.S. construction industry now needs to improve its standards similar to those of the Temporary or Mobile Construction Site Directive, 1992, which the European Commission, the European Union's executive body, enacted. The directive places responsibility for construction safety on designers and building owners, as well as contractors.