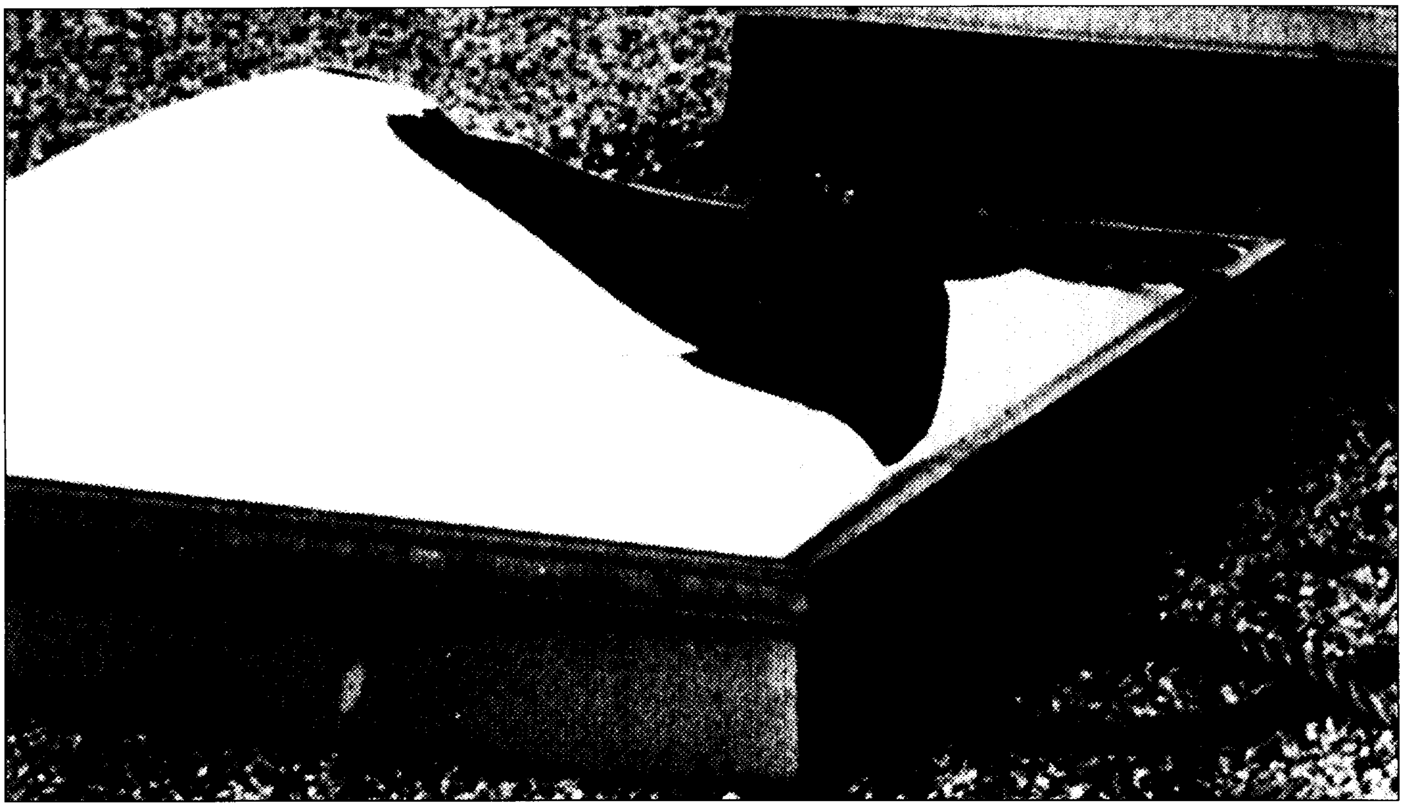
Preventing Falls Through SKYLIGHTS AND ROOF OPENINGS



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Occupational fatalities caused by falls are a serious problem throughout the U.S. Data from Bureau of Labor Statistics (BLS) show that 10 percent (290 of 2,900) of all traumatic occupational fatalities in 1990 were the result of falls (*Occupational Injuries and Illnesses in the U.S. by Industry*). The National Traumatic Occupational Fatalities (NTOF) Surveillance System maintained by the National Institute for Occupational Safety and Health (NIOSH) provides similar statistics. Analysis of this data shows that, from 1980 through 1989, occupational falls were the fourth leading cause of death, accounting for nearly 10 percent (6,015 of 63,589) of all traumatic occupational deaths for which a cause was identified (*Fatal Injuries to Workers in the U.S.*).

Of the 6,015 deaths that resulted from a fall, 73.7 percent (4,435) were classified as "falls from elevation." Specifically, falls were the leading cause of death in the construction industry, accounting for 26 percent (2,930 of 11,430) of construction-related deaths from 1980-1989. Falls from elevation accounted for 696,276 workers' compensation cases in the 27 states covered by BLS's Supplementary Data System for 1980-1985 (Bobick, et al 527+). (Stout-Weigand discusses differences between these databases; see references, page 37.)

Skylight popularity has introduced new fall-related hazards to construction sites. Each year, 14 workers die following falls through unguarded or poorly guarded skylights or roof openings.

SKYLIGHT DEVELOPMENT

The popularity of smoke-dome skylights has greatly increased during the past 30 years, reflecting changing trends in architecture and construction, and increased availability of lightweight plastics. Skylights have replaced materials such as glass block and wire-reinforced glass as light sources in industrial buildings, and are used to illuminate homes, shopping centers, office buildings and other structures. Availability of inexpensive, easily installed, weather-proof plastics has contributed to this trend. Skylights, which are designed to melt, have also replaced traditional louvered smoke vents as ways to remove smoke during fire.

Skylight popularity has brought with it a greater potential for injuries and deaths during construction (i.e., employees falling through unguarded skylight openings or through skylights). In addition, maintenance personnel, service personnel or firefighters are exposed to potential fall hazards once construction is complete.

REGULATORY REQUIREMENTS

Occupational Safety and Health Administration (OSHA) addresses hazards of working near unguarded skylights and roof openings in its standards for both General Industry and Construction Industry (29 CFR 1910 and 1926, respectively). Under the General Industry Standard, *"Every skylight floor opening and hole shall be guarded by a standard skylight screen or a fixed standard railing on all exposed sides"* [29 CFR 1910.23, sec.(a)(4)]. In addition, *"Skylight screens shall be of such construction and mounting that they are capable of withstanding a load of at least 200 pounds applied perpendicularly at any one area on the screen. They shall also be of such construction and mounting that, under ordinary loads or impacts, they will not deflect downward sufficiently to break the glass below them. Construction shall be of grillwork with openings not more than four inches long or of slatwork with openings not more than two inches wide with length unrestricted"* [29 CFR 1910.23, sec.(e)(8)].

The Construction Industry Standard addresses hazards from floor openings by stating: *"Wherever danger of falling through a skylight opening [exists], it shall be guarded by a fixed standard railing on all exposed sides or a cover capable of sustaining the weight of a 200-lb. person"* [29 CFR 1926.500, sec.(b)(4)].

SURVEILLANCE DATA

NTOF data from 1980-1989 identified 56 deaths caused by falls through skylights; another 79 deaths were attributed to "falls through roofs or roof openings" (National Traumatic Occupational Fatalities Surveillance System). According to these data, on average, 14 employees are killed annually from falls through skylights, roofs or roof openings. (No national database currently identifies and compiles non-fatal, injury-causing incidents associated with skylight fixtures.)

Typical Fatal Incidents

Investigations conducted as part of the NIOSH-sponsored Fatality Assessment and Control Evaluation (FACE) project reveal that regulatory requirements for protecting employees from hazards of falling through skylights and roof openings are often not known or implemented (*NIOSH Alert*). Some regard plastic domes covering skylights as adequate load-bearing devices and fail to perceive hazards posed by sitting or stepping on the domes. The following six FACE case histories illustrate potential hazards of working near unguarded skylights and roof openings (*NIOSH Alert*).

CASE ONE An 18-year-old sheet metal worker died after he fell through an unguarded skylight to a concrete floor some 33 feet below. Three months earlier, an employee at the *same* site had stepped on an unprotected skylight and fallen to his death. The current victim and other employees were replacing temporary skylight protection (corrugated metal sheeting) with permanent installations of chain-link fencing over 3 × 8-ft. fiberglass skylights. At the time of the accident, the supervisor had temporarily stopped work. As the crew moved off the roof work site, the victim stepped on and fell through an unguarded skylight.

CASE TWO A 21-year-old laborer died after falling through a domed smoke-vent skylight to a concrete floor 27 feet below. He had been throwing old roofing materials off a roof that had six unguarded skylights. During a break, the victim sat on a skylight, which cracked under his weight. The laborer attempted to push himself up from the skylight, but the plastic dome shattered completely and he fell through. According to state OSHA officials, the victim had been repeatedly warned by his supervisor and co-workers not to sit on skylights.

CASE THREE A 24-year-old plumber died when he fell through an unguarded skylight opening to a concrete floor, approximately 22 feet below. The plumber and a co-worker were installing fixtures on the roof of a new building, which contained several 4×4-ft. openings intended for smoke-vent skylights. Although the project had begun several days earlier, no fall protection or guarding had been installed. The victim stepped into one of the skylight openings.

CASE FOUR A 26-year-old roofer died when he fell through a domed smoke-vent skylight to a concrete floor 25 feet below. He and two co-workers were installing a spray-on roof covering. While applying granular material, the victim stumbled over a skylight curb, lost his balance and fell backward onto the skylight. When the plastic dome fractured, he fell to his death.

CASE FIVE A 37-year-old roofer died after he stepped through a partially covered skylight opening and fell 27 feet. Along with seven other employees, the roofer had been installing roofing material on an area that contained 35 unguarded 4×4-ft. openings for domed smoke-vent skylights. While handling a roll of material, the victim stepped backward and fell through an opening that had been partially covered by another roll.

CASE SIX A 39-year-old electrician's helper died when he fell 16 feet through a domed smoke-vent skylight to a concrete floor. Using a one-inch-diameter rope, the victim and a co-worker had lowered an electric sign to the ground. The victim stayed on the roof to coil the rope while the co-worker left to load the sign onto a truck. Later, the co-worker saw the victim lying on the floor beneath a shattered skylight. Apparently, he either sat on or fell onto the skylight, which collapsed under his weight. The photo (page 33) shows the damaged skylight involved in this fatal accident.

TABLE 1 INJURY REDUCTION MATRIX

BUILDING PHASE	RESPONSIBLE ORGANIZATION	WORK REQUIREMENT	CORRECTIVE ACTION
BEFORE CONSTRUCTION	a. Manufacturer	a. Skylight Design	a. Improve the Designs
	b. Architect	b. Skylight Specification	b. Specify: 1. Improved Designs, AND 2. Protective Barriers.
	c. Building owner or operator	c. Contract specifications for skylights and roof openings	c. Emphasize fall protection and prevention programs for skylights and roof openings. Make these a requirement of the contract specifications.
DURING CONSTRUCTION	a. Building Owner/ Operator	a. Monitors compliance of contract with the safety & health requirements.	a. Ensure that contract safety and health spec's are implemented.
	b. Prime Contractor	b. Manage job-site safety & health (S&H) program.	ALL PARTIES (a, b, and c):
	c. Subcontractor	c. Responsible for S & H of OWN workers.	" ... [must] assure ... safe and healthful working conditions..."*
AFTER CONSTRUCTION (including final demolition)	a. Building Owner/ Operator	a. Overall Responsibility for: 1. Contract Compliance, and 2. S&H of maintenance workers.	BOTH PARTIES (a and b): " ... [must] assure ... safe and healthful working conditions..."*
	b. On-site Contractor(s)	b. Responsible for safety of OWN workers	

*Source: Occupational Safety and Health Act of 1970, sec(2)(b).

INJURY REDUCTION MATRIX

Preventing or reducing the frequency of fall-related injuries and deaths requires a comprehensive approach from all involved in construction and operation of a building or structure with skylights. A matrix has been developed to identify appropriate responsibilities to prevent falls through skylights and roof openings. Divided into the pre-construction, construction and post-construction activities, this matrix is a modification of one developed to conduct injury research related to motor-vehicle crashes (Haddon 193+). The concept helps identify the responsibilities of each building construction (or operation) organization to ensure proper management of a work-site fall prevention program.

Table 1 presents an injury reduction matrix for the conditional event of falling through a roof opening or skylight fixture. It identifies work requirements and organizational responsibilities that should be implemented during the three phases of construction.

As the table shows, two types of prevention techniques are involved—primary and secondary. Primary prevention ensures that a fall event will not occur. By preventing access to a skylight or installing an "unbreakable" model, employees cannot be injured by falling through it.

Secondary prevention involves minimizing (or eliminating) the injury after an incident has occurred. Fall protection equipment (safety belt and lanyard) or safety netting under the skylight or roof opening are examples of such measures.

The generic scope of the injury-reduction matrix permits its application to most work situations. It can be applied to investigation of an injury-causing or fatal incident. By analyzing previous incidents with the matrix format, investigators can logically consider all aspects of the injury or fatality during all time phases (pre-event, event and post-event conditions). Ideally, this type of analysis should be used to evaluate situations in an attempt to anticipate and correct dangerous conditions.

DETAILS OF THE INJURY-REDUCTION MATRIX

Falls through skylights and/or roof openings occur during both building construction and skylight installation activities, and as well as during maintenance operations. Preventive measures can be implemented at each stage.

Phase I: Pre-construction

Skylight manufacturers and building architects have separate, yet related, responsibilities for preventing falls through skylights during the pre-construction phase. At this stage, product selection and specification are key injury prevention strategies. Architects should specify skylights that can support the required static load [200 lbs., according to 29 CFR 1910.23, sec. (e)(8)]. Consideration should also be given to the additional dynamic loading caused by sitting, walking or falling onto the fixture. In areas with high maintenance, slip-trip hazards or high traffic, architects should consider the use of protective barriers over skylights. Similarly, manufacturers must recognize potential hazards and utilize stronger materials in the manufacturing process.

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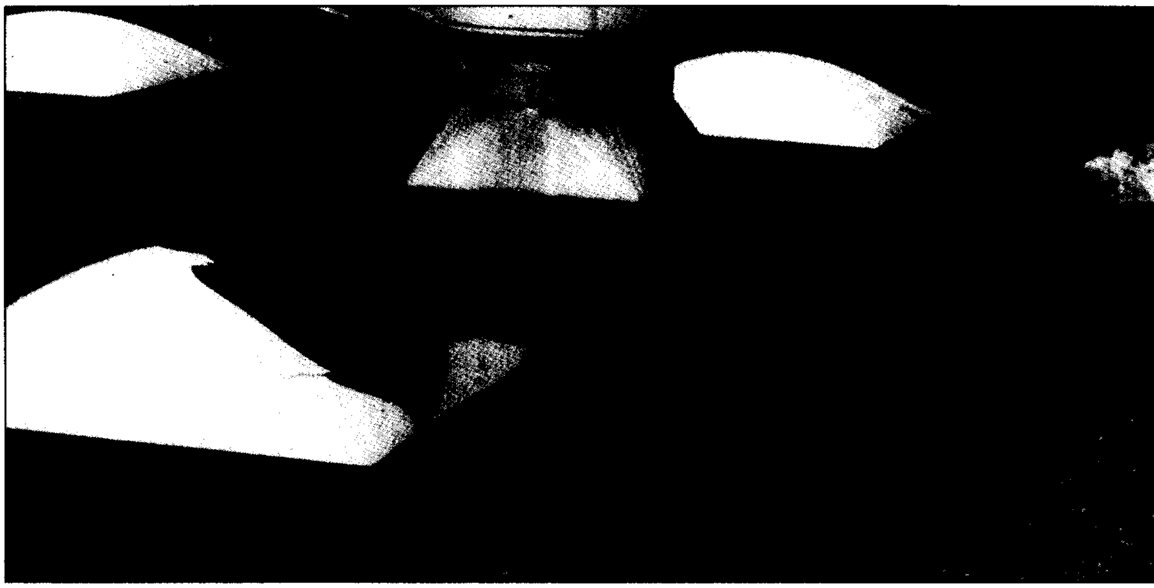

Investigation has revealed that regulatory requirements for protecting employees from falling through skylights are often not known or implemented.

Skylight Manufacturers

Manufacturers can use high-strength or deformable plastics; reinforced products (with high-strength fibers); or laminate (sandwich) materials to decrease the potential for collapse. Also, installation instructions should describe methods of protecting employees working near roof openings. "Do Not Sit, Stand or Step" warning labels can be applied as well.

Manufacturers are the logical candidates to help develop new standards for high-strength products. They can play a key role in researching and developing a strength-testing protocol that addresses dynamic loading to simulate walking on, falling against or sitting on a skylight.

Architects

During the design phase, architects determine specific needs for a building or structure. For example, specifications may address hallway width, heating and cooling equipment, and number and type of fire doors, as required by building codes. However, codes stipulating minimum strength requirements to prevent falls through skylights do not exist.

Design criteria for skylights should be added to building codes. With their knowledge of new processes and synthetic materials, architects can help develop design criteria and building codes. Until new codes are developed, specifications should call for skylights that exhibit increased strength characteristics. In addition, architects should become familiar with current occupational safety and health standards and specify appropriate barriers for skylights and roof openings.

Building owner/operator

Detailed safety requirements for preventing fall-related events should be integral to the contract bidding process; incorporated into the construction contract; and a component of accountability requirements. The building owner should play a leading role in ensuring that, (at least) the minimal level of OSHA regulations are followed and that responsibilities of involved parties are described in the contract.

Phase II: Construction

Until skylight strength requirements are developed, current OSHA standards that require employees to be protected when working near skylight fixtures are applicable (29 CFR 1910.23; 29 CFR 1926.500). During construction or skylight installation, perimeter guardrails or temporary covers over openings are required.

Building owner/operator

The building owner/operator must implement reporting requirements during the construction phase. An employee of the owner/operator or a consultant should monitor effectiveness of the safety and health program during construction.

Primary contractor

The primary contractor has overall responsibility for safe erection of the structure. According to OSHA regulations (29 CFR 1926.16; 29 CFR 1926.20), the primary contractor must provide a safe, healthful work environment by preventing exposure to hazardous situations. This requires a worksite safety and health program.

Implementation of this program may, in part or whole, be subcontracted to another employer. For example, the primary contractor's work crew may fabricate and install required guarding; or, a subcontractor may install fall protection throughout the entire job site. In either case, the contract between owner and primary contractor should require that fall protection and prevention programs are implemented at the work site, and that all parties comply. Regardless of who is responsible for program implementation, employee protection must be in place.

Subcontractor

The primary contractor has overall responsibility for safety and health at a worksite. He/she should designate who is responsible for guarding work surface openings (for skylights, elevators, stairways, etc.) and what methods should be used to guard these openings. The subcontractor is then responsible for on-site implementation of the primary contractor's fall protection and prevention programs.

Phase III: Post-construction

Finally, the building owner/operator must be aware of hazards posed by skylights after construction. Protective devices, such as permanent guardrails or metal grid covers, must be installed. Contractors performing maintenance, renovation or demolition work should inform their employees of related hazards and verify that some form of guarding (guardrails, covers, screens, etc.) is in place before work begins.

Building management should develop and implement measures to protect employees during all work on-site. Both the owner's employees and contractor's employees must be aware of potential fall hazards.

WRITTEN PROGRAM REQUIRED

Companies of all sizes should develop and implement a written safety and health program that relates to the scope of its operations. This program should include a policy statement regarding the company's commitment to

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employee safety and health—and it should apply to all employees.

To prevent falls through skylights and roof openings, personnel responsible for on-site safety should identify and eliminate/control conditions that precipitate such incidents. The overall safety program should discuss methods for preventing these types of falls. OSHA's fall-related standards and applicable ANSI (or other consensus) standards should be included in a fall prevention/protection program. In addition, written work procedures should identify types of fall protection equipment to use, and stipulate additional protective measures (i.e., barriers along the perimeter of all work surface openings; proper installation and use of safety nets).

Before work begins, the first-line supervisor should conduct a work hazard analysis, which focuses on new construction activities or maintenance operations on roofs, around HVAC equipment, skylights, elevator shafts and floor openings. Employees should be informed about identified hazards and corresponding control measures. The first-line supervisor should also make sure that necessary personal protective equipment is provided and used. Management should evaluate the effectiveness of the first-line supervisor to ensure accountability.

Accountability extends to employees as well, as stated in the OSH Act of 1970: *"Each employee shall comply with occupational safety and health standards and rules, regulations and orders issued pursuant to this Act which are applicable to his own actions and conduct"* [Public Law 91-596, sec. 5(b)]. Therefore, employees must share in the responsibility of protecting themselves by complying with the fall prevention program.

Effective, regular training is a key aspect of any safety and health program. Both management and employees should have input. Results from work hazard analyses can be used to inform employees about hazards and proper protective/preventive measures. In addition, training should address proper inspection, use and maintenance of fall protection equipment. New employee orientation and annual (at least) refresher training must also be provided. Regular tool-box meetings should be conducted.

To be effective, a fall protection program must be enforced. Preventive and corrective measures can be used to motivate employee compliance with written work procedures (Eninger 11). In addition, the program should be reassessed annually to evaluate effectiveness, identify deficiencies and develop improvements. It should then be updated to reflect assessment results.

CONCLUSION

By developing an overall fall protection/prevention program, hazards posed by falls through skylights or roof openings can be controlled, thus preventing deaths and serious, non-fatal injuries. The matrix concept presented here can be used to identify safety responsibilities in order to prevent or minimize the frequency of fatal falls. In fact, this approach can be applied to numerous hazardous situations to identify potential injury-risk factors and develop corrective actions, or to conduct a post-incident investigation. ■

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