

PART I

FATAL FALLS FROM ELEVATIONS

OVERVIEW OF POTENTIAL HAZARDS FOR FALLS FROM ELEVATIONS

Falls from elevations occur in all industries, in all occupations, and in a myriad of work settings, from the ironworker connecting steel columns 200 feet in the air, to the laborer washing windows from a suspended scaffold 60 feet from the ground, to the stock clerk retrieving goods from a shelf using a 4-foot stepladder. Fatal falls from elevations are classified by external cause of death codes (E-codes) E880-E888 of the International Classification of Diseases, Ninth Revision, (ICD-9).¹ For the purpose of this monograph, the following categories will be discussed: 1) falls from ladders (E881.0), 2) falls from scaffolding (E881.1), 3) falls from or out of buildings or other structures (E882), 4) other falls from one level to another (e.g., falls from stationary vehicles and falls from trees) (E884.9), and 5) other and unspecified falls (E888). The E-codes E885, E886 (falls on the same level), and E887 (falls resulting in fractures with cause unspecified), were excluded from this monograph since these types of falls were not investigated as part of the FACE program. Figure 1 illustrates examples of common elevated working environments.

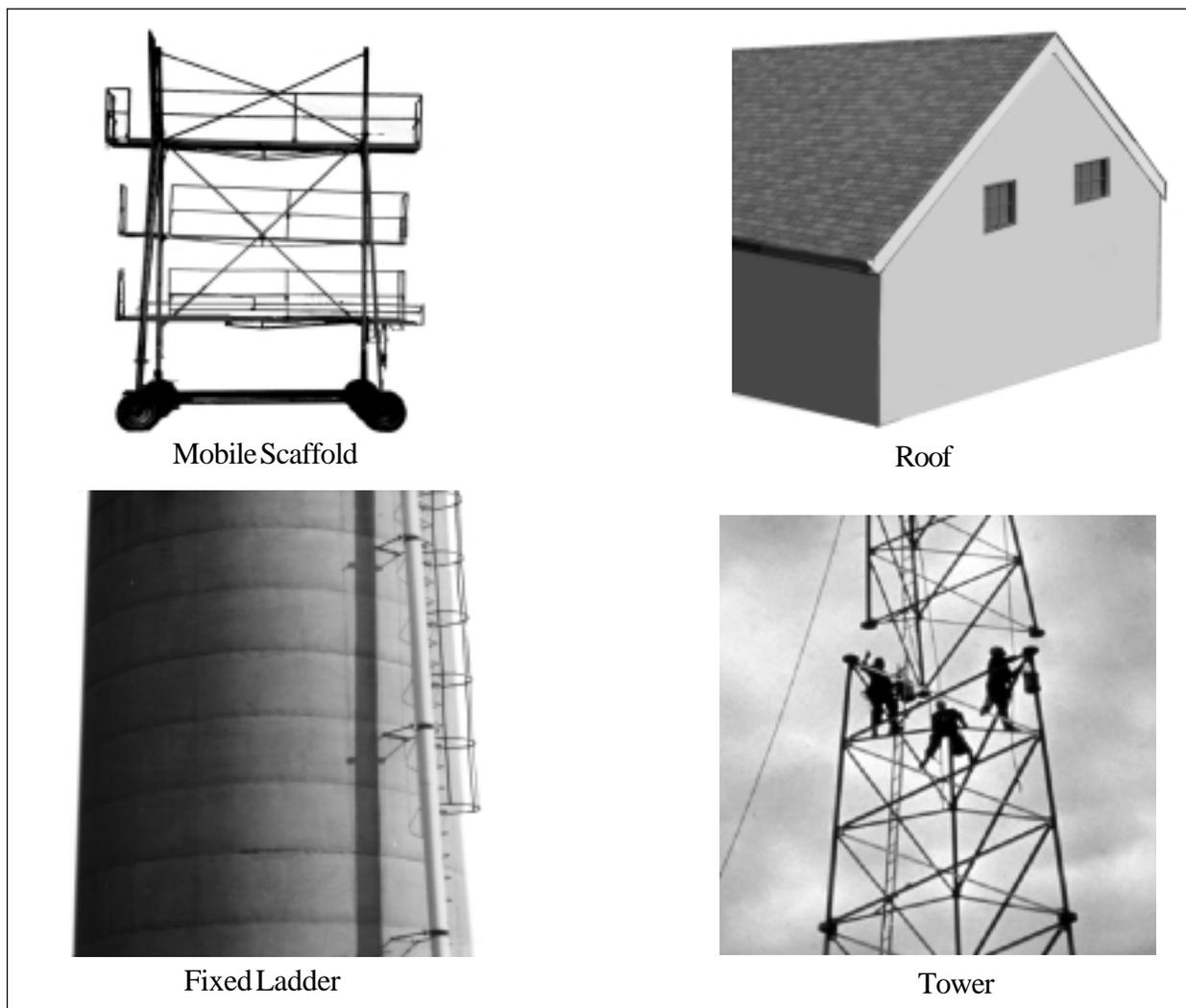


Figure 1. Common Types of Fall Environments

FALL ENVIRONMENTS

Ladders (E881.0)

Ladders are designed and manufactured to be fixed or portable and are intended to provide easy access to various work settings. Ladder configurations vary by length, load rating (e.g., type IA, I, II, or III), and ladder material (e.g., wood, aluminum, or fiberglass). Common types of ladders include straight, step, trestle, extension trestle, platform, combination, mason's, and two- and three-section extension ladders. Ladder sizes range from 2-foot step ladders to 72-foot, three-section extension ladders as well as fixed ladders that can extend hundreds of feet (e.g. providing access to the top of a water tower).

Safety features that have been designed into some ladders, or are available as retrofits, are slip resistant rungs/steps, positioning feet that fully articulate, and top and bottom stabilizers. Fixed ladders typically have a glide-rail system through the middle that is accessed and egressed while using a full body harness with a glide lock attached to a chest D-ring. Other fixed ladders have caging systems which are a less effective tool for fall protection. Some important factors to be considered before using or climbing a ladder are placement, securing or tying down, climbing style, angle of inclination, three-point contact, and tasks to be performed.

Factors that contribute to falls from ladders are ladder slip (top or bottom), overreaching, slipping on rungs/steps, defective equipment, and improper ladder selection for a given task. There are appropriate uses for stepladders and for extension ladders, but the choice of the wrong ladder for a particular job can put the user at increased risk for a fall.

Scaffolds (E881.1)

Scaffolds are defined as temporary elevated platforms and their substructures, that are used for supporting workers or materials or both. Scaffolds vary greatly in type, size, material, and function and are used in a multitude of work settings. Familiar tasks associated with scaffold use include drywall and stucco application, sand blasting and painting, window washing, structural cleaning, caulking, removing asbestos, performing maintenance, installing piping/conduit, laying brick/concrete block, and inspecting. See the glossary for definitions of scaffold types.

Factors associated with falls from scaffolds include improper maintenance or erection/dismantling procedures, incorrect methods for mounting or dismounting, overloading, absence of guardrails, scaffold component failures, defective personal protective equipment (PPE), or absence or improper use of PPE.

Falls from or out of buildings or other structures (E882)

Included in this group are falls from or through roof and floor openings and edges, structural framing, skylight fixtures, utility poles and towers, bridges, tanks, window openings, and platforms.

Regardless of the industry or occupation, a worker may, at some time in his or her working career, be exposed to one or more of the fall-from-elevation environments described above. For example, in the construction industry numerous tasks associated with fall hazards will be performed by workers every day. Tasks such as installing shingles on roofs, erecting skeleton steel for buildings and structures, climbing towers, painting bridges and storage tanks, or installing and maintaining skylight fixtures can and do result

in injuries and death to workers. These tasks represent only a few of the many tasks that can result in injuries and death to workers due to failure to recognize fall hazards, failure to use personal protective equipment, overreaching, loss of balance, tripping, slipping, or equipment failure.

Other falls from one level to another (including falls from embankments, haystacks, stationary vehicles or trees) (E884.9)

Falls from embankments, haystacks, and trees occur in limited work settings and to selected occupational groups, whereas falls from stationary vehicles occur in numerous industries and occupations, since vehicles are used in a wide variety of industrial sectors. Vehicles include automobiles, buses, trucks, vans, construction machinery being used as transport vehicles on public highways, farm and industrial machinery, fire engines, motorcycles, motorized bicycles or scooters, and trolley buses not operating on rails. Primary hazards relating to vehicles include lack of or failure to use seat belts, and slipping/tripping.

Conclusions

One of the serious and oftentimes deadly hazards found in the workplace is falls from elevations. Fall-prevention measures can be general, varied, specific, or elaborate; and the recognition, planning, and implementation of a sound fall-prevention program is the first step in reducing falls in the workplace. When fall hazards are recognized, provisions to abate the hazards can be developed, implemented, and reinforced on a timely basis to prevent deaths and injuries resulting from falls in the workplace.

EPIDEMIOLOGY OF FATAL FALLS FROM ELEVATIONS

INTRODUCTION

Falls were identified as the fourth leading cause of occupational-injury fatality in the United States between 1980 and 1989 by the National Traumatic Occupational Fatalities (NTOF) surveillance system of the National Institute for Occupational Safety and Health (NIOSH), accounting for 10% of all occupational-injury deaths.² NTOF data also showed that workers in the construction, mining (including oil and gas extraction), and agriculture/forestry/fishing industries had the highest fatality rates due to falls during the decade. The Census of Fatal Occupational Injuries (CFOI) of the Bureau of Labor Statistics (BLS) reported that falls to a lower level comprised 9.9% of fatalities in 1996.³ The CFOI data identified roofs, ladders, and scaffolds as the most common fall locations. Other studies have noted falls associated with steel erection,^{4,5} falls from equipment or materials,⁴ and falls through floor openings.^{5,6}

Previous research has identified falls as a leading cause of fatalities in the construction industry. Falls accounted for 25% of the construction deaths identified by NTOF for 1980 through 1989,⁷ 32% reported by the 1996 CFOI,³ and 33% of construction fatalities investigated by the Occupational Safety and Health Administration (OSHA) between 1985 and 1989.⁶ Falls comprised 29% of construction fatalities in Washington State between 1973 and 1983,⁸ and 46% in New Jersey between 1983 and 1989.⁹ Occupational groups identified with high frequencies of fatal falls include roofers, painters, ironworkers, carpenters, construction laborers, and tree trimmers.⁹⁻¹¹

The following analysis combines 15 years of data from the NTOF surveillance system with final reports on 91 fatalities investigated by NIOSH through the Fatality Assessment and Control Evaluation (FACE) program to describe work settings in which fatal falls are likely to occur and the associated risk factors.

METHODS

The NTOF surveillance system is based on death certificates from all 50 states and the District of Columbia meeting the following criteria: age 16 years and older, external (injury) cause of death, and the certifier noted that the injury occurred at work.² The inclusion in NTOF of the injury description, cause of death, occupation, and industry in narrative form provides an opportunity for detailed examination of fall-related fatalities.

Limitations of the use of death certificates in ascertaining work-relatedness and as a source of occupational-fatality data have been described previously.^{2, 12-15} Among the chief limitations are a lack of specific employment information, the customary use of “usual” occupation and industry as they appear on the death certificate as proxies for occupation and industry at the time of injury, and the absence of national guidelines for completion of the “injury at work?” item on the death certificate at the time these NTOF data were collected. Despite these limitations, it has been demonstrated that death certificates identify, on the average, 80% of work-related fatalities nationally, more than any other single source.¹⁴ The frequencies presented here should be viewed as the minimum number of fall-related fatalities occurring during the study period.

This analysis includes NTOF data from 1980 through 1994 for fatal falls from elevations identified by external cause of death codes (E-codes) E880-E884 and E888 of the International Classification of Diseases (ICD-9), Ninth Revision (Table 1).¹

Table 1. ICD-9 External Cause of Death Codes for Falls from Elevations

ICD-9	DESCRIPTION
E880	Falls on or from stairs or steps
E881	Falls on or from ladders or scaffolding
E882	Falls from or out of buildings or other structures
E883	Falls into a hole or other opening in the surface
E884	Other falls from one level to another (e.g., tree, stationary vehicle, haystack, embankment)
E888	Other and unspecified falls

Falls on the same level (E885 and E886) were excluded from this analysis, as were falls resulting in fractures with cause unspecified (E887). Cases assigned these three E-codes comprised less than 3% of the 8,545 total cases for the period 1980-1994. Several other types of fall-related incidents are excluded from the ICD-9 falls rubric, notably falls from machinery in operation, falls from railway trains or in water transport, falls from moving motor vehicles, falls while boarding or alighting from motor vehicles, falls preceded by the collapse of a building or structure, falls from burning buildings or structures, and falls preceded by electrocution. Cases that had fall-related E-codes but whose injury descriptions matched the exclusions described above were also eliminated from the analysis, as were cases with an E-code of E888 whose injury descriptions were consistent with falls on the same level, resulting in a final total of 8,102 fatalities.

In the analysis of fall-related fatalities, E-codes provide insufficient detail to ascertain specific circumstances and hazards, particularly in the instance of E882, falls from buildings or structures. The injury description and cause of death narratives in NTOF were used to obtain more precise information about the location from which the worker fell.

Cases were classified by major industry division according to the 1987 Standard Industrial Classification (SIC) system,¹⁶ and by occupation division according to Bureau of the Census classification schemes.^{17,18} Average annual employment data used to calculate fatality rates by industry division were obtained from the Current Population Survey, a monthly household survey conducted for the Bureau of Labor Statistics by the Bureau of the Census.¹⁹ Because of lack of comparability with earlier classification systems (before 1983), fatality rates by occupation were calculated only for the years 1983 through 1994.

Between 1982 and 1997, the NIOSH FACE program investigated 90 fatal fall incidents in which 91 workers were killed. FACE investigations yield detailed information pertaining to the risk factors and sequence of events leading to fatalities. In addition to site investigations and employer interviews, FACE investigators use police and medical examiner reports, death certificates, OSHA documents, newspaper accounts, and other sources to develop summary reports containing recommendations for prevention of similar incidents. FACE investigations constitute a case series; results of analyses of FACE data may not be generalized to all fatal falls from elevations. FACE data are not directly comparable with sources such as NTOF which seek to enumerate all occupational fatalities. However, FACE data complement NTOF surveillance data by providing greater detail for identifying and describing work situations associated with fatal injury.

RESULTS

Between 1980 and 1994, 8,102 workers in the United States died as a result of falls from elevations. There was an average of 540 deaths per year, comprising 9.6% of work-related fatalities over the 15-year period. The average annual fatality rate was .49 per 100,000 workers. The annual rate declined from .68 in 1980 to .42 in 1994 (Figure 2). This 38% decrease paralleled the overall 41% decrease in rates for all causes of death.

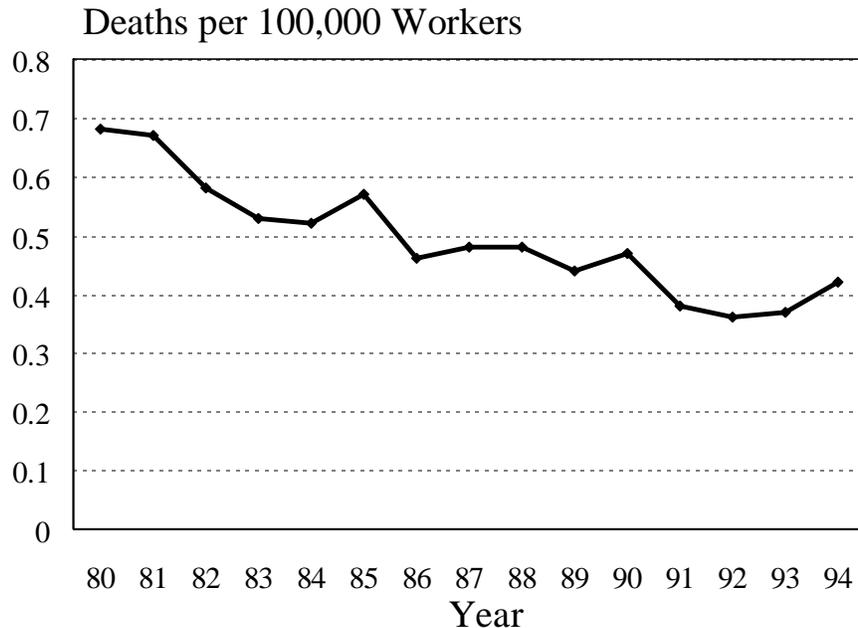


Figure 2. Work-related Fall Fatality Rates, NTOF, United States, 1980-1994 (N=8,102)

Ninety-seven percent of the workers (7,859) were male. Decedents ranged in age from 16 to 96, with a median age of 42. While the greatest number of falls occurred among workers aged 25 to 34 years, the rate of fall fatalities increased with age (Table 2).

Table 2. Number and Rate Per 100,000 Workers of Fatal Falls by Age of Worker, United States, 1980-1994

Age Group (Years)	N	%	RATE
16-19	220	2.7	0.23
20-24	749	9.2	0.38
25-34	1870	23.1	0.40
35-44	1567	19.3	0.39
45-54	1479	18.3	0.54
55-64	1469	18.1	0.86
65+	741	9.1	1.57
Unknown	7	0.1	----
Total	8102	100.0	0.49

Source: National Traumatic Occupational Fatalities (NTOF) Surveillance System

The distribution of workers by race was 86.8% white, 8.9% black, 1.9% other races, and 2.3% of unknown race. Fatality rates due to falls from elevation were .49 deaths per 100,000 workers among whites, .44 among blacks, and .31 among workers of other races.

The greatest numbers of deaths occurred within the construction, manufacturing, and services industry divisions, and the highest rates per 100,000 workers were observed in construction, mining, and agriculture/forestry/fishing (Table 3).

Table 3. Number and Rate Per 100,000 Workers of Fatal Falls by Industry Division, United States, 1980-1994

INDUSTRY DIVISION	N	%	RATE
Agriculture/Forestry/Fishing	507	6.3	0.99
Mining	211	2.6	1.69
Construction	4044	49.9	3.89
Manufacturing	943	11.6	0.30
Transportation/Communications/Public Utilities	518	6.4	0.45
Wholesale Trade	145	1.8	0.22
Retail Trade	250	3.1	0.09
Finance/Insurance/Real Estate	106	1.3	0.10
Services	765	9.4	0.14
Public Administration	181	2.2	0.23
Not Classified	432	5.3	----
Total	8102	100.0	0.49

Source: National Traumatic Occupational Fatalities (NTOF) Surveillance System

NTOF contained detailed SIC codes for fatalities occurring between 1990 and 1994, a total of 2,381 cases. The greatest numbers of deaths were found in construction industry subgroups (Table 4).

Table 4. Detailed SIC Codes with 50 or More Fatalities Due to Falls from Elevations, United States, 1990-1994

SIC CODE	DESCRIPTION	DEATHS
1542	General Contractors — Nonresidential Buildings, Other Than Industrial Buildings and Warehouses	205 *
1611	Highway and Street Construction, Except Elevated Highways	177 **
1761	Roofing, Siding, and Sheet Metal Work	147
1791	Structural Steel Erection	121
1751	Carpentry Work	79
1721	Painting and Paper Hanging	71
1521	General Contractors — Single Family Houses	63
1731	Electrical Work	59
7349	Building Cleaning and Maintenance Services, not elsewhere classified (n.e.c.)	56
783	Ornamental Shrub and Tree Services	56

Source: National Traumatic Occupational Fatalities (NTOF) Surveillance System

* Default category when death certificate specifies building construction

** Default category when death certificate specifies only construction

Analysis of age-specific rates by industry revealed a pattern consistent across most industry divisions. In general, rates increased slowly with age up to age 55, then increased markedly among workers aged 55 to 64 years, and rose even more sharply beginning at age 65 (Figure 3). The only exception to this pattern was the mining industry, where the lowest rate was observed among workers aged 35 to 44 years, and workers below age 25 had fatality rates nearly as high as those seen among the oldest workers. In all other industry divisions, fatality rates among workers aged 65 years and older were five to ten times higher than those among workers below age 25.

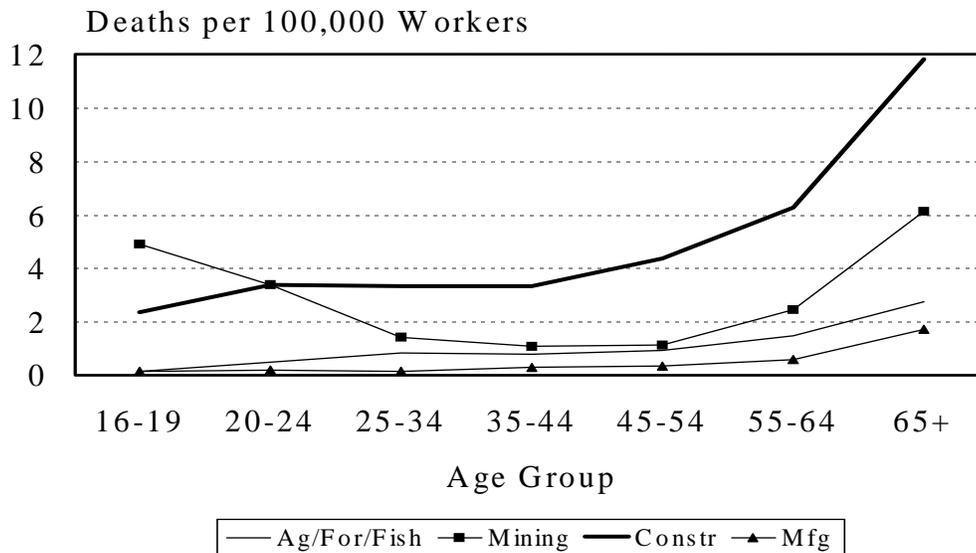


Figure 3. Rates of Work-related Fatal Falls by Age for Selected Industry Divisions, NTOF, United States, 1980-1994

Occupation divisions in which the greatest numbers of fall-related fatalities occurred were precision production, craft, and repair; laborers; executive, administrative, and managerial; and service. Fatality rates were highest among laborers, crafts workers, and workers in farming, forestry, and fishing occupations (Table 5). Detailed occupations with the greatest numbers of deaths between 1990 and 1994 were construction laborers, carpenters, roofers, managers and administrators, n.e.c., structural metal workers, and construction supervisors, n.e.c.

Table 5. Number and Rate Per 100,000 Workers of Fatal Falls by Occupation Division, United States, 1980-1994

OCCUPATION DIVISION	N	%	RATE*
Executive/Administrative/Managerial	513	6.3	0.24
Professional Specialty	260	3.2	0.12
Technicians/Support	74	0.9	0.13
Sales	185	2.3	0.09
Clerical	117	1.4	0.04
Service	508	6.3	0.2
Farmers/Foresters/Fishers	488	6.0	0.91
Precision Production/Craft/Repair	3569	44.1	1.7
Machine Operators	409	5.0	0.32
Transportation/Material Moving	369	4.6	0.5
Laborers	1307	16.1	1.79
Not Classified	303	3.7	----
Total	8102	100.0	----

* 1983-1994

Source: National Traumatic Occupational Fatalities (NTOF) Surveillance System

Location of Fall

Buildings (particularly roofs), ladders, and scaffolds were the most frequently observed locations from which workers fell (Table 6).

Table 6. Work-related Fatal Falls by Location From Which Worker Fell, United States, 1980-1994

LOCATION	N	%
Stairs or steps	207	2.6
Ladder	994	12.3
Scaffolding Scaffold collapse (n=74)	1055	13.0
Building Roof (n=1230) Floor (n=83)	1774	21.9
Specified structures	657	8.1
Unspecified structure/building	381	4.7
Fall into hole or other opening	391	4.8
Other fall from one level to another Tree (n=234) Stationary vehicle/machine (n=177)	1346	16.6
Fall, n.e.c./unspecified	1297	16.0
Total	8102	100.0

Source: National Traumatic Occupational Fatalities (NTOF) Surveillance System

Falls from Ladders

Construction industry workers accounted for a far greater proportion of falls from ladders (46%) than did workers in any other industry. An additional 11% of workers were employed in manufacturing and 11% in service industries. Between 1990 and 1994, the greatest numbers of deaths occurred among General Contractors — Nonresidential, Other Than Industrial Buildings and Warehouses (SIC 1542), and Painting and Paper Hanging (SIC 1721).

Ladders were the leading cause of fatal work-related falls in the retail trade (22%) and finance, insurance, and real estate (21%) industry divisions, and the second leading cause in services (14%) and public administration (18%). They were associated with 20% of fatal falls among sales occupations, more than any other fall-related cause. Ladders accounted for 17% of falls among executive, administrative, and managerial workers and 18% of falls among technician/support and service occupations.

Workers aged 55 years or older were involved in 27% of all fatal falls, but accounted for 42% of falls from ladders. Less than 7% of ladder-related deaths were among workers under the age of 25 years.

Falls from Scaffolds

Construction industry workers accounted for over 70% of falls from scaffolding. Fourteen percent of scaffold-related fatalities between 1990 and 1994 occurred among workers in General Contractors — Nonresidential, Other Than Industrial Buildings and Warehouses (SIC 1542), 11% in Highway and Street Construction, Except Elevated Highways (SIC 1611), and 10% in Masonry, Stone Setting, and Other Stone Work (SIC 1741). Workers in crafts occupations experienced 58% of fatal falls from scaffolding. Detailed occupations with the greatest numbers of fatal falls from scaffolding between 1990 and 1994 were construction laborers, carpenters, and brickmasons and stonemasons.

Falls from Buildings or Structures

Sixty-one percent of fatal falls from buildings and structures occurred within the construction industry, 8% in manufacturing, and 8% in services. Between 1990 and 1994, the specific industries with the greatest proportions of these fatalities were General Contractors — Nonresidential, Other Than Industrial Buildings and Warehouses (SIC 1542); Roofing, Siding, and Sheet Metal Work (SIC 1761); and Highway and Street Construction, Except Elevated Highways (SIC 1611).

More than 50% of workers who died in falls from buildings or structures were employed in the crafts occupation division; 18% were laborers. Between 1990 and 1994, the greatest numbers of these fatalities were seen among construction laborers, roofers, and carpenters.

Of the 1,774 fatal falls from buildings, 1,230 (69%) were falls through or from a roof (Table 7).

Table 7. *Circumstances of Fatal Roof-related Falls, United States, 1980-1994*

	N	%
Falls through roof		
Through roof opening	43	3.5
Through roof (non-supportive materials)	13	1.1
Through skylight	83	6.7
Through roof, n.e.c./unspecified	103	8.4
Falls from Roof		
From roof structural member	19	1.5
From roof	961	78.1
Roof, n.e.c./unspecified	6	0.50
Total	1230	100.0

Source: National Traumatic Occupational Fatalities (NTOF) Surveillance System

Workers in crafts occupations experienced 56% of fatal falls through or from roofs. Between 1990 and 1994, the greatest numbers of roof-related falls occurred among roofers, carpenters, and construction laborers.

Disproportionately high numbers of falls from specified structures were observed in the mining industry, which includes oil and gas extraction, and in transportation/communications/ public utilities (TCPU). In mining, 36% of all fatal falls were from specified structures, the majority of which were rigs and derricks. Fatal falls in mining were most prevalent within SIC Major Group 13, Oil and Gas Extraction (101 of 144 fatal falls assigned to a major group, or 70%). Fifty-nine (58%) of the 101 were clearly falls from oil rigs, derricks, or towers. An additional 17 mining fatalities not classified to a major group were falls from rigs or derricks. In other mining sectors, the incidence of fatal falls was much lower than in Oil and Gas Extraction: metal (9), coal (11), and nonmetal (23).

In TCPU, 23% of fatal falls were from structures, predominantly poles and towers. This industry contributed only 6% of falls overall, but 18% of falls from structures.

Other Falls from Elevation

Falls from trees (17%) and stationary vehicles (13%) were most prevalent among the 1,346 other falls from elevation. The greatest numbers of falls from stationary vehicles or machinery occurred within manufacturing and TCPU. Within both industries, the majority of these were falls from stationary trucks. Workers in the agriculture/forestry/fishing industry accounted for only 6% of all fatal falls, but suffered 57% of falls from trees. The majority of fatalities in this industry division occurred within agricultural crop production (Major Group 01) and agricultural services (Major Group 07). In crop production, fatal falls were evenly distributed among falls from ladders, roofs, structures such as silos, stationary vehicles, and trees. In contrast, falls from trees comprised over two-thirds of fatal falls in the agricultural services sector.

FACE Investigations

Between 1982 and 1997, the Fatality Assessment and Control Evaluation (FACE) project investigated 90 fatal fall-related incidents resulting in 91 deaths. The fatalities occurred in 13 states. Eighty-eight of the workers (97%) were male. The workers ranged in age from 16 to 70 years, with a median age of 36. The majority (78%) were white and non-Hispanic. Nine percent were black, 8% were Hispanic, and 5% were of other races.

The majority of fatal falls investigated by FACE (82%) occurred in the construction industry. In 51 of the 75 construction cases (68%), the worker was employed by a special trades contractor (SIC Major Group 17). The specific industries noted most frequently in the FACE data were SIC 1761 (Roofing, Siding, and Sheet Metal Work), SIC 1721 (Painting and Paper Hanging), and SIC 1542 (General Contractors — Nonresidential Buildings, Other Than Industrial Buildings and Warehouses). The remainder of FACE fall investigations were in agriculture/forestry/fishing, manufacturing, TCPU, wholesale trade, services, and public administration.

The majority of workers (76%) were employed in crafts occupations; 13% were laborers. The specific occupations observed most frequently were painters, structural metal workers, carpenters, construction supervisors, n.e.c., and roofers.

Eighty-two percent worked for private sector employers; the remainder were self-employed (14%) or government employees (2%). The employment class of one worker was unknown. Company size ranged from one employee to more than 10,000, with a median of 40 (Figure 4). In 36% of the cases, the employer had been in business for 5 to 10 years. In another 28%, the employer had been in business for 11 to 20 years.

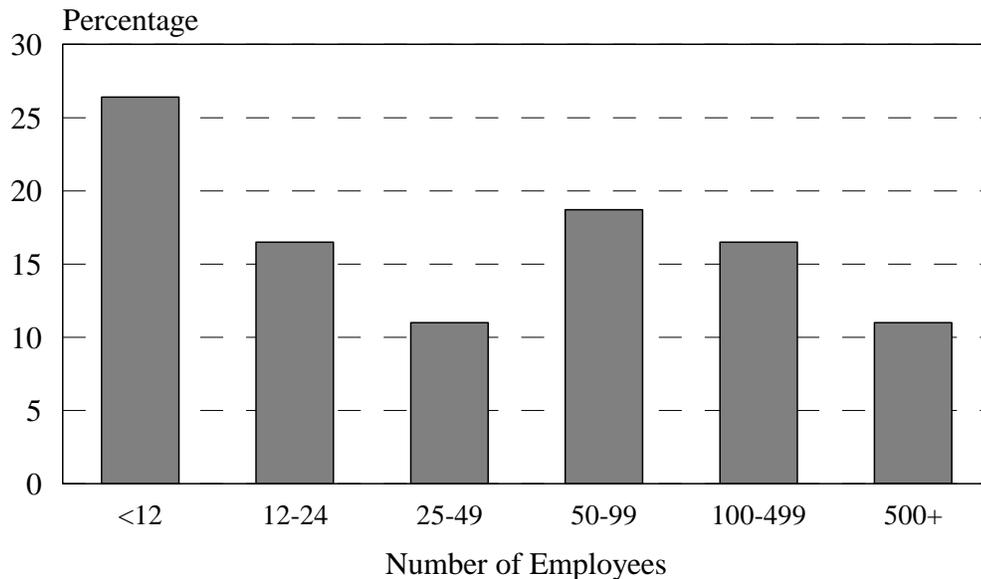


Figure 4. *Distribution of Work-related Fatal Falls by Company Size, FACE Investigations, 1982-1997 (N=91)*

The worker's length of employment with his or her current employer ranged from 1 day to 24 years; 16 of the workers (18%) had been employed by their company for 1 month or less (Figure 5). The median employment period was 18 months. Nearly half (49%) had been working for their current employer for less than 12 months; 83% of these were employed in construction. In many of the fatal falls in construction investigated by FACE, the worker had little additional experience performing the same task for another employer. Only 4 of the 35 construction workers with 12 months or less service with their current employer had more than a year's experience doing the same type of work, and only 3 had more than a year of experience in the specific job task associated with the fatality.

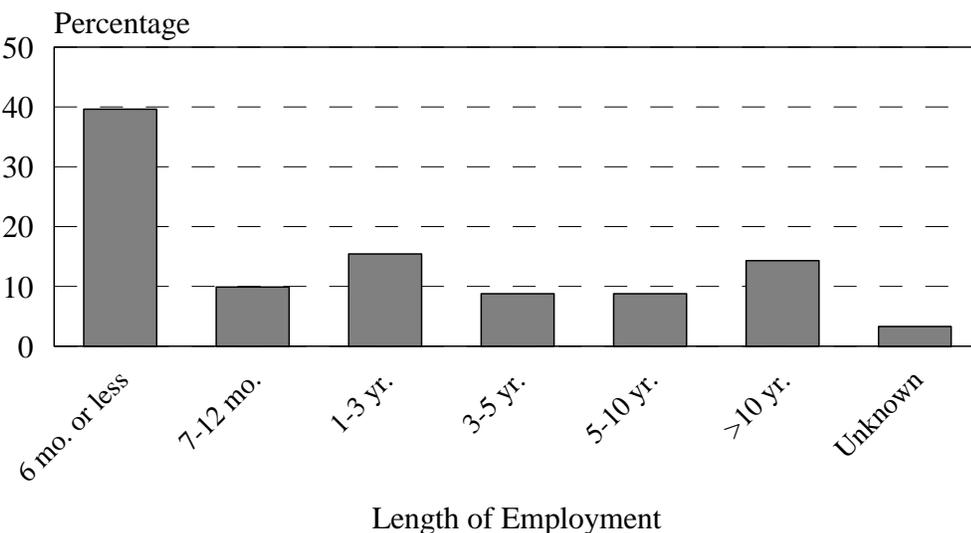


Figure 5. *Distribution of Work-related Fatal Falls by Time with Employer, FACE Investigations, 1982-1997 (N=91)*

Forty-nine percent of the employers had a designated safety officer, and 58% had a written safety program. However, only 37% had written rules covering the task being performed by the worker at the time of the fatal fall. Thirteen percent of employers provided no employee training; 59% provided on-the-job training only. A combination of training methods (on-the-job, classroom, and manuals) was used by 23% of employers, and training status was unknown in 4% of cases.

Availability and use of personal protective equipment (PPE) was ascertained for over three-fourths of the fatalities investigated. Nonuse and incorrect use (n=41) were more frequent than PPE not being available at the worksite (n=18) (Table 8). The kinds of equipment most frequently present at the worksite or used by the worker were safety belts and lanyards, guardrails, and lifelines.

Table 8. Fatal Falls by Availability and Use of PPE, FACE, 1982-1997

PPE STATUS	N	%
PPE not available	18	19.8
PPE available, but not wearing	15	16.5
Wearing PPE, but not using	14	17.6
Using PPE incorrectly	12	13.2
Using PPE, but PPE failed	2	2.2
PPE not applicable	9	9.9
Unknown	21	23.1
Total	91	100.0

The greatest numbers of incidents investigated through FACE were falls from roofs, scaffolding, and ladders (Table 9).

Table 9. Fatal Falls by Location From Which Worker Fell, FACE, 1982-1997

LOCATION	N	%
Stairs or steps	0	0.0
Ladder	8	8.8
Scaffolding Scaffold collapse (n=2)	17	18.7
Building Roof (n=26) Floor (n=10)	40	44.0
Specified structures	7	7.7
Unspecified structure/building	11	12.1
Fall into hole or other opening	0	0.0
Other fall from one level to another Tree (n=1) Stationary vehicle/machine (n=5)	8	8.8
Fall, n.e.c./unspecified	0	0.0
Total	91	100.0

The kinds of ladders involved in fall fatalities investigated by FACE were extension ladders (3), fixed ladders (3), rope ladders (1), and stepladders (1). Four of the eight fatalities occurred inside tanks or towers (three fixed ladders and one rope ladder). Absence of confined space entry procedures or failure to adhere to existing procedures played a role in all four fatalities. In two of these cases that involved fixed ladders, personal protective equipment such as harnesses, safety belts, lifelines, and respirators were required by the employer and available at the site but not used by the worker who fell.

Three of the falls from ladders investigated by FACE occurred while the worker was ascending or descending. In the fatality involving a rope ladder, the worker used an inappropriate climbing procedure, facing the ladder rather than ascending it along the side to minimize swaying. In another instance, the upper section of an extension ladder was used without the bottom section, and the bottom of that section slipped out on the wet concrete work surface.

Six of the scaffolds were suspended scaffolds; one of these events resulted in two fatalities. Six were tubular welded-frame scaffolds; two were mobile scaffolds; and the remaining two were other types. FACE investigations identified several factors associated with falls from scaffolds: improper maintenance or erection procedures (e.g., failure to lock casters, failure to check tightness of bolts, failure to check suspension rope for damage, or failure to secure planking); incorrect methods of mounting and dismounting (e.g., using guardrails or diagonal braces to climb from one level to another); and absence of guardrails.

Of the roof-related falls, nine were through roof openings (four of which were openings cut for skylights); eight were from a roof edge; five were from roof structural members; and two were through skylights. FACE investigations identified several factors associated with roof-related falls including unguarded roof openings, unsecured or unstable materials, and loss of balance. Loss of balance occurred in conjunction with work activities such as carrying metal decking, attempting to free a snagged cable, or unwinding an extension cord. Investigations of the skylight-related fatalities revealed that the employers failed to provide the standard skylight cover or fixed standard railing on all exposed sides as required by OSHA General Industry Standard 29 CFR 1910.23(a)(4).²⁰ These investigations also suggested that workers may have been unaware that the structural integrity of the skylights was insufficient to support their weight.

Overall, the mean height of the fall was 41 feet, and the median was 28. Eight percent of the workers for whom fall height was known fell 10 feet or less; 22% fell more than 50 feet (Figure 6). In four of the six falls from ladders, the worker fell 20 feet or less. The 16 fatalities which were falls of 15 feet or less were evenly distributed among falls from ladders, scaffolds, roofs, floors, and vehicles. Twelve of the 26 falls from roofs (46%) were from heights of 21 to 30 feet. Eight of the 17 falls from scaffolding (47%) were from heights of 46 feet or more.

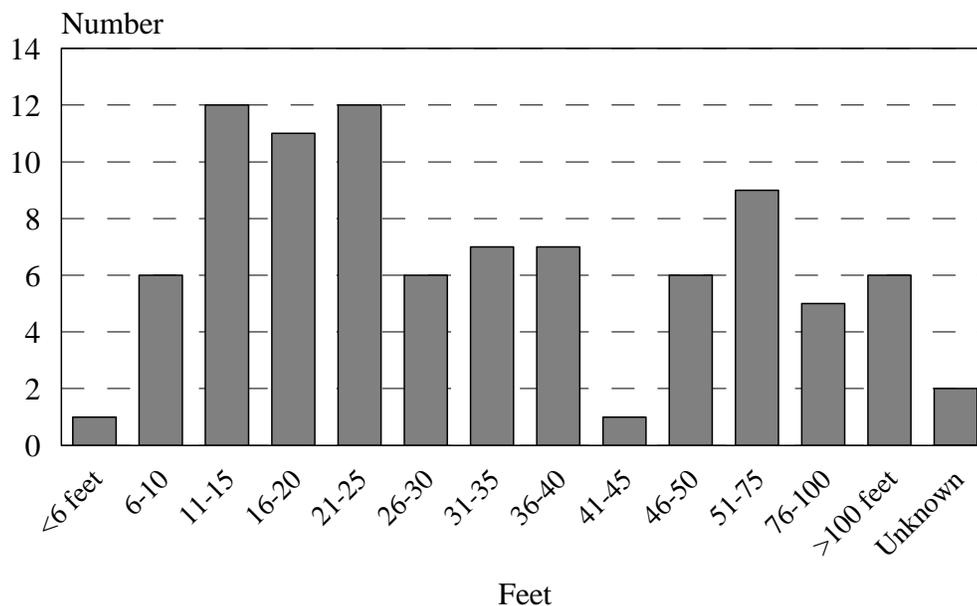


Figure 6. *Distribution of Fatal Falls by Height of Fall, FACE Investigations, 1982-1997 (N=91)*

DISCUSSION

Analysis of NTOF data on fatal work-related falls in the United States identified falls as the fourth leading cause of workplace fatalities. Fifty percent of all fatal falls identified by NTOF occurred in the construction industry, which had both the highest frequency and rate of fatal falls between 1980 and 1994. The industry is characterized by self-employment, small firms, irregular and seasonal employment, temporary and inexperienced workers, intense pressure to meet deadlines, multiple contractors and subcontractors working at the same site, and changing work settings (within a single jobsite or between sites).²¹⁻²³

FACE investigations showed that the above characteristics of the construction industry can contribute to fatal falls. Lack of hazard recognition can result from lack of coordination of work tasks between contractors, rapid physical changes in the work environment, and worker inexperience. Deviation from standard operating procedure and lack of adherence to safety standards (e.g., failing to use PPE and allowing accumulated debris to create fall hazards) may be associated with contract deadlines, the worker's inexperience, the worker's lack of familiarity with the task or the work environment, and the employer's lack of written task-specific work procedures.

For many construction workers, exposure to fall hazards is a nearly constant aspect of employment. Fall prevention challenges facing the construction industry are not necessarily limited to recognition that hazards exist and that means of fall protection are required and available. Also of concern are the difficulties in providing regular, consistent safety training, coordinating work activities among a variety of contractors and subcontractors, and development of safe work practices in a changing workforce amid changing work settings.

The manufacturing and services industry divisions had the second and third highest frequencies of fatal falls. These industries, however, had lower fatality rates, and levels of exposure to fall hazards may be less constant than in construction. Thus, employer and worker recognition of fall hazards may be lower. In addition, because work environments in these industries vary widely no single fall location predominates, and injury prevention programs may have to address various kinds of hazards. This presents diverse challenges to those responsible for protecting workers in these industries from fall hazards.

Following the construction industry, the highest fall-fatality rates were observed in the mining (including oil and gas extraction) and the agriculture/forestry/fishing industries. Fatal falls within mining were concentrated within the oil and gas extraction sector, suggesting that fall prevention programs for the industry should emphasize hazards associated with working from rigs and derricks. The wide variety of fall types seen in agricultural production suggests that fall prevention programs targeted at farmers need to address a wide variety of fall hazards. On the other hand, falls from trees predominated in the agricultural services sector (particularly SIC 0783, Ornamental Shrub and Tree Services), where prevention efforts could most effectively be directed at this specific hazard.

The NTOF analysis corroborated previous research in identifying roofers, carpenters, construction laborers, structural steel workers, painters, and tree trimmers as occupations that experienced high frequencies of fatal falls. NTOF also identified notable numbers of falls among managers, administrators, and construction supervisors, who may have less constant levels of exposure to fall hazards than workers such as roofers and structural steel workers. Emphasis on hazard recognition skills and use of PPE are important not only to managers' personal safety but to demonstrate management commitment to safe work practices.

Ladder-related incidents were the leading cause of fatal falls in retail trade and finance, insurance, and real estate, and the second leading cause in services and public administration. Although these industries had low fall-fatality rates overall, it is nonetheless important to recognize the risk posed by ladders in these work settings and to provide appropriate worker training where ladders are in use.

Workers aged 55 years and older accounted for a disproportionately high share of fatal falls from ladders, 42%. Ladders are generally used with minimal fall protection, with workers relying on balance and coordination to avert falls.²⁴ Even minor declines in balance, coordination, and reaction times associated with the normal aging process may result in increased risk of falls from ladders among older workers.²⁴

The NTOF data also showed that fall fatality rates due to all causes increased with age, particularly after age 65. Compared with younger workers, injuries to older workers tended to result in more complications and prolonged recovery periods and were more likely to result in death.^{25,26} Another source reported that workers aged 55 years or older were at decreased risk for nonfatal injury yet spent greater median days away from work when injured (10 days vs. 6 days for younger workers).²⁷

NTOF and FACE data reveal that the risk and nature of fatal falls vary substantially by factors such as industry, age, work setting, and experience. In some industries a single type of fall or similar group of fall types predominates (falls from rigs and derricks in oil and gas extraction, and falls from trees in agricultural services). For these industries, fall prevention strategies should include intensive training and interventions directed at specific hazards. In other sectors, such as construction, agricultural production, and manufacturing, workers are at risk for a wide variety of fall types. Safety programs for these industries should address risks associated with working from ladders, working from various buildings and structures, and operating and maintaining machinery and vehicles.

PREVENTION: ELEMENTS OF A FALL PROTECTION PROGRAM

Every day at worksites across the nation many workers are required to work at elevations and are exposed to numerous fall hazards. Therefore, it is essential for employers to develop and implement comprehensive, written fall-protection programs where workers are exposed to fall hazards. Fall protection programs should always be applied to all tasks with identified fall hazards—including work involving: aerial-lifts; walking/working surfaces with questionable strength and structural integrity; bridges; demolition; floor-openings; leading edges; low-slope, steep, and built-up roofs; personnel platforms; precast concrete; safety nets; scaffolds; silos/tanks; steel erection; and tree trimming.

Implementation of written fall-protection programs can reduce the number of fall-related injuries. These written programs should describe the appropriate fall-protection systems and equipment to be used for each anticipated fall hazard. Fall-protection systems covered in a written fall-protection program may utilize either passive or active systems. Passive systems, when installed, protect workers without the need for them to take additional action on their own behalf. Examples of passive systems include guardrails, parapet walls, railings, safety nets, and hole covers. Active systems, on the other hand, are protection systems or devices that require each worker to take positive action to protect against/or arrest a fall. An example of an active system is when a worker puts on a full-body harness and connects a lanyard or a self-retracting lifeline to a proper anchorage point. Where possible, passive systems should be used because their effectiveness does not depend on specific actions by the worker being protected.

There are two basic fall-protection systems in use in the construction industry, namely fall-prevention and personal fall-arrest systems. Fall-prevention systems usually involve passive components, such as guardrails and hole covers. However, when passive systems are not feasible, it is possible to prevent falls by having workers tie off to self-retracting lifelines that are short enough to prevent the worker from reaching the fall hazard. Personal fall-arrest systems are designed to limit the distance that a worker can fall, thus limiting the forces acting on the worker's body in the event of a fall. Fall-arrest systems require the use of a full-body harness to distribute fall arrest forces so as to minimize the extent of injury sustained in a fall. Other components of a fall-arrest system may include one or more of the following—rope grabs, shock absorbing lanyards, various types of connection hardware (e.g., snap hooks or carabiners), horizontal or vertical lifelines, and anchorage points sufficient to withstand 5000 pounds or two times the load expected in a fall.

The employer should develop, implement, and enforce a comprehensive, written fall protection program. The program should be in writing and at a minimum meet the requirements of OSHA 29 CFR 1926.502.²⁰ The following elements are recommended as a guide in developing a fall protection program. The program should include, but not be limited to, the following:

1. Addressing all aspects of safety and hazards in the planning phase of projects.
2. Identifying all fall hazards at the worksite.
3. Training employees in the recognition and avoidance of unsafe conditions and the OSHA regulations applicable to their work environment to control or eliminate the hazards. OSHA recommends that fall-protection training include classroom instruction supplemented by hands-on

training with the equipment. Training should commence at the time of hire for new employees exposed to fall hazards, and continue periodically thereafter. Involve workers, when feasible, to help identify which tasks create fall hazards, and what methods could be used to eliminate these hazards. Employee participation and acceptance is crucial to implementing an effective fall protection program.

4. Performing a job hazard analysis for each task to be performed.
5. Providing appropriate fall protection equipment, training workers on the proper use of fall protection equipment and enforcing its use, and daily inspection of equipment.
6. Conducting scheduled and unscheduled safety inspections of the worksite.
7. Addressing:
 - a) environmental conditions,
 - b) multi-language differences,
 - c) alternative methods/equipment to perform assigned tasks,
 - d) establishment of medical and rescue programs.
8. Encouraging workers to actively participate in workplace safety.

Fall protection equipment is very specific in its application, and great care should be taken to choose the correct system for the application intended, in accordance with industry standards or guidelines on specific worker needs. Manufacturer's instructions for correct use and maintenance must be followed explicitly; otherwise, injuries and fatalities can result. Compatibility of a fall-protection system's components is crucial. Employers and employees should realize that not all components (such as lanyards, connectors, lifelines, deceleration devices, and harnesses) are interchangeable. The benefits derived from safely performed work at heights include more organization, more employee cooperation, greater productivity for management, less danger to life on the job and a lower insurance risk for hazardous work in high places.

OSHA regulations under 29 CFR 1926.501 require employers to provide workers who are exposed to fall hazards of over 6 feet with adequate fall protection, which may involve the installation of either fall-prevention systems, or of personal fall-arrest systems. However, the OSHA regulations provide an exception in selected work situations where the employer can demonstrate that it is infeasible, or creates a greater hazard to install these systems. Employers have the option of developing and implementing a fall protection plan in lieu of installing fall protection systems only when they can demonstrate the infeasibility, or greater hazard created by fall protection systems. This exception in the OSHA fall protection regulation is further described below.

Exception: When the employer can demonstrate that it is infeasible or creates a greater hazard to use these systems, the employer shall develop and implement a fall protection plan which meets the requirements of paragraph (k) of 1926.502 (e.g., employers engaged in leading edge work, precast concrete construction work and residential construction).

The fall protection plan shall be prepared by a qualified person and developed specifically for the site where the leading edge work, precast concrete work, or residential construction work is being performed and the plan must be maintained up to date. A "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. The implementation of the fall protection plan shall be

under the supervision of a competent person. A “competent person” is one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them. This plan is designed to enable employers and employees to recognize the fall hazards on this job and to establish the procedures that are to be followed in order to prevent falls to lower levels or through holes and openings in walking/working surfaces. Each employee will be trained in these procedures and strictly adhere to them except when doing so would expose the employee to a greater hazard. The fall protection plan shall document the reasons why the use of conventional fall protection systems (guardrail systems, personal fall arrest systems, or safety net systems) are infeasible or why their use would create a greater hazard. The fall protection plan shall include a written discussion of other measures that will be taken to reduce or eliminate the fall hazard for workers who cannot be provided with protection from the conventional fall protection systems. For example, the employer shall discuss the extent to which scaffolds, ladders, or vehicle mounted work platforms can be used to provide a safer working surface and thereby reduce the hazard of falling. Where no other alternative measure has been implemented, the employer shall implement a safety monitoring system.

To help reduce occupational fatalities resulting from falls from elevations, NIOSH recommends the following prevention strategies, in addition to the general recommendations provided on pages 21 - 23, by fall hazard environment (i.e., ladders, scaffolds, buildings or other structures, machinery, and trees). The prevention strategies were derived from worksite incident investigations conducted by NIOSH personnel, requirements contained in the Occupational Safety and Health Administration (OSHA) Standards for General Industry and the Construction Industry, and standards from the American National Standards Institute (ANSI).

Ladders

The following recommendations were based on NIOSH investigative/research experience, and OSHA²⁰ and ANSI²⁸⁻³² safety standards for ladders. Every worker should be knowledgeable of the following when using ladders.

Prior to using a ladder, workers should visually inspect it for:

- structural damage, such as split/bent side rails, broken or missing rungs/steps/cleats
- missing or damaged safety devices, such as rung locks, lock spreaders or safety shoes/feet/spurs/spikes
- grease, dirt, or other contaminants that could cause slips or falls
- paint or stickers (except warning labels) that could hide possible defects.

Damaged ladders should be: Tagged or marked for repair, replacement, or destruction.

Climbing guidelines

- Wear slip-resistant footwear.
- Keep the area around the top and bottom of the ladder clear.

- Wear approved fall protection equipment, if applicable.
- Never carry large objects while ascending or descending the ladder. Use a hoist or pulley mechanism to move large/awkward objects up to working level or down to the ground.
- Keep both hands free for climbing.
- Face the ladder and maintain three-point contact (two hands and one foot or one hand and two feet on the ladder) at all times.
- Do not load ladders beyond the maximum intended load for which they were built, nor beyond their manufacturer's rated capacity.
- Use ladders only for the purpose for which they were designed.

Portable ladders (OSHA §1910.26 and §1926 Subpart X)²⁰

There are two basic classifications of portable ladders, self-supporting (step ladders) and non-self-supporting (straight or extension ladders). Remember to use the proper ladder for the job/task being performed. In choosing between a self-supporting and a non-self-supporting ladder, an important factor to consider is the bottom (working surface) and top support conditions. If unsure of what the proper ladder selection should be, consult the ladder manufacturer or the nearest OSHA office. Proper selection of a ladder is essential for ensuring safety and reducing the potential for injury events.

A portable ladder must:

- be long/tall enough to safely reach the work area
- have a load rating that can support the weight of the user, materials, and tools
- have non-conductive side rails, when used near energized equipment.

When using a non-self-supporting straight or extension ladder, observe the following precautions:

- Use ladders only on stable and level surfaces unless secured to prevent accidental displacement.
- Extend ladder side rails at least 3 feet above the upper landing to which the ladder is used to gain access.
- Set up the ladder so that the height-to-base ratio is 4 feet to 1 foot (e.g., 4 feet away from vertical member for a 16-foot ladder). *A general "rule of thumb" is to place feet at base of ladder; extend arms; hands should just touch side rails.*
- Have another person hold the ladder during ascent or descent, or tie/stake/foot it in place (top and bottom).
- Set ladder so that both rails of the ladder maintain equal contact with the supporting structure.

- Use adjustable feet to level the ladder, if applicable.
- Never lean more than 12 inches beyond either side rail. *Belt-buckle rule: always keep your belt buckle inside the side rails of the ladder.*
- Carry small tools and other work materials in your clothing or attached to a tool belt.
- The third highest rung is the maximum climbing height

When using a self-supporting step ladder:

- Use a step ladder only on a solid, level surface.
- Never try to use a folded step ladder as a straight ladder.
- Fully extend and lock the spreaders.
- Never climb or stand on the leg braces, the top step, or on the service tray.
- Avoid using an unprotected step ladder in a doorway or high-traffic areas.
- When working in a high-traffic area, lock or barricade doors, mark the area off, or have a co-worker monitor the area while work is performed.
- Carry small tools and other work materials in your clothing or attached to a tool belt.
- Maintain three-point contact if it is necessary to carry large objects up or down a ladder.

General Information (ANSI A14 and OSHA §1910.26)²⁰

The duty rating is to be considered the maximum working load, which includes the weight of the user, materials, and tools. The following summarizes the classification of ladders by duty rating:

TYPE	DUTY	DUTY RATING
Type IA	Extra heavy	300 lbs.
Type I	Heavy	250 lbs.
Type II	Medium	225 lbs.
Type III	Light	200 lbs.

Each section of a multi-section ladder, when fully extended, should overlap the adjacent section by at least the number of feet indicated in the table below.

Minimum required overlap (extension ladders)

Normal Length of Ladder		
16 ft - 36 ft	>36 ft - 48 ft	>48 ft - 60 ft
3 feet	4 feet	5 feet

The length of single ladders or individual sections of ladders shall not exceed 30 feet. Two-section ladders shall not exceed 48 feet in length and ladders with more than two sections shall not exceed 60 feet in length.

Maximum lengths for wooden, aluminum, and fiberglass step ladders.

DUTY RATING	LENGTH
Type IA and Type I	20 feet
Type II	12 feet
Type III	6 feet

Stepladders shall not exceed 20 feet in length.

Fixed Ladders (§1926.1053)²⁰

- Fixed ladders shall be used at a pitch no greater than 90 degrees from the horizontal, as measured to the back side of the ladder.
- Each step or rung shall be capable of supporting a single concentrated load of at least 250 pounds (114 kg) applied in the middle of the step or rung.
- The rungs and steps of fixed metal ladders shall be corrugated, knurled, dimpled, coated with skid-resistant material, or otherwise treated to minimize slipping.
- Where the total length of a climb equals or exceeds 24 feet (7.3 m), fixed ladders shall be equipped with one of the following: cages, wells, ladder-safety devices, or self-retracting lifelines.

Scaffolds (§1926.451)²⁰

The following recommendations were based on NIOSH investigative/research experience, and OSHA²⁰ and ANSI²⁸⁻³² safety standards for scaffolds. Every worker should be knowledgeable of the following when using scaffolds.

- The footing or anchorage for scaffolds should be sound, rigid, and capable of carrying the maximum intended load without settling or displacement. Unstable objects, such as barrels, boxes, loose bricks, or concrete blocks, should not be used to support scaffolds or planks.
- No scaffold should be erected, moved, dismantled, or altered except under the supervision of a competent person.
- Guardrails and toeboards should be installed on all open sides and ends of platforms more than 10 feet above the ground or floor, except needle-beam scaffolds and floats.
- Guardrails should be 2 by 4 inches, or the equivalent, approximately 42 inches high, with a midrail, when required. Supports should be at intervals not to exceed 8 feet, and toeboards should be a minimum of 4 inches in height.
- Scaffolds 4 feet to 10 feet in height, having a minimum horizontal dimension in either direction of less than 45 inches, should have standard guardrails installed on all open sides and ends of the platform.

- Scaffolds and their components should be capable of supporting without failure at least 4 times the maximum intended load.
- Any scaffold having accessories such as braces, brackets, trusses, screw legs, ladders, etc. which are damaged or weakened from any cause should be immediately repaired or replaced.
- All scaffold platforms should be tightly planked with scaffold plank grade, or equivalent, as recognized by approved grading rules for the species of wood used.
- After the erection of scaffolding at any project site, the employer should designate a competent person to initially inspect the scaffolding and, at designated intervals, re-inspect the scaffolding. Areas of consideration for inspection should include but not be limited to the following: 1) braces, 2) brackets, 3) footing (anchorage), 4) guardrails and toeboards, 5) ladders, 6) legs, 7) locking pins, 8) overhead protection, 9) planking, 10) poles, 11) securing, 12) slippery conditions, 13) trusses, and 14) uprights.
- Suspension-scaffold rigging should be inspected periodically by a competent person to ensure that all connections are tight and that no damage to the rigging has occurred since its last use.
- Synthetic rope used in suspension scaffolding should be protected from heat-producing sources.
- Employers should ensure that employees are informed of the hazards of using diagonal braces as a means of climbing scaffolds and instruct workers on the proper way to climb scaffolding.

Falls from buildings (§1926.502)²⁰

The following recommendations were based on NIOSH investigative/research experience, and OSHA²⁰ and ANSI²⁸⁻³² safety standards for falls from or out of buildings or other structures.

- Designers of buildings such as multi-tiered steel-framed structures should provide for fall protection anchorage systems as part of the overall design of the structure.
- Designers of tanks should incorporate anchorage points (for securing scaffolds and lifelines) and toe boards into the design of their products; owners of tanks should consult with tank manufacturers to devise means of installing these safety features on existing tanks.
- A competent person should evaluate potential tie-off anchorage points and determine if the available safety equipment can work as designed. If the equipment will not work as designed, contact equipment manufacturers to determine what equipment is available that can do the job properly.
- A competent person should routinely inspect all protective devices (e.g., guardrails, lifelines, etc.) to ensure they operate properly.
- Employers should ensure that workers follow pre-fabrication building plans and procedures and comply with existing standards regarding structural steel assembly.
- Employers should ensure that workers using personnel hoists and work platforms comply with existing standards regarding the use of personnel hoists and work platforms.

- Plant/facility owners/operators should identify areas that may be hazardous to all personnel, including contractors, and restrict or prohibit the use of, or access to, these areas.
- Unused or unsecured construction materials should be stored only in designated areas.
- Lifts or hoists should be used to raise tools and materials to working heights or to lower tools and materials to ground level.

Roof Openings

- Install guarding and/or fall protection on all roof openings.
- Warning signs should be present on all roof openings.
- Employers should consider, when applicable, cutting the roof openings as the last action on the roof to help minimize exposure to this type of hazard.

Floor Openings

- Install guarding in the form of a standard railing and toe boards on all sides of floor openings, or install a cover capable of supporting the maximum intended load and so installed as to prevent accidental displacement.
- Hatchway floor openings should be guarded by hinged-floor-opening covers of standard strength and construction, equipped with standard railings or permanently attached thereto so as to leave only one exposed side. When the opening is not in use, the cover shall be closed or the exposed side shall be guarded at both top and intermediate positions by removable standard railings.

Skylights

- Install guarding in the form of standard railing around skylight openings, or install a cover capable of supporting the maximum intended load. Covers over skylight openings should be installed so as to prevent accidental displacement.
- To guard against falls through skylights by maintenance or other personnel who must access the roof once construction is completed, building owners should consider installing permanent railings around skylight perimeters or protective covers over individual skylights.
- Skylight manufacturers and building owners should voluntarily affix warning signs (e.g., “DANGER—skylights have been installed on this building. Stepping or sitting on the skylight may result in severe injury or death.”) on the skylights and at or near points of access (e.g., roof hatches, fixed ladders, stairways, doors, etc.) to areas containing these skylights.
- Designers/manufacturers of skylights should evaluate current designs with a view toward increasing load capacities and/or incorporating safeguards (e.g., protective grillwork).

Leading Edges and Wall Openings

- Provide fall protection measures along unguarded roof perimeters and balconies.
- During steel erection, secure temporary flooring from displacement.
- Work near an open or damaged window should be done from the side rather than from directly in front of the window, whenever possible. This is also true of door and window openings prior to installation of the door and window. Guardrails should be installed across the opening until the door or window is installed.

Stationary Vehicles and Tree Work

The following recommendations were designed for aerial lifts (§1926.556),²⁰ fork lifts (powered industrial trucks)(§1910.178), and tree work,¹¹ and should be followed where applicable.

Aerial lifts can be defined as any vehicle-mounted aerial device used to elevate personnel to jobsites above ground such as extensible boom platforms, aerial ladders, articulating boom platforms, vertical towers, or any combination of these devices.

- A full-body harness should be worn and a lanyard attached to the boom or basket when working from an aerial lift.
- Attaching the lanyard to an adjacent pole, structure, or equipment while working from an aerial lift should not be permitted.
- Employees should always stand firmly on the floor of the basket, and should not sit or climb on the edge of the basket or use planks, ladders, or other devices for a work position.
- An aerial lift truck should not be moved when the boom is elevated in a working position with personnel in the basket, except for equipment which is specifically designed for this type of operation.
- Climbers should not be worn while performing work from an aerial lift.
- The brakes should be set, and when outriggers are used, they should be positioned on pads or a solid surface. Wheel chocks should be installed before using an aerial lift on an incline, provided they can be safely installed.
- Regular inspection and maintenance should be performed on all tools and equipment prior to use.

Fork lifts

Whenever a truck used for lifting personnel is equipped with vertical controls only, or vertical and horizontal controls elevatable with the lifting carriage or forks, the following precautions should be taken for the protection of the personnel being elevated:

- A safety platform firmly secured to the lifting carriage and/or forks should be used.
- Means should be provided whereby personnel on the platform can remotely shut off power to the truck.
- Protection from falling objects should be provided.

Trees

- Workers should not perform tree trimming or cutting without appropriate safety training.
- Use safe work procedures provided by the employer and/or equipment manufacturer for climbing, felling, topping and pruning trees.
- Use safe work procedures provided by the employer and/or equipment manufacturer to prevent the cutting of climbing ropes, lanyards, and harnesses or straps.
- Ensure that proper fasteners are used at the connectors for all climbing-cradle ropes.
- Inspect trees and limbs for structural weakness and the presence of powerlines before climbing or cutting.
- Inspect all equipment, including fall-protection equipment, before use to ensure that it is not damaged or defective.
- Operate mobile equipment (e.g., aerial lifts) only if properly trained.
- Evaluate the feasibility of a redundant fall-arresting system.

Summary Recommendations

The following is a summary of recommendations that may be applicable to all fall environments. These recommendations are based on the 90 FACE investigations and should be considered as part of an overall fall protection program.

Employers should:

- Coordinate site-specific safety programs between multiple contractors.
- Prime contractors and subcontractors should abide by the Rules of Construction, which state: “The prime contractor and any subcontractors may make their own arrangements with respect to obligations which might be more appropriately treated on a jobsite basis rather than individually.” Thus, for example, the prime contractor and his subcontractors may wish to make an express agreement that the prime contractor or one of the subcontractors will provide all required first-aid or toilet facilities, thus relieving the subcontractors from the actual, but not any legal, responsibility (or, as the case may be, relieving the other subcontractors from this responsibility). In no case shall

the prime contractor be relieved of overall responsibility for compliance with the requirements of this part (1926.16)²⁰ for all work to be performed under the contract.

- Instruct new employees in the proper methods to be used in the performance of assigned tasks and periodically observe the working habits of new employees to ensure that they are performing their assigned tasks in a safe manner.
- Design, develop, and implement a verbal and/or written post-training examination to reinforce and evaluate the effectiveness of the safety training program.
- Recognize and provide for language differences among workers.
- Conduct scheduled and unscheduled safety inspections.
- Consider all environmental conditions prior to the commencement of work activities.
- Provide appropriate signs/placards at areas where fall hazards may exist such as roofs containing skylights or floor openings secured with barriers.
- Use standby persons where work is performed in confined spaces.
- Design, develop, and implement procedures to be followed in the event of a medical emergency, including rescue operations.
- Incorporate safety program requirements in contract language.
- Follow applicable safety rules and standards established by OSHA and ANSI.

Conclusion

The Occupational Safety and Health Act of 1970 was established “to assure so far as possible every working man and woman in the Nation safe and healthful working conditions and to preserve our human resources.”³³ One means of achieving this goal is by providing for the development and promulgation of occupational safety and health standards. Included in these standards are safety and health regulations applicable to fall protection and guarding which include, but are not limited to, ladders, scaffolds, floor and wall openings, vehicles, tree trimming, and personal protective and life saving equipment. These regulations and other applicable standards from the American National Standards Institute along with NIOSH recommendations, should be followed where the possibility of falls from elevations exists.

Additionally, NIOSH has developed and disseminated the following Alerts as a further means to help reduce the number of fatalities resulting from falls from elevations: *Falls Through Skylights and Roof Openings*,³⁴ *Preventing Falls and Electrocutions During Tree Trimming*,¹¹ and *Preventing Worker Injuries and Deaths Caused by Falls From Suspension Scaffolds*.³⁵

GLOSSARY

The Code of Federal Regulations list the following scaffold types.²⁰

- 1) **Boatswain's chair** -- A seat supported by slings attached to a suspended rope, designed to accommodate one worker in a sitting position.
- 2) **Bricklayer's square** -- A scaffold composed of framed wood squares which support a platform, limited to light and medium duty.
- 3) **Carpenter's bracket** -- A scaffold consisting of wood or metal brackets supporting a platform.
- 4) **Crawling boards or chicken ladders** -- A plank with cleats spaced and secured at equal intervals, for use by a worker on roofs, not designed to carry any material.
- 5) **Float or ship** -- A scaffold hung from overhead supports by means of ropes and consisting of a substantial platform having diagonal bracing underneath, resting upon and securely fastened to two parallel plank bearers at right angles to the span.
- 6) **Horse** -- A scaffold for light or medium duty, composed of horses (i.e., sawhorses or other simple framing) supporting a work platform.
- 7) **Interior hung** -- A scaffold suspended from the ceiling or roof structure.
- 8) **Ladder jack** -- A light duty scaffold supported by brackets attached to ladders.
- 9) **Manually propelled mobile** -- A portable rolling scaffold supported by casters.
- 10) **Mason's adjustable multiple-point suspension** -- A scaffold having a continuous platform supported by bearers suspended by wire rope from overhead supports, so arranged and operated as to permit the raising or lowering of the platform to desired working positions.
- 11) **Needle beam** -- A light-duty scaffold consisting of needle beams (i.e., a horizontal beam or group of beams for carrying the load of a column, wall, or other part of a structure) supporting a platform.
- 12) **Outrigger** -- A scaffold supported by outriggers or thrustouts projecting beyond the wall or face of the building or structure, the inboard ends of which are secured inside of the building or structure.
- 13) **Plasterer's, decorator's, and large area single-pole scaffold** -- Platforms resting on putlogs or cross beams, the outside ends of which are supported on ledgers secured to a single row of posts or uprights, and the inner ends of which are supported on or in a wall.
- 14) **Roofing or bearer bracket** -- A bracket used in slope roof construction, having provisions for fastening to the roof or supported by ropes fastened over the ridge and secured to some suitable object.

- 15) **Single-point adjustable suspension** -- A manually or power-operated unit designed for light-duty use, supported by a single wire rope from an overhead support so arranged and operated as to permit the raising or lowering of a platform to desired working positions.
- 16) **Stone setter's adjustable multiple-point suspension** -- A swinging-type scaffold having a platform supported by hangers suspended at four points so as to permit the raising or lowering of the platform to the desired working position by the use of hoisting machines.
- 17) **Tube and coupler** -- An assembly consisting of tubing which serves as posts, bearers, braces, ties, and runners, a base supporting the posts, and special couplers which serve to connect the uprights and to join the various members.
- 18) **Tubular welded frame** -- A sectional panel or frame-metal scaffold substantially built up of prefabricated welded sections which consists of posts and horizontal bearer with intermediate members.
- 19) **Two-point suspension (Swinging scaffold)** -- A scaffold, the platform of which is supported by hangers (stirrups) at two points, suspended from overhead supports so as to permit the raising or lowering of the platform to the desired working position by tackle or hoisting machines.
- 20) **Window jack** -- A scaffold, the platform of which is supported by a bracket or jack which projects through a window opening.
- 21) **Double pole or independent pole** -- A scaffold supported from the base by a double row of uprights, independent of support from the walls and constructed of uprights, ledgers, horizontal platform bearers, and diagonal bracing.

Additionally, scaffolds are classified into weight-bearing categories which include heavy-duty scaffolds which are designed and constructed to carry a working load not to exceed 75 pounds per square foot. Medium-duty scaffolds are designed and constructed to carry a working load not to exceed 50 pounds per square foot, and light-duty scaffolds are designed and constructed to carry a working load not to exceed 25 pounds per square foot.

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