



FLIGHT SAFETY FOUNDATION
CABIN CREW SAFETY

Vol. 35 No. 1

For Everyone Concerned with the Safety of Flight

January–February 2000

Working in, Around Aircraft Cabins Requires Awareness of Fall Prevention

The availability of limited data on slips, trips and falls during normal aircraft operations complicates efforts to improve the prevention of injury to crewmembers and passengers in the cabin environment. Nevertheless, airlines periodically should review fall-prevention strategies and related training of flight attendants and other workers.

FSF Editorial Staff

In most contexts, being injured by a fall simply means that the force of gravity caused a person's downward motion and injury occurred when the moving person suddenly decelerated by striking a surface or an object. When aircraft are in flight or in motion on the ground, a variety of factors can contribute to falls. For example, accident/incident reports have identified factors such as turbulence, autopilot malfunctions, aircraft upsets, sudden evasive maneuvers by flight crews, aircraft collisions with airport structures, collisions between ground vehicles and aircraft, and sudden braking while a flight crew is taxiing the aircraft.

From a safety perspective, transport aircraft can be considered a complex work environment in which various exposures to fall hazards may occur simultaneously to people who often work under the pressure of time constraints and in inclement weather. Rain, snow, wind and extreme temperatures may increase the risk of falling around transport aircraft, for example. Based on the 1988 compensation claims of nearly 2,500 U.S. pilots and flight attendants from 14 states, a 1992



study by the U.S. Bureau of Labor Statistics said that falls were the most common "injury and illness cases by event or exposure" for pilots, most involving walkways, stairs and vehicles. Falls were the third most common such event for flight attendants, most involving walkways and stairs.¹

In the early 1990s, researchers attempting to study fatal falls in the workplace encountered difficulty identifying such occurrences in most industries.² Researchers have found that the available data do not specify the circumstances for a large proportion of falls.³ Similarly, little public data and few studies are available in the United States to provide information about specific types of reported occurrences, such as falls in, on or from aircraft. The most recent U.S. Department of Labor data (see Table 1 on page 2) show that more than 10,000 nonfatal slips, trips and falls resulted in days away from work during 1997 among workers in scheduled air transportation.

Safety specialists commonly use the terms "slip," "trip" and "fall" to refer to events of different types. Slips and trips

Table 1
Nonfatal Slips, Trips and Falls by Workers in U.S. Air Transportation:
Days-away-from-work Cases, 1997

Industry Category	Event or Exposure Leading to Injury or Illness			
	Total Cases ¹	Fall to Lower Level	Fall on Same Level	Slips or Trips Without Fall
U.S. Private Industry	1,833,380	99,882	198,128	57,425
Transportation by Air ²	80,041	2,362	6,715	2,349
Air Transportation, Scheduled ³	75,131	2,151	6,238	2,251
Air Transportation, Nonscheduled ⁴	1,296	NA	201	NA
Airports, Flying Fields and Services ⁵	3,614	174	276	NA

NA = Not available

Notes:

1. Days-away-from-work cases comprise a range of occupational injuries and illnesses, selected by the U.S. government, that result in days away from work, with or without restricted work activity.
2. In the *Standard Industrial Classification (SIC) Manual* published by the U.S. Office of Management and Budget, Major Group 45, "Transportation by Air," is defined, in part, as "establishments engaged in furnishing domestic and foreign transportation by air and also those operating airports and flying fields and furnishing terminal services."
3. SIC Industry Group 451, "Air Transportation, Scheduled, and Air Courier," is defined as "establishments primarily engaged in furnishing air transportation over regular routes and on regular schedules. This industry includes Alaskan carriers operating over regular or irregular routes."
4. SIC Industry Group 452, "Air Transportation, Nonscheduled," is defined as "establishments primarily engaged in furnishing nonscheduled air transportation. Also included in this industry are establishments primarily engaged in furnishing airplane sightseeing services, air taxi services and helicopter passenger transportation services to, from, or between local airports, whether or not scheduled."
5. SIC Industry Group 458, "Airports, Flying Fields and Airport Terminal," is defined, in part, as "establishments primarily engaged in operating and maintaining airports and flying fields; in servicing, repairing (except on a factory basis), maintaining and storing aircraft; and in furnishing coordinated handling services for air freight or passengers at airports."

Source: Bureau of Labor Statistics, U.S. Department of Labor

occur on the same level. Falls may occur on the same level or from one level to a lower level. Stair falls may include slips and trips leading to falls. Slips and trips also may lead to falls when they occur close to exposed edges of one surface positioned above another surface. Terms such as "stumble" and "misstep" are used to describe occurrences other than slips, trips and falls in which a person recovers balance and stability.

Accident/incident reports from several sources indicate that crewmembers and passengers have been involved in falls in, on or from aircraft during normal operations because of controllable factors such as objects in aisles, wet surfaces, unserviceable equipment and noncompliance with standard operating procedures (see "U.S. National Transportation Safety Board Data Describe Falls" on page 3, "Crewmembers Describe Circumstances of Falls" on page 5, and "Reports by Transportation Safety Board of Canada Describe Falls" on page 6). Moreover, because transport aircraft typically have door sills higher than four feet (1.2 meters) above the ground, open doors also can present hazards.⁴

In the United States, a study published in 1997 reviewed 1980 data and 1990 data on fatalities in aviation. The study identified five deaths in 1980 attributed to "fall in, on or from aircraft" among 1,543 aviation-related fatalities, and one death in 1990 attributed to that cause among 1,011 aviation-related fatalities.

Four of the 1980 deaths and one of the 1990 deaths were classified as "ground workers," but the report did not specify the cause of death. The study used public data from the U.S. National Center for Health Statistics and other cause-of-death databases.⁵

A search of similar public data in a cause-of-death database maintained by the U.S. Centers for Disease Control and Prevention found that from 1979 through 1997, deaths attributed to "fall in, on or from aircraft" included two fatalities among crewmembers (defined as "crew of commercial aircraft in surface-to-surface transport"), eight fatalities among passengers (defined as "other occupant of commercial aircraft in surface-to-surface transport"), one "ground worker" fatality and eight fatalities among "other persons." Excluded from the preceding data were occupants of spacecraft or military aircraft, occupants of other powered aircraft, occupants of powered aircraft in surface-to-air transport (such as aerial applicators), occupants of unpowered aircraft and parachutists.⁶

To plan *fall prevention* (measures taken to prevent a fall from occurring) and *fall protection* (measures taken to prevent injury or minimize injury from a fall), airline cabin-safety specialists and ground-safety specialists often rely on private data (such as internal accident/incident safety data, worker's compensation data and insurance claim data), qualitative

U.S. National Transportation Safety Board Data Describe Falls

The U.S. National Transportation Safety Board's Accident/Incident Database contains the following examples of circumstances in which slips, trips or falls occurred during operations by scheduled air carriers under U.S. Federal Aviation Regulations Part 121, Part 129 and Part 135 *without* external forces such as turbulence, intentional aircraft maneuvers, braking, aircraft upsets, jet blast or ground contact with other aircraft, vehicles or equipment:

- “An 86-year-old male passenger was assisted in his wheelchair to board the airplane [via] the rear portable stairs by a gate agent. The passenger was instructed to remain at the top of the steps while the gate agent loaded his wheelchair in the cargo bin. The passenger continued walking into the airplane, through the aft galley, then through the catering door, falling to the tarmac between the catering truck and the airplane. The passenger was taken to the hospital, where he died from his injuries.”¹
- “The flight attendant was helping a company ground person, who was outside on the boarding step. The boarding step was not against the aircraft but about one foot [0.3 meter] away from it. When the door was opened, the flight attendant fell through the open doorway and to the ground about 20 feet [6.1 meters] below. The company procedure requires hand-signal communication between personnel inside and outside during door opening. The investigation revealed that radio communications were being used between the ground personnel and a company representative. The ground person could not activate the door and requested the company representative to open it. The door still would not open. The company representative requested help from the nearby flight attendant. The boarding steps were initially fully against the aircraft but were pulled away when the door would not clear the handrails of the boarding step. The airframe has a curvature at the L5 door location. The boarding step is square shaped. Probable cause: crew/group coordination, not performed, ground personnel. Contributing factors: aircraft/equipment inadequate, company/operator management, insufficient staff-surveillance of operation, company/operator management.”²
- “The parked airplane was ready for pushback when the ‘B’ flight attendant told the ‘A’ flight attendant that a through passenger had reported [that] the cabin cleaning crew had mistakenly removed his child’s stuffed animal and he wanted it returned. The ‘A’ flight attendant opened the forward entry door after the jetway had backed away from the airplane. Either losing his balance or not realizing the jetway had backed away, he fell eight feet, three inches [2.5 meters] to the tarmac below, fracturing both wrists [and] his jaw and sustaining a concussion. According to the company’s chief flight attendant, the injured flight attendant violated company policy and procedures by opening the cabin door prior to the jetway being placed in position. Probable cause: the flight attendant’s failure to assure that the jetway was placed in the proper position prior to opening the forward cabin entry door.”³
- “While deplaning passengers, a 4-year-old boy exited through the galley servicing door and fell through a nine-inch [23-centimeter] gap between the airplane and the catering truck. The boy’s mother had her arms loaded with another child, a carry-on bag, a diaper bag and her purse. Three of the crew members were helping her when the child fell. Probable cause: the flight attendants’ lack of supervision of deplaning passengers. A factor was lack of supervision by [the] accident victim’s mother.”⁴
- “While deplaning at night, a passenger was seriously injured when she tripped against the wing-spar hump in the cabin-floor main-exit aisle. The operator reported that the spar hump was visibly marked. Probable cause: the deplaning passenger’s failure to observe a raised and marked area in the passenger cabin floor exit aisle. Contributing factors to the accident were: darkness and the fuselage floor exit aisle was designed with a raised area which partially obstructed its use.”⁵
- “During passenger boarding at Tallahassee [Florida, U.S.,] it was discovered that the left handrail on the airstair was collapsed. The failure was at the soldered joint at the handrail-locking mechanism. The station manager used metal glue for a temporary repair of the joint. The flight crew was made aware of the discrepancy. The aircraft then departed for West Palm Beach [Florida] via Orlando [Florida]. The airstair was not used at Orlando. A disabled passenger was injured when the handrail collapsed when boarding the aircraft unassisted at West Palm Beach. The passenger stated that he did not need assistance in boarding, just a little extra time. When the handrail collapsed, the passenger lost his balance and fell to the ground, receiving serious injuries. Probable cause: door, entrance stair, previous damage; door, entrance stair, failure, partial; maintenance, inadequate, company/operator management. Contributing factors: communications, inadequate, company/operator management.”⁶
- “While deplaning, a passenger from the first row of the cabin was removing carry-on luggage from a compartment in the forward bulkhead, adjacent to

Continued on page 4

the 1L entry door, as other passengers were exiting via the 2L door. None of the flight attendants were monitoring the forward (1L) door, which was not in compliance with company procedures. [Unexpectedly,] a gate agent opened the 1L door from the outside. As it moved inward and upward, the passenger's head and left shoulder were caught between the door and the forward bulkhead, causing him to be carried up with the door. He then fell to the cabin floor as the door went fully open, sustaining a fractured arm. The compartment was normally used by crew only, but was utilized in this case due to lack of other space. Probable cause: unexpected opening of the 1L door, which caught the passenger between it and the bulkhead as the door moved inward and upward. A secondary cause was the failure of the flight attendants to follow company procedures requiring them to guard all entry doors during the deplaning process.⁷

- "While in cruise during the international flight, a flight attendant stepped on a salt shaker, breaking her left ankle and cutting her finger. She was in the first class galley at the time of the accident. The flight was at 35,000 feet, and there was no reported turbulence. First aid was administered by the second officer, followed by medical treatment at the destination. Probable cause: the failure of the flight attendants to maintain control of loose cabin service equipment, a salt shaker, that resulted in an uncorrected tripping hazard."⁸
- "A 73-year-old passenger was attempting to board the airplane using the airplane's integral airstairs/door. She lost her balance and fell. She was transported to a local hospital and treated for a fractured left kneecap. Probable cause: the passenger's loss of footing (miscellaneous)."⁹
- "An 84-year-old male passenger got up from his seat shortly after takeoff and headed toward the aft lavatories. The seat belt and no smoking signs were still illuminated. The aircraft was at about 1,000 feet above ground level and in a steep climb attitude. The passenger fell face-forward toward the rear of the plane and broke his hip. Probable cause: passenger briefing, not followed, passenger."¹⁰ ♦

Notes and References

1. U.S. National Transportation Safety Board (NTSB) Accident/Incident Database, identification MIA97WA226. This accident occurred Aug. 2, 1997 near Lima, Peru, on a Boeing 757-200 operated by Continental Airlines under U.S. Federal Aviation Regulations (FARs) Part 121 and resulted in one fatality and 149 occupants uninjured.
2. NTSB identification BFO87FA053. This accident occurred Aug. 11, 1987 at Washington, D.C., U.S. on a Boeing 747-200B operated by All Nippon Airways under FARs Part 129 and resulted in one fatality and 334 occupants uninjured.
3. NTSB identification FTW97LA177. This accident occurred May 4, 1997 at Denver, Colorado, U.S. on a Boeing 737-201 operated by Frontier Airlines under FARs Part 121 and resulted in one serious injury and 96 occupants uninjured.
4. NTSB Identification FTW95LA103. This accident occurred Jan. 27, 1995 at Dallas, Texas, U.S. on a Boeing 737-2H4 operated by Southwest Airlines Co. under FARs Part 121 and resulted in one serious injury and 124 occupants uninjured.
5. NTSB Identification MIA95IA134. This accident occurred July 26, 1989 at Bullhead City, Arizona, U.S. on a British Aerospace 3201 operated by American International (doing business as Air LA) under FARs Part 135 and resulted in one serious injury and 19 occupants uninjured.
6. NTSB Identification MIA87LA063. This accident occurred Dec. 30, 1986 on a Fokker F28 Mark 4000 operated by Piedmont Aviation under FARs Part 121 and resulted in one serious injury and 78 occupants uninjured.
7. NTSB Identification FTW88LA050. This accident occurred Jan. 10, 1988 at Dallas/Fort Worth International Airport, Texas, U.S., on a McDonnell Douglas DC-10 operated by American Airlines under FARs Part 121 and resulted in one serious injury and 290 occupants uninjured.
8. NTSB Identification ATL97LA075. This accident occurred May 26, 1997 over the Atlantic Ocean on a Lockheed L-1011-385-3 operated by Delta Air Lines under FARs Part 121 and resulted in one serious injury and 223 occupants uninjured.
9. NTSB Identification CHI93LA327. This accident occurred May 7, 1993 at Green Bay, Wisconsin, U.S. on a British Aerospace ATP operated by Air Wisconsin (doing business as United Express) under FARs Part 121 and resulted in one serious injury and 33 occupants uninjured.
10. NTSB Identification ATL87LA102. This accident occurred April 1, 1987 at Miami, Florida, U.S. on a Boeing 727-295 operated by Piedmont Aviation (doing business as Piedmont Airlines) under FARs Part 121 and involved one serious injury and 95 occupants uninjured.

Crewmembers Describe Circumstances of Falls

The following descriptions were selected and excerpted from the U.S. National Aeronautics and Space Administration Aviation Safety Reporting System (ASRS) to indicate some of the reported circumstances in which slips, trips and falls occurred during normal operations *without* external forces such as turbulence, intentional aircraft maneuvers, braking, aircraft upsets, jet blast or ground contact with other aircraft, vehicles or equipment.¹

- "As I exited the cockpit [flight attendant X, flight attendant Y] and the provisioner were all in the forward galley area. [Flight attendant X] and [flight attendant Y] proceeded to move to the forward lounges to assist [passengers] and tell passengers goodbye. I began to position myself in front of the forward flight attendant jump seat. I noticed [passenger A] (the little boy involved in this incident) moving toward the forward exit door (jetway door). At the same time, my attention was drawn to [passenger A's] mother [passenger B] who was looking for her stroller for her young girl. I was attempting to point out the stroller in the jetway, when [passenger B], with a panicked look on her face pointed to the forward service door and said, 'My boy went out that door!' I exited the forward service door onto the provisioning platform expecting to find [passenger A] on the provisioning truck. The provisioner (already starting down the ladder) pointed behind me and down. [As] I turned around, [passenger B] was attempting to exit the aircraft holding the little girl. I told her to remain in the aircraft. I then looked down through the small gap between the provisioning truck and the aircraft. [Passenger A] was standing up on his own, crying. I talked to [passenger A] for a few seconds while the ramp personnel (already in motion toward the boy) approached him. I then took [passenger B] to the jetway door where ramp personnel were to bring [passenger A]. As [passenger A] arrived in the jetway, I assisted one of the ramp personnel in comforting [passenger A]. This whole incident took place in a matter of seconds." ASRS Report 295033, January 1995.

- "As passengers were deplaning at [Lexington, Kentucky, U.S.], a woman fell on the steps, apparently because one step had failed to come down properly when the door was opened. I examined the step, and it worked normally after it was lowered into place manually. Since the operation of the door was not affected, and there were no passengers for the return flight to [St. Louis, Missouri, U.S.], it did not occur to me to enter the discrepancy in the maintenance log at that time. ... The flight attendant dropped the door and then stepped back to let the passenger out the door. She told the first passenger to watch her step. The passenger turned to ask the flight attendant what [the flight attendant had] said and [the passenger] fell down the steps. The [second-from-last] step did not drop down when the door came down, and the flight attendant did not see that [the step had] not come down; and when the passenger

turned, she did not see [that] the step was up, and [she] fell. Usually, if the step is a problem, the flight attendant lets us know, and we have maintenance repair the step. In this case, we did not know of any problem until the passenger fell. The flight attendant, who was new, did not inform us [that] this was a problem. After the incident, [the flight attendant] told us [that] this was the second time this step had not dropped into place. We decided to have the steps checked by maintenance since this had happened twice and [this was] the second time [that] a passenger had been hurt. Since we were returning to St. Louis empty, we elected to repair the step, have it inspected and repaired in St. Louis, where we had mechanics skilled in such repairs." ASRS Report 246126, July 1993.

- "During the flight, an elderly passenger went to the lavatory even though the seat belt sign was on. Coming out of the lavatory, the man fell and broke his hip. Although the seat belt sign was on, there was no turbulence associated with him falling, [the sign] had been left on from previous intermittent light turbulence. I made an announcement, as did the first flight attendant when I initially turned [on the sign]. The passenger, a 73-year-old diabetic with thick glasses chose to ignore the seat belt sign and got up to [use the lavatory]. An eyewitness passenger said [that] the man appeared unsteady on his feet and held on to the seat backs for support as he walked to the lavatory. As I stated earlier, he fell when he came out of the lavatory due to loss of balance. No operation of the aircraft had anything to do with his injury; nevertheless, this is considered by the [U.S. National Transportation Safety Board] as an aircraft accident. Is there a solution for a passenger who needs to use the lavatory and ignores crew warnings and seat belt signs? Short of restraint, which would be cruel, I don't think so." ASRS Report 305270, May 1995.♦

Notes and References

1. The U.S. National Aeronautics and Space Administration (NASA) Aviation Safety Reporting System (ASRS) is a confidential incident-reporting system. ASRS acknowledges that its data have certain limitations. ASRS *Directline* (December 1998) said, "Reporters to ASRS may introduce biases that result from a greater tendency to report serious events than minor ones; from organizational and geographic influences; and from many other factors. All of these potential influences reduce the confidence that can be attached to statistical findings based on ASRS data. However, the proportions of consistently reported incidents to ASRS, such as altitude deviations, have been remarkably stable over many years. Therefore, users of ASRS may presume that incident reports drawn from a time interval of several or more years will reflect patterns that are broadly representative of the total universe of aviation-safety incidents of that type."

Reports by Transportation Safety Board of Canada Describe Falls

The aviation occurrence database maintained by the Transportation Safety Board of Canada (TSB) — searched for the period January 1989 through November 1999 — contains the following examples of circumstances in which slips, trips or falls occurred during normal operations *without* external forces such as turbulence, intentional aircraft maneuvers, braking, aircraft upsets, jet blast or ground contact with other aircraft, vehicles or equipment:

- “The flight attendant was carrying out her normal duties in the aft galley, coordinating the catering of the aircraft through the 3R door. She stepped through the door of the [aircraft] onto what she assumed was the catering-truck bridge. The bridge, however, had been retracted a few seconds before and she fell from a height of five meters [16.4 feet]. She was taken to [a] hospital and had emergency surgery to both wrists. Further surgery will also be required. The company issued a memo reminding all crewmembers that they are forbidden to board catering [equipment] or any other company's equipment during the course of their duties.”¹
- “[The aircraft] arrived in St. Johns [Newfoundland, Canada] and was marshalled to a gate on the open ramp. An airstair was positioned at door L1, and passengers began to deplane. After approximately 10-12 passengers had exited the aircraft, a flight attendant deplaned with an infant in a car seat in his arms and proceeded down the airstairs. The flight attendant became aware that a gap had appeared between the door sill and the airstairs but was unable to prevent the infant's 5-year-old brother, who was following his mother, from falling between the aircraft and stairs to the apron below. The child suffered a broken arm and lacerations to the head in the fall and

was taken to the hospital, where he remained for a couple of days under observation.”²

- “When [the first officer] opened [the] cabin door to lower stairs, a child fell out onto [the] ramp, landing on her head. [The] child was taken to hospital with cut forehead, lip and other facial cuts. First aid [was] administered, and [the] child did not appear to have concussion or shock. [The child was] not hospitalized. Minor injuries [occurred].”³
- “[The aircraft] ... was on a technical stop in Gander [Newfoundland, Canada] when one of the passengers, a U.S. deportee en route to Germany, tried to leave the aircraft. A flight attendant, who was chasing the deportee to stop him, fell down the aircraft stairs and broke his leg in three places.”⁴

Notes and References

1. Transportation Safety Board of Canada (TSB) Occurrence no. A99F0073. The event occurred Oct. 1, 1999 on an Airbus A310-300 operated by Royal Aviation.
2. TSB Occurrence no. A99A0046. The event occurred March 31, 1999 on a Boeing 767-200 operated by Air Canada.
3. TSB Occurrence no. A91W0142. The event occurred July 24, 1991 on a DeHavilland DHC-6-300 operated by Ptarmigan Airways at Yellowknife, Northwest Territories, Canada.
4. TSB Occurrence no. A93A0123. The event occurred June 14, 1993 on a Boeing 757 operated by American Trans Air.

information from any occurrences for which they have details, and sharing experiences through industry committees and meetings. Detailed understanding of known slips, trips and falls is valuable for preventing these occurrences under similar circumstances, but some researchers are concerned that findings may not be generally applicable enough to guide further research, change current policies or reorder intervention priorities.

Fall Prevention Ranks as a Significant Issue in the United States

The study of slips, trips and falls in the United States — in the fields of occupational safety and medicine among others — has produced the following information:

- Accidents that involved slips, trips and falls in the 1980s comprised about 16 percent of all U.S. work-related injuries;⁷
- One group of researchers in 1992 said, “Falls, the second leading cause of unintentional injury death, are the most common cause of injuries and of hospital admissions for trauma. ... In recent years, more than 11,000 deaths annually have been attributed to falls;”⁸
- The researchers said that almost one-third of all deaths from falls occur among people 85 years old or older, although people in this age bracket comprise only 1 percent of the U.S. population. Fifty-nine percent of all fall deaths involve people who are age 75 or older, who comprise about 5 percent of the U.S. population; and,⁹

- A substantial majority of all falls occur in the home, and such falls often have been associated with trips.¹⁰

In the United Kingdom, the U.K. Health and Safety Executive (HSE) said in 1996 that more than one-third of all reported major injuries at work each year are the result of a slip or a trip, and that slips and trips are the most common cause of nonfatal injuries in both manufacturing and service industries in the United Kingdom and more than half of all injuries to the public.¹¹

Slips, Trips and Falls Led Workplace-accident Causes Among One Airline's Ground Employees

A 1995 report used five categories to classify 523 accidents that occurred among 2,000 airport ground personnel employed by an Israeli airline from 1988 through 1992 — counting accidents that resulted in at least three days of loss of work.¹² “Airport ground personnel” were defined only as “full-time employees” and “airline ground workers” with 82 percent males and 18 percent females, mean age of 48 years (plus/minus nine years) and mean experience of 21 years (plus/minus four years), the study said. Slips, trips and falls were one of the categories used in the report.¹³

The report said, “Work-related accidents at the airport are common, but the incidence and type of such events occurring [among] aviation ground personnel have not been reported previously. Information regarding the most common ground accidents at the airport is essential in order to implement preventive programs. The purpose of this study was to examine the descriptive epidemiology of injury-producing accidents among ground personnel at a modern airline. ... We conclude that slips, trips and falls are the most common cause of accidents [among] airport ground personnel. Further studies in other airports are warranted to confirm our findings.”

The report said that 211 accidents (40.3 percent) that occurred during the five-year period were classified in the “slips, trips and falls” category. Separate slip data, trip data and fall data were not given. There were 54 such accidents in 1988, 42 in 1989, 41 in 1990, 42 in 1991 and 32 in 1992.

“The incidence of such events in our study was 27 [accidents per] 1,000 worker-years in 1988 and 16 [accidents per] 1,000 worker-years in 1992, which is similar to that reported in a study of a large automobile manufacturing company,” said the report. The data showed that in accidents involving slips, trips and falls, 63 percent of employees lost three days to 10 days of work, 22.8 percent of employees lost 11 days to 20 days of work, 9 percent of employees lost 21 days to 30 days of work and 7.5 percent of employees lost more than 30 days of work.

Science of Falling Yields Insights To Preventive Measures

Specialists in workplace fall prevention and fall protection recognize not only the external factors involved in slips, trips and falls, but human capabilities and limitations as people interact with the environment. Cyril Gryfe, M.D., a specialist in geriatric medicine and author of a chapter on physiological factors in falls in one fall-protection textbook, said that postural stability (commonly called “keeping your balance”) is understood as the result of the body’s rapid muscular adjustments to external forces, especially gravity. These adjustments are believed to be extremely complex but largely reflexive — that is, they do not require conscious thought — comprising vision, inner-ear mechanisms that detect the body’s position in space, changes in pressure on the skin and the position of weight-bearing joints. Equally important is the body’s ability to maintain gaze stability.¹⁴

Gryfe said, “The [body’s] gaze-stability system keeps the image of the world fixed on the retina of the eye during movements of not only the body, but also when the head itself is moved. This ability to immobilize a visual reference point in the environment is of absolutely fundamental importance.”¹⁵

Illnesses, medications, sensory changes during aging (such as reduced field of peripheral vision) and other problems that impair the body’s sensory system and the brain can affect normal balance. Problems in postural stability or gaze stability are major factors in falling; impairment of vision appears to be the most important, said Gryfe. Some research also has found that while people normally have the ability to fixate their gaze on specific objects within their visual field while moving, considerable attention is required to do this.

Gryfe said, “Furthermore, allocating attention to the visual pursuit of a moving target results in deterioration in the performance of any other simultaneous, attention-demanding task. ... The study of the role of disease in causing falls is complicated by the fact that so many of these illnesses are treated by medications, and the medicines themselves have the potential to interfere inadvertently with postural [stability] and gaze stability.”^{16, 17}

Suggested practical applications of this understanding for flight attendants might include recognition of possibly increased exposure to fall hazards when vision problems or inner ear problems are present; when medications are known to cause drowsiness; when hurrying to arrive at a duty station on time or to complete work; or when focusing attention on a distant moving object while walking or using stairways.

Gryfe said, “Environmental modification remains the chief [method of fall prevention], but should not be limited to assuring well-lit, obstacle-free, firm-and-even-surfaced physical space. The visual cues in the environment need more

attention in planning to prevent falls. ... Visual information is especially important in the relation between self and environment through its role in sway control [slight reflexive body movements to maintain postural stability], walking guidance and obstacle avoidance.”¹⁸

The following physical factors are involved in slips, trips and falls:

- One group of researchers said, “Injuries from falls result from an abrupt dissipation of mechanical energy. ... When a person falls, the likelihood of injury increases as the decelerative, or stopping, distance increases. This stopping distance depends on several things, including the energy-absorbing qualities of the structure that a person falls onto or against, the thickness and energy-absorbing qualities of clothing, and the yield or compressibility of the part of the body on which the forces operate. ... Falling against a narrow, sharp or pointed structure focuses the forces and increases the chance of injury, whereas a wider contact area distributes the forces less harmfully over a larger portion of the body, with less likelihood of injury. ... When concrete or other rigid surfaces are involved, injury can occur in falls from low heights. ... In general, preventive efforts have emphasized the behavioral aspects of falls, despite the difficulty of changing relevant behaviors such as hurrying, shuffling or thrill seeking. Largely ignored has been the potential benefit from modifying the environment”;^{19,20}
- Fall-prevention consultant William Marletta, Ph.D., said that the expectations of a person while walking are significant; that is, when walking conditions are contrary to those anticipated, the probability of a fall is increased significantly. People walk more carefully when they anticipate that a walking surface is slippery or that hazards are present that might cause them to trip. Marletta said, “A change in conditions contrary to expectation will result in the gait that our brain intended for one set of conditions now being used for another set of conditions. ... Sudden changes in surface coefficient [of friction, the relative resistance between two surfaces in contact (for example, a person’s shoes and the walking surface)], surface design or the introduction of a foreign substance create the potential for a trip, slip and fall accident. A significant causal relationship is established between the ‘unexpectedness’ of the event and the accident. This basic theory of ‘expectation’ cannot be overemphasized with respect to slip, trip and fall occurrence”;²¹
- Research has found that these types of accidents increase whenever people encounter a walking-surface transition — such as tile to carpet, stair steps that vary in height, an abrupt change in surface height greater than one-quarter inch [6.3 millimeters] or a single step to a different level. People typically do not notice such

transitions because of inadequate lighting, momentary distractions or intentional diversions of attention by external factors. Marletta said, “Safe practice requires that potential hazards be highlighted to improve perception or removed to avoid a pedestrian encounter with an unexpected event”; and,²²

- Marletta said, “The walking process, which we take for granted, is the result of thousands of calculations made by the brain responding (within milliseconds) to information provided to it, thus coordinating the neuromuscular control necessary to accomplish the walking cycle. ... People walking quickly take longer strides. Longer strides increase the angle between the floor gripping surface and the heel’s contact angle, the reason longer strides need a higher [coefficient of friction] for safe walking. Therefore, what was a safe surface for one type of walking may not be safe for another. One can walk on ice without slipping by walking slowly and taking shorter strides, thus reducing the heel contact angle and the horizontal force component.”²³

Slips, Trips and Falls May Involve Separate Factors

Fall-protection consultant J. Nigel Ellis, Ph.D., described significant factors in slips, trips and falls as separate types of occurrences. He said that among other significant factors in *slips* are the shape, style, fit and sole material of footwear (new leather soles, for example, can increase risk whether the walking surface is wet or dry); whether a person is carrying something; disabilities; individual locomotion or gait characteristics, age, physical health, mental health, emotional state, attentiveness and agility; and the ability to maintain balance at all times in the workplace.²⁴

To help prevent *trips*, Ellis said that people should be aware not only of objects in their path (such as aircraft aisles blocked by bags), but also of situations in which friction between footwear and floor surfaces is excessive, the physical layout might cause people to take unsafe shortcuts, or people might be inattentive, distracted by their emotional state or experiencing physical or mental impairments.²⁵

To help prevent *stair falls*, Ellis said that a “tennis racket” grip on handrails (with the rail between the thumb and forefinger) should be used whenever possible. The safest type of handrail does not require a person to change or release their grip along the handrail. In the workplace, safety on stairs also is enhanced if crewmembers and passengers avoid carrying objects with both hands, if they avoid reaching for objects from steps, and if lighting directs their attention to the edges of steps to help maintain stability.²⁶

Regarding *falls* to a lower level, Ellis said that people should not depend on being able to reach a nearby handhold in time

to interrupt a fall because “grabbing onto something to catch oneself after balance is accidentally lost is rare.”²⁷ Another factor in falls to a lower level is that, unlike the unforgettable lessons that people learn after slipping on a slick surface or stumbling over an object — lessons that tend to increase their situational awareness and caution — real-life falls have not been preceded by such “close calls.”²⁸ Deceleration forces transmitted in a typical fall to a lower level generally produce the least injury when the person lands with feet first and allows the knees to flex on impact, said one study.²⁹

U.S. Airlines Give Examples Of Fall-prevention Methods

Steve Runge, cabin safety specialist at Continental Airlines, said that data about slips, trips and falls that cause injuries typically are kept by the worker’s compensation departments and risk-management departments of individual airlines.³⁰ U.S. airlines use these data internally to improve safety and to comply with occurrence-reporting requirements under regulations of the U.S. Occupational Safety and Health Administration (OSHA), the U.S. National Transportation Safety Board (NTSB) and other regulatory authorities. The government’s public summaries of falls in the air transport industry provide limited information for hazard assessment by individual airlines or for the control of fall-hazard exposures, he said.

Runge said that preventing falls to the same level in aircraft cabins mainly requires prompt compliance by flight attendants and passengers with instructions to be seated and fasten the seat belt before and during turbulence encounters; attention to removing spilled ice or beverages to prevent slips on some floor surfaces; and clearing all aisles of bags and other items that could cause someone to trip. Vigilance when operating doors and in working around open doors is essential to prevent falls to a lower level.

“It is quite rare for a fall to a lower level to occur,” Runge said. “Compliance with standard operating procedures is an important part of prevention because they are designed to prevent fall-hazard exposure. For example, the standard procedure for a narrow-body aircraft on arrival at the gate is for flight attendants to crack the door (that is, turn the handle partially to break the seal), then the gate agent is supposed to swing the door open. Doors of wide-body aircraft and Boeing 757 aircraft are not cracked; they are opened from the outside after the door has been disarmed properly [that is, the system that deploys the evacuation slide must be disarmed before opening the door]. These procedures help us make sure that there is a jet bridge in place before the door opens. When a door will remain open for awhile — for example, when an aircraft is parked for maintenance — crewmembers place barrier straps across the opening as a visual reminder.”

Timothy Racicot, director of ground safety at Continental Airlines, said that a nearly completed upgrade of the airline’s

data systems will provide managers with more quantifiable, detailed information on occurrences such as slips, trips and falls — including injuries and costs — helping managers to identify problems and to make decisions about appropriate action.³¹

Voluntary guidelines published by the Air Transport Association of America (ATA) are available to assist airlines in the prevention of fall-related injuries during aircraft maintenance.³² The ATA guidelines identify current industry practices and hazard exposures, describe elements of fall protection and recommend protective measures for work from platforms and for work from aircraft surfaces other than the interior parts of an aircraft.

Robert Hites, manager of corporate safety at Delta Air Lines, said U.S. airlines have shared their experience to identify problems and prioritize further work on prevention of injuries from workplace falls.³³

Hites said, “Three years ago, ATA did an informal survey of major carriers. All the fall injuries during maintenance were falls from work stands. Many times when an injury occurs, the protection capability was there, but not used. I remember hearing of a fall involving a catering worker. He had pulled the truck to the aircraft but failed to use the engineering controls provided — the railings that extended around the walkway to provide protection.”

The ATA guidelines said that although fall protection during aircraft maintenance has been addressed previously by the airline industry, the need to prevent such falls by anticipating risks was identified because of the higher volume of flight operations and the increased use of airplanes.

Hites said that some airlines have worked proactively to identify potential fall hazards beyond the aircraft maintenance environment.

“Through ATA, we took a step back and asked not only ‘Where are the injuries?’ but ‘Where would be the most potential for injury?’” he said.

Hites said that fall-prevention practices for aircraft doors, for example, have included the proper use of warning straps across open doors, updating procedures and training on safe operation of doors, and the use of door safety-net systems when an aircraft is in the hangar and doors are kept open during maintenance.

Delta Air Lines, for example, designed and implemented a generic safety net that attaches to existing aircraft door hardware and covers the door openings of the airline’s Boeing aircraft (including former McDonnell Douglas aircraft) and some Airbus aircraft.

Hites said that when an aircraft arrives and needs extensive cleaning before the next flight, a common practice —

depending on weather conditions — is for the aircraft air-conditioning system to be turned off and for several aircraft doors to be opened for ventilation and cooling.

"Any time someone works with a door open and no jetway/bridge or airstairs in place the warning strap should be used," Hites said. "For catering and cleaning, contract workers typically use a truck for access via an aircraft door. The truck has railings that extend out to the aircraft. As long as they are not working near an open door marked with a warning strap, there is nothing to cause a fall. But if a person is scrubbing a door frame, for example, you would want a truck or a jetway positioned at the door."

Situational awareness is a fundamental element of fall prevention for cabin crews and flight crews, he said. This includes practices such as watching for any hazardous gap between the aircraft and the jetway or airstairs when boarding and exiting, and climbing or descending stairs to note any hazards that could cause a person to slip or to trip. Flight attendants entering an aircraft immediately after cleaning might find that the nonslip floor surfaces in galleys are wet, indicating a need for cleaners to dry slick surfaces and/or for flight attendants to step carefully until the floor dries completely.

"Flight attendants can be focused on their duties in getting the flight out and may not be thinking, 'Where can I slip or fall?' With aircraft doors, the best of all worlds is for gate agents to close the doors from outside while the jetway is still there and for the catering staff or the cabin-service staff to close galley-access doors while the catering truck is still there. We want people outside the aircraft to close the doors while the fall hazard is minimized."

Typically, closing and securing a door involves several steps — such as removing the warning strap, releasing the hold-open lock and then releasing the door stop to close the door. Safe door operation is accomplished routinely when a jetway/bridge or airstairs has been positioned properly. Extra care must be taken, however, if such equipment has not been positioned at the aircraft. Specifically, flight attendants must be able to maintain a stable footing while reaching through the doorway to close a door, or while opening a door by swinging the door outward, said Hites.

Flight attendants should adhere to the appropriate procedures and use specified handholds when provided. Pilots and other personnel who might not operate aircraft doors routinely also must be aware of fall hazards under various circumstances, said Hites.

United Kingdom's Safety Advice Has Practical Applications in Aviation

Laws in the United Kingdom require employers to take steps to control risks of slips, trips and falls; to assess these risks;

and to take action to safeguard health and safety. The U.K. Health and Safety Executive said that the following steps should be considered to prevent these accidents:³⁴

- Identify key areas of risk, set goals for improvement, and review work practices to eliminate or minimize the risks;
- Involve workers, gain commitment from employees to reduce risks and keep records of specific responsibilities assigned to managers;
- Provide strong control mechanisms such as reviews, records and safety checklists; and,
- Monitor the effectiveness of preventive measures and interventions by regular review of accident investigations and inspection reports.

HSE said that fall-prevention situational awareness must include the following actions:

- Checking frequently the condition of floors and mats, especially if they are likely to become wet or dusty during normal operations;
- Following procedures to assure that lights are repaired, replaced or cleaned before illumination of floors and steps decreases to an unsafe level;
- Taking action to assure that obstructions are removed from aisles and other walkways — and marked clearly with signs or barriers until they can be removed;
- Providing guidance on appropriate footwear (especially correct types of soles) for maximum safety on the typical floor surfaces; and,
- Close coordination between the workers who regularly clean and maintain the workspace (with training to detect hazardous situations and to avoid creating hazards during their work) and those who work in that space — including control of access.

Nick Butcher, head of the U.K. Civil Aviation Authority (U.K. CAA) Flight Operations Department Cabin Safety Office, said, "[U.K. CAA records] incidents where injuries to cabin crew have occurred, and these would include falls out of aircraft doors during normal operations. These types of incidents sometimes have a weather factor such as wind and rain, when maybe the floor surface in the exit vicinity may be wet. Also, some time ago we advised operators that cabin crew should wear sensible footwear and this [is] especially important during emergency situations when cabin crew may have to open doors with the evacuation slide engaged."

Crewmembers should wear appropriate shoes for work aboard aircraft and in extreme weather conditions; nevertheless, one

of the most important methods of preventing falls involves maintenance of safe walking areas near aircraft by plowing, shoveling, deicing, salting and sanding as needed to ensure the removal of snow, ice and standing water.

On stairways, several factors might increase the risk of crewmembers or passengers misjudging their position and overstepping or understepping. These include changes in views (such as while exiting an aircraft onto the top landing of airstairs), changes that require gait alteration (such as adjusting speed to the movements of other people on airstairs) and direction changes (such as turning from an aisle onto a jetway to exit the aircraft).³⁵

Situational awareness for flight crews and cabin crews also should include observing whether equipment is in serviceable condition to prevent falls; for example, observing that all steps and guardrails are properly positioned on boarding equipment and aircraft-related work platforms.♦

Notes and References

1. Mohler, Stanley R. "Airline Crew Members Suffer High Rate of Occupational Injuries." *Human Factors & Aviation Medicine*. Volume 40 (May–June 1993): 3.
2. Baker, Susan P.; O'Neill, Brian; Ginsburg, Marvin J.; Li, Guohua. *The Injury Fact Book, Second Edition*. New York, New York, U.S.: Oxford University Press, 1992, 135–136.
3. Baker et al., 145.
4. The Chaffing Report to the U.S. Occupational Safety and Health Administration in 1978 recommended physical barriers and protection when a free fall greater than four feet could occur. (From Ellis, J. Nigel. *Introduction to Fall Protection, Second Edition*. Des Plaines, Illinois, U.S.: American Society of Safety Engineers, 1993. 38.)
5. Li, Guohua; Baker, Susan P. "Injury Patterns in Aviation-related Fatalities: Implications for Preventive Strategies." *The American Journal of Forensic Medicine and Pathology*. Volume 18 (3), 1997, 265–270.
6. U.S. Centers for Disease Control and Prevention (CDC). CDC WONDER Database. Search conducted Dec. 10, 1999. Search parameters were "death count, all ages, all races, both genders, 1979–1997, by year, United States, ICD9 Codes E843.0–E843.9 (inclusive)." ICD9 Code E843 "Fall in, on, or from aircraft" was among standardized cause-of-death data categories studied by Guohua Li and Susan P. Baker in 1995.
7. Marletta, William. "Slip, Trip and Fall Prevention." In *The Work Environment, Volume One: Occupational Health Fundamentals*. Edited by Hansen, Doan J. Chelsea, Michigan, U.S.: Lewis Publishers, 1991. 241–276.
8. Baker et al., 134.
9. Baker et al. 137.
10. Baker et al. 137, citing Blake, A.J. et al. "Falls by Elderly People at Home: Prevalence and Associated Factors." *Age and Ageing* Volume 17. 365–372.
11. U.K. Health and Safety Executive (HSE). "Preventing Slips, Trips and Falls at Work." Sheffield, England: HSE. May 1996.
12. Ribak, Joseph; Cline, Betty; Froom, Paul. "Common Accidents Among Airport Ground Personnel." *Aviation, Space and Environmental Medicine*. December 1995, 1188–1190.
13. Medicode Publications. *International Classification of Diseases, Ninth Revision [ICD•9]*. Salt Lake City, Utah, U.S.: Medicode Publications, 1999. A version of this publication — 1999 *Physician ICD•9-CM [Clinical Modification]* — defines accidental falls in the following major categories: fall on or from stairs or steps; fall on or from ladders or scaffolding; fall from or out of building or other structure; fall into hole or other opening in surface; fall from one level to another; fall on same level from slipping, tripping or stumbling; fall on same level from collision, pushing or shoving, by or with another person; fracture, cause unspecified; and other and unspecified fall. Each major category contains subcategories and exclusions. The study by Ribak, Cline and Froom used all the ICD9 major categories for accidental falls.
14. Gryfe, Cyril I. "Causes and Prevention of Falling." In *Fundamentals of Fall Protection*. Edited by Sulowski, Andrew C. Toronto, Canada: International Society for Fall Protection, 1991, 155–163.
15. Gryfe, 157.
16. Gryfe, 160.
17. Gryfe, 162.
18. Gryfe, 162.
19. Baker et al. 134–135.
20. Baker et al. 142.
21. Marletta, 241.
22. Marletta, 244.

23. Marletta, 242–243.
24. Ellis, J. Nigel. *Introduction to Fall Protection, Second Edition*. Des Plaines, Illinois, U.S.: American Society of Safety Engineers, 1993.
25. Ellis, 34–35.
26. Ellis, 35.
27. Ellis, 35.
28. Ellis, 35.
29. Bowyer, G.W. “Injury From Falls.” Citing Swearingen, J.J. et al. “Human Tolerance to Vertical Impact.” *Aerospace Medicine*. Volume 31, 1960, 989–998. In Cooper, Graham J., et al. *Scientific Foundations of Trauma*. Oxford, England: Butterworth-Heinemann, 1997, 331, 333.
30. Runge, Steve. Interview by Rosenkrans, Wayne. Alexandria, Virginia, U.S., 1 December 1999. Flight Safety Foundation, Alexandria, Virginia.
31. Racicot, Timothy. Interview by Rosenkrans, Wayne. Alexandria, Virginia, U.S., 1 December 1999. Flight Safety Foundation, Alexandria, Virginia.
32. Air Transport Association of America. “Fall Protection Guidelines for Aircraft Maintenance Within the Airline Industry.” 1999.
33. Hites, Robert. Interview by Rosenkrans, Wayne. Alexandria, Virginia, U.S., 3 December 1999. Flight Safety Foundation, Alexandria, Virginia.
34. HSE.
35. Hyde, Alvin S. *Accidental Falls: Their Causes and Their Injuries*. Tallahassee, Florida, U.S.: HAI, 1996. 154.

Join Flight Safety Foundation

For more information, contact Carole Pammer, director of marketing and business development,
by e-mail: pammer@flightsafety.org or by telephone: +1(703) 739-6700, ext. 109.

Visit our World Wide Web site at <http://www.flightsafety.org>

We Encourage Reprints

Articles in this publication, in the interest of aviation safety, may be reprinted, in whole or in part, in all media, but may not be offered for sale or used commercially without the express written permission of Flight Safety Foundation's director of publications. All reprints must credit Flight Safety Foundation, *Cabin Crew Safety*, the specific article(s) and the author(s). Please send two copies of the reprinted material to the director of publications. These reprint restrictions apply to all Flight Safety Foundation publications.

What's Your Input?

In keeping with FSF's independent and nonpartisan mission to disseminate objective safety information, Foundation publications solicit credible contributions that foster thought-provoking discussion of aviation safety issues. If you have an article proposal, a completed manuscript or a technical paper that may be appropriate for *Cabin Crew Safety*, please contact the director of publications. Reasonable care will be taken in handling a manuscript, but Flight Safety Foundation assumes no responsibility for material submitted. The publications staff reserves the right to edit all published submissions. The Foundation buys all rights to manuscripts and payment is made to authors upon publication. Contact the Publications Department for more information.

Cabin Crew Safety

Copyright © 2000 Flight Safety Foundation Inc. ISSN 1057-5553

**Suggestions and opinions expressed in FSF publications belong to the author(s) and are not necessarily endorsed by
Flight Safety Foundation. Content is not intended to take the place of information in company policy handbooks
and equipment manuals, or to supersede government regulations.**

Staff: Roger Rozelle, director of publications; Mark Lacagnina, senior editor; Wayne Rosenkrans, senior editor; Linda Werfelman, senior editor; Karen K. Ehrlich, production coordinator; Ann L. Mullikin, production designer; Susan D. Reed, production specialist; and David A. Grzelecki, librarian, Jerry Lederer Aviation Safety Library.

Subscriptions: One year subscription for six issues includes postage and handling: US\$240. Include old and new addresses when requesting address change. • Attention: Ahlam Wahdan, assistant to director of marketing and business development, Flight Safety Foundation, Suite 300, 601 Madison Street, Alexandria, VA 22314 U.S. • Telephone: +1(703) 739-6700 • Fax: +1(703) 739-6708