FLIGHT SAFETY FOUNDATION

2023 SAFETY REPORT

Flight Safety Foundation

MARCH 2024

INTRODUCTION

An analysis of data in the Foundation's Aviation Safety Network (ASN) database reveals that 2023 was one of the safest years on record for commercial airline operations. The ASN data show that there were zero fatal accidents[1] involving commercial jet airliners last year. Additionally, the total number of accidents, including fatal and nonfatal events, fell to 94 last year, compared to 121 in 2022. This decline in accidents also represents a significant improvement when compared to the average of 115.8 accidents recorded per year from 2018 to 2022.

The absence of fatal commercial jet airliner accidents in 2023 is indeed a reason to be thankful and serves as a reminder of the importance of continued vigilance in maintaining aviation as the safest mode of transportation. But it is also important to recognize that 2023 witnessed seven fatal accidents involving turboprop or piston-engine airliners. Those seven accidents resulted in 107 fatalities among passengers and crew and the death of one person on the ground. In addition, corporate jets used in a variety of operational roles were involved in 32 accidents last year, seven of which were fatal accidents.

ASN data show significant progress has been made in reducing the number of events in historically high-risk accident categories, such as controlled flight into terrain, loss of control–in flight, and runway excursions. Improvements in these areas have been made through advances in technology and through the collaborative efforts of operators, manufacturers, and regulators, among others.

However, the absence of an accident is not evidence of the presence of safety. The aviation industry experienced an unacceptably high number of high-profile incidents in 2023 that could have been fatal accidents if not for a last-minute intervention or action by a pilot or air traffic controller or a stroke of luck. One notable incident was the near-collision of a FedEx Boeing 767 and a Southwest 737 at Austin-Bergstrom International Airport in Texas, U.S., in February 2023. The two aircraft came within 100 feet (30 m) of each other as the FedEx aircraft was attempting to land and the Southwest jet was taking off from the same runway. A collision was avoided when the FedEx pilots rejected their landing. In a dozen other similar serious incidents, crews barely avoided catastrophic collisions. In the December 2023 Global Action Plan for the Prevention of Runway Incursions (GAPPRI) report, the Foundation warned of the severe consequences of runway incursion risks if proactive measures are not taken.

Just a few days into the new year, however, two accidents were recorded. On Jan. 2, 2024, a JAL Airbus A350 collided with a Japanese coast guard de Havilland Dash 8 on the runway at Tokyo Haneda International Airport, killing five of the six people in the coast guard airplane; all 379 JAL passengers and crew escaped without serious injuries. On Jan. 5, 2024, an Alaska Airlines Boeing 737 MAX-9 door plug blew out minutes after takeoff from Portland (Oregon, U.S.) International Airport; no one was seriously injured. These were preventable accidents and incidents that not only threatened the safety of passengers and crew but also undermine the public's confidence in our industry.

[1] The International Civil Aviation Organization (ICAO) defines an accident as an occurrence associated with the operation of an aircraft that takes place between the time any person boards the aircraft with the intention of flight until such time as all such persons have disembarked, in which a person is fatally or seriously injured as a result of being in the aircraft or in direct contact with any part of the aircraft or has direct exposure to jet blast, or the aircraft sustains serious damage or structural failure. The complete definition is available here.

These close calls serve as stark warnings against complacency in an industry where impressive safety achievements are a given. While we acknowledge the safety performance achieved in 2023, all stakeholders must remain vigilant. Complacency is a stealthy threat that can quietly infiltrate safety and quality protocols unless it is actively countered with a strong safety culture. Complacency can lead to shortcuts, neglect of procedures, the use of unconventional terminology, diminished awareness of surroundings, and a delayed response to escalating risks.

Combatting complacency demands an active strategy focused on ongoing quality enhancement, regular safety training, strict adherence to safety protocols, cultivation of a safety-first attitude, open discussions of potential risks, and the promotion of both personal and collective responsibility. Essentially, achieving sustained improvements in safety hinges on establishing and nurturing a robust safety culture.

Safety culture embodies an organization's perception, valuation, and prioritization of safety. A strong safety culture originates from leadership and flows through the entire organization, mirroring its genuine dedication to maintaining the highest levels of safety. It is crucial for leaders across all industry sectors to consistently convey, via their actions, words, policies, and procedures, that safety supersedes all other factors.

The near misses of the past year, the notable accidents in 2024, and the ongoing issues with runway incursions and other serious safety and quality concerns signal that safety buffers within the industry are being stretched thin, highlighting the need to pay attention to these alarms. The industry is grappling with numerous challenges, including the recruitment, sourcing, and training of tens of thousands of new workers; the rising demand for travel; and the need to accommodate new and diverse types of operations within the airspace system. However, it also stands at the threshold of opportunity to bolster the resilience and safety of the aviation system through effective technological implementation, a deeper comprehension of human factors, a sustained dedication to quality, and a steadfast focus on leadership and safety culture values.

Runway Incursion Threat

Although there have only been five runway incursion accidents in the past six years and none in 2023, this accident category is included because there have been a number of serious close calls, among other reasons. Other long-standing accident categories — such as controlled flight into terrain (CFIT) and loss of control–in flight (LOC-I) — have seen a reduction in the number of accidents over the years, but because of the complex set of related factors that contribute to runway incursions, the industry could see more close calls as traffic increases. Runway incursions usually do not result in accidents, but the International Civil Aviation Organization (ICAO) lists runway incursions among the five highest-risk categories of events that must be addressed to reduce the possibility of aviation fatalities. Reducing the risk requires a collaborative approach involving aircraft operators, air navigation service providers, airports, and regulators.

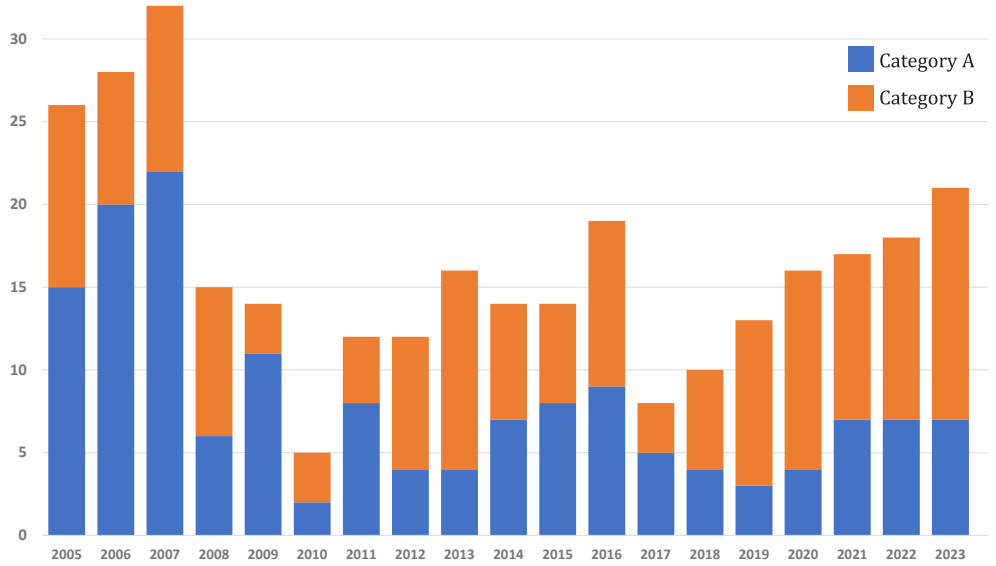
In December 2023, the Foundation published the Global Action Plan for the Prevention of Runway Incursions (GAPPRI). This effort involved more than 200 aviation experts from 80 organizations around the world working together on the analysis of multiple global and regional datasets, combined with insights garnered from operational expertise. This strategy extended beyond the study of only hazardous events; the recommendations incorporate lessons from all operations —

operations in which everything goes right as well as those in which something goes wrong. It's worth reviewing the analysis that was part of the GAPPRI initiative.

The analysis, which led to the project's recommendations, found that:

- The frequency of runway incursions in the U.S. National Airspace System (NAS) during 2022 was 33 per 1 million takeoffs and landings. The number and rate of the most serious runway incursions (Categories A and B) [2] are increasing. (Figures 1 and 2)

Figure 1:
The number of Category A and B runway incursions reported at U.S. airports since 2005.



(Source: U.S. Federal Aviation Administration)

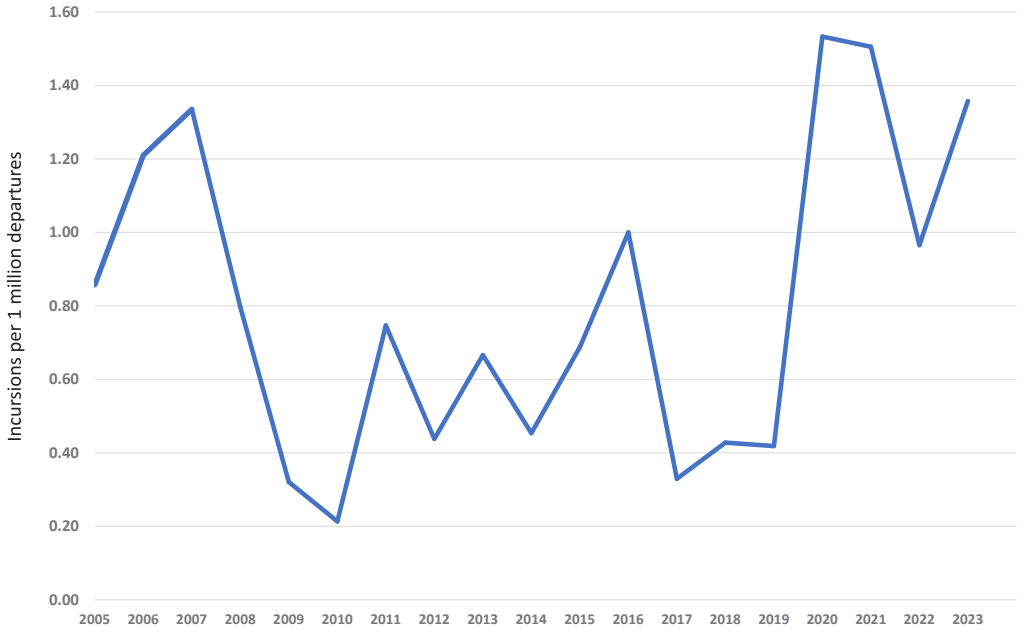
- In the United States, the most frequent contributor to runway incursion events is pilot deviation. Over a recent five-year span, pilot deviation accounted for 64 percent of the incursions, followed by vehicle/pedestrian deviation (19 percent), and operational incidents related to air traffic controllers (17 percent).
- In the United States, general aviation aircraft were involved in 70 percent of the runway incursion incidents during the five-year period.
- In a review of international accidents and incidents, several events from a sample of 68 runway incursion events involved the use of different radio channels and/or language for communication between air traffic control (ATC) and vehicles authorized for airside operations. This impacted the situational awareness of other traffic and prevented the resolution of traffic conflicts.
- In the same international review of 68 runway incursion accidents and serious incidents, several events involved controllers not checking compliance with potentially critical clearances.
- The rate of reported runway incursion incidents increased during the period from January

[2] Category A is a serious incident in which a collision was narrowly avoided. Category B is an incident in which separation decreases and there is a significant potential for collision, which may result in a time critical corrective/evasive response to avoid a collision.

2020 through December 2022, according to an analysis of International Air Transport Association (IATA) Incident Data Exchange (IDX) data. The most reported events came from the European region (35 percent), followed by Latin America/Caribbean (26 percent) and North America (18 percent).

- The majority of runway incursion incidents involving aircraft taxiing across a runway without clearance occur during the after-landing phase.

Figure 2 The number of Category A and B runway incursions per 1 million departures incurred by Part 121 and Part 135 carriers since 2005.



(Source: U.S. Federal Aviation Administration

Airliner Accidents

There were no commercial jet airliner[3] fatal accidents in 2023 and seven turboprop and piston engine airliner fatal accidents. Those seven accidents, five of which involved Cessna 208 Caravans, resulted in 107 fatalities among passengers and crew and one ground fatality. Three of the fatal accidents occurred in nonscheduled passenger operations, one in scheduled passenger operations and one in cargo operations. The other two fatal accidents occurred in passenger operations, but the type of operation is unknown.

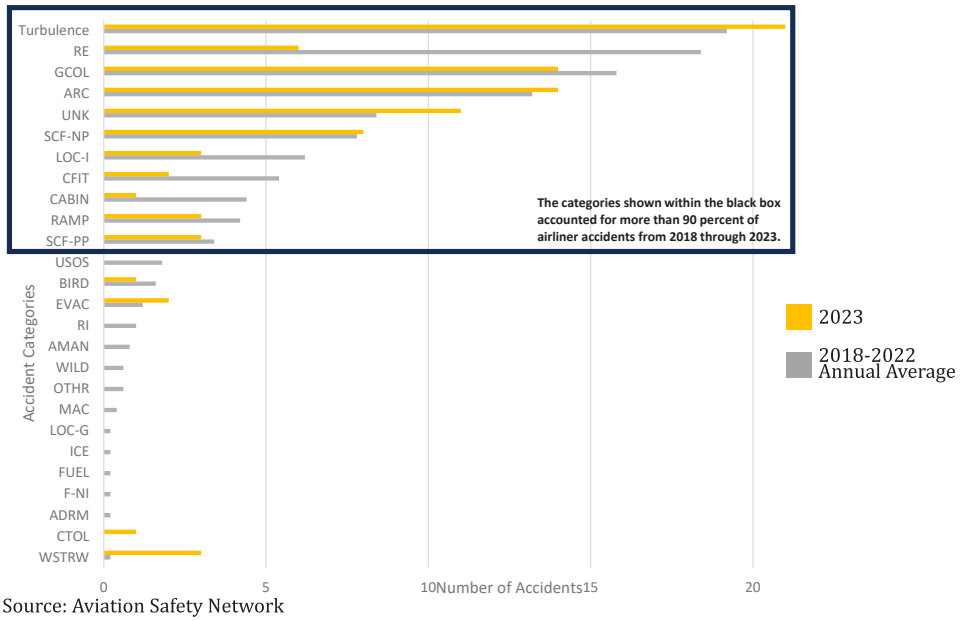
The total number of airliner accidents, including both fatal and nonfatal accidents involving jet-, piston-, and turboprop-powered aircraft, declined 22 percent to 94 in 2023 from 121 the previous year. The 94 accidents in 2023 also represent a decline of nearly 22 percent from the average of 115.8 accidents per year in the five-year 2018-2022 period.

For the second year in a row in 2023, turbulence-related accidents were the most frequent accident type. However, the number of accidents in the high-risk category (runway excursions, LOC-I and CFIT), was 63 percent less in 2023 than the annual average for the five-year 2018–2022 period.

[3] In the ASN database, airliners are defined as aircraft originally certificated to carry 14 or more passengers.

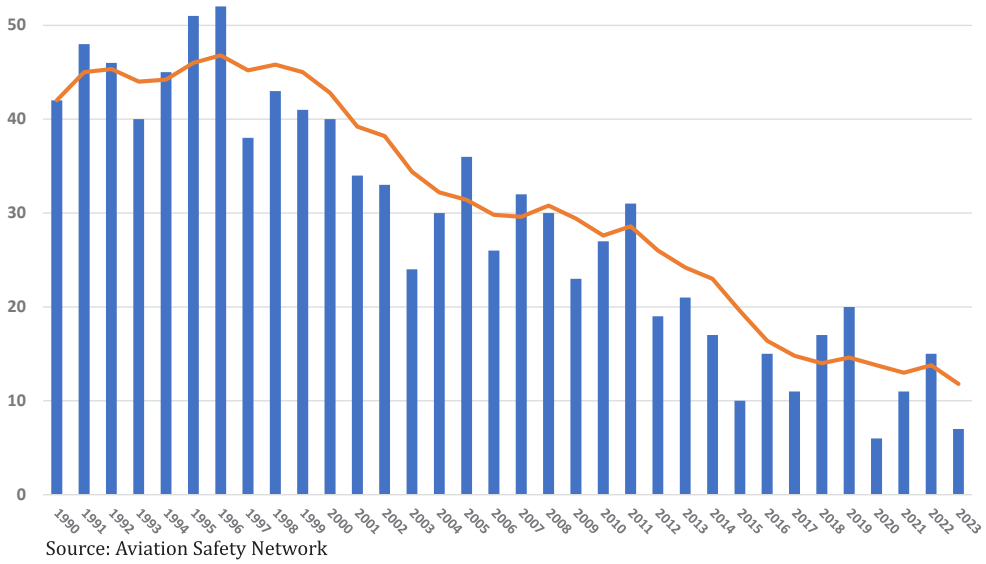
As accidents become less common, the Foundation believes safety analysis must be strengthened through an improved understanding of accident risks — an understanding that can be achieved through an assessment of incidents or other operational precursors, such as runway incursions, near-midair collisions, and go-arounds.

Figure 3 Airline Accidents and Accident Categories, 2018-2023.



Source: Aviation Safety Network

Figure 4 Airliner Fatal Accidents, 1990-2023 (Blue bars represent annual number of fatal accidents; orange line indicates the rolling average.)



Source: Aviation Safety Network

The Foundation's analysis of airliner accident data shows that 11 accident categories accounted for slightly more than 92 percent of total airliner accidents in 2023 and all of last year's fatal accidents. During the five-year period from 2018 through 2022, those categories or accident types accounted for a little less than 92 percent of all airliner accidents and nearly all fatalities. Each of those categories is highlighted in more detail below.

Airliner Accident Categories

Turbulence (TURB): For the second year in a row, turbulence-related accidents were the most frequent accident type. There were 21 turbulence-related airliner accidents in 2023, which is a slight change downward from 22 accidents in 2022, when there were fewer overall operations. In the 2018–2022 period, there were 97 turbulence-related accidents, or an average of 19.4 per year. The worst year for turbulence-related airliner accidents was 2019, when there were 27. None of the 2023 turbulence-related accidents was a fatal accident but all involved serious injuries to passengers and/or crewmembers.

During the period under review (2018–2023), turbulence events occurred more often in North America and Asia and less often in Europe and Africa. North America accounted for 41 percent of all accidents, but for 51 percent of all turbulence accidents. Asia accounted for 16 percent of all accidents but 26 percent of all turbulence accidents. The United States had the most turbulence-related accidents, with 59, and there were 16 in Japan. Together, these two countries accounted for 63 percent (72 of 117) of all turbulence accidents during the review period.

Turbulence has long been a leading cause of injuries to airplane occupants, particularly flight attendants, in nonfatal accidents, and incidences of turbulence are expected to increase because of climate change, IATA said in 2018 when launching its Turbulence Aware program. In a Safety Research Report[4] published in 2021, the U.S. National Transportation Safety Board (NTSB) said that from 2009 through 2018, turbulence-related accidents accounted for more than one-third of all accidents involving U.S. scheduled airlines.

According to the ASN database, there were three wind shear/thunderstorm-related accidents in 2023. Together, turbulence and wind shear/thunderstorm accidents represent more than 25 percent of all airliner accidents last year. During the previous five years, those two categories combined represented roughly 17 percent of total airliner accidents.

The incidences of turbulence-related accidents are far higher among Part 121 (scheduled operations) carriers than among Part 135 (commuter and on-demand) operators, and flight attendants are the most likely people on board airliners to be seriously injured, the NTSB report said. This is likely due in part to the fact that Part 121 aircraft often are larger than Part 135 aircraft and carry more passengers and cabin crew, which increases the potential for injuries if an aircraft encounters severe, unexpected turbulence.

Runway Excursions: The ASN database shows there were five runway excursion accidents involving airliners in 2023, which is a significant reduction from the 2018–2022 period, when then there was an average of more than 18 runway excursion accidents per year. There were 25 runway excursion accidents in 2020, during which much of the commercial aviation industry was shut down due to the pandemic, but only six in 2021 as the industry began to recover.

Runway excursions occur frequently, but usually are not fatal. In 2023, of five runway excursion accidents, one was a fatal accident. In that accident, an Embraer EMB-110P1 Bandeirante crashed at Barcelos Airport in Amazonas, Brazil, during heavy rain. After touching down, it ran off the

[4] "Preventing Turbulence-Related Injuries in Air Carrier Operations Conducted Under Title 14 Code of Federal Regulations Part 121," Safety Research Report, NTSB/SS-21/01 PB2021-100927, Adopted Aug. 10, 2021.

runway and collided with the airport's protective fence and, subsequently, with an embankment. The two pilots and 12 passengers died in the accident.

Since 2018, there have been nine fatal runway excursion accidents resulting in 101 fatalities among passengers and crew. All but one of the nine occurred during the landing phase of flight. The worst fatal runway excursion accident during the period occurred in March 2018 when a US-Bangla Airlines de Havilland Dash 8 veered off the runway while landing at Kathmandu, Nepal, resulting in 51 fatalities among the 71 passengers and crewmembers.

Since 2018, 82 percent of the 97 excursion accidents in the ASN database occurred during landing, with more veer-offs than overruns. Unstable approaches and failure to go around were the most common contributing factors. Other contributing factors included flight crew handling errors (speed and directional control), contaminated runways, crosswinds, late or inaccurate reports on runway conditions and/or weather, mechanical failures or gear collapses, and failure to reject the takeoff before V_1.[5]

In the period under review, runway excursion accidents occurred disproportionately more often in Asia, Africa, and South America and less often in Europe and North America.

Asia, Africa, and South America accounted for 35 percent of all accidents during the period, but 49 percent of all runway excursion accidents.

Because of the complexity of risk factors involved in runway excursions — such as stability of the approach, stability of the landing, condition of the runway, capabilities of the aircraft, and instructions from air traffic control, among others — prevention requires coordination among numerous stakeholders, including operators, airports, air navigation service providers, manufacturers, and regulators. In 2021, the Foundation and EUROCONTROL, working with more than 100 aviation professionals from 40 organizations, published the Global Action Plan for the Prevention of Runway Excursions (GAPPRE), which provides recommendations and guidance materials to a variety of stakeholders. The Foundation's 2017 Go-Around Decision-Making and Execution (GADM&E) Project report also contains valuable data and recommendations.

Ground Collision (GCOL): In 2023, there were 14 ground collision (GCOL) accidents, but in four cases the accident is counted twice because it involved a collision between two commercial aircraft. Those four cases resulted in damage to eight aircraft. The other six events involved collisions between an aircraft and ground equipment or between a commercial aircraft and a non-commercial aircraft. The five-year average for GCOL accidents is 15.8 per year. The worst year was 2019, when there were 28 accidents. Ground collision accidents usually occur during pushback or taxi operations at an airport. If a collision occurs during a runway incursion, that event is included in the runway incursion category.

Abnormal Runway Contact (ARC): In 2023, there were 15 abnormal runway contact (ARC) accidents, slightly more than the average of 13.2 per year during the 2018-2022 period. None of the 15 ARC accidents in 2023 were fatal. ARC includes any landing or takeoff involving abnormal runway or landing surface contact. Included in this category are hard and heavy landings, long/fast landings, off-center landings, and crabbed landings. Included in the 2023 accidents were five tail strikes, one main landing gear collapse, one failure of a nose landing gear to extend, and one

[5] V_1 is the maximum speed at which a rejected takeoff can be safely initiated in an emergency.

wingtip strike. In the six-year period 2018-2023, one of the 80 ARC accidents was fatal. All but seven of the 80 accidents occurred during the landing phase, with six on takeoff and two on the ground. Of the 80 accidents, 35 involved a tail strike, eight involved landing gear not extending, three involved the landing gear not being selected down, and 10 involved a go-around. Many of these types of events happen when wind conditions at the airport are challenging, when unstable approach criteria may not be met before attempting to land, or because of improper handling as the airplane approaches the ground or while the aircraft is being flared for landing.

Unknown: Accidents are categorized as "unknown" if there is not sufficient information to place them in other categories. There were 12 accidents in 2023 in this category. The average for the previous five years was 8.4 per year. Three of the 12 accidents in 2023 were fatal accidents, resulting in 20 fatalities. The worst accident occurred on Oct. 29, 2023, when a Cessna 208B Grand Caravan operated by ART Táxi Aéreo was destroyed when it crashed in a heavily wooded area shortly after takeoff from Rio Branco–Plácido de Castro International Airport, Brazil. All 12 people on board were killed. For many of the accidents in this category, little is known about what happened during the flight or the aircraft crashed without any communication from the flight crew. As accident investigations are completed, many of these accidents may be recategorized.

In the previous five years, there were 42 accidents in the unknown category, 11 of which were fatal accidents resulting in 219 fatalities. In the 2018-2022 period, there was a lack of evidence or a missing investigation in 21 of the accidents; eight accidents involved some form of mechanical failure (engine, flaps, electrical fire, landing gear, or other part failures); nine involved collisions with something on takeoff, approach, taxi, or landing; and the remainder involved issues like foreign object damage, cargo fires, and possible weight and balance issues.

System Component Failure–Non Powerplant (SCF-NP): There were eight SCF-NP accidents in 2023, about equal to the average per year for the previous five years. Four of the 2023 events were gear collapses, two involved hydraulic failure, one was a burst tire, and the other was a pressurization problem. For the six-year 2018-2023 period, there were 47 accidents, including one fatal accident. The fatal accident occurred in September 2022, when a float-equipped de Havilland Canada DHC-3T Turbine Otter that was en route to its destination abruptly pitched down and crashed in the water in Mutiny Bay, Washington, U.S. All 10 people aboard were killed. The NTSB determined that the probable cause was the in-flight unthreading of a clamp nut from the horizontal stabilizer trim actuator, which resulted in the stabilizer moving to an extreme trailing-edge-down position.

Nearly all of the SCF-NP accidents during the review period resulted in substantial damage to the aircraft. At least one involved injury to passengers. More than half of the accidents occurred during the landing phase, but 11 occurred during the ground phase, six during takeoff, one during initial climb, and three during the en route phase. Generally, these events were caused by landing gear malfunctions that resulted in a landing gear collapse while operating (28) or a failure to extend or retract (three). Other mechanical failures involved flight controls, pressurization, tires, windows, brakes, cargo door, damage to landing gear, damage to a generator, and foreign object damage (FOD). Insufficient or incorrect maintenance was related to at least five events.

Loss of Control-In Flight (LOC-I): In 2023, there were three airliner LOC-I accidents, of which two were fatal, resulting in 73 fatalities among passengers and crew. The worst of the two fatal

accidents occurred on Jan. 15, 2023, when an ATR 72-500 crashed while on final approach to the new Pokhara International Airport in Nepal. All 72 passengers and crew were killed in the accident. In the 2018-2022 period, there were an average of 6.2 LOC-I accidents per year.

LOC-I is considered a high-risk accident category because these accidents often are fatal. During the 2018–2022 period, there were 31 LOC-I accidents, and 20 of them, or 65 percent, were fatal accidents resulting in 846 fatalities among passengers and crew and seven ground fatalities. Two of the three worst fatal LOC-I accidents since 2018 were the Boeing 737 MAX crashes in Indonesia and Ethiopia, which together resulted in 346 fatalities. Also included in the total is the accidental January 2020 shootdown of a Ukraine International Airlines Boeing 737-800 near Tehran, Iran, by Iranian air defense forces, which resulted in 176 fatalities.

Ten accidents in 2018–2022 involved aerodynamic stalls, some because of icing conditions and others because of excessive pitch and slow airspeeds. Improper response to downdrafts, wind shear or crosswinds was noted in six of the accidents, and four involved excessive maneuvers. Other conditions included loss of situational awareness in severe weather, inadvertent activation of go-around mode, and engine failure.

Controlled Flight Into Terrain (CFIT): Like LOC-I accidents, CFIT accidents are a high-risk category because of the likelihood of fatalities. However, neither of the two CFIT accidents that occurred in 2023 was a fatal accident.

During the 2018–2022 period, there were 27 CFIT accidents, or an average of 5.4 per year. Fifteen of the accidents during the five-year period were fatal, resulting in 111 fatalities among passengers and crew. One of the worst accidents during the period occurred on July 6, 2021, when an Antonov An-26B-100 being operated by Kamchatka Aviation Enterprise on a scheduled domestic flight in Russia struck a cliff while on approach to Palana Airport on the Kamchatka Peninsula. Twenty-eight passengers and crew were killed in the accident.

Most of the CFIT accidents that occurred during the 2018–2022 period involved adverse weather conditions, such as low visibility and ceilings, fog, and snow. Many happened in mountainous terrain. In addition, the majority of accidents involved operational shortcomings of some kind, including visual flight rules flights continuing into instrument meteorological conditions, descent below established minimums, deviations from established routes, and late or improper go-arounds. Many of the deviations and descents below minimums could be characterized as intentional noncompliance, a factor that some believe may be under-recognized in accident investigations. Of the total of 27 CFIT accidents since 2018, 12 occurred during cargo operations.

Cabin: In the six-year period 2018-2023, there were 23 events that occurred in passenger cabins that are considered accidents because of the seriousness of the injuries suffered by crew and/or passengers. None of the events were fatal. Nineteen of these events involved crew injuries, and six involved passenger injuries. Generally, these events were caused by falls in or outside the aircraft, tripping over something, collisions with galley carts, hot liquid spills, and the aircraft abruptly changing speed, among other reasons. There was one cabin-related accident in 2023, and the average for the 2018-2022 period was 4.6 per year.

Ramp: There were three ramp accidents in 2023, two in the United States and one in Germany.

The average for the previous five years was 4.2 accidents per year. In the six-year period, 2018-2023, there were 24 ramp accidents, one of which was fatal. In the fatal accident, a flight attendant fell from an open aircraft door. Ten of the 24 events involved passenger injuries, four involved crew injuries, and nine were ground staff injuries. Generally, these events were caused by falls from the aircraft stairs, an aircraft door, jet blast, a sudden stop by the aircraft, or ground staff being hit by the aircraft.

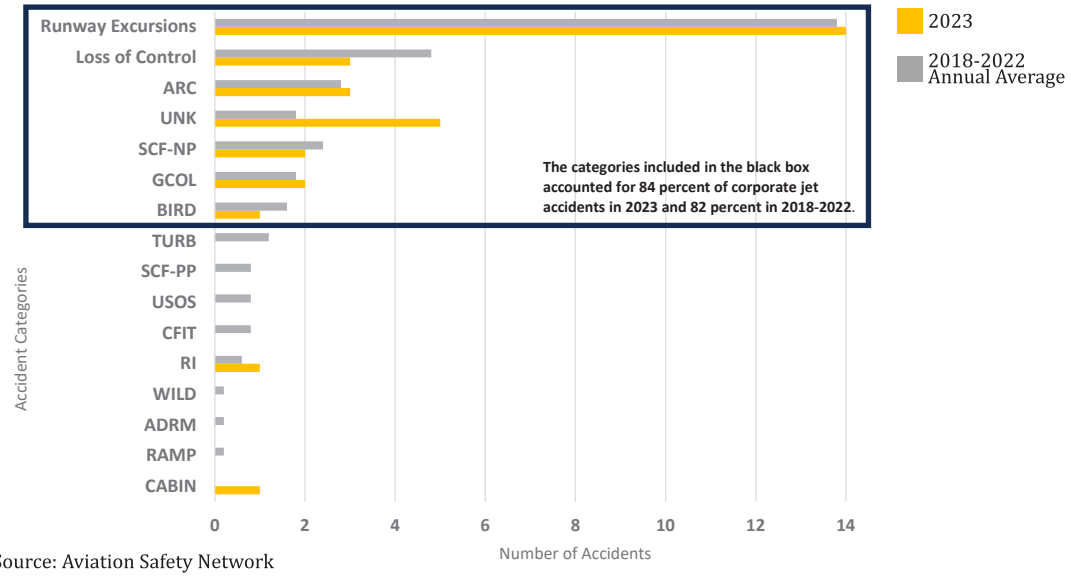
System Component Failure–Powerplant (SCF-PP): In 2023, there were three SCF-PP accidents, two of which were engine fire-related, and one of which was a flameout. None of the accidents were fatal. In the previous five-year period, there were an average of 3.4 accidents per year.

In the six-year period 2018-2023, there were 21 SCF-PP accidents. Five of these accidents were fatal, resulting in 11 fatalities among passengers and crew and one ground fatality. Eight of the 21 accidents happened during the en route flight phase, with the others being divided among takeoff (four), initial climb (two), approach (three), and one each during landing or standing. Most involved loss of thrust in one of the engines. Other factors included fire or fire warnings, uncontained failures (two), ingestion of something or someone, fuel starvation, heavy vibrations, and compressor stalls. Often these created conditions in which pilots had to shut down an engine, or deal with complete power loss or flameouts. The loss of engine operation in many cases led to a forced landing.

Corporate Jet Accidents

Corporate jets[6] were involved in 32 accidents in 2023, of which seven were fatal accidents, according to the ASN database. The fatal events resulted in 27 fatalities among passengers and crew in addition to two people on the ground. During the five-year 2018–2022 period, corporate jets were involved in an average of 33.8 accidents per year.

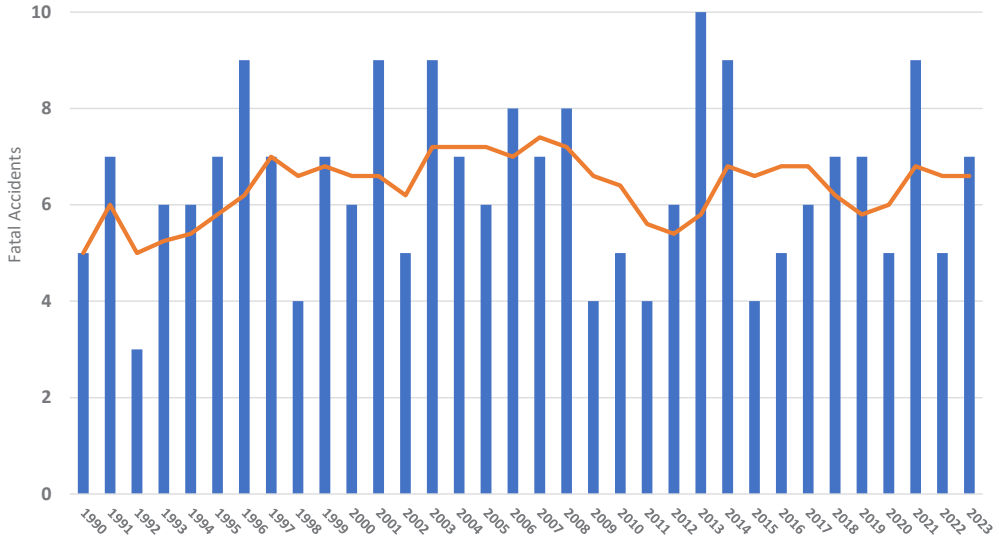
Figure 5 Corporate Jet Accidents and Accident Categories, 2018 2023



Source: Aviation Safety Network

[6] The following are the ICAO aircraft designators for the corporate jet models covered in this analysis: ASTR, BE40, C25A, C25B, C25C, C25M, C500, C501, C510, C525, C526, C550, C551, C55B, C560, C56X, C650, C680, C68A, C700, C750, CL30, CL35, CL60, DJET, E545, E550, E50P, E55P, EA50, F2TH, F900, FA10, FA20, FA50, FA5X, FA6X, FA7X, FA8X, G150, G250, G280, G650, GA4C, GA5C, GA6C, GA7C, GA8C, GALX, GL5T, GL7T, GLEX, GLF3, GLF4, GLF5, GLF6, GSPN, HA4T, HDJT, HF20, LJ23, LJ24, LJ25, LJ28, LJ31, LJ35, LJ40, LJ45, LJ55, LJ60, LJ70, LJ75, LJ85, MS76, MU30, PC24, PRM1, S601, SF50, SJ30, SJET, SP33, WW24

Figure 6 Corporate Jet Fatal Accidents, 1990-2023 (Blue bars represent annual number of fatal accidents; orange line indicates the rolling average.)



Source: Aviation Safety Network

In the six years from 2018 through 2023, corporate jets were involved in 203 accidents, slightly more than half of which (110) occurred during the landing phase. Of those 203 events, 40 were fatal accidents resulting in 148 fatalities among passengers and crew and five ground fatalities.

The Foundation's analysis of corporate jet accident data focused on six accident categories, which accounted for approximately 84 percent of accidents in 2023 and 82 percent of the accidents during 2018–2022 period (Figure 5).

Corporate Jet Accident Categories

Runway Excursions (RE): Runway excursions were, by far, the most common accident type in corporate jet operations in 2023 and throughout the period under review. In 2023, 14 of the 32 accidents involved runway excursions, and in the six year-period, there were 84 runway excursion accidents.

One of the 14 runway excursions in 2023 was a fatal accident. In November, a Learjet 35A operating as an air ambulance was destroyed when it crashed at Cuernavaca International Airport in Mexico. Two pilots and two passengers were killed.

During the 2018–2023 period, seven of the 84 runway excursion accidents recorded were fatal accidents, resulting in 21 fatalities among passengers and crew and one person on the ground. The worst of the fatal accidents occurred on March 29, 2020, when an Israel Aerospace Industries 1124A Westwind II crashed following a rejected takeoff from Manila-Ninoy Aquino International Airport in the Philippines and burst into flames. Eight passengers and crew were killed.

Runway excursions are far more prevalent after landing than during the takeoff phase. Of the 84 excursion accidents reported for the 2018–2023 period, 72 occurred during the landing phase. Analysis of a broader ASN data set including corporate jets and commercial airliners showed that

186 of 222 runway incursion accidents reported during the 2018–2023 period occurred during the landing phase. That broader dataset is available on the Global Action Plan for the Prevention of Runway Excursions (GAPPRE) page on the Foundation's website. The broader dataset also shows that veer-offs are more common than runway overruns.

Loss of Control (LOC-I): After runway excursions, LOC-I accidents usually are the most common accident type. There were three corporate jet LOC-I accidents in 2023, but in the five-year 2018–2022 period, there were 24, or an average of 4.8 per year. One LOC-I accident last year was fatal and resulted in a total of eight fatalities.

In the five-year 2018–2022 period, 16 of the 24 LOC-I accidents were fatal accidents resulting in 80 fatalities among passengers and crew. The worst year for fatalities was 2021, when five accidents resulted in 27 fatalities. The worst fatal LOC-I accident during the period involved a Canadair Challenger 601-3A corporate jet that crashed in desert terrain during a flight from Las Vegas, Nevada, U.S., to Monterrey, Mexico. All 13 passengers and crew were killed.

Aerodynamic stalls remain a leading cause of LOC-I accidents, and about 25 percent of these accidents involved stalls. More specifically, a stall during a circling approach remains a significant factor in LOC-I accidents. Another contributor is spatial disorientation.

Abnormal Runway Contact (ARC): There were three abnormal runway contact accidents in 2023, none of which were fatal. In the previous five-year period, there were 14 abnormal runway accidents, or an average of 2.8 per year. None of the ARC accidents during the period was fatal.

In at least two of the accidents during the five-year period, the crew did not lower the landing gear, and in other events, a part failed, causing the gear to collapse. In two cases, improper maintenance had been performed on the landing gear, and one case involved a runway excursion and landing gear collapse following a rejected takeoff. In two of the 2023 accidents, the aircraft landed hard after a stable approach and gear failed upon touchdown. Both accidents are still under investigation.

Unknown (UNK): There were five accidents in 2023 that qualify as unknown, which means there is not enough information available about the event to put the accident in a more specific category. In the previous five years, there were an average of 1.8 accidents of unknown causes per year, which is more than in any year in the prior five years. Four of the unknown accidents in 2023 were fatal accidents, which equals the total for the previous five years. During the six-year period under review, there were eight fatal accidents. This category also accounted for 24 fatalities in five of the seven events. For many of the other accidents, little is known about what happened; in some cases, the aircraft crashed without any communication from the flight crew before they died. As accident investigations are completed, some of these accidents may be recategorized.

In the previous five years, there were 15 accidents that are categorized as unknown. Contributing factors in this group of accidents included mechanical failures; collisions with something on takeoff, approach or landing; mishaps during taxiing; and damage during armed conflicts.

System Component Failure–Non-Powerplant (SCF-NP): There were two SCF-NP accidents in 2023, one of which was fatal. On March 3, 2023, a Bombardier BD-100-1A10 (Challenger 300) was involved in an accident while en route from Keene, New Hampshire, U.S, to Leesburg, Virginia. A

passenger was injured during an abrupt pitch-up event that was potentially caused by a faulty stab trim (trimmable horizontal stabilizer) system. The passenger later died at a hospital because of her injuries.

In the previous five years, there were 12 SCF-NP accidents, two of which were fatal. On Sept. 4, 2022, a Cessna 551 Citation II/SP was destroyed when it crashed into the Baltic Sea while en route from Spain to Germany. Radio communication indicated a pressurization problem, and fighter escorts took photos showing an incapacitated pilot in the left seat and his oxygen mask hanging unused in its place. An investigation continues, but it is suspected that the plane crashed into the Baltic Sea after fuel was exhausted. The other fatal accident occurred in January 2018, when a Gulfstream G150 cabin became pressurized while the aircraft was on the ground. The captain of the aircraft died from injuries sustained when he was struck by the cabin door which blew open with excessive force. The remaining accidents in the 2018–2022 period involved gear collapses, pressurization failures during flight, and brake fires.

Bird Strike: There was one bird strike accident in 2023. In the previous five years, there were eight accidents, or 1.8 per year, on average. None of the accidents during the review period was fatal. In every event, significant damage occurred to the aircraft, and these events happened in nearly every phase of flight. All but one of the reported accidents occurred in the United States, which likely is related to the country's extensive business aviation traffic and to the emphasis that U.S. Federal Aviation Administration puts on encouraging operators to report bird and wildlife strikes.

Call to Action

The aviation industry has made significant safety progress over the decades, but the Foundation and other industry stakeholders are continually in pursuit of greater improvement. Technology has had a positive impact on the decline in the number of midair collisions, CFIT accidents, and, to a lesser extent, LOC-I accidents and runway excursions. Safety also is improved by changes to processes and behavioral norms. As safety performance improvement has slowed in recent years, there is often an even greater need to strengthen SOPs and weak links in the chain of events leading to an accident. The Foundation believes there is still much to learn from the worldwide accident record about prioritizing accident-reduction efforts in the accident categories discussed in this report.

Safety Culture — Given the importance of a robust safety culture and the need to drive safety improvements as operations increase, it is imperative for operators, manufacturers, regulators, and other stakeholders to combat complacency and maintain an active focus on actions and policies that will help reduce risk. These include strict adherence to safety protocols and SOPs, regular safety training, promoting personal and collective responsibility for safety, collaborating on risk identification and mitigation, and sharing safety information up and down and across organizations.

Turbulence — Turbulence-related accidents are increasing, and climate change may be a contributing factor. Airline passengers need to recognize the importance of adhering to crew instructions to fasten their seat belts, whether those instructions are delivered verbally or through illumination of the seat belt sign. Passengers should also habitually keep their seat belts fastened

whenever seated. Operators should consider ways of bringing to the attention of all passengers and cabin crew the risk associated with failing to wear a seat belt. Additionally, operators should review their SOPs to ensure that the balance between cabin or galley checks and self-protection for cabin crewmembers is included in the threat and error management processes for flight and cabin crews. The industry must continue to improve its ability to detect areas of turbulence, particularly clear air turbulence, and to share that information. The NTSB study referenced in this report contains several recommendations that deserve consideration, not just in the United States but around the world.

Runway Excursions — Excursions are a significant risk for all sectors of aviation. The Foundation strongly encourages the implementation of recommendations made in the GAPPRE and GADM&E reports. In advance of the coming European Union Aviation Safety Agency mandate that large aircraft operated in commercial air transport be equipped with a runway overrun awareness and alerting system, some manufacturers are already equipping their fleets. The technology has not been in the fleet long enough to measure its effectiveness, but the Foundation believes this technology has potential to reduce excursions and equipage should be encouraged.

Runway Incursion — The Foundation also is concerned about the ongoing risk of runway incursions, particularly in light of the incursion events reported since the start of 2023, and believes it is important to raise awareness of this safety risk. In December, the Foundation released the Global Action Plan for the Prevention of Runway Incursions (GAPPRI) and strongly encourages all relevant aviation stakeholders to review the document and its recommendations.

Ground Damage — The risk of a ground collision and resulting damage requires precautions as part of regular procedures in flight operations, ground operations, maintenance, and elsewhere. As the industry acquires a large number of new, inexperienced personnel, the interfaces between operational areas can lead to risks that may have been handled more capably by seasoned professionals. The Foundation highly recommends that operators and maintenance and ground handling organizations reinforce safety norms and proper procedures among front-line workers when daily activities are conducted. Investment in proper training also is critical. In addition, the Foundation supports the practical use of technology solutions, such as anti-collision systems, to reduce ground damage occurrences.

LOC-I — Despite some recent improvement, this area still needs attention and better compliance with checklist procedures. When pressures to meet schedules clash with SOPs, operators need to practice healthy crew resource management efforts and recognize that risk must be managed within the boundaries of an acceptable process. If the process is not serving the needs of flight crewmembers, it must be revisited and revised accordingly. Operators and regulators must ensure that the training of flight crewmembers is carried out in the spirit of International Civil Aviation Organization Annex 6 Part 1 Chapter 9 Para 9.3.1, which covers training in knowledge and skills related to human performance.

CFIT — Despite improvement, risks persist, with loss of situational awareness in instrument meteorological conditions one of the most common occurrences in this accident category. As with LOC-I, ensuring the quality of flight crew training is paramount. If aircraft are equipped with terrain warning systems, operators should regularly monitor adherence and response to these warnings, and if aircraft are not equipped with these systems, operators should ensure additional

precautions are part of their SOPs. It is also important that operators ensure that the most up-to-date terrain database is being used and, where possible, the global positioning system should be used as the source of position information.

The Foundation chose to focus on accident categories that are sizeable and relevant around the world. Making significant safety progress requires focusing on the circumstances and causes of accidents in the categories that account for the majority of accidents and more than 90 percent of all fatalities. Technology improvements likely will continue to address some of the causes of these accidents, but human attention to details, revising processes to ensure the highest confidence of safe outcomes and applying the necessary lessons learned from the mistakes of the past also play an important role and will require actions on several fronts. As we have noted in our analysis, not every region of the world or every sector is experiencing similar results, and solutions may need to be focused on unique experiences and challenges. The Foundation will continue to look for opportunities to improve the overall risk picture for the industry, and undoubtedly, improvements will require great collaboration among stakeholders.

ASN Accident Dashboard

The Foundation has created an interactive dashboard where data on the accidents that occurred in 2023 and in the previous five years can be found. The dashboard, which covers airliner and corporate jet accidents, enables users to examine the data and do their own research. It also includes links to the relevant accident entries in ASN. The dashboard can be found here.