FLIGHT SAFETY FOUNDATION

2021 Safety Report

Flight Safety Foundation

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A Flight Safety Foundation analysis of 2021 aircraft accident data identified a number of safety risks that need to be proactively mitigated. Some of the risks, such as loss of control–in flight (LOC-I), are well understood and have been documented thoroughly over the years by the Foundation and other organizations. Other risks have been less well studied and require increased attention. In addition, operational changes brought about by the COVID-19 pandemic pose potential threats if not identified and mitigated.

The purpose of this report, which is based on an analysis of data and information drawn from the Foundation's Aviation Safety Network (ASN) database[1] and an ongoing assessment of risks introduced by the pandemic, is to bring these issues to the attention of the operators, regulators and global aviation stakeholders.

Accident Data

In 2021, commercial passenger and cargo operations involving aircraft certified to carry at least 14 passengers suffered 44 accidents (Figure 1, p. 2). Of that total, 11 were fatal accidents that resulted in 123 fatalities among passengers and crew, plus one person killed on the ground, according to the ASN data. Seven of the 11 fatal accidents, and 20 accidents overall, occurred during cargo operations.

Noncommercial operations using the same types of aircraft on missions such as surveying, training, parachuting and test flights, experienced 26 accidents last year, of which nine were fatal and in which 50 people died.

Corporate jets were involved in 28 accidents in 2021. Nine of the accidents were fatal and resulted in 36 fatalities among passengers and crew.

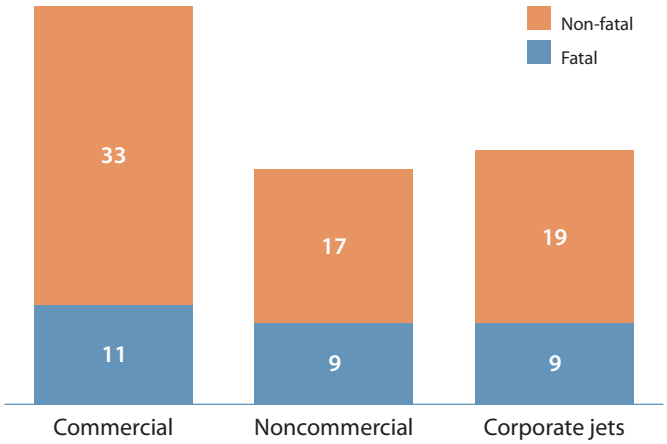
The number of commercial operation fatal accidents last year is up from eight in 2020, but the number of fatalities in 2021 declined more than 60 percent from the 315 passenger and crew who were killed in 2020's accidents. There were two noncommercial fatal accidents in 2020, resulting in four fatalities.

In 2019, commercial operations recorded 20 fatal accidents that resulted in 285 fatalities among passengers and crew and an additional six people on the ground. Noncommercial operations saw three fatal accidents and six fatalities in that year.

More information on the accidents is available here: https://aviation-safety.net/database/report.php

[1] The Foundation examined data drawn from the ASN accident database, which is updated daily and contains descriptions of airliner (aircraft originally certified to carry 14 or more passengers), military transport category aircraft and corporate jet aircraft accidents dating back to 1919. For the purposes of this paper, we primarily examined accidents involving these airliners used in commercial and noncommercial operations that occurred in 2021. Some business jet operations were included, but military aircraft operations were excluded, as were commercial aircraft that were intentionally destroyed.

Figure 1
2021 Accidents

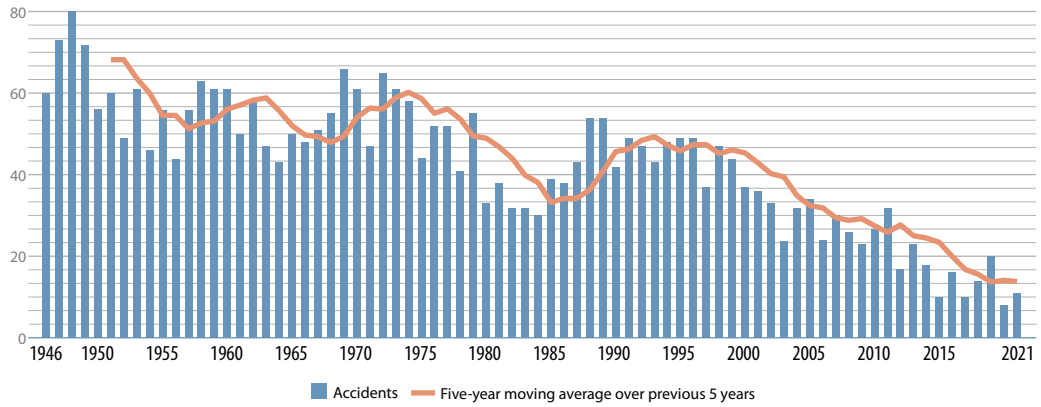


COVID-19 has significantly reduced global air travel in the past two years. While full-year statistics are not yet available, International Air Transport Association (IATA) data indicate that total international scheduled passenger traffic through the first 11 months of 2021 was down about 60 percent from the same period in pre-pandemic 2019.[2] Cargo traffic during the same 2021 period, on the other hand, was up more than 6.5 percent from 2019.[3] It is important to note that these traffic statistics are for scheduled airline operations only, and do not take into account unscheduled commercial operations. Scheduled operations, however, do comprise the majority of commercial flights in a given year. Therefore, these statistics are a good barometer for flight activity and demand.

The International Civil Aviation Organization (ICAO) estimated in mid-January that the number of passengers carried worldwide in 2021 was 2.3 billion, which is 49 percent below pre-pandemic 2019 levels, but an improvement from the 60 percent decline seen in 2020.

ASN's five-year moving average of fatal accidents has been trending steadily downward since the early 1990s (Figure 2).

Figure 2
Fatal Accidents per Year, 1946–2021, and 5-Year Moving Average



[2] IATA. "Air Passenger Market Analysis." November 2021, released Jan. 12, 2022.

[3] IATA. "Air Cargo Market Analysis." November 2021, released Jan. 11, 2022.

Aviation Risk Areas

Fatal accidents are a widely used and understood measure of aviation safety performance. But because there are few fatal accidents relative to the number of flight operations per year, it is necessary to examine a broader array of data to get an accurate picture of risk, to identify emerging or extant risk areas, and to compare risk across different sectors.

The Foundation examined the data and narratives on 70 commercial and noncommercial aircraft accidents[4] (Table 1). Approximately 23 percent of the accidents could not be classified into an accident category based on the available data. But of those that could be preliminarily classified, we identified three well-known risk areas: runway excursion (RE), LOC-I and controlled flight into terrain (CFIT), all of which are among the five ICAO high-risk categories (HRC) of occurrence.[5] The other HRCs are runway incursions and midair collisions (MAC).

Table 1
Accidents According to Category, 2021

	LOC-I	CFIT	RE	MAC	Runway Mishaps	Damaged on Ground	Technical Issues	Other	Unknown
Commercial	4	3	6	2	13	2	3	5	6
Noncommercial	3	3	1	0	1	10	3	0	5

CFIT = controlled flight into terrain, LOC-I = loss of control–in flight, MAC = midair collision, RE = runway excursion

Note: Categorizations are based on preliminary information available at the time of publication and may change as more information becomes available and as investigations proceed.

LOC-I: LOC-I accidents accounted for 10 percent of all accidents in 2021 and three of the 11 fatal commercial accidents, including the year's deadliest accident, the Jan. 9 crash of a Sriwijaya Air Boeing 737-500 that resulted in 62 fatalities. Sriwijaya Air Flight 82 crashed into the sea shortly after departure from Jakarta, Indonesia, on a scheduled passenger flight. KNKT, Indonesia's national transport safety committee, has issued a preliminary report, and its investigation is ongoing. An analysis of the LOC-I accident narratives in ASN indicated some of the loss-of-control situations involved powerplant-related problems, such as an engine fire or a power loss.

CFIT: CFIT accidents accounted for 8.6 percent of the total accidents in 2021. Three of the eight CFIT accidents were fatal accidents, including the year's second-deadliest event, the crash of an Antonov An-26B on July 6 that killed 28 passengers and crew. The aircraft, which was on a scheduled passenger flight, struck a cliff while on approach to an airport on the Kamchatka Peninsula in Russia. An investigation is being conducted. CFIT accidents often are related to a loss of situational awareness by the flight crew. A lack of ground proximity warning systems on accident aircraft also can play a role.

RE: Excursions are the most frequent accident type in aviation and often are identified as one of the most serious risks for large and small aircraft. REs accounted for approximately 10 percent of

[4] The typical ASN database accident entry includes flight number; type of operation; date, time, location and phase of flight of the accident; name of the operator; a variety of details about the accident aircraft, the number of passengers and crew; the number of fatalities (if any); severity of aircraft damage; departure and destination airports; and a narrative outlining what happened. Importantly, for our purposes, most accident entries include a preliminary accident classification, such as loss of control or controlled flight into terrain. These classifications are assigned based on the available details about the accidents and are in no way intended to be speculative. Accident narratives that do not contain enough detail to assign a classification are listed as "unknown." Links to preliminary and final accident reports are added if and when they become available.

[5] ICAO bases its categorization on actual fatalities, high fatality risk per accident or the number of accidents and incidents, as well as results from the analysis of safety data collected from proactive and reactive sources of information from ICAO and other non-governmental organizations.

the accidents involving airliners in 2021. In addition, an analysis of ASN data on business jet accidents showed that half of the 28 accidents in that sector could be categorized as runway excursions. REs are less often fatal than CFIT or LOC-I accidents, but two of the corporate jet aircraft accidents last year were fatal. None of the commercial or noncommercial airliner runway excursion accidents was fatal. The Global Action Plan for the Prevention of Runway Excursions (GAPPRE), which was published in 2021 as part of a joint Foundation/Eurocontrol initiative, details many of the contributing factors associated with REs.

MAC: Of the two MACs last year, one resulted in fatalities. On Dec. 21, a Cessna 208B Super Cargomaster on a cargo flight crashed southwest of Houston, Texas, U.S. The National Transportation Safety Board reported that the aircraft collided in midair with a powered paraglider. The Cessna pilot and the paraglider pilot were killed.

Runway mishaps: Twenty percent of the accidents that occurred in 2021 were categorized as runway mishaps. Included in this group are events such as tail strikes, amphibious aircraft landing on water with their landing gear extended, heavy or hard landings that resulted in substantial airframe damage, and landing gear collapses or other landing gear issues. Three of the four tail strikes identified in the data occurred during the landing phase and all involved commercial jets. In one event, a Boeing 747-8 freighter suffered a tail strike during a go-around. The aircraft landed safely on its second attempt. The event was initially categorized as a serious incident but later was reclassified as an accident.

Damaged on the ground: The Foundation analysis identified 12 damaged-on-the-ground events, accounting for approximately 17 percent of the commercial and noncommercial occurrences. Accidents in this category include airport vehicles colliding with aircraft, mishaps that occurred while aircraft were being towed, wing-to-wing or wing-to-wingtip collisions during taxiing, and damage during maintenance. In one case, the nose gear of a Boeing 787 retracted while the aircraft was being loaded with cargo when a locking pin was placed in the wrong downlock hole during a procedure to clear maintenance messages. Failure to adhere to standard operating procedures, using work-arounds instead of following maintenance manual steps, and operational pressures often are cited as contributory factors in such accidents. None of the damaged-on-the-ground events were fatal accidents, but these types of event are significant because of the disruption they can cause to airline and airport operations and the potential for serious injury or significant equipment damage. Also, damage caused by an airport vehicle, like a baggage conveyor belt or fuel truck, colliding with a carbon fiber aircraft structure may not always be visible, which makes it critical that all such events, no matter how seemingly minor, are reported.

Technical issues: The Foundation's analysis also indicates that a number of accidents last year involved engine and non-powerplant technical or mechanical problems, which raises several concerns. First, a mechanical issue that arises in flight adds to the flight crew's workload, which can be significant if it occurs during a high workload period, such as on descent or while the aircraft is maneuvering in complex airspace during severe weather. There also is the potential for a pilot or pilots to become too focused on resolving a technical issue and losing broader situational awareness. Any equipment malfunction that can disrupt the flight mission raises the issue of aircraft airworthiness. These malfunctions, while sometimes unavoidable, can bring into question maintenance programs and related functional testing and inspection.

Accident Investigations

Accident investigations and the resulting reports are critical to improving safety performance. Understanding the causes, contributing factors and dynamics of past accidents is crucial to preventing future accidents and incidents. In the weeks after an accident, regulators, accident investigators and manufacturers often will disseminate notices and other guidance based on

preliminary investigative findings, but it is important that comprehensive final investigative reports are made widely available so that what is learned through investigations can be incorporated into risk assessment programs and safety management systems. But a significant percentage of accidents and serious incidents are not investigated, and in other cases, investigations may take years to complete.

The international standards and recommended practices related to accident investigations are found in ICAO Annex 13, Aircraft Accident and Incident Investigation. Approximately 71 percent of all ICAO member states have promulgated regulations requiring that all final reports from aircraft accidents and serious incidents investigations be completed and made publicly available.[6] However, fewer than half of the ICAO member states have established and effectively implemented procedures to ensure that the final report is completed as soon as possible and that, if the report is not made available within 12 months, an interim statement is made publicly available on each anniversary of the occurrence, detailing the progress of the investigation and any safety issues raised.[7]

The ASN accident database includes links to final accident reports once they are published and made available. In 2019, there were 94 accidents involving commercial passenger or cargo flights, including four ground collisions. As of early January 2022, final reports — either full formal reports or reports in a summarized format — had been issued for 43 of the 94 accidents. The remaining accidents are still under investigation or will not be investigated.

It is also possible, using the ASN database, to determine the average duration of investigations. For example, in 2021, a total of 37 final reports related to accidents in the database were released. All but one of the reports were for accidents that occurred in 2020 or earlier. The average duration of the investigations was 766 days, or just over two years. In 2020, 60 reports were released. Several final reports were released within four to seven months after the accident events, but one investigation took more than 14.5 years and another lasted 13.75 years. The average duration of investigation for the reports issued in 2020 was 1,018 days, or more than 2.75 years.

Investigation backlog: It is clear from the analysis that some states have serious investigation backlogs. These can result from a lack of resources or investigative expertise. In fact, according to an analysis, 57 percent of states have not implemented an effective mechanism to ensure that the accident investigation authority has sufficient personnel to meet its national and international obligations related to accident investigations, and 38 percent have not established or implemented a process to ensure that the accident investigation authority has sufficient financial resources to investigate accidents and serious incidents.[8]

Pandemic Challenges

The COVID-19 pandemic's impact on the global aviation community has been unprecedented. It resulted in an extreme reduction in aviation activity and, in some cases, a complete shutdown of operations. The shutdown and subsequent return to service have led to changes to the operating environment, and it is important that those changes be managed effectively. In order to properly assess the impact that the pandemic has had on the aviation sector, the Foundation is conducting a global assessment of pandemic-related safety issues. It is noteworthy to highlight that over 72 percent of operators surveyed globally requested and received from regulators exemptions related to pilot proficiency checks and recency experience, license renewal and medical certificates.[9] It is essential that these and other types of changes be identified and managed within an operator's safety management system (SMS) and, at the regulatory level, in a state safety

[6] ICAO iSTARS
[7] ICAO iSTARS
[8] ICAO iSTARS
[9] Flight Safety Foundation Global Safety Assessment Survey distributed to 185 operators

program (SSP). While exemptions have been issued to air operators, equally important is the need for regulators to publish these exemptions to ensure the acceptance by other states when an operator flies from one state to another.

An SMS is the cornerstone of an effective strategy to prevent hazards from becoming unrecoverable risks. An important element of an SMS is change management. The myriad changes introduced at all organizational levels — slashed schedules, parked aircraft, layoffs, loss of experienced personnel, recruiting new employees to keep pace with recovery, quickly bringing back mothballed aircraft and developing COVID-19–related safety and wellness procedures, to name a few — have tested change management like never before. Operators have had to manage traditional safety issues while at the same identifying and managing risk resulting from the pandemic-related changes.

While the level of SMS maturity varies by operator, the industry has benefited from the fact that operators have been implementing SMSs for more than a decade. In fact, 97 percent of all operators surveyed have established and implemented an SMS, including establishing a hazard identification and risk assessment process. Over the past two years, many operators have further matured their SMSs and adjusted them to account for pandemic-driven changes, thus helping to ensure safe operations. However, the Foundation identified gaps in applying SMS consistently: 42 percent of operators surveyed did not perform, on a routine (frequent) basis, a review of their operational safety risk assessment process to identify new risks, hazards and mitigations related to flight operations during the pandemic.

Operator change management: Preliminary results from the global assessment show that change management processes as they relate to flight operations protocols, the review of established standard operating procedures (SOPs) and the introduction of new SOPs and other more traditional operational issues have been regimented and robust. However, change management as it relates to the many pandemic-related issues has been less robust and is in need of further maturation. For example, 40 percent of operators surveyed felt that risks arising from staff workforce changes were managed at a satisfactory level or less. In addition, the potential impacts of delays in implementing previously planned safety improvements due to the pandemic need to be assessed.

Regulators also have been faced with identifying and managing pandemic-related safety issues — both issues related to their oversight of operators and issues related to their own workforces about the ability to staff safety critical roles. However, at the state level, regulatory authorities have less experience in developing and implementing SSPs that would provide them effective ways to monitor, measure and ensure state safety performance at the appropriate level. The ICAO Global Aviation Safety Plan has established a target for all countries to implement the foundations of an SSP by 2022. During the ICAO Assembly later this year, that target is likely to be extended to 2023.

Regulatory oversight: Running an SSP is more complex than simply publishing a policy or procedures and there is a learning curve that can take several years. The target for implementing an effective SSP, based on ICAO's definition of effective, is 2028. While there are safety oversight capabilities around the world, the oversight mechanisms necessary for robust risk management systems may take quite some time to develop. Managing the many waivers and exemptions issued to enable the industry to survive the pandemic and begin recovery should be an area of extra focus as SSPs mature over the next several years.

Well-being of aviation professionals: Like it has in many industries, the pandemic has taken a toll on the wellbeing of aviation professionals. It is important for all stakeholders to understand the degree of this impact and implement countermeasures to address it. Fifty-two percent of the operators surveyed indicated that staff reported increased fatigue after returning to work following a long period of inactivity. Constant alertness to ongoing fears and concerns around

employment, infection and protection have a cumulative effect on the psyche. Fifty-one percent of operators reported increased stress due to nonstandard operations while 31 percent of the operators indicated that there was an increase in the level of reports on mental health issues during the pandemic. It is worth noting that while there is no ICAO provision for states to require air operators to establish mental health programs, almost 59 percent of operators had or put in place a program to deal with mental health.

Call to Action

The Flight Safety Foundation 2021 Safety Report identified several risks and concerns that will need to be proactively addressed by operators, regulators and other stakeholder organizations. While our data and analysis reveal that the aviation system exhibited a surprising degree of resiliency in the aftermath of the pandemic, we also identified important gaps and risk areas that need to be acted upon. The following are the Flight Safety Foundation Call-to-Action focus areas for 2022:

- The Foundation identified three risk areas that require particular attention: runway excursions, LOC-I and CFIT. The Foundation urges regulators and operators to continue to collaborate to mitigate these high-risk areas.
- Learning from accidents and incidents is important to driving improved safety performance, but in many cases, investigations take years or are not conducted at all. The Foundation urges states to make necessary resources available and to strive for comprehensive, independent investigations.
- Operators have requested and received regulatory exemptions related to pilot proficiency checks and recency experience, license renewal, medical certificates and others. We urge regulators to publish these exemptions to ensure acceptance by other states when an operator flies from one state to another.
- During the pandemic, many operators have further matured their established SMSs and adjusted them to account for pandemic-driven changes. The Foundation believes further improvement is needed to ensure that frequent reviews of operational safety risk assessments are performed during periods of constant change.
- Operators have performed well in managing changes to flight operations protocols, such as reviewing, revising and adding new standard operating procedures. However, change management as it relates to many pandemic-related issues that cut across entire organizations has been less robust and the Foundation urges further improvement and maturation of these efforts.
- To keep pace with industry, regulators must make greater effort to enhance their oversight capability and to progress with the implementation of the foundation required for a state safety program to achieve the global target established by ICAO.
- The pandemic has had an extensive impact on the well-being of aviation professionals across the industry. The Foundation urges all stakeholders to assess these impacts and mitigate these impacts in their safety programs and to make the appropriate resources and support available to all personnel.