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An Analysis of the Safety Performance of Air Cargo Operators

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In This Issue

Flight Safety Foundation is an international membership organization dedicated to the continuous improvement of aviation safety. Nonprofit and independent, the Foundation was launched officially in 1947 in response to the aviation industry's need for a neutral clearinghouse to disseminate objective safety information, and for a credible and knowledgeable body that would identify threats to safety, analyze the problems and recommend practical solutions to them. Since its beginning, the Foundation has acted in the public interest to produce positive influence on aviation safety. Today, the Foundation provides leadership to more than 830 member organizations in more than 150 countries.

An Analysis of the Safety Performance Of Air Cargo Operators

Nighttime operations and an aging aircraft fleet are among factors affecting the safety of cargo operations worldwide. Data from 1970 through June 1999 show that accidents during takeoff and climb occur more frequently in cargo operations than in passenger operations.

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Introduction

A previous study by the National Aerospace Laboratory (NLR)–Netherlands and the U.K. Civil Aviation Authority (CAA) indicated that cargo operators have a disproportionately high number of accidents.[1] Because of the limited scope of the study, the accident rates for different categories of cargo operations were not calculated. Calculation of accident rates requires accurate information on flight activity, such as the total number of flights conducted. Many flights conducted by cargo operators are unscheduled, and obtaining accurate information on the number of unscheduled flights that take place around the globe is difficult. In this study, an innovative method — based on using flight-cycle information for individual aircraft — was used to determine accurately the number of unscheduled flights that are being conducted.

This study focused on the quantification of the accident rates of different categories of cargo operations and the factors that influence the safety of cargo operations.

The study also examined whether results of inspections conducted in the Netherlands under the Joint Aviation Authorities (JAA) Safety Assessment of Foreign Aircraft (SAFA) program can provide additional insight into the causes of the relatively high accident rates among air cargo operations. Aviation authorities in Europe perform SAFA inspections (ramp checks) of aircraft operated by non-European companies. SAFA inspections include determinations of compliance with specific International Civil Aviation Organization (ICAO) standards.

Characteristics of Cargo Operations

Definitions

Cargo operations, for the purpose of this study, were defined as flights in which no fare-paying passengers are carried; the flights are conducted primarily for the purpose of carrying cargo (including mail).

Passenger operations were defined as flights conducted with aircraft that are equipped primarily for the transportation of fare-paying passengers — that is, the cabin does not contain any significant cargo area (generally, however, some cargo will be carried in the cargo section of the aircraft).

Combi flights — flights conducted with aircraft in which the cabin is partially equipped to carry cargo and partially equipped to carry fare-paying passengers — were excluded from the study because of their relative infrequency (less than 1 percent of all scheduled flights).

Safety-related Characteristics of Cargo Operations

The following comments were made by people experienced in cargo operations:

- "Many worldwide cargo operations are [conducted] at night [when] ground [crew,] flight crew and controllers are, in general, less alert … than during daylight hours. The high percentage of nighttime operations is one of the reasons why turnover in personnel is relatively high. Young pilots often use the cargo business … to log the flight hours that are necessary for entry into the world of the big flag carriers. Older pilots, who have retired from the big operators (for reasons of age) sometimes find employment at cargo operators, where they spend an additional five years in service. This can lead to flight crews with very large differences in age between captain and copilot, which could be a problem as far as crew resource management (CRM) is concerned."

- "A noticeable problem for cargo operators is their use of older aircraft — aircraft that have been withdrawn from use for the carriage of passengers for some time. Few, if any, of the ad-hoc [unscheduled] operators use modern, dedicated cargo aircraft with glass cockpits, modern performance and systems capability."

- "When aircraft become freighters, some safety equipment may be removed. For example, on some old turboprop freighters, the autopilots may have been removed. Older aircraft are more likely to have exemptions from new, costly safety systems such as traffic-alert and collision avoidance systems, high-spec flight data recorders and cockpit voice recorders."

- "Old aircraft [might have inadequate] internal lighting, cabin heating and crew facilities, as well as old safety equipment and [inadequate] evacuation facilities. Access to the full length of the cabin may also be very limited, owing to the size, shape and location of the cargo. Fire detection and suppression systems may be limited in their capability."

- "Operations may be [conducted at airports with] limited fire fighting services."

- "Cargo facilities at airports are typically remote from the passenger facilities. Access to and from the aircraft [is] not generally as good for aircraft occupants, and rest [facilities] and refreshment facilities for them may not be as good as at a passenger terminal. This can have an impact on the comfort of flight crews during lengthy turnarounds. Facilities for crews may be primitive, cold, [inadequately] illuminated and not conducive to adequate preflight crew briefings."

- "Commercial pressures can be evident. Cargo can arrive hours late, but crews are still expected to deliver on time and … may, therefore, infringe [upon] their legal duty hours. This may also lead to rushed procedures — for example, to depart before night-takeoff curfews."

- "Training standards [for cargo operations] are probably comparable with those for passenger operations. However, cargo operators have a much higher turnover of flight crews. This may be because cargo operations are often [conducted] to diverse, unfamiliar and unattractive destinations, which may be less appealing to pilots in the longer term than [destinations served in] passenger operations."

Weight-and-balance Problems

Weight-and-balance problems are a frequent hazard to cargo operations. Several accidents have involved errors during cargo loading that resulted in either a center of gravity that was not within limits or cargo that was not properly restrained and shifted during flight.

The entire sequence of cargo-loading operations — from preparation of the pallets/containers through the information provided to flight crews — has a direct effect on safety. While ultimately responsible for proper aircraft loading, the flight crew often has no practical way to verify the aircraft's weight and balance before takeoff.

Cargo-handler positions typically are entry-level positions characterized by relatively high turnover. The U.S. National Transportation Safety Board has recommended that all individuals associated with the loading process be provided with consistent and comprehensive training in aircraft loading, and that the flight decks of cargo aircraft be equipped with a system that displays aircraft weight and balance.[2]

Night Operations

The U.K. CAA found that the fatal accident rate at night is more than twice the fatal accident rate during the day.[3] This finding was based on the estimate that 20 percent of all landings are made at night; no distinction was made between cargo operations and passenger operations.

For the purpose of this study, a comparison was made between the number of day movements and the number of night movements of cargo aircraft and passenger aircraft. A night movement is defined as a departure or an arrival between 2000 and 0600. The comparison was limited to scheduled flights during 1995.

Figure 1 (page 3) shows the differences in the proportions of night movements of cargo aircraft and passenger aircraft. More than half of all cargo operations took place at night, while

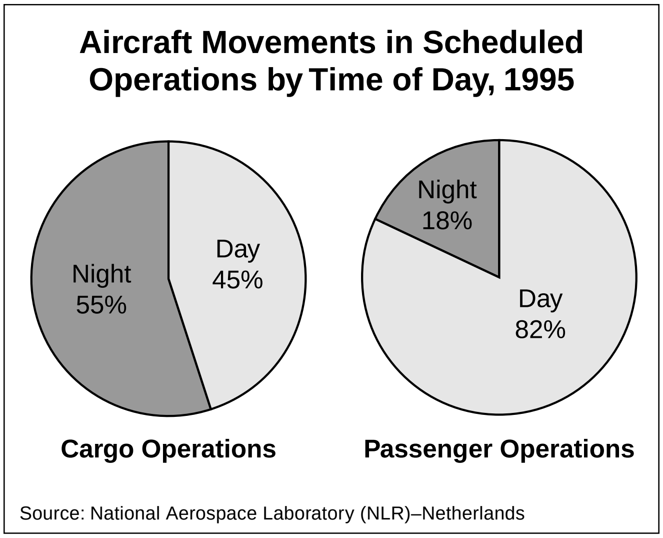


Figure 1

only about one-fifth of all passenger operations took place at night.

A U.S. National Aeronautics and Space Administration report on the effects of night operations concluded that flying at night presents a number of physiological challenges that are not present in comparable daytime operations.[4] The physiological challenges can cause lower performance. The report said that the quality of daytime sleep obtained by overnight cargo crewmembers is inferior to the quality of sleep obtained by crewmembers who sleep at night. In addition, factors such as restricted visibility, loss of depth perception and loss of visual acuity affect the safety of night operations.

Fleet Characteristics

Figure 2 shows the average fleet-age history for 1980–1998 for cargo aircraft and for passenger aircraft built in the Commonwealth of Independent States (CIS). The fleet includes jet aircraft and turboprop aircraft. The average age of both cargo aircraft and passenger aircraft increased from approximately 10 years to 20 years.

Figure 3 (page 4) shows the average fleet-age history for 1980–1998 for Western-built cargo aircraft and passenger aircraft. The fleet includes jet aircraft and turboprop aircraft. The average age of cargo aircraft increased steadily from 14 years to 22 years, whereas the average age of passenger aircraft remained relatively constant at approximately 10 years.

A comparison of Western-built aircraft flight cycles and design-life information indicates that, on average, jet cargo aircraft have been utilized for 50 percent of the original design life in flight cycles and that jet passenger aircraft have been utilized for 33 percent of the original design life in flight cycles.[5] (The original design-lives for many aircraft have been adjusted to increase their service lives.)

Calculating Accident Rates

Method

To calculate an accident rate, the number of accidents and flight activity, such as the total number of flights conducted during a specific period, must be known. Flight-activity data for

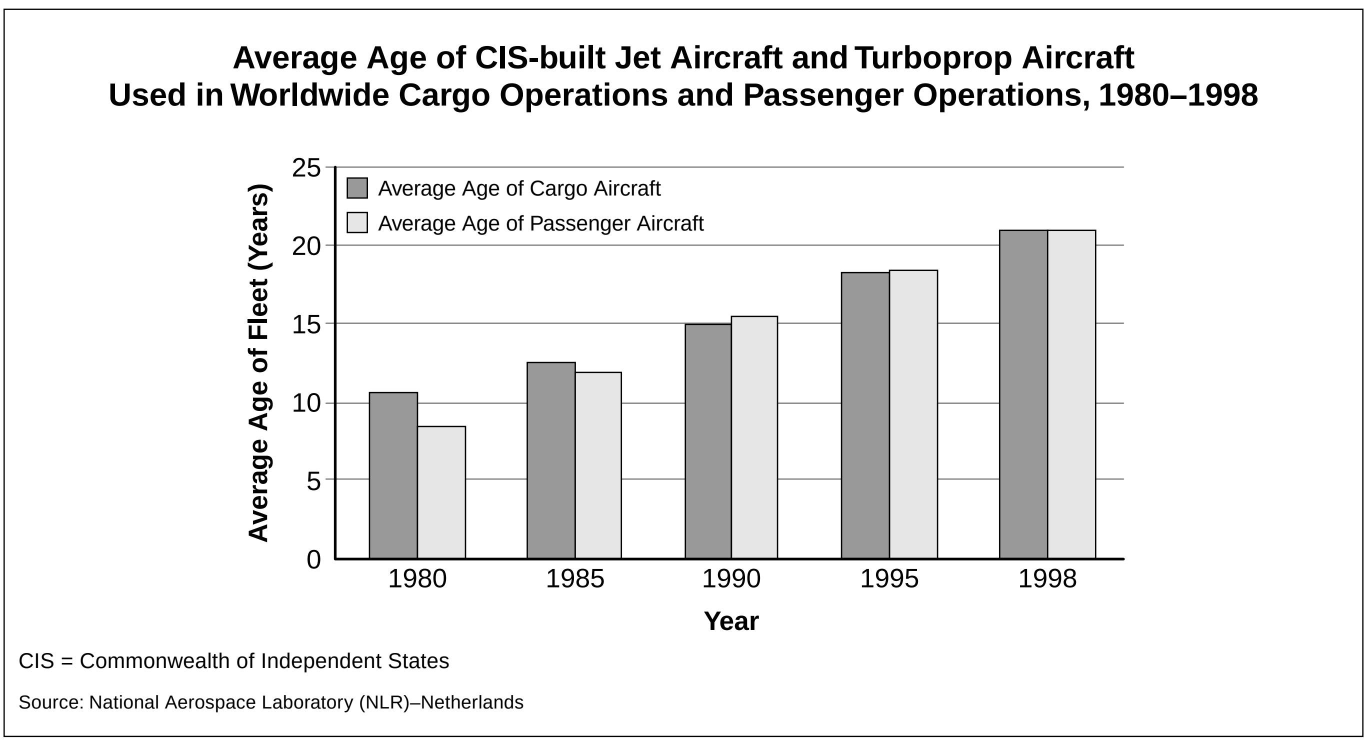
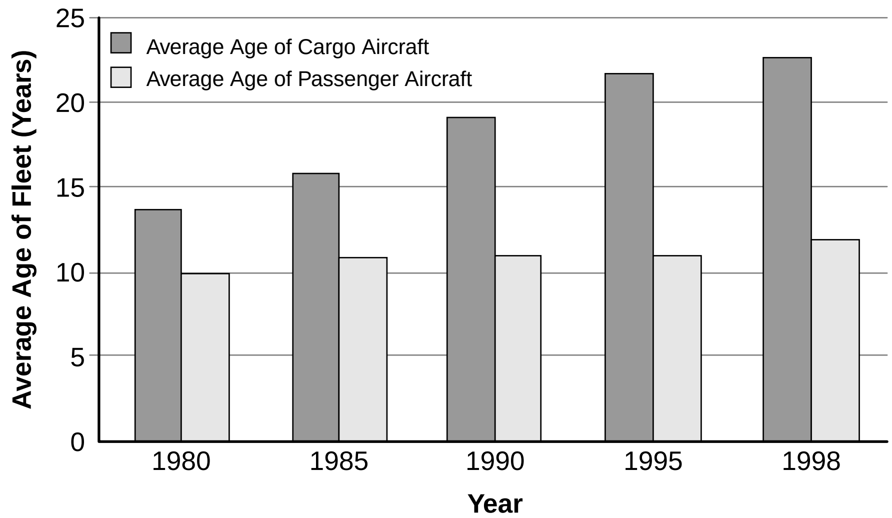


Figure 2

Average Age of Western-built Jet Aircraft and Turboprop Aircraft Used in Worldwide Cargo Operations and Passenger Operations, 1980–1998



Source: National Aerospace Laboratory (NLR)–Netherlands

Figure 3

scheduled operations are available readily, but flight-activity data for unscheduled operations are not available readily.

Flight-activity data for unscheduled operations were estimated by analyzing flight-cycle information for individual aircraft, identified by their serial numbers. The flight-cycle information then was combined with the ownership history of the individual aircraft to estimate the total number of flights conducted by each operator.

Flight-activity Calculations

Aircraft utilization data were obtained from the Aircraft Analytical System (ACAS), an AvSoft computer program that details the history and the operational status and maintenance status of more than 30,000 aircraft, including transport aircraft with more than 15 passenger seats and business jets.

ACAS data for specific Western-built jet aircraft and turboprop aircraft from 1970 through June 1999 were used in this study. The study sample did not include business jets, turboprop aircraft with maximum takeoff weights (MTOWs) less than 5,700 kilograms/12,500 pounds or aircraft used primarily for air ambulance operations, corporate/government operations, military operations, utility operations, search-and-rescue operations or patrol. Also excluded from the sample were aircraft with fewer than 10 landings during the study period.

The appendix on page 16 shows the aircraft types included in the study sample.

Approximately 2,000 aircraft operators were included in the sample. The following definitions of operators were used:

- *Major operators* have large fleets of jet aircraft. They typically operate both cargo aircraft and passenger aircraft on scheduled flights and on unscheduled flights. The operators use the same flight crews, training facilities and maintenance facilities for cargo operations and for passenger operations;

- *Integrators* are large parcel-delivery companies. Parcel-delivery operations are characterized by a requirement for on-time performance. Because of the importance of on-time performance, the investments made in maintenance are high. Some integrators have spare aircraft that can be used if a technical problem grounds or delays another aircraft;

- *Supplemental air carriers* are commuter airlines and their counterparts in the cargo industry. They typically deliver passengers and cargo to major operators for further transportation. In general, supplemental air carriers use smaller aircraft, and relatively large parts of their fleets are turboprop aircraft; and,

- *Ad-hoc operators* are characterized by a very high percentage of unscheduled flights on routes not served by major operators. The number of aircraft in an ad-hoc operator's fleet typically is low (i.e., one aircraft or two aircraft), and the cargo aircraft are older-generation models (e.g., Boeing 707, Douglas DC-8).

Most ad-hoc passenger operations are conducted during holiday seasons.

The ACAS database includes, for each aircraft, the total number of flights for the period that a specific operator owned the aircraft. Consequently, for aircraft whose ownership began before 1970 and ended after 1970, the number of flights after 1970 were estimated for this study by assuming that aircraft utilization (number of flights per day) was constant for a given aircraft/ownership combination.

Utilization data for several aircraft — typically, older aircraft (e.g., Aerospatiale Caravelle, Boeing 707) operated by small companies on an ad-hoc basis — are not included in the ACAS database. Deleting these aircraft from the study sample might have resulted in the calculation of incorrect accident rates; therefore, the number of flights conducted in these aircraft was estimated based on the average utilization of the aircraft in the ACAS database.

Table 1 shows average aircraft utilization (i.e., flights per day) by the various operators.

Table 2 shows total aircraft utilization (i.e., total flights) by the various operators. Integrators are, by definition, cargo operators. The small number of flights in the "Integrator, Passenger" category were conducted to transport company personnel in passenger aircraft operated by the companies.

Accident Sample

The primary source of accident information was the ICAO Accident/Incident Reporting (ADREP) database. The database contains worldwide accident information and incident information from 1970 for jet aircraft and for turboprop aircraft with MTOWs greater than 5,700 kilograms. Fatal accidents and hull-loss accidents from the ADREP database were included in the study sample.[6]

The study sample did not include the following:

- Fatal accidents involving no damage or minor damage to the aircraft (e.g., fatal accidents involving in-flight turbulence, jet blast, people falling from aircraft stairs during boarding); and,
- Hull-loss accidents that occurred while the aircraft were on the ground with no payload aboard (e.g., collisions while the aircraft were being taxied for maintenance purposes).

The resulting accident sample included 606 accidents. Each accident was categorized as having involved an aircraft configured to carry cargo or configured to carry passengers, having involved a revenue flight or a non-revenue (training, ferry, positioning or test) flight, and having involved a scheduled flight or an unscheduled flight.

Table 1
Average Aircraft Utilization By Operators, 1970–June 1999

Operator	Type of Flight	Flights per Day
Major[1]	Cargo	2.80
Major	Passenger	4.79
Integrator[2]	Cargo	2.29
Integrator	Passenger	2.70
Supplemental[3]	Cargo	6.77
Supplemental	Passenger	6.27
Ad-hoc[4]	Cargo	3.22
Ad-hoc	Passenger	3.68

Note: The data include Western-built jet aircraft (excluding business jets) and turboprop aircraft with maximum takeoff weights of 5,700 kilograms/12,500 pounds or more.

[1]Major operators are defined as large companies with large fleets of jet aircraft.

[2]Integrators are defined as large parcel-delivery operators.

[3]Supplemental air carriers are defined as commuter airlines and equivalent cargo operators that typically deliver cargo and passengers to major operators.

[4]Ad-hoc operators are defined as operators with a large percentage of unscheduled flights.

Source: National Aerospace Laboratory (NLR)–Netherlands

Table 2
Total Number of Flights by Operators, 1970–June 1999

Operator	Type of Flight	Flights
Major[1]	Cargo	13,098,005
Major	Passenger	329,754,290
Integrator[2]	Cargo	5,899,989
Integrator	Passenger	198,852
Supplemental[3]	Cargo	4,861,079
Supplemental	Passenger	89,245,965
Ad-hoc[4]	Cargo	6,707,868
Ad-hoc	Passenger	17,149,140

Note: The data include Western-built jet aircraft (excluding business jets) and turboprop aircraft with maximum takeoff weights of 5,700 kilograms/12,500 pounds or more.

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Source: National Aerospace Laboratory (NLR)–Netherlands

Table 3 shows the distribution of the 606 accidents among the various operators.

Table 3
Fatal Accidents and Hull-loss Accidents,[1] 1970–June 1999

	Type of Flight	
Operator	**Cargo**	**Passenger**
Major[2]	46	355
Integrator[3]	6	0
Supplemental[4]	9	98
Ad-hoc[5]	46	46
Total	**107**	**499**

Note: The data include Western-built jet aircraft (excluding business jets) and turboprop aircraft with maximum takeoff weights of 5,700 kilograms/12,500 pounds or more.

[1]A hull-loss accident is an accident involving damage to a commercial airplane that is substantial and beyond economic repair, an airplane that remains missing after search for wreckage has been terminated or an airplane that is substantially damaged and inaccessible.

[2]Major operators are defined as large companies with large fleets of jet aircraft.

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[5]Ad-hoc operators are defined as operators with a large percentage of unscheduled flights.

Source: National Aerospace Laboratory (NLR)–Netherlands

Analysis of the Results

Accident Rates Among Operators

The accident rate for each of the operators was calculated by dividing the number of accidents (Table 3) by the total number of flights (Table 2). The results are shown in Figure 4 (page 7) as accidents per million flights.

The accident rate for ad-hoc cargo operations was almost seven times higher than the accident rate for passenger operations conducted by major operators. The accident rate for ad-hoc passenger operations was almost three times higher than the accident rate for passenger operations conducted by major operators.

Among the major operators, the accident rate for cargo operations was more than three times higher than the accident rate for passenger operations.

Among all of the operators, the accident rate for cargo operations was higher than the accident rate for passenger operations.

Regional Accident Rates

Accident rates for operations involving Western-built aircraft were calculated for the following regions:[7]

- Africa — Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde Islands, Central African Republic, Chad, Ciskei, Comoros, Congo, Democratic Republic of Congo, Djibouti, Egypt, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Ivory Coast, Kenya, Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Republic of Bophuthatswana, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Tanzania, Togo, Tunisia, Uganda, Zambia and Zimbabwe;

- Asia — Afghanistan, Bahrain, Bangladesh, Bhutan, Brunei, Cambodia, China, Hong Kong, India, Indonesia, Iran, Iraq, Israel, Japan, Jordan, Korea, Kuwait, Laos, Lebanon, Macau, Malaysia, Maldives, Mongolia, Myanmar, Nepal, Oman, Pakistan, Palestine, Philippines, Qatar, Saudi Arabia, Singapore, Sri Lanka, Syria, Taiwan, Thailand, Vietnam and Yemen;

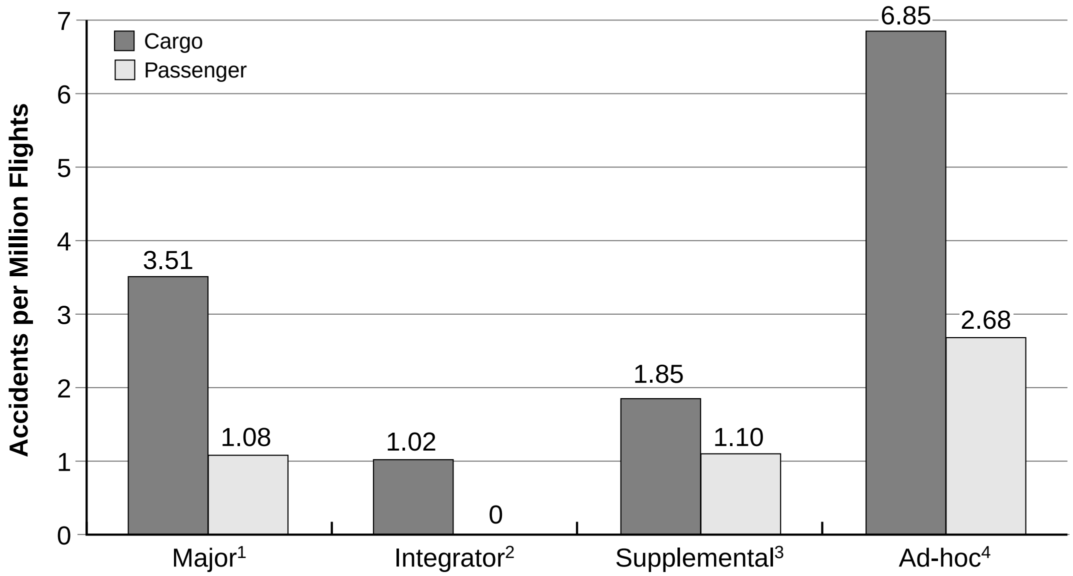
- Australasia — American Samoa, Australia, Cook Islands, Fiji, French Polynesia, Guam, Kiribati, Marshall Islands, Nauru, New Caledonia, New Zealand, Northern Marianas Islands, Pacific Islands, Palau, Papua New Guinea, Solomon Islands, Tonga, Vanuatu and Western Samoa;

- Central America and South America — Argentina, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Falkland Islands, French Guyana, Guatemala, Guyana, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Suriname, Uruguay and Venezuela;

- Europe — Albania, Austria, Belgium, Bosnia-Herzegovina, Bulgaria, Croatia, Cyprus, Czechoslovakia, Czech Republic, Denmark, Estonia, Faroe Islands, Finland, France, Germany, Gibraltar, Greece, Greenland, Hungary, Iceland, Ireland, Italy, Latvia, Lichtenstein, Lithuania, Luxembourg, Macedonia, Malta, Monaco, Montenegro, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom and Yugoslavia; and,

- North America — Anguilla, Antigua and Barbuda, Aruba, Bahamas, Barbados, Bermuda, Canada, Cayman Islands, Cuba, Dominica, Dominican Republic, Grenada, Guadeloupe, Haiti, Jamaica, Martinique, Montserrat, Puerto Rico, St. Kitts and Nevis, St. Lucia, St. Pierre and Miquelon, St. Vincent

Accident Rates Among Operators, 1970–June 1999



Note: The data include Western-built jet aircraft (excluding business jets) and turboprop aircraft with maximum takeoff weights of 5,700 kilograms/12,500 pounds or more.

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Source: National Aerospace Laboratory (NLR)–Netherlands

Figure 4

and the Grenadines, Trinidad and Tobago, Turks and Caicos Islands, United States and Virgin Islands.

The total number of flights conducted in Western-built aircraft by operators in the CIS was too low to calculate accident rates that are statistically robust.

For the purpose of this study, the criterion for assigning an accident to a region was the state of registry of the accident aircraft.

Figure 5 (page 8) shows that the highest accident rates in cargo operations involved aircraft registered in Africa, Asia and Central America/South America. The variation in the accident rates among the regions generally is much greater for cargo operations than for passenger operations. Also noteworthy is that Europe's cargo-operations accident rate is relatively low and does not differ significantly from the accident rate for passenger operations.

A possible explanation for the variation in regional accident rates is the variation in regional economic performance. Figure 6 (page 8) shows the 1996 gross domestic product per capita in U.S. dollars for the regions.

Figure 5 and Figure 6 indicate that the regions with the lowest economic performance have the highest accident rates.

Figure 7 (page 9) shows the accident rates among the various operators in the regions. The accident rates are relatively high in Africa, Asia and Central America/South America. The accident rates among Australasian operators and European operators are relatively low, and there is little difference between the accident rates for cargo operations and for passenger operations. The accident rates among North American operators also are relatively low, but there is a significant difference between the accident rates for cargo operations and the accident rates for passenger operations. The accident rate for ad-hoc cargo operations in North America is higher than the accident rate for unscheduled passenger operations in Africa and in Central America/South America.

State-owned Airlines

Figure 8 (page 10) shows the accident rates among state-owned airlines and privately owned airlines in Africa. An airline was classified as state-owned if more than 50 percent of the shares in the company were held by the state in which the airline was based.

Whereas there is little difference between the accident rates for passenger operations conducted by state-owned airlines and the accident rate for passenger operations conducted by privately owned airlines, the accident rate for cargo operations conducted by state-owned airlines is two times higher than the accident rate for cargo operations conducted by privately owned airlines.

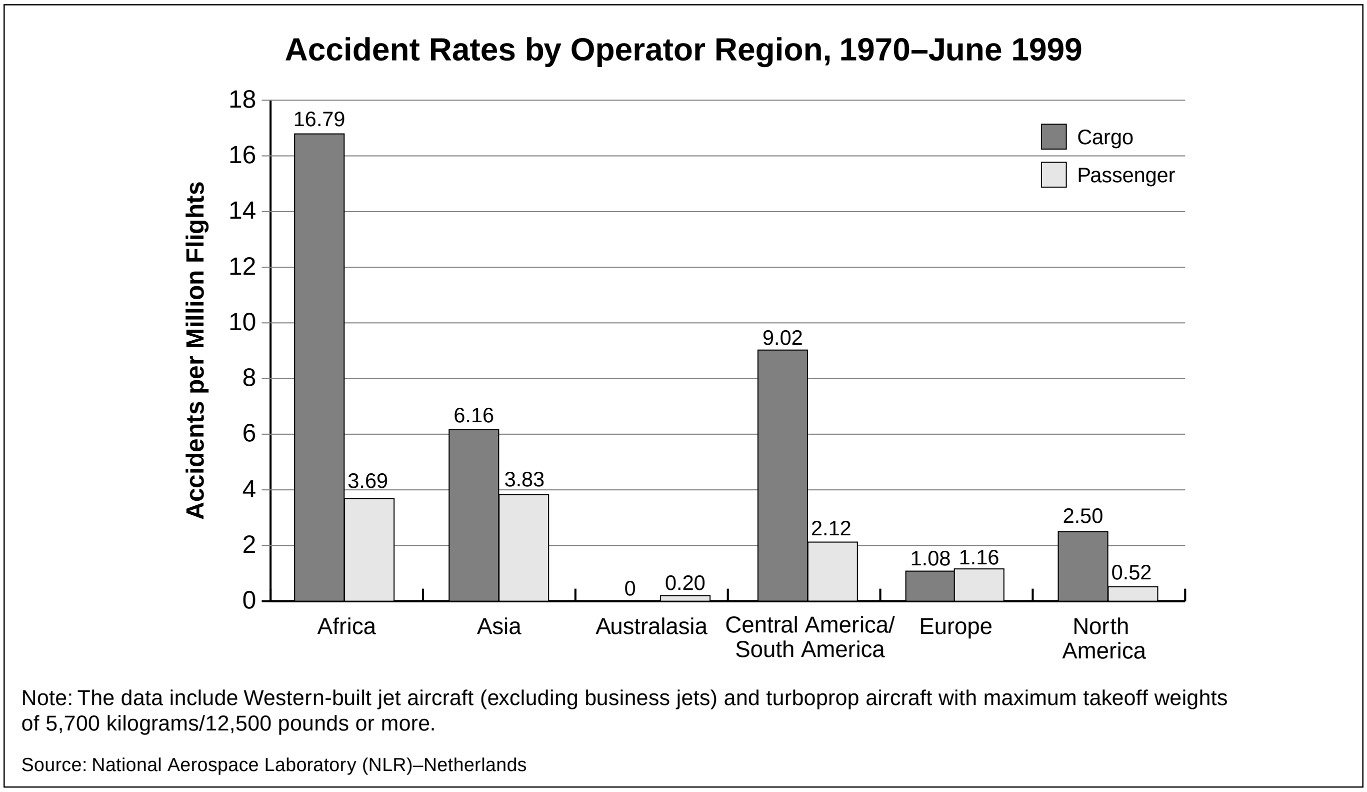


Figure 5

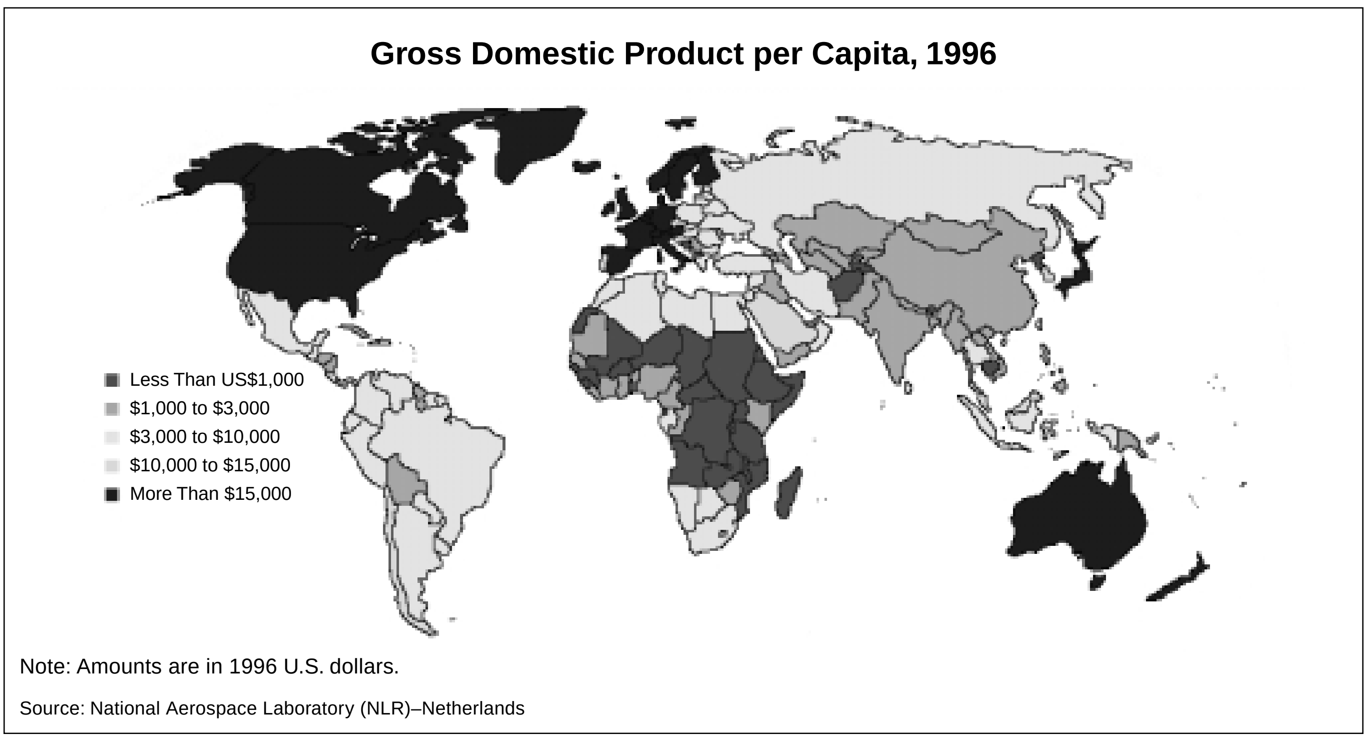
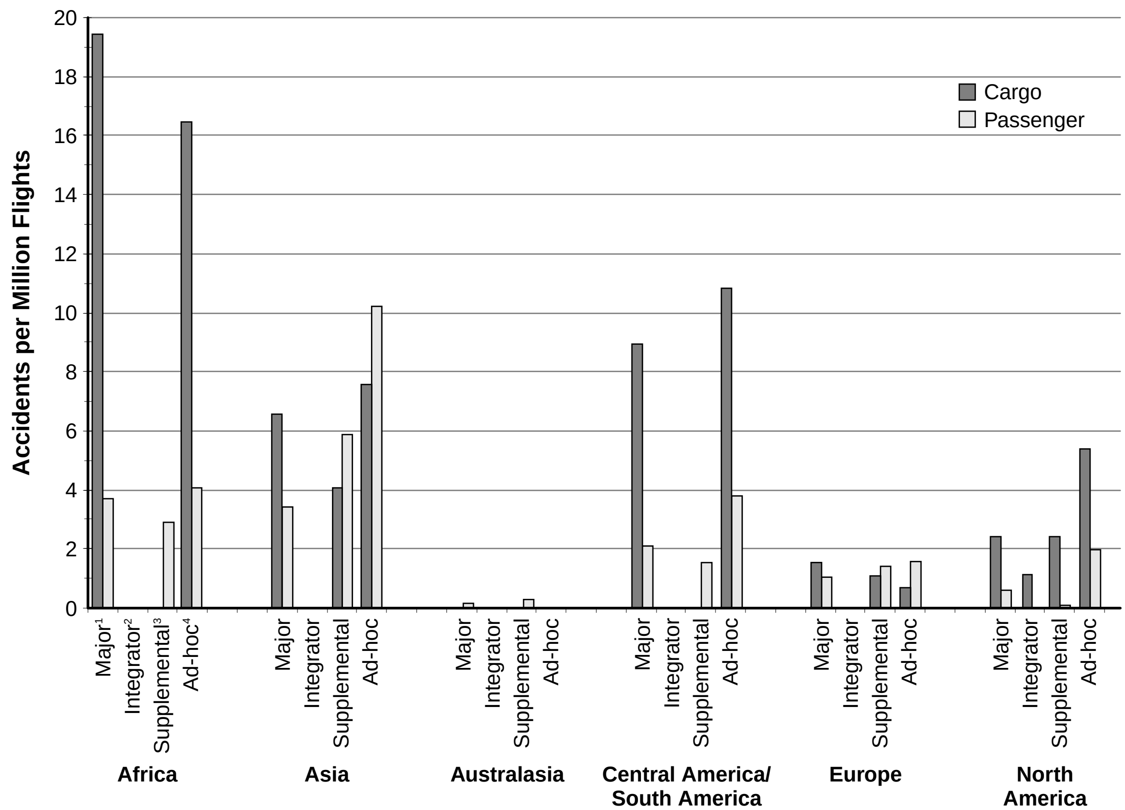


Figure 6

Accident Rates Among Operators by Region, 1970–June 1999



Note: The data include Western-built jet aircraft (excluding business jets) and turboprop aircraft with maximum takeoff weights of 5,700 kilograms/12,500 pounds or more.

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[4]Ad-hoc operators are defined as operators with a large percentage of unscheduled flights.

Source: National Aerospace Laboratory (NLR)–Netherlands

Figure 7

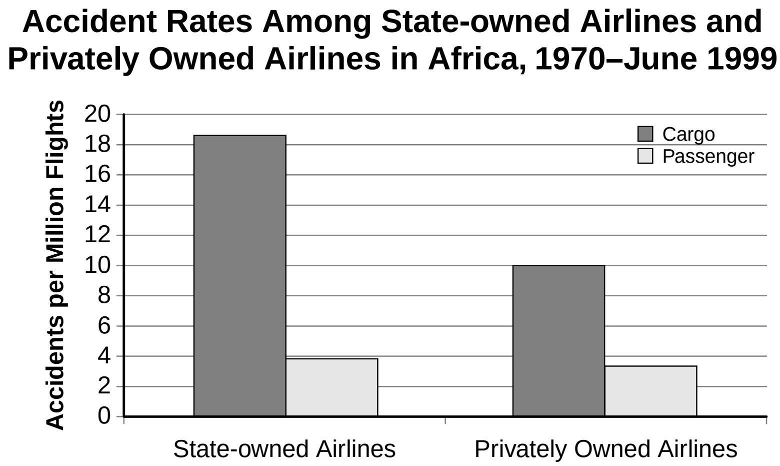
Types of Accidents

The reason for the higher accident rates among cargo operations worldwide was further examined by comparing the different types of accidents that occurred in cargo operations and in passenger operations. The identification of accident types was based on information listed for each accident in the sample of 606 accidents from the ADREP database.

The results of this comparison are shown in Figure 9 (page 10). Of the 107 accidents that occurred in cargo operations, 28 accidents (26 percent) involved collisions with the ground. Of the 499 accidents that occurred in passenger operations, 130 accidents (26 percent) involved collisions with the ground. Nearly equal distributions also are shown for several other frequent accident types, including engine failure, loss of control, runway undershoot, fire/explosion, landing-gear failure and hard landing.

The higher frequency of accidents involving criminal acts in passenger operations most likely is because these events are intended by their perpetrators to have the highest-possible impact on society. Military-intervention accidents might occur more frequently during cargo operations because cargo operations are conducted more often than passenger operations in regions with high military activity (e.g., for weapons delivery or humanitarian purposes). Most accidents in the cargo-related category were caused by weight-and-balance problems (e.g., improper loading or cargo shifting in flight).

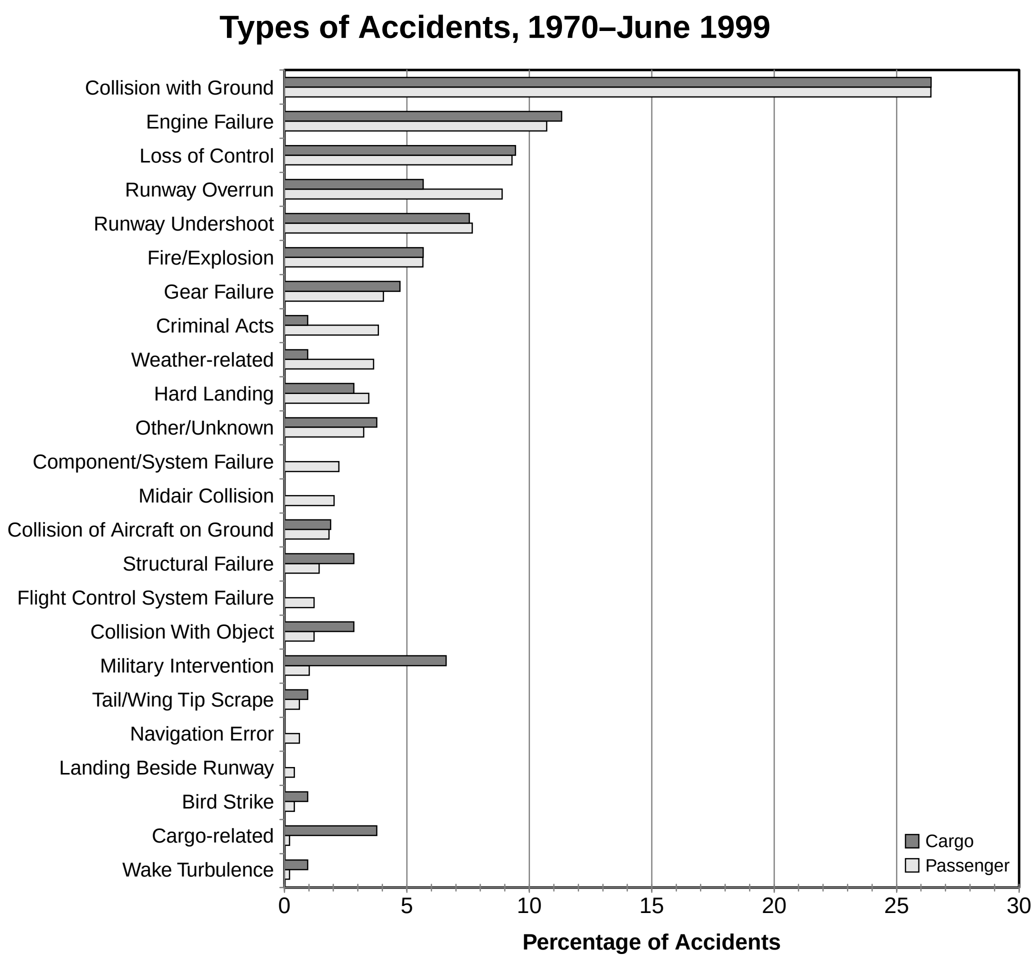
The absence of major differences in the distribution of accident types between cargo operations and passenger operations indicates that the higher accident rate in cargo operations



Note: The data include Western-built jet aircraft (excluding business jets) and turboprop aircraft with maximum takeoff weights of 5,700 kilograms/12,500 pounds or more.

Source: National Aerospace Laboratory (NLR)–Netherlands

Figure 8



Note: The data include Western-built jet aircraft (excluding business jets) and turboprop aircraft with maximum takeoff weights of 5,700 kilograms/12,500 pounds or more.

Source: National Aerospace Laboratory (NLR)–Netherlands

Figure 9

cannot be attributed to a single cause. The previous study[8] concluded that the five most frequent causal factors of fatal accidents are the same for cargo operations and for passenger operations. These causal factors — all attributed to crew — are the following:

- Flight handling;
- Inappropriate action;
- Lack of positional awareness;
- Inadequate professional judgment; and,
- Slow/low on approach.

Accident Flight Phase

Figure 10 shows the flight phases in which the accidents occurred during cargo operations and passenger operations.

The six flight phases used in this study were adapted from the 22 ADREP flight-phase classifications as follows:

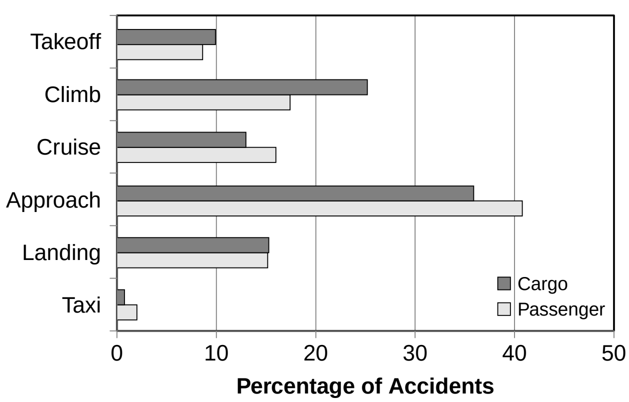
- Takeoff — aborted takeoff, takeoff, takeoff run;
- Climb — initial climb, climb to cruise;
- Cruise — change of cruise level, cruise, en route;
- Approach — approach, approach/holding, base leg, uncontrolled descent, final approach, intermediate approach, missed approach/go-around, normal descent;
- Landing — landing, touchdown, landing roll, level-off/touchdown; and,
- Taxi — taxiing/pushback/tow, taxi to runway/taxi from runway.

Figure 10 shows that relatively more accidents during takeoff and climb occurred in cargo operations than in passenger operations. Relatively fewer accidents during cruise and approach occurred in cargo operations than in passenger operations. The percentage of landing accidents was nearly the same for cargo operations and passenger operations.

Aircraft Generation

Figure 11 shows accidents rates involving three generations of aircraft used in cargo operations and in passenger operations.

Flight Phase in Which Accidents Occurred, 1970–June 1999

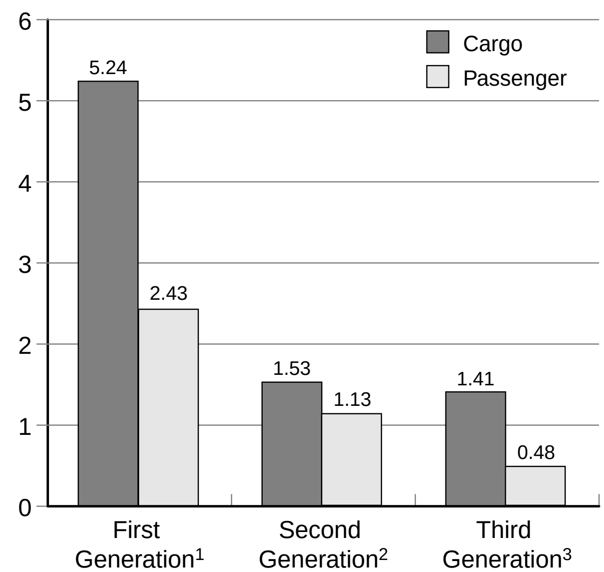


Note: The data include Western-built jet aircraft (excluding business jets) and turboprop aircraft with maximum takeoff weights of 5,700 kilograms/12,500 pounds or more.

Source: National Aerospace Laboratory (NLR)–Netherlands

Figure 10

Accident Rates by Aircraft Generation, 1970–June 1999



Note: The data include Western-built jet aircraft (excluding business jets) and turboprop aircraft with maximum takeoff weights of 5,700 kilograms/12,500 pounds or more.

[1]First-generation aircraft typically were designed in the 1950s and certified before 1965. Flight decks were characterized by limited automation and relatively simple equipment for navigation and instrument approaches.

[2]Second-generation aircraft were designed in the 1960s and 1970s and certified between 1965 and 1980. Flight decks were characterized by more advanced autopilots, autothrottles, flight directors and navigational equipment.

[3]Third-generation aircraft, designed in the 1980s and 1990s, include electronic flight instrument systems and improved autopilots, and some types have fly-by-wire systems.

Source: National Aerospace Laboratory (NLR)–Netherlands

Figure 11

For the purpose of this study, the aircraft generations were defined as follows:

- First-generation aircraft typically were designed in the 1950s. Most of the aircraft were certified before 1965. The aircraft have limited flight deck automation and relatively simple equipment for navigation and instrument approaches. Examples are the Boeing 707 and Fokker F-27;

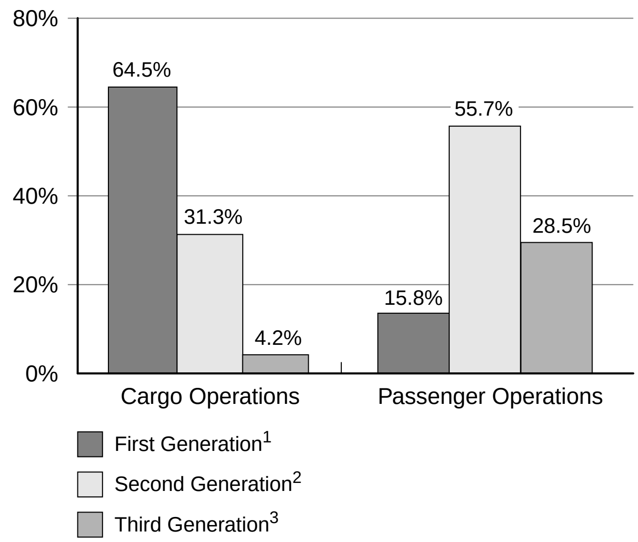
- Second-generation aircraft typically were designed in the 1960s and 1970s, and certified between 1965 and 1980. The aircraft have more reliable engines and more advanced equipment and systems than first-generation aircraft. Examples are the Airbus A300, Boeing 737-200 and Fokker F-28; and,

- Third-generation aircraft, designed and certified in the 1980s and 1990s, typically have electronic flight instrument systems and advanced flight management systems. Examples are the Airbus A320, Boeing 737-700 and Fokker 50.

Figure 11 shows that the accident rate for cargo operations conducted in first-generation aircraft was more than twice as high as the accident rate for passenger operations conducted in first-generation aircraft. The accident rate for cargo operations in second-generation aircraft was significantly lower than the accident rate for cargo operations in first-generation aircraft and was much closer to the accident rate for passenger operations in second-generation aircraft. Although the accident rate for passenger operations in third-generation aircraft was much lower than the accident rate for passenger operations in second-generation aircraft, the accident rate for cargo operations decreased only slightly. (The accident rate for cargo operations in third-generation aircraft is based on a very small number of accidents, however, and is not reliable statistically.)

As shown in Figure 3, the average age of Western-built cargo aircraft is higher than the average age of Western-built passenger aircraft. This indicates that a larger portion of the cargo fleet is composed of older-generation aircraft. To test this assumption, the percentages of flights conducted in aircraft of each generation were calculated. The results are shown in Figure 12.

Flights by Aircraft Generation, 1970–June 1999



Note: The data include Western-built jet aircraft (excluding business jets) and turboprop aircraft with maximum takeoff weights of 5,700 kilograms/12,500 pounds or more.

[1]First-generation aircraft typically were designed in the 1950s and certified before 1965. Flight decks were characterized by limited automation and relatively simple equipment for navigation and instrument approaches.

[2]Second-generation aircraft were designed in the 1960s and 1970s and certified between 1965 and 1980. Flight decks were characterized by more advanced autopilots, autothrottles, flight directors and navigational equipment.

[3]Third-generation aircraft, designed in the 1980s and 1990s, include electronic flight instrument systems and improved autopilots, and some types have fly-by-wire systems.

Source: National Aerospace Laboratory (NLR)–Netherlands

Figure 12

While more than half of all passenger flights were conducted with second-generation aircraft and almost a third with third-generation aircraft, the majority of cargo flights were conducted with first-generation aircraft.

SAFA Inspections

The SAFA program began in the Netherlands at the end of 1997. In 1997 and in 1998, a total of 273 SAFA inspections were performed on aircraft operated by 83 of the 85 foreign operators that conducted scheduled services in the Netherlands and 26 of the 98 foreign operators that conducted unscheduled services in the Netherlands.

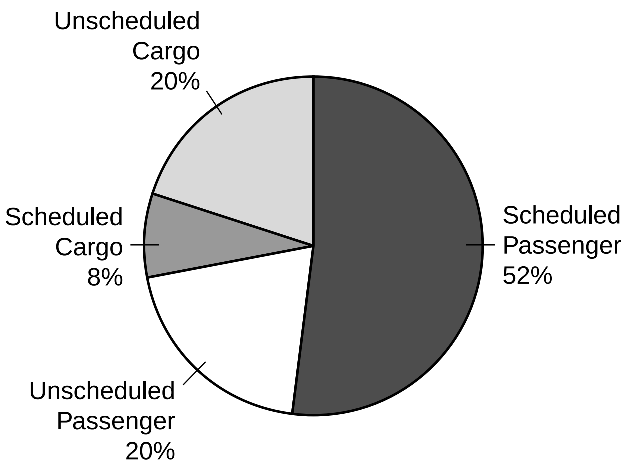
SAFA inspections performed in the Netherlands in 1999 focused on operators that were found during previous inspections to have deviated significantly from ICAO standards. A total of 162 inspections of aircraft operated by 98 foreign operators were conducted in 1999.

Figure 13 (page 13) shows the percentages of SAFA inspections conducted in 1999 on aircraft operated by unscheduled (ad-hoc) cargo operators, scheduled cargo operators, unscheduled passenger operators and scheduled passenger operators.

Inspection Findings

SAFA inspections include checks for compliance with ICAO Annex 1 (*Personnel Licensing*), Annex 6 (*Operation*

SAFA Inspections of Aircraft Operators in the Netherlands by Type of Operation, 1999

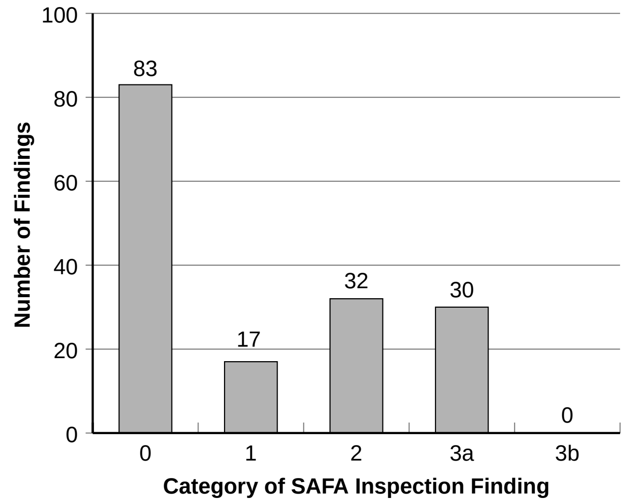


SAFA = The European Joint Aviation Authorities Safety Assessment of Foreign Aircraft program.

Source: National Aerospace Laboratory (NLR)–Netherlands

Figure 13

Findings of SAFA Inspections Conducted in the Netherlands, 1999



SAFA = The European Joint Aviation Authorities Safety Assessment of Foreign Aircraft program.

Category 0 = No deviations from International Civil Aviation Organization (ICAO) standards.

Category 1 = Deviations from ICAO standards but no immediate safety concern.

Category 2 = Major deviations from ICAO standards and corrective action required but no direct safety concern.

Category 3a = Major deviations from ICAO standards and corrective action required before flight because of safety concern.

Category 3b = Major deviations from ICAO standards and corrective action required before flight; action not accepted by the flight crew and therefore enforced by the SAFA team.

Source: National Aerospace Laboratory (NLR)–Netherlands

Figure 14

of Aircraft) and Annex 8 (*Airworthiness of Aircraft*). The inspection findings are categorized as follows:

- Category 0 — No deviations from ICAO standards were found;
- Category 1 — Deviations from ICAO standards were found; no immediate safety concern;
- Category 2 — Major deviations from ICAO standards were found; corrective action was required; no direct safety concern;
- Category 3a — Major deviations from ICAO standards were found; corrective action was required before flight because of safety concern; and,
- Category 3b — Major deviations from ICAO standards were found; corrective action was required before flight; corrective action was not accepted by flight crew, therefore enforced by SAFA team.

Figure 14 shows the findings of the 162 SAFA inspections performed in the Netherlands in 1999. Because of the focus on operators that had serious findings in previous inspections, the number of category 3a findings (18.5 percent of all inspections) was relatively high.

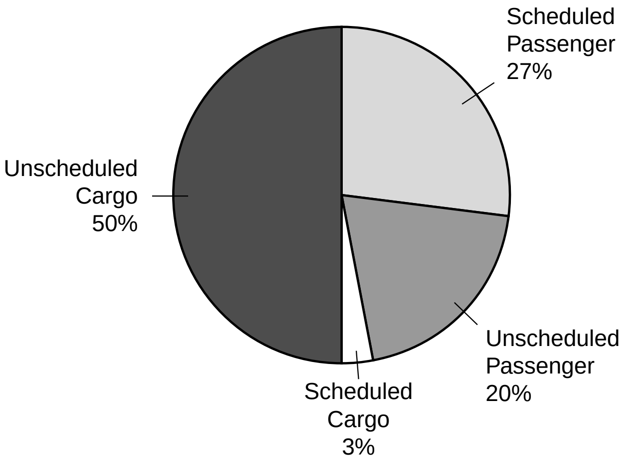
Figure 15 (page 14) shows the distribution of category 3a findings among the various operators. Fifty percent of the category 3a findings resulted from inspections of aircraft operated by ad-hoc cargo operators.

Ad-hoc Cargo Operator Inspection Findings

Typical deviations observed during SAFA inspections of aircraft operated by ad-hoc cargo operators in the Netherlands were the following:

- Flight deck — improper flight preparation (e.g., weight-and-balance calculations, fuel calculations); absence of safety equipment (e.g., shoulder harnesses); pilot license not available or expired; navigation maps out of date or not available;
- Cabin — insufficient oxygen supply for passengers; baggage not properly stowed; dangerous goods in cabin; insufficient numbers of seats for passengers aboard; no (spare) seat belts or no seat belt extensions; seats blocking access to emergency exits; and,

SAFA Inspection Category 3a Findings in the Netherlands by Type of Operation, 1999



SAFA = The European Joint Aviation Authorities Safety Assessment of Foreign Aircraft program.

Category 3a = Major deviations from International Civil Aviation Organization standards and corrective action required before flight because of safety concern.

Source: National Aerospace Laboratory (NLR)–Netherlands

Figure 15

- Airframe — structural damage; no proper repair of fuselage dents/scratches.

The majority of these findings were observed on aircraft of Russian design and operated by Eastern European states and former CIS states.

Summary

The major findings of the study were as follows:

- More than half of all cargo movements take place at night, while only a fifth of all passenger operations take place at night;
- There is an increased risk associated with cargo flights conducted at night, compared with cargo flights conducted during the day. This association could not be found for passenger operations;
- Over the past 18 years, the average age of Western-built cargo aircraft has been increasing steadily from 14 years to 22 years, whereas the average age of Western-built passenger aircraft has remained constant at approximately 10 years;
- The accident rate for ad-hoc cargo operations is almost seven times higher than the accident rate for scheduled passenger operations conducted by major operators;
- The accident rate for cargo operations conducted by major operators is more than three times higher than the accident rate for passenger operations conducted by major operators;
- The accident rate for unscheduled passenger operations is almost three times higher than the accident rate for scheduled passenger operations;
- Africa, Asia and Central America/South America have the highest accidents rates for cargo operations;
- The difference in the level of safety between cargo operations and passenger operations is most noteworthy in Africa, Central America/South America and North America;
- In Africa, Asia and Central America/South America, there is no significant difference in the accident rates for major operators and for ad-hoc operators. In North America, however, the accident rate for ad-hoc cargo operators is more than two times higher than the accident rate for major cargo operators;
- In Africa, the accident rate for cargo operations conducted by state-owned airlines is two times higher than the accident rate for cargo operations conducted by privately owned airlines. There is no difference between the accident rate for passenger operations by state-owned airlines and the accident rate for passenger operations by privately owned airlines;
- When the types of accidents that occurred in cargo operations and in passenger operations are compared, there are no significant differences in the relative distribution. This indicates that the higher accident rate for cargo operations cannot be attributed to a single cause;
- Compared with accidents in passenger operations, accidents in cargo operations occur more frequently in the takeoff phase and the climb phase;
- Both cargo aircraft and passenger aircraft have lower accident rates for aircraft of a newer generation;
- The majority of cargo flights in the past three decades were conducted with first-generation aircraft; the majority of passenger flights in the past three decades were conducted with second-generation aircraft;
- Results of SAFA inspections conducted in the Netherlands indicate that ad-hoc cargo operators more often are noncompliant with ICAO standards than other operators; and,

- The main cause for the higher accident rates among cargo operators in regions with the lowest economic performance is lack of financial resources.

Recommendations

Based on these findings, the study resulted in the following recommendations:

- Airlines should adopt a "safety first" attitude toward cargo operations;
- Cargo operators should know the potential problems associated with night flying and minimize the negative effects of night flying;
- The operation of older aircraft does not, in itself, compromise safety if adequate maintenance and adequate inspection are performed. Identification of required maintenance procedures and required inspection procedures is the combined responsibility of regulators, operators and manufacturers; these organizations should cooperate in the continued analysis of problems affecting aging aircraft;
- The civil aviation authorities in regions with the lowest economic performance should be supported in their efforts to become strong and effective; and,
- Although grounding of aircraft by civil aviation authorities is necessary if an immediate safety concern exists, grounding of aircraft does not solve problems. The prime instrument for safety improvement should be support.♦

[FSF editorial note: To ensure wider distribution in the interest of aviation safety, this report has been adapted from the National Aerospace Laboratory (NLR)–Netherlands' *An analysis of the safety performance of air cargo operators*, NLR-TP-2000-210, March 2000. Some editorial changes were made by FSF staff for clarity and for style. A.L.C. Roelen and A.J. Pikaar are NLR research scientists. W. Ovaa is national SAFA (Safety Assessment of Foreign Aircraft program) coordinator for the Netherlands Directorate General of Civil Aviation. Albertine Verweij and Hans Knuvers (Air Transport Association, Netherlands), Robert Baltus (Schreiner Airways), Jos van der Woensel (Zygene European Freight Consult) and Adrian Sayce (U.K. Civil Aviation Authority) contributed to the research and preparation of the NLR report.]

Notes and References

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2. U.S. National Transportation Safety Board (NTSB). *Aircraft Accident Report: Uncontrolled Impact With Terrain, Fine Airlines Flight 101, Douglas DC-8-61, N27UA, Miami, Florida, August 7, 1997*. NTSB/AAR-98/02, June 1998. The aircraft struck terrain during takeoff, killing the three flight crewmembers, a security guard aboard the aircraft and one person on the ground. NTSB said that the accident "resulted from the airplane being misloaded to produce a more aft center of gravity and a correspondingly incorrect stabilizer trim setting that precipitated an extreme pitch-up at rotation." NTSB said that the probable causes of the accident were "the failure of Fine Air to exercise operational control over the cargo loading process and the failure of Aeromar [a freight-forwarding company] to load the airplane as specified by Fine Air."

3. U.K. Civil Aviation Authority. *Global Fatal Accident Review 1980–1996*. Civil Aviation Publication (CAP) 681, March 1998.

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5. Kingsley-Jones, M.; Sheppard, I. "Aging Airliner Census, 1997," *Flight International* Volume 152 (July 9–15, 1997).

6. A *hull-loss accident* is defined as an accident involving damage to a commercial airplane that is substantial and beyond economic repair, an airplane that remains missing after search for wreckage has been terminated or an airplane that is substantially damaged and inaccessible.

7. The definitions of the regions and the countries in each region were derived from U.K. Civil Aviation Authority CAP 681.

8. Roelen et al.

Further Reading from FSF Publications

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FSF Editorial Staff. "Improper Loading of Cargo Causes Loss of Aircraft Control on Approach." *Accident Prevention* Volume 57 (May 2000).

FSF Editorial Staff. "NTSB Recommends Changes in MD-11 Cargo Control Units." *Aviation Mechanics Bulletin* Volume 48 (January–February 2000): 6–7.

FSF Editorial Staff. “Cargo Airplane Strikes Building During Rejected Takeoff.” *Accident Prevention* Volume 57 (January 2000).

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FSF Editorial Staff. “Misloaded Douglas DC-8 Pitches Up Excessively on Takeoff, Then Stalls and Strikes the Ground.” *Accident Prevention* Volume 55 (September 1998).

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Sarkos, Constantine P. “FAA Proposes New Rules on Cargo Compartment Fire Detection and Suppression.” *Cabin Crew Safety* Volume 31 (November–December 1996).

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Chipkevich, Robert J. “Safeguarding Against Hazardous Cargo Presents a Variety of Challenges.” *Airport Operations* Volume 20 (November–December 1994).

Lawton, Russell. “Steep Turn by Captain During Approach Results in Stall and Crash of DC-8 Freighter.” *Accident Prevention* Volume 51 (October 1994).

FSF Editorial Staff. “Sudden Aileron Lock Sends Cargo Turboprop Plummeting to the Ground.” *Accident Prevention* Volume 49 (August 1992).

Appendix
Aircraft Types Included in Study Sample

Manufacturer	Model(s)
Airbus	A300, A300-600, A310, A319, A320, A321, A330, A340
Aerospatiale	Caravelle, Corvette, Nord 262
Aerospatiale/BAe	Concorde
ATR	ATR 42, ATR 72
BAe	146, ATP, J-31, J-41, 1-11, 748, Vanguard, Viscount, VC-10
Beech	1900
Boeing	707, 720, 727, 737, 747, 757, 767, 777
Bombardier	DHC-7, DHC-8
CASA	C-212, CN-235
Convair	CV-580, CV-600, CV-640
Dassault	Mercure
Douglas/MDD	DC-8, DC-9, DC-10, MD-80, MD-90, MD-11
Dornier	228, 328
Embraer	Brasilia
Fairchild	Metro, F27
Fokker	F27, F28, F50, F100
Grumman	Gulfstream 1
Handley Page	Herald
IPTN	NC-212, NC-235
Lockheed	L-1011, L-188, C-130
NAMC	YS-11
Saab	340, 2000
Shorts	330, 360

ATR = Avions de Transport Regional, BAe = British Aerospace, CASA = Construcciones Aeronauticas SA, IPTN = Industri Pesawat Terban Nusantara (Nusantara Aircraft Industries), MDD = McDonnell Douglas, NAMC = Nanchang Aircraft Manufacturing Co.

Five Accidents on Takeoff and Initial Climb In 2000 Involved Western-built Large Commercial Jets

Boeing data also show that, during the decade that ended in 2000, 17 percent of all accidents involving Western-built large commercial jets — and 16 percent of fatalities — occurred during takeoff and initial climb.

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Data compiled by The Boeing Co. show that five airplanes in the worldwide fleet of Western-built large commercial jets were involved in accidents during takeoff and initial climb (before the airplane's flaps were retracted) in 2000 (Table 1, page 18). Three other accidents occurred in the climb phase (after flaps were retracted).

The Boeing data include Western-built commercial jet airplanes with maximum gross weights of more than 60,000 pounds/27,000 kilograms. The data exclude airplanes manufactured in the Commonwealth of Independent States because of a lack of operational data. Commercial airplanes in military service also are excluded.

Three of the five accidents that occurred during takeoff and initial climb were classified as "hull loss" accidents, which Boeing defines as accidents that involve damage to an airplane that is substantial and beyond economic repair. Boeing also classifies an accident as a hull loss if the airplane is missing, if the wreckage has not been found and the search has been terminated, or if the airplane is substantially damaged and is inaccessible. Four of the five accidents involved fatalities.

Figure 1 (page 18) shows that from 1991 through 2000, 17 percent of all accidents — and 16 percent of fatalities — occurred during takeoff and initial climb.

Data show that, during the same 10-year period, 10 percent of all accidents — and 26 percent of fatalities — occurred in the climb phase.

Figure 2 (page 18) shows that, from 1991 through 2000, 41 hull loss accidents and/or fatal accidents occurred during takeoff and initial climb. Those accidents resulted in 1,121 fatalities. Twenty-three hull loss accidents and/or fatal accidents occurred during the climb phase; those accidents resulted in 1,855 fatalities.♦

Table 1
Accidents During Takeoff and Climb

Western-built Large Commercial Jet Airplanes[1]
2000

Date	Airline	Airplane Type	Accident Location	Hull Loss	Fatalities	Phase	Description
Jan. 30, 2000	Kenya Airways	Airbus A310	Abidjan, Ivory Coast	X	169	Climb[2]	Struck terrain (ocean)
Feb. 16, 2000	Emery Worldwide	McDonnell-Douglas DC-8-81	Sacramento, California, U.S.	X	3	Initial Climb[3]	Struck terrain after cargo shifted aft
May 25, 2000	Air Liberia	McDonnell-Douglas MD-80-83	Paris, France		1	Takeoff	Runway collision with Shorts 330
June 7, 2000	Varig Airlines	Boeing 767-200	São Paulo, Brazil		0	Takeoff	Rejected takeoff — engine fire
July 25, 2000	Air France	British Aerospace/ Aerospatiale Concorde	Paris, France	X	113	Initial climb	Struck terrain after takeoff
Aug. 8, 2000	Airtran Airlines	McDonnell-Douglas DC-9-32	Greensboro, North Carolina, U.S.		0	Climb	Bulkhead electrical fire
Oct. 31, 2000	Singapore Airlines	Boeing 747-400	Taipei, Taiwan	X	85	Takeoff	Takeoff on closed runway
Nov. 24, 2000	Airtran Airlines	McDonnell-Douglas DC-9-32	Atlanta, Georgia, U.S.		0	Climb	Fire in forward cargo compartment

[1]Heavier than 60,000 pounds/27,000 kilograms maximum gross weight; excludes airplanes manufactured in the Commonwealth of Independent States and commercial airplanes in military service.

[2]After flap retraction.

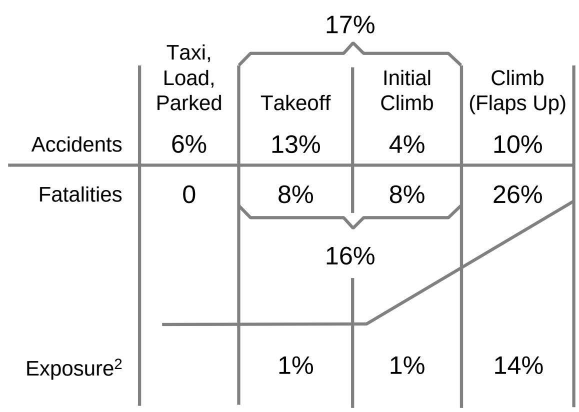
[3]Before flap retraction.

Source: The Boeing Co.

Accidents and On-board Fatalities By Phase of Flight

Western-built Large Commercial Jet Airplanes[1]
1991–2000

Percentage of Accidents/Fatalities



[1]Heavier than 60,000 pounds/27,000 kilograms maximum gross weight; excludes airplanes manufactured in the Commonwealth of Independent States and commercial airplanes in military service.

[2]Exposure = Percentage of flight time based on flight duration of 1.5 hours.

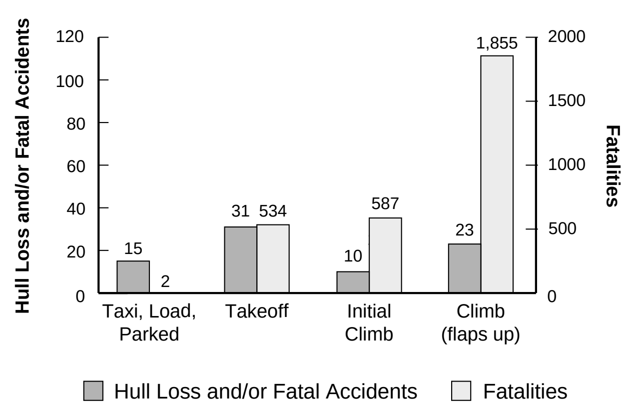
Source: The Boeing Co.

Figure 1

Hull Loss and/or Fatal Accidents

Western-built Large Commercial Jet Airplanes*
1991–2000

Distribution of Accidents and Fatalities



*Heavier than 60,000 pounds/27,000 kilograms maximum gross weight; excludes airplanes manufactured in the Commonwealth of Independent States and commercial airplanes in military service.

Source: The Boeing Co.

Figure 2

Publications Received at FSF Jerry Lederer Aviation Safety Library

U.K. CAA Document Provides Information on Developing Safety Management Systems

Guidance from the regulatory authority and the civil aviation industry includes recommendations for civil aviation transport operations and maintenance activities.

—

FSF Library Staff

Reports

Safety Management Systems for Commercial Air Transport Operations: A Guide to Implementation. U.K. Civil Aviation Authority (CAA) Safety Regulation Group (SRG), Air Transport Operations — Safety Management Group. May 2001. Civil Aviation Publication (CAP) 712. 43 pp. Tables, appendixes.

The U.K. CAA SRG and operating sectors and maintenance sectors of the U.K. civil aviation industry comprise a working group called the Air Transport Operations — Safety Management Group (ATO-SMG). The group is responsible for developing guidance material for commercial air transport operators and maintenance organizations to use in establishing effective, comprehensive systems for managing safety within their own operations.

This guidance document answers three questions: What is a safety management system (SMS), what is it expected to achieve, and how is it implemented and maintained? The document defines safety management as "the systematic management of the risks associated with flight operations, related ground operations and aircraft engineering or maintenance activities to achieve high levels of safety performance." An SMS is defined as "an explicit element of the corporate management responsibility which sets out a company's safety policy and defines how it intends to manage safety as an integral part of its overall business."

FAA Aerospace Forecasts — Fiscal Years 2001–2012. U.S. Department of Transportation, Federal Aviation Administration (FAA) Office of Aviation Policy and Plans, Statistics and Forecast Branch. FAA APO-01-1. March 2001. 296 pp. Figures, tables. Available through NTIS.*

The FAA Statistics and Forecast Branch develops annual forecasts of aviation activity for the agency's use in planning and decision making. The report covers four major areas of aviation activity:

- U.S. and world economic environment, assumptions and predictions used in developing this forecast;
- Historical data and detailed forecasts of future aviation demand and aircraft activity for major nonmilitary user groups — large commercial air carriers, regional airlines and commuter airlines, general aviation and helicopter operators;
- Workload measures for FAA air traffic control towers and contracted air traffic control towers, en route centers and flight service stations; and,
- Outlook for commercial space transportation.

FAA said that the outlook for its 12-year forecast period is for moderate economic growth and inflation and declining fuel prices. Based on these assumptions, aviation activity is forecast to increase by 33.2 percent at towered airports and by 34.0 percent at en route traffic control centers. U.S. scheduled domestic passenger enplanements are expected to increase 53.8 percent. International passenger traffic between the United States and other countries is projected to increase 91.8 percent.

Assessment of Compatibility between Ultrawideband (UWB) Systems and Global Positioning Systems (GPS) Receivers. U.S. Department of Commerce, National Telecommunications and Information Administration (NTIA). Anderson, David S.; Drocella, Edward F.; Jones, Steven K.; Settle, Mark A. NTIA Special Publication 01-45. February 2001. 150 pp. Figures, tables, appendixes. Available through NTIS* and on the Internet at http://www.ntia.doc.gov/osmhome/reports.html.

NTIA is the U.S. government agency responsible for developing domestic telecommunications policy and U.S. policy on international telecommunications. NTIA is responsible for managing U.S. government use of the radio frequency spectrum and making recommendations to the U.S. Federal Communications Commission (FCC), which manages use of the radio frequency spectrum by those outside the federal government.

NTIA, FCC, the U.S. Federal Aviation Administration and other interested organizations have conducted studies to determine the effect of ultrawideband (UWB) transmission systems upon other parts of the radio spectrum. Of particular concern is the global positioning system (GPS), a satellite-based system that uses radio operating frequencies in restricted bands for aviation navigation, marine navigation and land navigation. Two aviation navigation applications being implemented are the wide area augmentation system (WAAS) and the local area augmentation system (LAAS).

The report said that GPS "will become the cornerstone of air navigation for all phases of flight (en route, precision [approach] and nonprecision approach)."

The objective of this technical study was to define the maximum allowable UWB levels that can be tolerated by GPS receivers, as they are used in various operational applications, without causing performance degradation of GPS receivers. The researchers found scenarios in which UWB could interfere or did interfere with GPS.

Measurements to Determine Potential Interference to GPS Receivers from Ultrawideband Transmission Systems. U.S. Department of Commerce, National Telecommunications and Information Administration (NTIA), Institute for Telecommunication Sciences. Hoffman, J. Randy; Cotton, Michael G.; Achatz, Robert J.; Statz, Richard N.; Dalke, Roger A. NTIA Report 01-384. February 2001. 218 pp. Figures, tables, appendixes. Available through NTIS* and on the Internet at http://www.its.bldrdoc.gov/pub/pubs.html.

The report says that use of new wireless technologies presents an inevitable conflict in radio frequency spectrum use and system compatibilities. Two such technologies are the global positioning system (GPS) and ultrawideband (UWB) transmission systems.

The GPS system consists of 24 satellites that transmit position codes and time codes around the world. UWB signals consist of short pulses that vary in timing and position across a wide bandwidth. One example of UWB technology is wireless communication.

Various organizations have conducted studies to determine the effect of UWB transmission systems on other parts of the radio spectrum. The Institute for Telecommunication Sciences (ITS), the research and engineering branch of NTIA, U.S. Department of Commerce, recently investigated the general characteristics of UWB. ITS also measured interference from UWB signals to GPS receivers. This technical report describes laboratory measurements of GPS receiver vulnerability to UWB interference.

Advisory Circulars

Announcement of Availability: FAA-S-8081-9B, Flight Instructor Instrument Practical Test Standards for Airplane and Helicopter. U.S. Federal Aviation Administration (FAA) Advisory Circular (AC) 61-133. May 9, 2001. 2 pp. Available through Superintendent of Documents.**

This AC announces the availability of test standards and information on obtaining copies of the AC or electronic access to the AC. FAA inspectors and designated pilot examiners conduct practical tests using standards established by FAA. This AC is intended to aid flight instructors and applicants during training and when preparing for the practical tests.

Books

Safety Through Design. Edited by Christensen, Wayne C.; Manuele, Fred A. U.S.: National Safety Council, 1999. 330 pp.

This book discusses the need to design safety into the job from the outset rather than to try to incorporate the elements of safety later. The book comprises 19 chapters by contributing authors with diverse backgrounds, including aviation and aerospace. For example, John M. Thaler, manager of occupational safety and industrial hygiene for Sikorsky Aircraft, writes about the use of safety through design techniques to improve employee health, safety and productivity. The book is written for engineers, managers and safety, health and environmental practitioners, and presents divergent viewpoints, insights into the concept and examples for integration and application in existing operations.♦

Sources

* National Technical Information Service (NTIS)
5285 Port Royal Road
Springfield, VA 22161 U.S.
Internet: http://www.ntis.org

** New Orders
Superintendent of Documents
P.O. Box 371954
Pittsburgh, PA 152-50-7954

Accident/Incident Briefs

Landing Gear Separates From Fuselage After Touchdown

The flight crew of the Fokker 100 said that the separation occurred after a stable approach and a normal touchdown.

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The following information provides an awareness of problems through which such occurrences may be prevented in the future. Accident/incident briefs are based on preliminary information from government agencies, aviation organizations, press information and other sources. This information may not be entirely accurate.

Crew Used Rudder to Maintain Directional Control

Fokker 100. Minor damage. No injuries.

Visual meteorological conditions prevailed for the approach and landing at an airport in the United States. The approach was flown visually, and the flight crew said that the approach was "stable, and the touchdown was normal."

After touchdown, however, the flight crew heard a bang.

The preliminary accident report said, "The right wing went down, and the aircraft started to move to the right."

The flight crew used the rudder to maintain directional control of the airplane, and they stopped the airplane on the runway. The passengers deplaned using mobile stairs.

An initial investigation showed that the lower portion of the right-main landing gear had separated from the airplane. The inner piston — along with the scissor and wheel assembly — and pieces of the outer case of the gear-strut assembly were found on the runway.

MEL Revised After Depressurization Incident

Airbus A320. No damage. No injuries.

The airplane was in cruise flight at Flight Level (FL) 370 (37,000 feet) during a domestic flight in Australia when the flight crew observed that the left-engine bleed-air fault-warning light had illuminated. The pressurization system and the air-conditioning system automatically shut down, and cabin pressure altitude began increasing at about 700 feet per minute.

The flight crew tried unsuccessfully to reselect the left-engine bleed air to the "ON" position, started the auxiliary power unit (APU) and contacted air traffic control to request an emergency descent to 10,000 feet. As the airplane reached FL 200 during the descent, the pressurization system and the air-conditioning system were restored using the APU bleed-air supply. The flight crew leveled the airplane at FL 180 and continued to the destination airport for a normal landing.

When the flight began, the airplane was operating with a minimum equipment list (MEL) restriction because of the failure of the right-engine high-pressure valve (HPV). The restriction required that the right-engine bleed-air HPV be locked in the closed position. The engine HPV normally is opened to supplement the bleed-air supply during periods of low engine speed; at higher speeds, the bleed-air system was supplied with enough air without using the HPV.

The operator's MEL (which differed in wording from the manufacturer's master MEL) said:

(1) At low engine power (around idle thrust) setting:

(a) Associated bleed is selected "OFF."

(b) Cross-bleed valve is selected open.

(c) If wing anti-ice is required, one pack is selected "OFF."

The incident report said, "The crew interpreted the operator's MEL to mean that, at engine 'idle thrust,' they were to turn the bleed air from that engine to 'OFF.' That prevented any supply of bleed air for the pressurization [system] and air-conditioning system coming from that engine. They then opened the bleed-air cross-bleed valve and operated both air-conditioning packs from the right engine only.

"The aircraft then flew with a usable bleed-air system isolated. Therefore, when the left-engine bleed-air system failed, there was a loss of pressurization and air conditioning."

After the incident, the operator revised the MEL "to reflect the intention of the manufacturer's [master] MEL" and to "reduce the possibility of incorrect system operation with one HP bleed source inoperative," the report said.

Cabin 'Smoke' Prompts Order to Deplane Passengers

De Havilland Dash 8. No damage. No injuries.

The flight crew was about to start the no. 2 engine in preparation for departure from an airport in Canada when a cabin crewmember told the captain that there was smoke in the cabin. The flight crew abandoned the engine-start procedure and called the aircraft rescue and fire fighting service. Passengers were deplaned.

The incident report said that maintenance personnel discovered that the "source of the 'smoke' was likely steam rising from a wet carpet that was exposed to bright sunlight through the passenger-cabin window."

Four Tires Fail During Landing on Wet Runway

Learjet 35A. Minor damage. No injuries.

The airplane was landed at an airport in South Africa after a late-afternoon heavy rain. After touchdown, the airplane hydroplaned on the wet runway, and all four main-wheel tires failed. The flight crew stopped the airplane on the runway.

A post-landing inspection revealed flat spots and deflation of all four tires. There was no indication of overheating or damage to the brake assemblies, the accident report said. Maintenance personnel said that the anti-skid system probably was not turned off.

The accident report said that the probable cause of the accident was hydroplaning after touchdown.

Airplane Stops on Access Road After Landing Overrun

Hawker Siddeley HS 125-3A. Substantial damage. No injuries.

Instrument meteorological conditions prevailed for the afternoon instrument landing system (ILS) approach to an airport in the United States.

The airplane was flown out of overcast clouds about 400 feet above ground level. The runway appeared to be dry, with blowing snow, and the two pilots — the only people in the airplane — continued the approach. The accident report said that, after touchdown, "dump flaps" and emergency brakes failed to slow the airplane, and the first officer applied the parking brake. The airplane continued off the departure end of the runway, struck a fence and stopped, with part of the airplane on a public access road.

An air traffic controller said that the airplane was landed at "a high rate of speed."

The pilot of a Piper PA-31 who had flown the same approach ahead of the accident airplane described braking action as "good," although there was slush and snow on the runway. An airport operations officer who conducted a braking-action test on the runway after the accident, driving a vehicle at 40 miles per hour (64 kilometers per hour), said that braking action was "good," with patches of slush between 0.13 inch (3.30 millimeters) and 0.25 inch (6.35 millimeters) thick.

An examination of the airplane showed that the emergency brake lever on the flight deck was in the release position and that the accumulator pressure was full-scale high.

"When the emergency brake was selected, a 'squishing sound' was heard, and the brake pads of the left [-main landing gear] and right-main landing gear were observed to move. The emergency brake was then released. The brake pedals on the left [side] and right side of the cockpit were applied individually. Each time pressure was applied to a brake pedal, a ‘squishing sound’ was heard, and the brake pads of the respective main landing gear were observed to move.”

A notice to airmen (NOTAM) had been issued about two hours before the accident for “thin wet snow all surfaces.” There were no subsequent NOTAMs that discussed runway surface operations.

Airplane Strikes Terrain During Night Approach for Landing

Cessna 310. Airplane destroyed. Four fatalities.

Night visual meteorological conditions prevailed for the landing at an airport in Australia. Police officers on the ground said that there was no apparent obstruction to visibility but that the night was “very dark,” with the moon obscured by clouds. Thunderstorms had been observed north of the airport, but no storms were reported along the airplane’s inbound path.

The accident report said that the police officers observed the airplane northeast of the airport and heard the engines “cough and sputter.”

“They saw the red and green navigation lights on the aircraft’s wings start to alternate as the aircraft appeared to rotate, descending vertically towards the ground,” the report said. “For the last part of the descent, there was no apparent noise from the engines. The sound of an impact was heard a short time after the aircraft had disappeared from view.”

An investigation showed that the airplane had struck the ground at a low forward speed in a nose-down attitude while rotating to the left. The accident report said that damage was “consistent with the aircraft being in a spin.”

Other General Aviation

Pilot Conducts Normal Landing Despite Failed Rudder Pedal

Cessna 172M. No damage. No injuries.

The airplane was being flown on a night approach to an airport in Canada when the pilot told air traffic control that the left rudder pedal was stuck. The pilot was given priority for landing and conducted a normal landing.

An inspection found that one of the two rudder-return springs was disconnected from the rudder-control pedal’s aft rudder bar. The spring had been installed on the incorrect side of the rudder-bar lever.

Airplane Veers Off Runway During Crosswind Landing

Cessna 172N. Minor damage. No injuries.

Before his mid-afternoon departure from an airport in England for a local flight, the pilot obtained an area weather forecast that called for visual meteorological conditions and surface winds from 210 degrees at 18 knots.

After takeoff, the pilot heard radio transmissions from pilots who were diverting to another airport because of bad weather. Air traffic control at the departure airport told the pilot that a storm was developing over the airport. The pilot flew to another airport.

During final approach to land at the other airport, the pilot received a report of turbulence from the pilot of the previous landing aircraft, and the pilot observed a “significant” crosswind, the accident report said. The airplane touched down normally, and the pilot closed the throttle. Then the airplane’s right wing dropped, and the airplane veered to the right and onto the grass next to the runway. After the airplane slowed, the pilot taxied the airplane back onto the runway. The pilot later observed that the propeller had been damaged by striking the ground and said that the incident was a result of a strong crosswind gust.

Rotorcraft

Tail Boom Severed During Crosswind Landing

Hughes 369HS. Minor damage. No injuries.

The helicopter was being hover-taxied to a fueling facility at an airport in England. After touchdown, the helicopter rotated left. The accident report said that after one complete revolution, the helicopter “appeared to become airborne briefly,” the rate of turn increased, and the helicopter rotated another half revolution before stopping near the fuel pumps. After shutting down the engines, the pilot observed that the tail boom had been severed.

Surface wind was from 60 degrees at 16 knots, with gusts to 25 knots. The touchdown was on a heading of 170 degrees.

Inspection showed that the tail-rotor flapping stops had been destroyed.

The accident report said, "The combination of low rotor rpm [revolutions per minute] and high yaw-pedal demand could have allowed the tail rotor to flap excessively during the gyration, causing pounding damage to the flapping stops, followed by the blades coming into contact with the tail boom. The normal clearance between the tail-rotor blade tips and the tail boom is about three inches (7.6 centimeters).

"[A maintenance technician] reported that the pilot's initial assessment was that the helicopter began to rotate to the right, so he applied left pedal to prevent this. The video recording of the event showed that the helicopter had rotated to the left. The tendency to rotate left was also exacerbated by the crosswind from the left side."

Faulty Switch Likely in Navigation Discrepancy

Aerospatiale AS 332L Super Puma. No damage. No injuries.

Instrument meteorological conditions prevailed for the flight to an airport in Australia, and the pilot was using the helicopter's global positioning system (GPS) to navigate to the initial approach fix for a very-high-frequency omnidirectional radio/distance measuring equipment (VOR/DME) approach.

After the pilot received clearance for the approach, he switched the navigation source-control switch from "A NAV" (for GPS navigation) to "NAV 2" and "VOR 2" (for the approach).

The incident report said, "Immediately, the navigation 'EMERG MODE' light on the pilot's bearing pointer's control panel illuminated. In accordance with the emergency checklist, the pilot selected his radio navigation sources to [automatic direction finder] 1, 'VOR 2' and 'NAV 2'."

After the helicopter was established on the final approach, the pilot observed that the course bar on the horizontal situation indicator (HSI) was centered but that the "NAV 2" bearing pointer indicated that the helicopter was five degrees to 10 degrees to the right of course.

"The course bar on the copilot's HSI was indicating half-scale left of track, and the copilot's bearing pointer was also showing that the helicopter was to the left of track," the report said.

The helicopter then entered visual meteorological conditions, and the crew discontinued the instrument approach. After the helicopter was landed, the problem was no longer apparent, and maintenance personnel were unable to reproduce the problem on the ground. Maintenance personnel said later that they believed there had been an internal fault in the navigation switching system.

Inadequate Lubrication Cited in Engine Failure

Bell 206B. Substantial damage. No injuries.

The helicopter was being flown from South Africa to Mozambique when the pilot heard a bang, and the helicopter yawed to the left. As the pilot applied right anti-torque pedal to counter the yaw, the engine-out warning light illuminated and the engine-out audio warning sounded.

The accident report said, "With the throttle still at full power, the main-rotor rpm [revolutions per minute] was decreasing, [and] the helicopter was established in autorotational flight."

The pilot decided to land the helicopter in an open area on a riverbank. During the descent, he observed that the power turbine rpm exceeded the main-rotor rpm. The pilot, who recently had completed recurrent training in which a similar scenario was discussed, left the engine running to maintain tail-rotor control for the landing. Nevertheless, the pilot observed that, with the throttle open, the engine gas generator speed (N_g) was at idle (58 percent), the power turbine was at 100 percent and the main-rotor rpm was at 45 percent and decreasing.

During the descent, the pilot also observed that the engine-chip warning light had illuminated.

As the helicopter touched down, a main-rotor blade severed the tail boom and the tail-rotor drive shaft.

The accident report said that the probable cause of the accident was that "the power transferred from the engine by the main drive shaft via the inner coupling to the outer coupling, combined with the relative movement between the two couplings, caused the generation of heat.

"The generation of excessive heat between the outer-[coupling-teeth] and inner-coupling-teeth mating faces is attributed to inadequate lubrication, resulting in seizure of the inner-teeth mating faces and, consequently, fractures of the fixation bolts."♦

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