Civil Aviation Authority

Global Fatal Accident Review

2002 to 2011

CAP 1036

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Contents

Executive Summary

1. This document summarises a study of worldwide fatal accidents to jet and turboprop aeroplanes above 5,700kg engaged in passenger, cargo and ferry/positioning flights for the ten-year period 2002 to 2011. The style and content of the document are similar to the previous Global Fatal Accident review (CAP 776). The main findings of the study are listed below.

Worldwide Fatal Accident Numbers

2. There were a total of 250 worldwide fatal accidents, which resulted in 7,148 fatalities to passengers and crewmembers onboard the aircraft. The proportion of aircraft occupants killed in these fatal accidents was 70%.

3. There was an overall decreasing trend in the number of fatal accidents, however there was much more fluctuation in the number of fatalities per year.

4. The approach, landing and go-around phases accounted for 47% of all fatal accidents and 46% of all onboard fatalities. Take-off and climb accounted for a further 31% of the fatal accidents and 28% of the onboard fatalities.

Worldwide Aircraft Utilisation

5. In the ten-year period 2002 to 2011, the number of flights flown increased by 22%, which equates to an average annual growth of 1.9%. The equivalent values for hours flown were 36% for overall growth and 3.0% for average annual growth.

Worldwide Fatal Accident Rates

6. The overall fatal accident rate for the ten-year period 2002 to 2011 was 0.6 fatal accidents per million flights flown, or 0.4 when expressed as per million hours flown.

7. There was a decreasing trend in both the overall rate of fatal accidents and onboard fatalities.

8. On average, the fatal accident rate for turboprops was four times that for jets, based on flights flown, and nine times greater when using hours flown as the rate measure.

9. On average, the fatal accident rate for aircraft with Maximum Take-Off Weight Authorised (MTWA) below 15 tonnes was three times that for aircraft with MTWA above 27 tonnes, based on flights flown, and nine times greater when using hours flown as the rate measure.

10. On average, the fatal accident rate for cargo flights was eight times greater than for passenger flights, based on flights flown, and seven times greater when using hours flown as the rate of measure.

11. The fatal accident rate for African operators was over seven times greater than that for all operators combined. North America had the lowest fatal accident rate of all the regions.

Factors and Consequences

12. Over half of all fatal accidents involved an airline related primary causal factor.

13. The most frequently identified primary causal factor was "Flight Crew Handling/Skill – Flight handling" which was allocated in 14% of all fatal accidents. "Flight Crew Handling/Skill – Flight handling" was also the joint most commonly assigned causal factor. This generally related to events in which the aircraft was controllable (including single engine failures on twin engine aircraft), however the flight crew's mishandling of the aircraft or poor manual flying skills led to the catastrophic outcome.

14. 66% of all fatal accidents involved at least one airline related causal factor. In addition to "Flight handling", "Omission of action or inappropriate action" was the joint most commonly assigned causal factor.

15. "Omission of action or inappropriate action" generally related to flight crew continuing their descent below the decision height or minimum descent/safety heights without visual reference, failing to fly a missed approach or omitting to set the correct aircraft configuration for take-off.

16. 38% of all fatal accidents involved at least one airworthiness related causal factor, of which "Engine failure/malfunction or loss of thrust" was the most common.

17. The most frequently allocated circumstantial factor was "Poor visibility or lack of external visual reference". In the majority of cases this circumstantial factor was assigned, the accident occurred during a period of thick fog. The second most frequently assigned circumstantial factor "Weather general" mainly referred to accidents which occurred during heavy rain/snow, high winds or icing conditions.

18. Nearly 40% of all fatal accidents involved some kind of loss of control, making this the most frequent type of accident. Loss of control events were broken down into four categories – following technical failure, following non-technical failure, following icing, and following unknown reasons. Of these four, non-technical failures (for example flight crew failing to correctly respond to a warning) were the predominant cause of loss of control accidents.

19. Roughly half of all fatal accidents in which the pilot(s) lost control following a non-technical failure resulted in a post-crash fire, making this the most common post-crash fire precursor.

20. Over a third of all fatal accidents involved a post-crash fire; however this was always in conjunction with, or as a result of another consequence rather than in its own right. Fires in flight were far less common, accounting for 5% of all fatal accidents.

18. Mid-air collisions accounted for three out of the 250 fatal accidents (1%).

CHAPTER 1

Introduction

1.1 The main risks to large commercial air transport (CAT) aeroplanes known as the CAA 'Significant Seven' were identified in 2009 following analyses of global fatal accidents and high-risk occurrences involving large UK CAT aeroplanes.

1.2 The former involved the systematic analysis, by the CAA 'Accidents Analysis Group' (AAG), of more than 1,000 global fatal accidents dating back to 1980; identifying causal and circumstantial factors and accident consequences. This analysis revealed that loss of control, post crash fire, controlled flight into terrain and runway excursions were the most common consequences in fatal accidents.

1.3 The latter involved a similar in-depth analysis of high-risk occurrences involving large UK CAT aeroplanes by 'The High Risk Events Analysis Team' (THREAT). This analysis highlighted precursors to the same four accident outcomes, together with an additional three items: airborne conflict, runway incursion and ground handling; hence the 'Significant Seven'.

1.4 The 'Significant Seven' have been used by the CAA as the basis to drive safety improvement activities in UK civil aviation and industry has been encouraged to assess their exposure to these risks, and take appropriate mitigating action, as part of an effective safety management system.

1.5 Further information about both the AAG and THREAT can be found in Appendix A and Appendix B respectively.

1.6 This document summarises a study of AAG analysed worldwide fatal accidents covering the ten-year period 2002 to 2011. The style and content of the document are similar to the previous Global Fatal Accident Review (CAP 776) but there are, however, some differences and these are outlined in Appendix A.

1.7 The main objectives of the study were to provide a statistical overview of global fatal accidents and identify the most prevalent factors that contributed to these accidents. The CAA deliberately avoided drawing

conclusions from the statistics and invites the reader to draw their own inferences.

1.8 The criteria for an accident to be included in the study dataset were as follows:

- Jet and turboprop aeroplanes
- Maximum take-off weight above 5,700kg
- Civil passenger, cargo and ferry/positioning flights
- At least one fatality to an aircraft occupant
- Excluding accidents known to have resulted from acts of terrorism or sabotage

1.9 The AAG uses a systematic process to analyse worldwide fatal accidents, which involves the allocation of primary causal factors, other causal factors, circumstantial factors and consequences. When allocating factors, it is not the intention of the AAG to apportion blame. The analysis process is described in greater detail in Appendix A.

1.10 There are various terms used in this study with respect to fatal accidents and their analysis. Explanations for these terms can be found in the Definitions section in Appendix C. There is also a Glossary of acronyms contained in Appendix D.

1.11 The raw accidents and aircraft utilisation data used in this study originated from Ascend (formerly Airclaims[1]) and was supplemented by accident briefs and reports from other sources (such as reports published by accident investigation bodies). All sources other than the CAA have been referenced in this document and are hereby acknowledged for the information supplied.

1.12 The CAA welcomes any comments regarding this study and in particular on how the document could be improved in the future. Comments can be forwarded by e-mail to Safety.Analysis@caa.co.uk.

1 The Airclaims Client Aviation System Enquiry

CHAPTER 2

Fatal Accident Statistics

Introduction

2.1 This chapter presents high-level statistics on the number and, where practicable, the rate of fatal accidents and fatalities, broken down by: year, type of aircraft, nature of flight, accident location and operator region or origin. There is also a brief section on aircraft utilisation.

2.2 The section on numbers of fatal accidents refers to all fatal accidents in the dataset. However, the section on rates excludes fatal accidents involving ferry or positioning flights and business jet aircraft. This is due to unavailability of consistent utilisation data for these types of operation and aircraft. The section on rates contains greater detail on fatal accident trends.

Worldwide Fatal Accident Numbers

Number of Worldwide Fatal Accidents and Fatalities by Year

2.3 There were a total of 250 worldwide fatal accidents in the ten-year period 2002 to 2011, which resulted in 7,148 fatalities to passengers and crewmembers onboard the aircraft. The proportion of aircraft occupants killed in these fatal accidents was 70%, which indicates that, on average, 30% of occupants survived. A further 252 casualties were incurred on the ground[2].

2.4 Figure 1 and Figure 2 show, respectively, the annual numbers of fatal accidents and onboard fatalities, together with a three-year moving average trend line. There was an overall decreasing trend in the number of fatal accidents, however there was much more fluctuation in the number of fatalities per year.

2 The number of ground casualties should be treated with caution due to uncertainty in the number of fatalities reported for some fatal accidents.

Figure 1 Annual numbers of worldwide fatal accidents

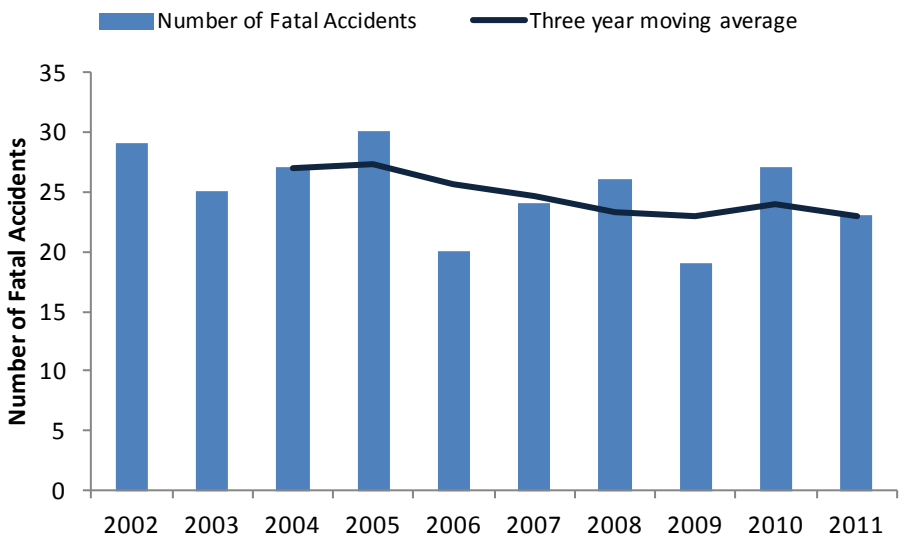
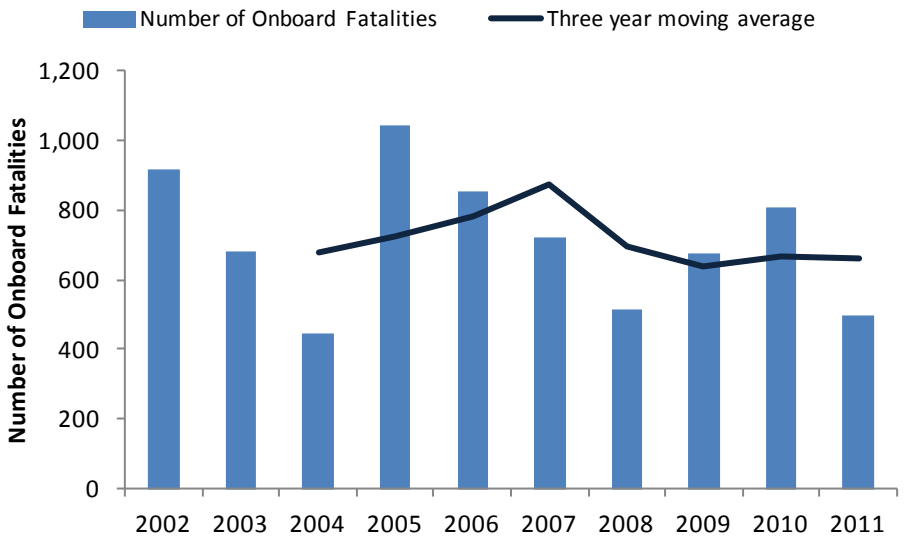


Figure 2 Annual numbers of onboard fatalities for worldwide fatal accidents



2.5 There were 2 fatal accidents in which more than 200 aircraft occupants were killed and 27 where the onboard fatality count was greater than 100. The average number of fatalities per fatal accidents was 29. The worst accident, in terms of the total number of fatalities, was to an Airbus A330 on a transatlantic flight from Rio de Janeiro-Galeao International Airport, RJ (GIG) to Paris-Charles de Gaulle Airport (CDG) on 1st June 2009 in which all 228 aircraft occupants were killed.

2.6 Of the 250 fatal accidents in total, 159 (64%) occurred during daylight, 82 (33%) occurred in darkness and the remaining 9 (4%) took place at an unknown time. Of the 82 that occurred in darkness, 37 took place during the descent/approach (45%), 5 during landing (6%), 3 during go-around (4%), 14 during take-off (17%), 10 during climb (12%) and a further 13 occurred en-route (16%).

Number of Worldwide Fatal Accidents and Fatalities by Aircraft Class, Age and Weight Group

2.7 Figure 3 shows the annual number of fatal accidents broken down by aircraft class, which includes jets, turboprops and business jets. A list of aircraft types that featured against each class of aircraft can be found in Appendix E. Fatal accident rates for jets and turboprops only are presented later in the Chapter.

2.8 Considering the overall ten-year period 2002 to 2011, jets were involved in 96 fatal accidents (or 38% of the total number of fatal accidents), turboprops in 125 (50%) and business jets in 29 (12%).

2.9 On average, jets were involved in 10 fatal accidents per year, turboprops in 13 and business jets in 3.

2.10 Considering the overall ten-year period 2002 to 2011, fatal accidents involving jets resulted in 5,567 onboard fatalities (or 78% of the total number of onboard fatalities), those involving turboprops resulted in 1,495 fatalities (or 21%) and those involving business jets resulted in 86 (or 1%). The proportion of occupants killed in jets was 69%, 73% in turboprops and 83% in business jets.

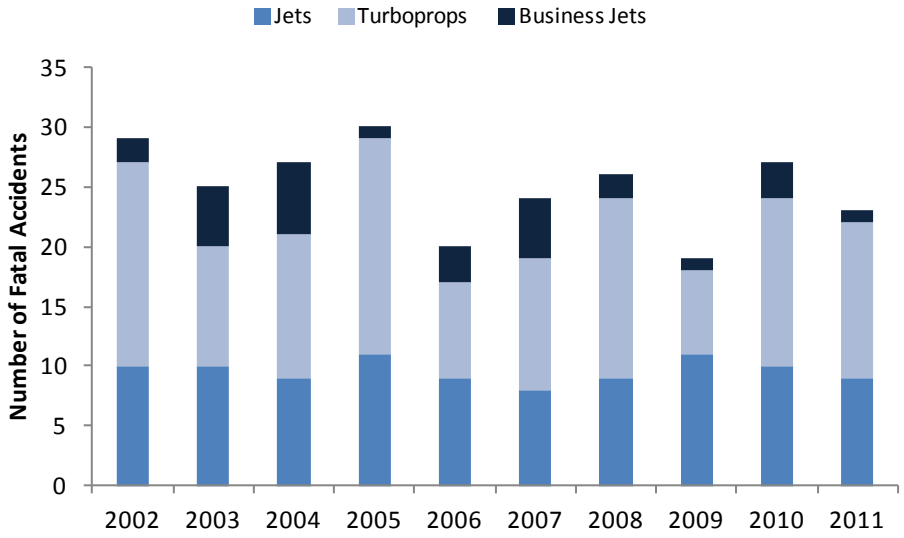
2.11 The average number of onboard fatalities per fatal accident involving jets, between 2002 and 2011, was 58. The largest number of onboard fatalities in a single fatal accident involving jets was 228, which resulted from loss of control stemming from inconsistency in measured airspeeds on an Airbus A330 over the Atlantic Ocean in 2009.

2.12 The average number of onboard fatalities per fatal accident involving turboprops, between 2002 and 2011, was 12. The largest number of onboard fatalities in a single fatal accident involving turboprops was 68, which resulted from an ATR72 crashing while en route between Santiago de Cuba and Havana during icing conditions in 2010.

2.13 The average number of onboard fatalities per fatal accident involving business jets, between 2002 and 2011, was 3. The largest number of onboard fatalities in a single fatal accident involving business jets was 8,

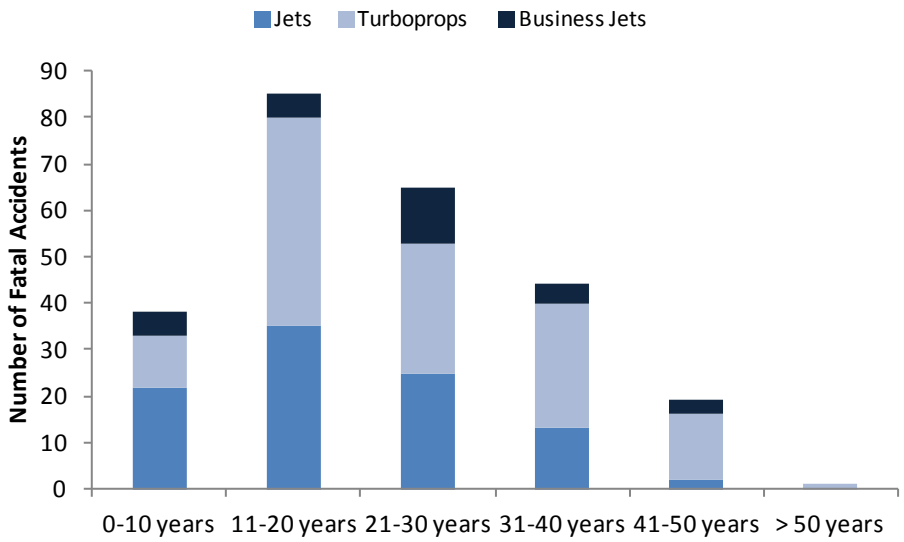
which resulted from a Hawker 800 crashing following an attempted go-around at Owatonna airport in 2008.

Figure 3 Annual numbers of worldwide fatal accidents broken down by aircraft class



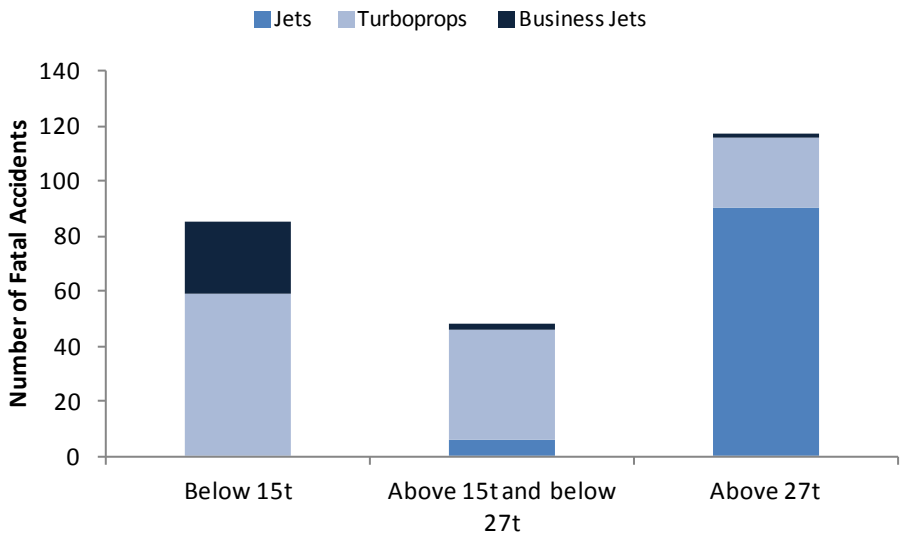
2.14 Figure 4 shows the overall numbers of fatal accidents involving aircraft in predefined age groups for each of jets, turboprops and business jets. The average age of all aircraft involved in fatal accidents in the ten-year period was 22 years. The equivalent value for jets was 19 years, 24 years for turboprops and 24 years for business jets.

Figure 4 Numbers of worldwide fatal accidents broken down by aircraft age and class for the ten-year period 2002 to 2011



2.15 Figure 5 shows the overall numbers of fatal accidents broken down by aircraft weight group for each of jets, turboprops and business jets. Considering the overall ten-year period 2002 – 2011, aircraft with a maximum take-off weight authorised (MTWA) below 15 tonnes accounted for 34% of all fatal accidents, aircraft with MTWA above 15 tonnes and below 27 tonnes accounted for 19% and aircraft with MTWA above 27 tonnes accounted for 47%.

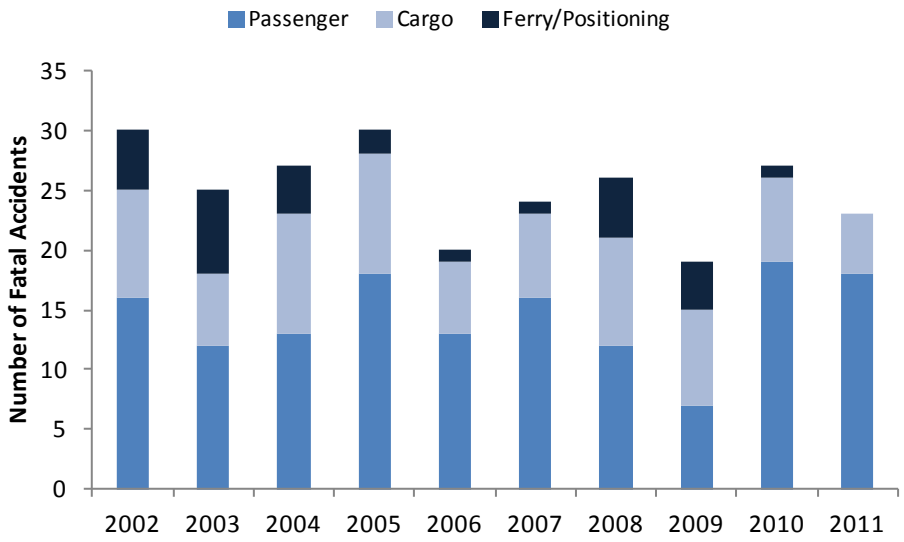
Figure 5 Number of worldwide fatal accidents broken down by aircraft class and weight group for the ten year period 2002 – 2011



Number of Worldwide Fatal Accidents and Fatalities by Nature of Flight

2.16 Figure 6 shows the annual number of fatal accidents broken down by nature of flight, which includes passenger, cargo and ferry/positioning flights. Fatal accident rates for passenger and cargo flights only are presented later in the Chapter.

Figure 6 Annual numbers of worldwide fatal accidents broken down by nature of flight



2.17 Considering the overall ten-year period 2002 to 2011, passenger flights were involved in 144 fatal accidents (or 57% of the total), cargo flights in 77 (31%) and ferry/positioning flights in 30 (12%)[3].

2.18 On average, passenger flights were involved in 14 fatal accidents per year, cargo flights in 8 and ferry/positioning flights in 3.

2.19 Considering the overall ten-year period 2002 to 2011, fatal accidents involving passenger flights resulted in 6,653 onboard fatalities (or 93% of the total number of onboard fatalities), those involving cargo flights resulted in 383 (5%), and those involving ferry/positioning resulted in 112 (2%). The proportion of aircraft occupants killed in passenger flights was 69%, 88% for cargo flights and 93% for ferry/positioning flights.

2.20 Of the fatal accidents involving passenger flights, 110 (76%) occurred on domestic sectors and 34 (24%) on international sectors. Scheduled passenger flights accounted for 99 fatal accidents (or 69% of the passenger flight total) and non-scheduled flights accounted for 45 (31%).

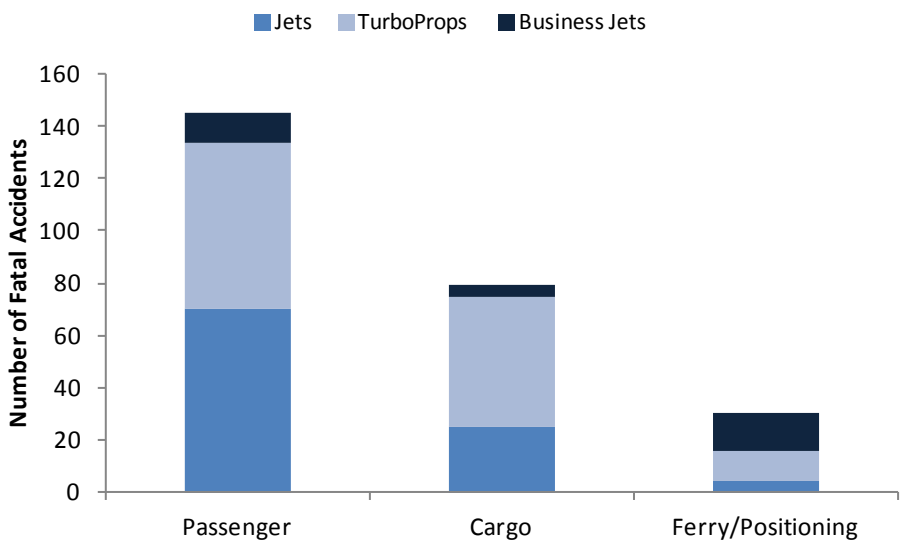
3 The sum of fatal accidents by nature of flight was 251, one more than the total stated in the overall statistics. This was due to a mid-air collision that involved a passenger and cargo flight, which were counted against each category. This mid-air collision was treated as one fatal accident in the overall statistics.

2.21 Of the fatal accidents involving cargo flights, 44 (57%) occurred on domestic sectors and 33 (43%) on international sectors. Scheduled cargo flights accounted for 14 fatal accidents (18%) and non-scheduled flights accounted for 63 (82%).

2.22 All but 7 of the fatal accidents involving ferry/positioning flights occurred on domestic sectors.

2.23 Figure 7 shows the overall number of fatal accidents broken down by nature of flight and aircraft class. Fatal accidents involving passenger flights were fairly evenly split between jets and turboprops. However, those involving cargo and ferry/positioning flights were far more biased towards turboprops and business jets respectively.

Figure 7 Numbers of worldwide fatal accidents broken down by nature of flight and aircraft class for the ten-year period 2002 to 2011

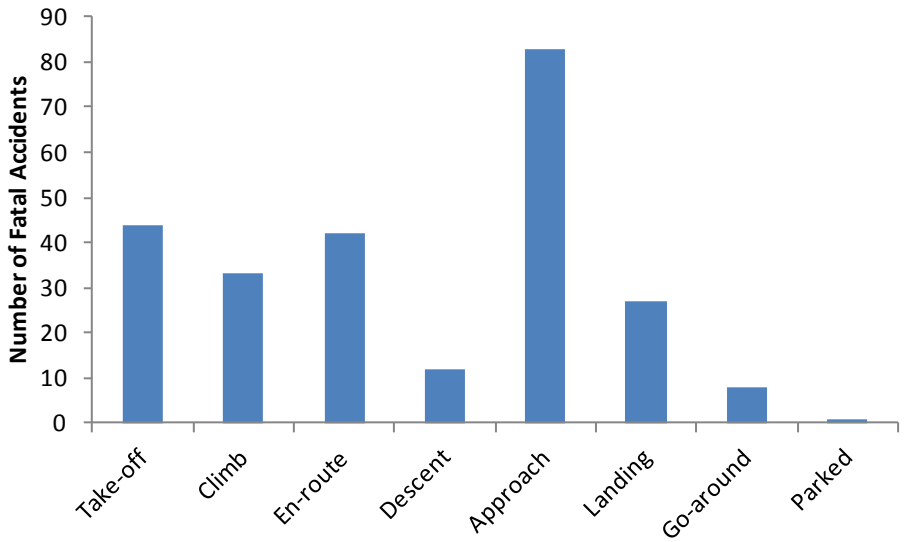


Number of Worldwide Fatal Accidents and Fatalities by Phase of Flight

2.24 Figure 8 and Figure 9 respectively; show the overall numbers of fatal accidents and onboard fatalities broken down by aircraft phase of flight. The approach, landing and go-around phases accounted for 47% of all fatal accidents and 46% of all onboard fatalities. Take-off and climb accounted for a further 31% of the fatal accidents and 28% of the onboard fatalities. Of the 118 fatal accidents that occurred during approach, landing or go-around, 66 (56%) involved a non-precision

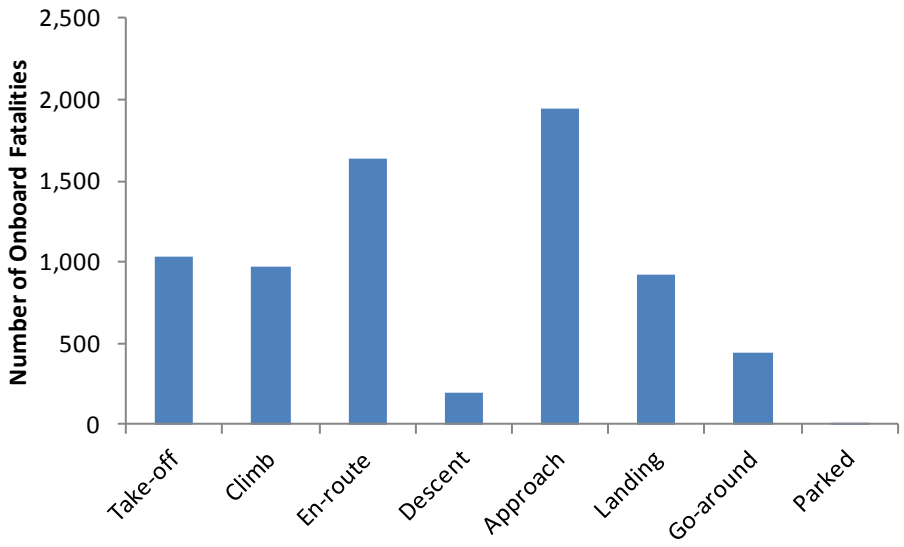
approach[4] and 15 (13%) occurred on at least the second attempt to land. For 7 (6%) of the fatal accidents which occurred during approach, landing or go-around there was insufficient information to determine whether the aircraft in question flew a precision or non-precision approach.

Figure 8 Numbers of worldwide fatal accidents broken down by phase of flight for the ten-year period 2002 to 2011



4 In the cases where the accident narrative did not explicitly state if the aircraft flew a precision or non-precision approach, it has been assumed that if the airport had the facilities to offer a precision approach, the aircraft made use of them.

Figure 9 Numbers of onboard fatalities for worldwide fatal accidents broken down by phase of flight for the ten-year period 2002 to 2011

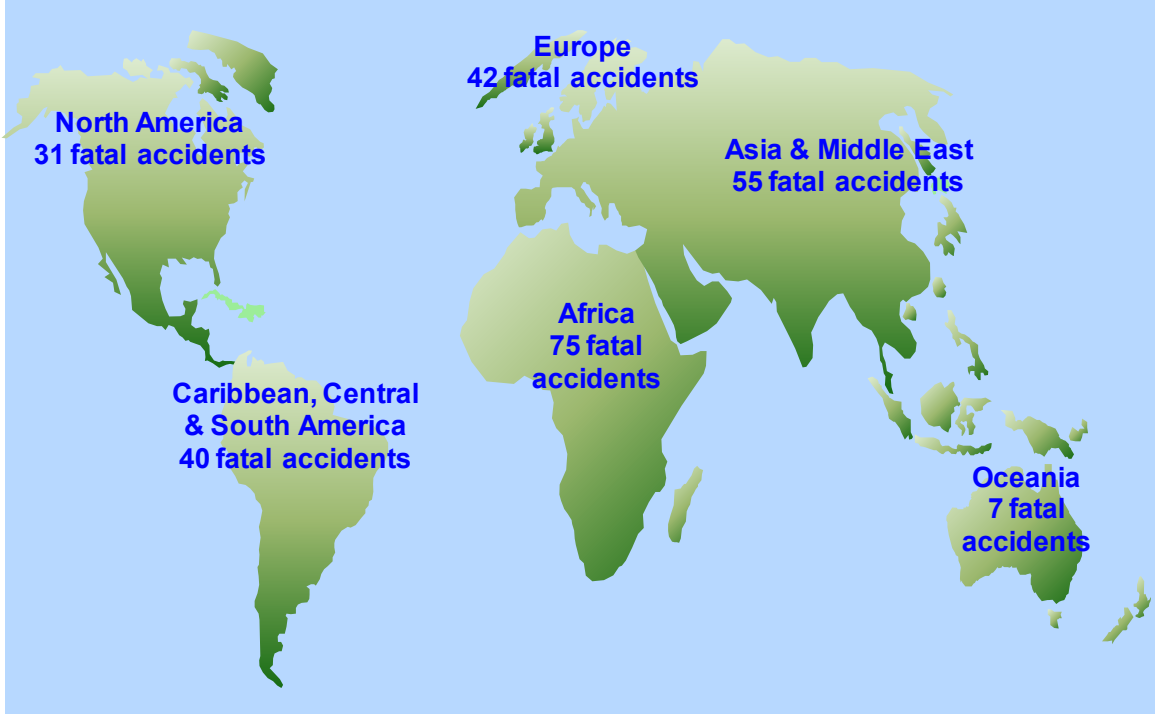


2.25 A total of 16 fatal accidents (6%) occurred during a diversion following a problem and 13 (5%) occurred whilst attempting a return to the departure airport. The values for onboard fatalities were 115 (2%) and 262 (4%) respectively.

Number of Worldwide Fatal Accidents and Fatalities by Accident Location

2.26 Figure 10 shows the overall numbers of fatal accidents broken down by location. The regions are based on those defined by the ICAO Safety Indicators Study Group and a list of the countries that form these regions can be found in Appendix C. For the purposes of this study, the Asia and Middle East regions were joined together, as were the Caribbean and Central America and South America regions.

Figure 10 Numbers of worldwide fatal accidents broken down by location region for the ten-year period 2002 to 2011



In terms of the percentage of all fatal accidents involving each location region (with the percentage of onboard fatalities in brackets):

- 30% of fatal accidents occurred in Africa (27% of onboard fatalities)
- 22% occurred in Asia and the Middle East (31%)
- 17% occurred in Europe (19%)
- 16% occurred in the Caribbean, Central and South America (18%)
- 12% occurred in North America (4%)
- 3% occurred in Oceania (1%)

Number of Worldwide Fatal Accidents and Fatalities by Operator Region

2.27 Figure 11 shows the overall numbers of fatal accidents broken down by operator region[5]. Fatal accident rates for each operator region are presented later in the Chapter.

Figure 11 Numbers of worldwide fatal accidents broken down by operator region for the ten-year period 2002 to 2011

2.28 In terms of the percentage of all fatal accidents involving each operator region (with the percentage of onboard fatalities in brackets):

- 28% of fatal accidents involved African operators (26% of onboard fatalities)
- 22% involved European operators (25%)
- 18% involved North American operators (3%)
- 17% involved Asian and Middle Eastern operators (31%)

5 The sum of fatal accidents by operator region of origin was 251, one more than the total stated in the overall statistics. This was due to a mid-air collision that involved a European and Middle Eastern operator, which was counted against each category. This mid-air collision was treated as one fatal accident in the overall statistics.

- 13% involved Caribbean, Central and South American operators (15%)
- 2% involved Oceania operators (1%)

Worldwide Aircraft Utilisation

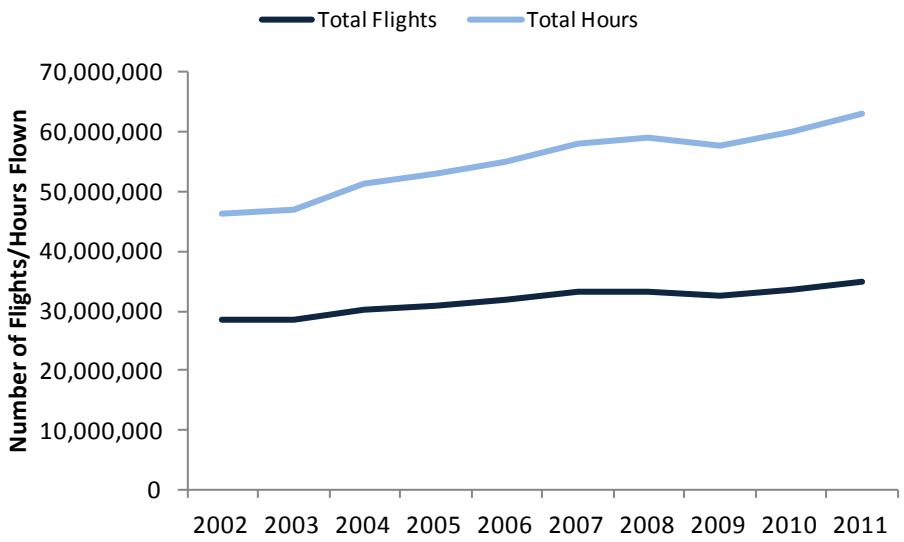
Introduction

2.29 The utilisation data presented in this section originated from Ascend and covers jet (excluding business jet) and turboprop aeroplanes engaged in passenger and cargo operations only.

Overall Flights and Hours Flown

2.30 Figure 12 shows the annual numbers of flights and hours flown for jets and turboprops combined. In the ten-year period 2002 to 2011, the number of flights flown increased by 22%, which equates to an average annual growth of 1.9%. The equivalent values for hours flown were 36% for overall growth and 3.0% for average annual growth.

Figure 12 Annual numbers of flights and hours flown by jets and turboprops engaged in passenger and cargo operations



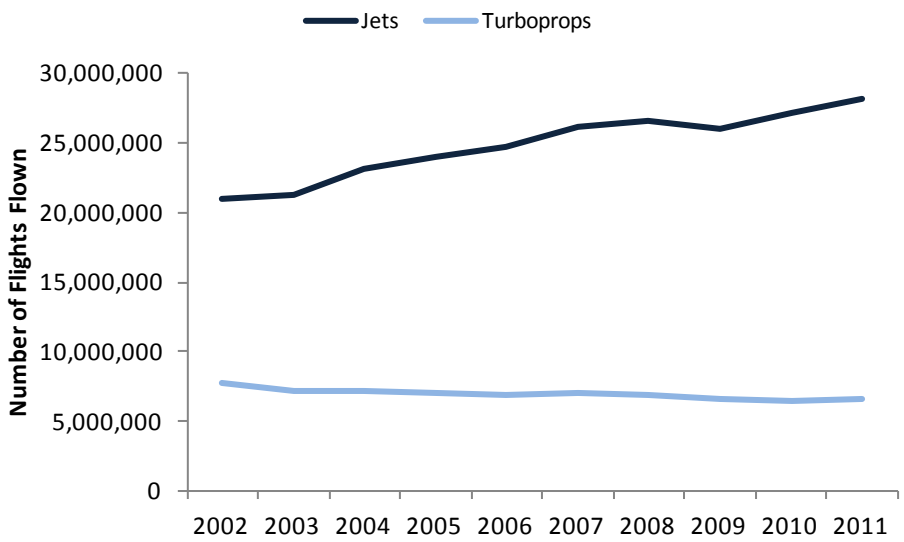
2.31 The total number of flights flown by jets and turboprops on passenger and cargo operations for the ten-year period 2002 to 2011 was 317,658,933 and the total number of hours flown was 549,748,598. The average flight duration for this period was one hour 44 minutes.

Worldwide Flights and Hours Flown by Aircraft Class

2.32 Figure 13 shows the annual numbers of flights flown broken down by aircraft class (the equivalent chart for hours flown has not been shown as it has an almost identical distribution to that for flights flown). In the ten-year period 2002 to 2011, the number of flights flown by jets increased by 35%, which equates to an average annual growth of 2.9%. However, in the same period, the number of flights flown by turboprops decreased by 14%, which equates to an average annual reduction of 1.4%.

2.33 In the ten-year period 2002 to 2011, the number of hours flown by jets increased by 45%, which equates to an average annual growth of 3.6%. However, in the same period, the number of hours flown by turboprops decreased by 13%, which equates to an average annual reduction of 1.3%.

Figure 13 Annual numbers of flights flown by jets and turboprops engaged in passenger and cargo operations



2.34 The total number of flights flown by jets on passenger and cargo operations for the ten year period 2002 to 2011 was 247,951,422 and the total number of hours flown was 487,122,700. The average duration of a jet flight for this period was one hour 58 minutes.

2.35 The total number of flights flown by turboprops on passenger and cargo operations for the ten-year period 2002 to 2011 was 69,707,511 and the

total number of hours flown was 62,625,898. The average duration of a turboprop flight for this period was 54 minutes.

Worldwide Flights and Hours Flown by Nature of Flight

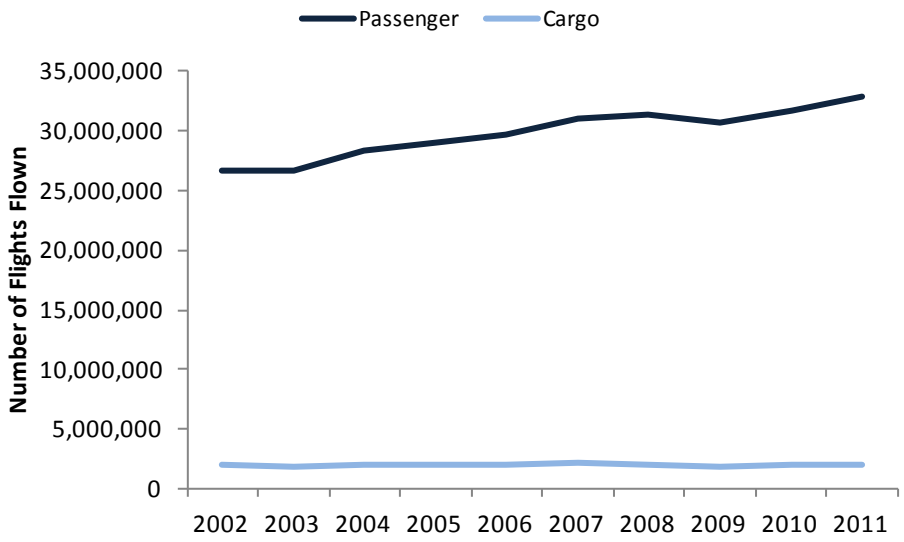
2.36 Figure 14 shows the annual numbers of flights broken down by nature of flight (the equivalent charts for hours has not been shown as it has an almost identical distribution to that for flights flown). In the ten-year period 2002 to 2011, the number of passenger flights flown increased by 23%, which equates to an average annual growth of 2.1%. In the same period, the number of cargo flights flown increased by 6% which equates to an average annual growth of 0.4%.

2.37 In the ten-year period 2002 to 2011, the number of hours flown on passenger flights increased by 38%, which equates to an average annual growth of 3.1%. In the same period, the number of hours flown on cargo flights increased by 17%, which equates to an average annual growth of 1.1%.

2.38 The total number of passenger flights flown by jets and turboprops for the ten-year period 2002 to 2011 was 297,532,797 and the total number of hours flown was 510,779,630. The average duration of a passenger flight for this period was one hour 43 minutes.

2.39 The total number of cargo flights flown by jets and turboprops for the ten-year period 2002 to 2011 was 20,126,136 and the total number of hours flown was 38,968,968. The average duration of a cargo flight for this period was one hour 56 minutes.

Figure 14 Annual numbers of flights flown broken down by nature of flight (for jets and turboprops combined)



Worldwide Fatal Accident Rates

Introduction

2.40 The remainder of this chapter focuses on fatal accident rates and covers jet and turboprop aeroplanes engaged in passenger and cargo flights only. Fatal accidents involving business jets and ferry or positioning flights were excluded from the rate calculations due to unavailability of consistent utilisation data for these types of aircraft and operation.

Worldwide Fatal Accident and Fatality Rates by Year

2.41 Table 1 shows a summary of the number and rate of fatal accidents and onboard fatalities, for jets and turboprops combined, for the ten-year period 2002 to 2011.

Table 1 Summary of the overall number and rate of fatal accidents and fatalities for the ten-year period 2002 to 2011

Number of Fatal Accidents	205
Number of Onboard Fatalities	6,983
Number of Flights Flown	317,658,933
Number of Hours Flown	549,748,598
Fatal Accident Rate (per million flights flown)	0.6
Fatal Accident Rate (per million hours flown)	0.4
Fatality Rate (per million flights flown)	22.0
Fatality Rate (per million hours flown)	12.7

2.42 Figure 15 and Figure 16 show, respectively, the fatal accident rate and onboard fatality rate (per million flights and hours flown) for jets and turboprops combined, using a three year moving average. There was a decreasing trend in both the rate of fatal accidents and onboard fatalities.

Figure 15 Overall fatal accident rate (per million flights and hours flown) for the ten-year period 2002 to 2011

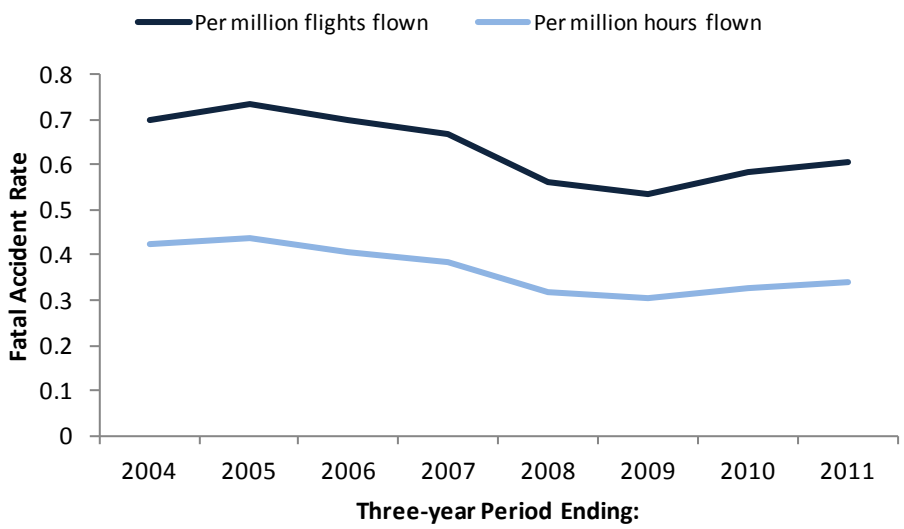
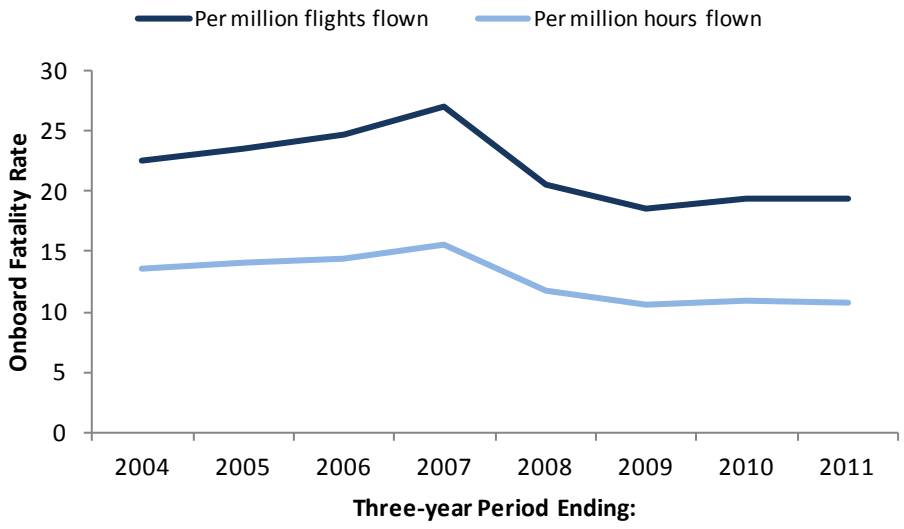


Figure 16 Overall onboard fatality rate (per million flights and hours flown) for the ten-year period 2002 to 2011



Worldwide Fatal Accident and Fatality Rates by Aircraft Class and Weight Group

2.43 Table 2 shows a summary of the number and rate of fatal accidents and onboard fatalities for the ten-year period 2002 to 2011 broken down by aircraft class.

2.44 Jet aircraft generated 78% of flights flown (and 89% of hours flown) and were involved in 45% of the fatal accidents. Turboprop aircraft generated 22% of flights flown (and 11% of hours flown) but were involved in 55% of the fatal accidents. On average, the fatal accident rate for turboprops was four times that for jets, based on flights flown, and nine times greater when using hours flown as the rate measure.

Table 2 Summary of the number and rate of fatal accidents and fatalities broken down by aircraft class for the ten-year period 2002 to 2011

	Jets	Turboprops
Number of Fatal Accidents	92	114
Number of Onboard Fatalities	5,540	1,443
Number of Flights Flown	247,951,422	69,707,511
Number of Hours Flown	487,122,700	62,625,898
Fatal Accident Rate (per million flights flown)	0.4	1.6
Fatal Accident Rate (per million hours flown)	0.2	1.8
Fatality Rate (per million flights flown)	22.3	20.7
Fatality Rate (per million hours flown)	11.4	23.0

2.45 Figure 17 and Figure 18 show, respectively, the fatal accident rate and onboard fatality rate (per million flights flown) broken down by aircraft class, using a three-year moving average. The fatal accident rate for jets has remained relatively stable; however there was a peak in the onboard fatality rate for jets for the three-year period ending 2007. The accident and fatality rates for Turboprops fluctuated during the ten-year period but show an increasing trend in the last three years.

Figure 17 Fatal accident rate (per million flights flown) broken down by aircraft class for the ten-year period 2002 to 2011

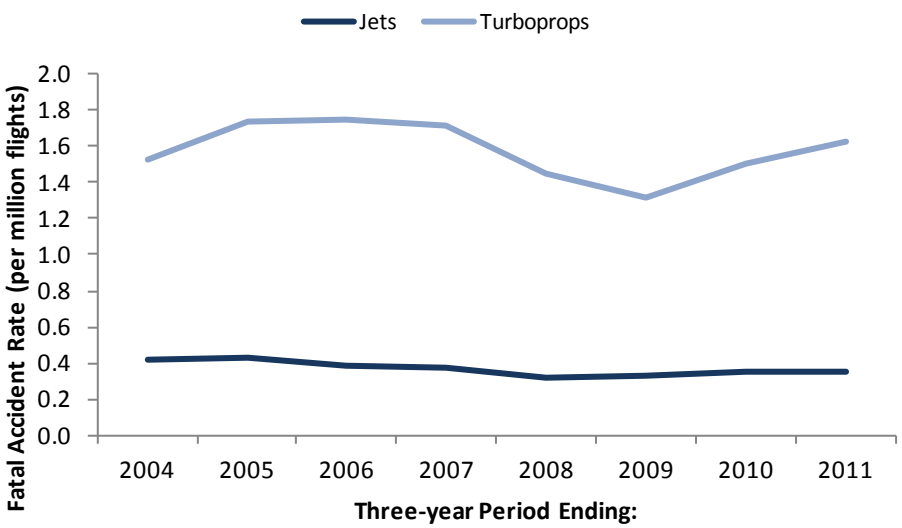
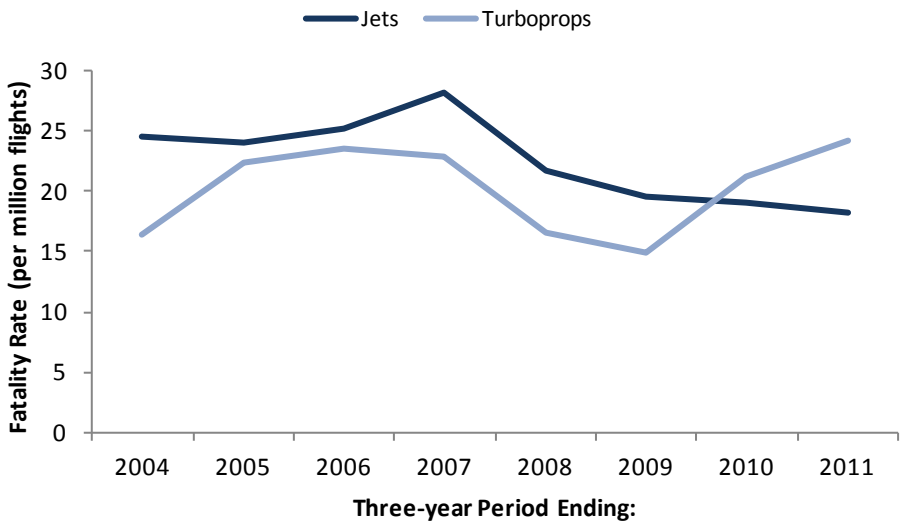


Figure 18 Onboard fatality rate (per million flights flown) broken down by aircraft class for the ten-year period 2002 to 2011



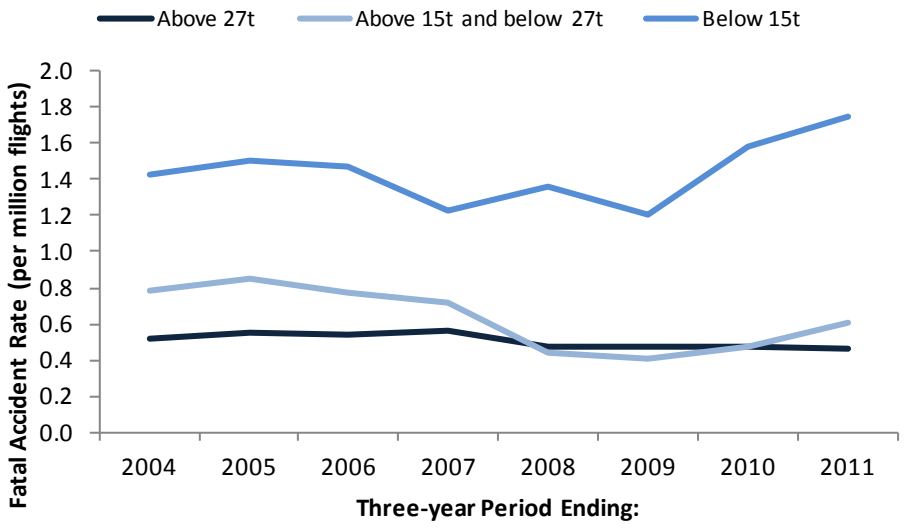
2.46 Table 3 shows a summary of the number and rate of fatal accidents and onboard fatalities for the ten-year period 2002 to 2011 broken down by aircraft weight group. On average, the fatal accident rate for aircraft with MTWA below 15 tonnes was three times that for aircraft with MTWA above 27 tonnes, based on flights flown, and nine times greater when using hours flown as the rate measure.

Table 3 Summary for the number and rate of fatal accidents and fatalities broken down by aircraft weight group for the ten-year period 2002 to 2011

	Below 15t	Above 15t and Below 27t	Above 27t
Number of Fatal Accidents	53	43	109
Number of Onboard Fatalities	524	893	5,566
Number of Flights Flown	34,927,747	64,801,526	217,929,660
Number of Hours Flown	29,354,510	68,645,400	451,748,688
Fatal Accident Rate (per million flights flown)	1.5	0.7	0.5
Fatal Accident Rate (per million hours flown)	1.8	0.6	0.2
Fatality Rate (per million flights flown)	15.0	13.8	25.5
Fatality Rate (per million hours flown)	17.9	13.0	12.3

2.47 Figure 19 shows the fatal accident rate (per million flights flown) broken down by aircraft weight group, using a three-year moving average. There was a generally decreasing trend in the fatal accident rate for aircraft with MTWA above 15 tonnes and below 27 tonnes, but an increasing trend for aircraft with MTWA below 15 tonnes. The fatal accident rate for aircraft with MTWA above 27 tonnes remained relatively stable.

Figure 19 Fatal accident rate (per million flights flown) broken down by aircraft weight group for the ten-year period 2002 to 2011



Worldwide Fatal Accident and Fatality Rates by Nature of Flight

2.48 Table 4 shows a summary of the number and rate of fatal accidents and onboard fatalities for the ten-year period 2002 to 2011 broken down by nature of flight.[6]

2.49 Passenger flights generated 94% of flights flown (and 93% of hours flown) and were involved in 65% of the fatal accidents. Cargo flights generated 6% of flights flown (and 7% of hours flown) but were involved in 36% of the fatal accidents. On average, the fatal accident rate for cargo flights was eight times greater than for passenger flights, based on flights flown, and seven times greater when using hours flown as the rate of measure.

6 The sum of fatal accidents by nature of flight was 206, one more than the total stated in Table 1. This was due to a mid-air collision that involved a passenger and a cargo flight, which was counted against each category. This mid-air collision was treated as one fatal accident in the overall statistics.

Table 4 Summary of the number and rate of fatal accidents and fatalities broken down by nature of flight for the ten-year period 2002 to 2011

	Passenger	Cargo
Number of Fatal Accidents	133	73
Number of Onboard Fatalities	6,609	374
Number of Flights Flown	297,532,797	20,126,136
Number of Hours Flown	510,779,630	38,968,968
Fatal Accident Rate (per million flights flown)	0.4	3.6
Fatal Accident Rate (per million hours flown)	0.3	1.9
Fatality Rate (per million flights flown)	22.2	18.6
Fatality Rate (per million hours flown)	12.9	9.6

2.50 Figure 20 and Figure 21 show, respectively, the fatal accident rate and onboard fatality rate (per million flights flown) broken down by nature of flight, using a three-year moving average. The fatal accident rate for passenger flights has remained relatively stable; however the onboard fatality rate shows a decreasing trend in the last 5 years. Both the fatal accident rate and onboard fatality rate for cargo flights showed a slight decreasing trend.

Figure 20 Fatal accident rate (per million flights flown) broken down by nature of flight for the ten-year period 2002 to 2011

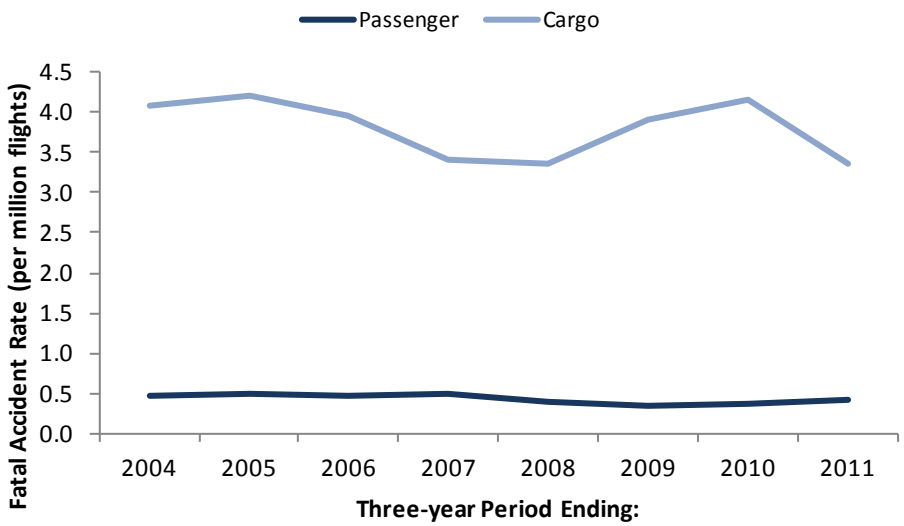
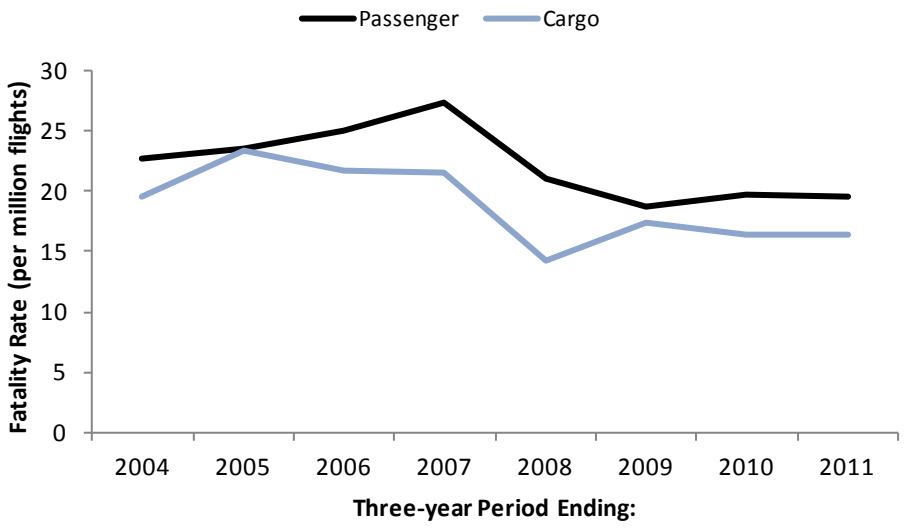


Figure 21 Onboard fatality rate (per million flights flown) broken down by nature of flight for the ten-year period 2002 to 2011



2.51 Table 5 takes the information in Table 4 and breaks it down further by aircraft class. It shows that the fatal accident rate (per million flights flown) for turboprop cargo flights was 19 times greater than that for jet passenger flights (over 37 times greater when using hours flown as the rate measure). These aircraft class-nature of flight combinations represented the two extremes of the dataset in terms of safety performance.

Table 5 Summary of the number and rate of fatal accidents and fatalities broken down by nature of flight and aircraft class for the ten-year period 2002 to 2011

	Passenger		Cargo	
	Jets	Turboprops	Jets	Turboprops
Number of Fatal Accidents	69	64	24	49
Number of Onboard Fatalities	5,400	1209	140	234
Number of Flights Flown	236,729,072	60,803,725	11,222,349	8,903,786
Number of Hours Flown	456,823,229	53,956,401	30,299,471	8,669,497
Fatal Accident Rate (per million flights flown)	0.3	1.1	2.1	5.5
Fatal Accident Rate (per million hours flown)	0.2	1.2	0.8	5.7
Fatality Rate (per million flights flown)	22.8	19.9	12.5	26.3
Fatality Rate (per million hours flown)	11.8	22.4	4.6	27.0

Worldwide Fatal Accident and Fatality Rates by Operator Region

2.52 Table 6 shows a summary of the number and rate of fatal accidents and onboard fatalities for the ten-year period 2002 to 2011 broken down by operator region[7].

2.53 The data for European operators was broken down further into European Union (EU) member states. For the purposes of this study, the EU was taken to be the 15 member states prior to the inclusion of the 12 accession states, as these 12 states were not members of the EU for the entire ten-year period.

7 The sum of fatal accidents by operator region was 206, one more than the total stated in Table 1. This was due to a mid-air collision that involved a European and Middle Eastern operator, which was counted against each category. The mid-air collision was treated as one fatal accident in the overall statistics.

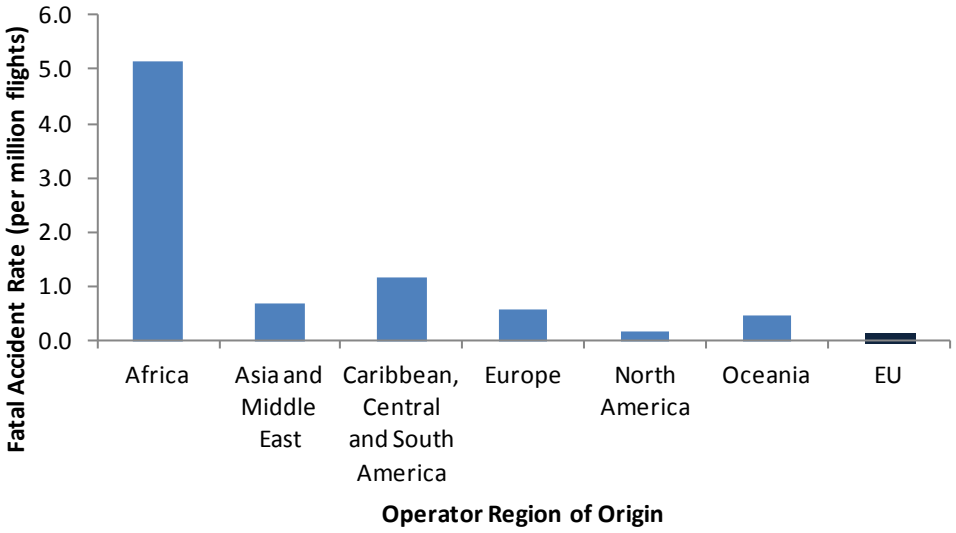
Table 6 Summary of the number and rate of fatal accidents and fatalities broken down by operator region for the ten-year period 2002 to 2011

	Africa	Asia and Middle East	Caribbean, Central and South America
Number of Fatal Accidents	63	42	30
Number of Onboard Fatalities	1,826	2180	1,058
Number of Flights Flown	12,227,187	62,525,256	26,065,675
Number of Hours Flown	19,175,829	119,360,458	34,682,865
Fatal Accident Rate (per million flights flown)	5.2	0.7	1.2
Fatal Accident Rate (per million hours flown)	3.3	0.4	0.9
Fatality Rate (per million flights flown)	149.3	34.9	40.6
Fatality Rate (per million hours flown)	95.2	18.3	30.5

	Europe (EU)	North America	Oceania
Number of Fatal Accidents	48 (9)	18	5
Number of Onboard Fatalities	1713 (418)	158	48
Number of Flights Flown	85,851,330 (61,460,835)	120,216,301	10,773,184
Number of Hours Flown	154,202,684 (108,540,823)	205,952,397	16,374,365
Fatal Accident Rate (per million flights flown)	0.6 (0.1)	0.1	0.5
Fatal Accident Rate (per million hours flown)	0.3 (0.1)	0.1	0.3
Fatality Rate (per million flights flown)	20.0 (6.8)	1.3	4.5
Fatality Rate (per million hours flown)	11.1 (3.9)	0.8	2.9

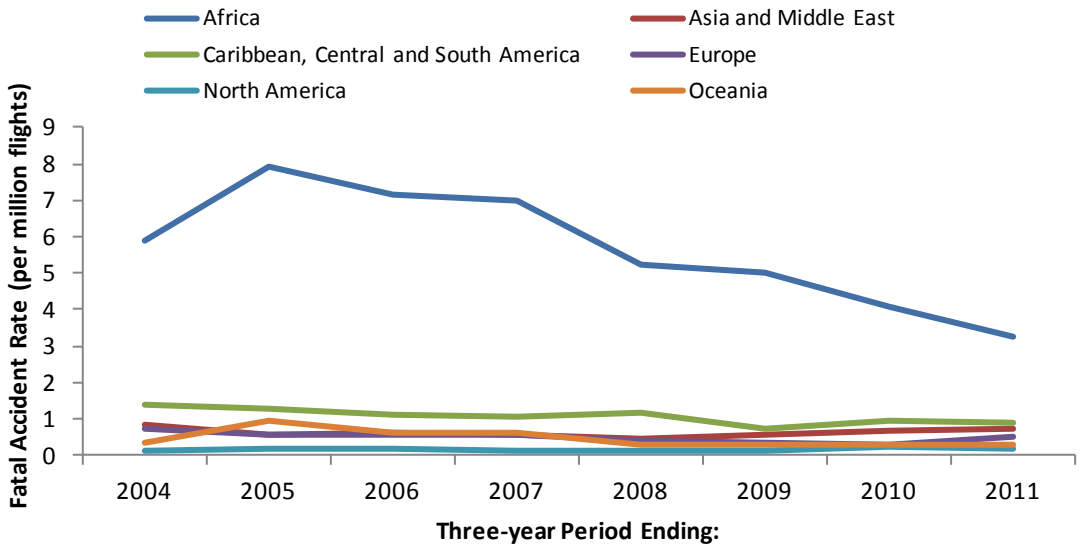
2.54 Figure 22 shows the overall fatal accident rate (per million flights flown) broken down by operator region. The fatal accident rate for African operators (5.2 per million flights) was over seven times greater than that for all operators combined (0.7 per million flights – see Table 1). North America had the lowest fatal accident rate of all the regions with 0.1 fatal accidents per million flights flown.

Figure 22 Overall fatal accident rate (per million flights flown) broken down by operator region for the ten-year period 2002 to 2011



2.55 Figure 23 shows the fatal accident rate (per million flights) broken down by operator region, using a three-year moving average. The fatal accident rates for Africa, European and Caribbean, Central and South American operators all showed a decreasing trend over the ten-year period 2002 to 2011. The rates for Asian and Middle Eastern and Northern American operators remained relatively stable. The rates for Oceania should be treated with caution as operators from this region had a very low number of fatal accidents during the ten-year period.

Figure 23 Fatal accident rate (per million flights flown) broken down by operator region for the ten-year period 2002 to 2011



Worldwide Mortality Risk for Passenger Flights

2.56 Whilst fatal accident rates are an established and useful measure of aviation safety performance, they do not distinguish between an accident that kills one passenger among 100 and another that kills everyone onboard. Use of fatality rates goes someway to addressing this, but it could still be argued that an accident that kills 50 out of 300 should not automatically assume more significance than one that kills all 40 persons onboard. Barnett[8] argues that mortality risk, which is the probability of a passenger not surviving a randomly chosen flight, could be a more appropriate measure. This statistic ignores the length and duration of a flight, which are unrelated to mortality risk, and weights each accident by the proportion of passengers killed. An accident that kills everyone onboard is counted as one fatal accident, whereas one that kills a quarter of the passengers is counted as the equivalent of one quarter of a fatal accident.

2.57 Table 7 shows the mortality risk for passenger flights expressed in three ways: (1) a pure probability, (2) the number of randomly chosen passenger flights it would take, on average, for an aircraft occupant to be killed and (3) the number of years that would pass if such a flight

8 Barnett, A. And Wang, A.; Passenger Mortality Risk Estimates Provide Estimates about Airline Safety, Flight Safety Digest, April 2000, p. 1-12, Flight Safety Foundation.

was taken every day. For the purposes of this study, the mortality risk statistic was applied to both passengers and crewmembers.

2.58 On average, a jet aircraft occupant could expect to travel on nearly four times the number of flights as a turboprop aircraft occupant before being killed in a fatal accident. However, all the values contained in Table 7 indicate that fatal aircraft accidents are a low probability event.

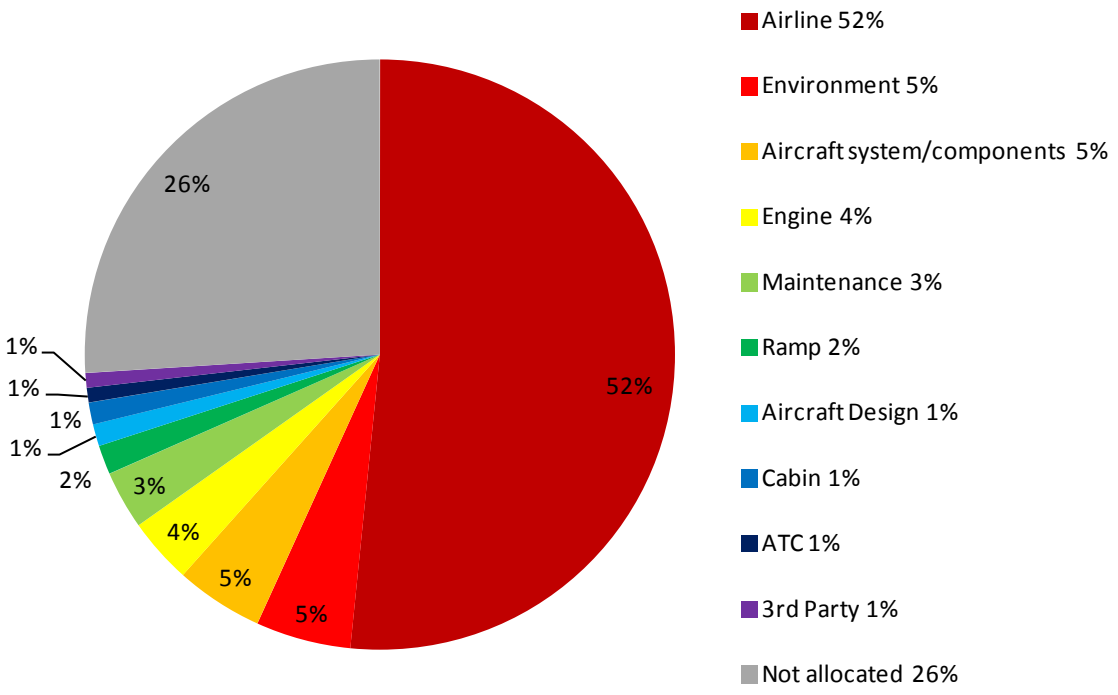
Table 7 Mortality risk for passenger flights for the ten-year period 2002 to 2011 broken down by aircraft class and operator region

	Per Flight	Number of Flights	Number of Years
All Passenger Flights	3.2x10-7	3.1 million	8,505
Jet Passenger Flights	2.0 x10-7	5.0 million	13,573
Turboprop Passenger Flights	7.9 x10-7	1.3 million	3,466
African Operator Passenger Flights	2.0 x10-6	0.5 million	1,390
Asian and Middle Eastern Operator Passenger Flights	4.0 x10-7	2.5 million	6,784
Caribbean, Central and South American Operator Passenger Flights	8.1 x10-7	1.2 million	3,365
European Operator Passenger Flights	2.7 x10-7	3.8 million	10,285
(EU)	5.8 x10-8	17.2 million	47,215
North American Operator Passenger Flights	5.3 x10-8	19.0 million	51,982
Oceania Operator Passenger Flights	1.9 x10-7	5.3 million	14,655

CHAPTER 3

Analysis of Primary Causal Factors

Figure 24 Breakdown of all fatal accidents by causal group (for primary causal factors only) for the ten-year period 2002 to 2011



Primary Causal Groups

3.1 Any number of causal factors may have been allocated for each fatal accident, of which only one was identified as the primary causal factor. Of the 250 fatal accidents that formed the dataset, 185 (74%) had sufficient information to allow allocation of primary causal factors. A complete list of all primary causal factors together with the number of times they were allocated can be found in Appendix F.

3.2 Figure 24 shows the proportion of all fatal accidents allocated a primary causal factor from each of the causal groups. 129 of the fatal accidents (52%) involved an Airline related primary causal factor. 32 of the fatal accidents (13%) involved an Airworthiness related primary causal factor such as system/component failure, engine failure, design issues and maintenance.

3.3 The proportion for individual aircraft classes, locations, and natures of flight were similar to those shown in Figure 24. The main difference was the proportion of accidents for which a primary causal factor was not allocated. 29 (38%) of the accidents that occurred in Africa had insufficient information to allow allocation of factors, compared with 1 (3%) accident in North America. Similarly, accidents involving turboprops or aircraft operating cargo flights had the highest numbers of unallocated primary causal factors.

Primary Causal Factors

Primary Causal Factors for All Fatal Accidents

3.4 Table 8 shows the top-ten individual primary causal factors allocated for all fatal accidents, together with the causal group to which they belong. These primary causal factors accounted for 59% of all fatal accidents and 80% of those that had a primary causal factor allocated.

Table 8 Top-ten primary causal factors allocated for all fatal accidents for the ten-year period 2002 to 2011

Rank	Causal Group	Primary Causal Factor	No. Fatal Accidents	Percentage
1	Airline	Flight Crew Handling/Skill – Flight handling	35	14%
2	Airline	Flight Crew Perception and Decision-making – Omission of action or inappropriate action	30	12%
3	Airline	Flight Crew Situational Awareness – Lack of positional awareness – in air	26	10%
4	Airline	Flight Crew Perception and Decision-making – Poor professional judgement or airmanship	20	8%
5	Maintenance	Maintenance or repair error	7	3%
6	Airline	Flight Crew Perception and Decision-making – Deliberate non-adherence to procedures	6	2%
7	Environment	Weather general	5	2%
7	Engine	Engine failure/malfunction or loss of thrust	5	2%
7	Environment	Icing	5	2%
10	Ramp	Loading error (includes load insecure, incorrectly distributed, inaccurately measured, or external door not secured)	4	2%
10	Aircraft System/ Components	System/component failure – other	4	2%

3.5 Table 9 shows the top ten individual primary causal factors in terms of the number of onboard fatalities incurred.

Table 9 Top-ten primary causal factors, in terms of onboard fatalities, allocated for all fatal accidents for the ten-year period 2002 to 2011

Rank	Causal Group	Primary Causal Factor	No. Fatalities	Percentage
1	Airline	Flight Crew Handling/Skill – Flight handling	1324	19%
2	Airline	Flight Crew Perception and Decision-making – Omission of action or inappropriate action	1109	16%
3	Airline	Flight Crew Situational Awareness – Lack of positional awareness – in air	559	8%
3	Airline	Flight Crew Perception and Decision-making – Poor professional judgement or airmanship	559	8%
5	Environment	Weather general	295	4%
6	Maintenance	Maintenance or repair error	273	4%
7	Airline	Flight Crew Perception and Decision-making – Deliberate non-adherence to procedures	232	3%
8	Airline	Flight Crew Situational Awareness – Lack of awareness of circumstances in flight	167	2%
9	Ramp	Loading error (includes load insecure, incorrectly distributed, inaccurately measured, or external door not secured)	155	2%
10	ATC	Failure to provide separation – air	152	2%

Primary Causal Factors by Aircraft Class

3.6 Table 10 shows the top-five individual primary causal factors allocated for each aircraft class. Data shown includes rank, number of fatal accidents allocated with the primary causal factor and percentage of all fatal accidents that this represents.

Table 10 Top-five primary causal factors allocated by aircraft class for the ten-year period 2002 to 2011

Primary Causal Factor	All Classes	Jets	Turboprops	Business Jets
Flight Crew Handling/Skill – Flight handling	1 [35] [14%]	2 [15] [16%]	1 [16] [13%]	1 [4] [14%]
Flight Crew Perception and Decision-making – Omission of action or inappropriate action	2 [30] [12%]	1 [18] [19%]	3 [9] [7%]	3 [3] [10%]
Flight Crew Situational Awareness – Lack of positional awareness – in air	3 [26] [10%]	4 [8] [8%]	2 [14] [11%]	1 [4] [14%]
Flight Crew Perception and Decision-making – Poor professional judgement or airmanship	4 [20] [8%]	3 [9] [9%]	4 [8] [6%]	3 [3] [10%]
Maintenance or repair error	5 [7] [3%]	10 [1] [1%]	5 [4] [3%]	5 [2] [7%]

3.7 All three aircraft classes had the same top four primary causal factors; however Jets had a lower proportion of 'Maintenance or repair error' primary causal factor. Both Turboprops and Business Jets had 'Flight Handling' as the most frequently assigned causal factor, whereas Jets had 'Omission of action or inappropriate action' as the most common causal factor.

Primary Causal Factors by Nature of Flight

3.8 Table 11 shows the top-five individual primary causal factors allocated for each nature of flight. Data shown includes rank, number of fatal accidents allocated with the primary causal factor and percentage of all fatal accidents that this represents.

Table 11 Top-five causal factors allocated by nature of flight for the ten-year period 2002 to 2011

Primary Causal Factor	All Natures of Flight	Passenger	Cargo	Ferry/ Positioning
Flight Crew Handling/Skill – Flight handling	1 [35] [14%]	1 [27] [19%]	4 [4] [5%]	2 [4] [13%]
Flight Crew Perception and Decision-making – Omission of action or inappropriate action	2 [30] [12%]	2 [21] [15%]	3 [6] [8%]	3 [3] [10%]
Flight Crew Situational Awareness – Lack of positional awareness – in air	3 [26] [10%]	3 [13] [9%]	1 [8] [10%]	1 [5] [17%]
Flight Crew Perception and Decision-making – Poor professional judgement or airmanship	4 [20] [8%]	4 [10] [7%]	2 [7] [9%]	3 [3] [10%]
Maintenance or repair error	5 [7] [3%]	6 [4] [3%]	N/A	3 [3] [10%]

3.9 All three natures of flight had the same top four primary causal factors. There were no fatal accidents assigned primary causal factor 'Maintenance or repair error' involving Cargo flights. Fatal accidents involving passenger flights accounted for 77% of all accidents allocated the 'Flight handling' primary causal factor.

Causal Factors by Operator Region

3.10 Table 12 shows the top-five primary causal factors allocated for each operator region. Data shown includes rank, number of fatal accidents allocated with the causal factor and percentage of all fatal accidents that this represents.

Table 12 Top-five primary causal factors allocated by operator region for the ten-year period 2002 to 2011

Primary Causal Factor	All Regions	Africa	Asia and Middle East
Flight Crew Handling/Skill – Flight handling	1 [35] [14%]	1 [7] [10%]	1 [9] [21%]
Flight Crew Perception and Decision-making – Omission of action or inappropriate action	2 [30] [12%]	4 [4] [6%]	2 [5] [12%]
Flight Crew Situational Awareness – Lack of positional awareness – in air	3 [26] [10%]	3 [5] [7%]	2 [5] [12%]
Flight Crew Perception and Decision-making – Poor professional judgement or airmanship	4 [20] [8%]	2 [7] [10%]	4 [3] [7%]
Maintenance or repair error	5 [7] [3%]	8 [1] [1%]	6 [1] [2%]

Primary Causal Factor	Caribbean, Central and South America	Europe	North America	Oceania
Flight Crew Handling/Skill – Flight handling	2 [5] [15%]	2 [6] [11%]	1 [8] [18%]	N/A
Flight Crew Perception and Decision-making – Omission of action or inappropriate action	4 [2] [6%]	1 [13] [24%]	3 [5] [11%]	1 [1] [20%]
Flight Crew Situational Awareness – Lack of positional awareness – in air	1 [6] [18%]	3 [4] [7%]	2 [6] [14%]	N/A
Flight Crew Perception and Decision-making – Poor professional judgement or airmanship	2 [5] [15%]	N/A	5 [4] [9%]	1 [1] [20%]
Maintenance or repair error	N/A	N/A	3 [5] [11%]	N/A

Note: Accident reporting criteria are not consistent throughout the world, so the number of factors assigned to fatal accidents may vary widely amongst the different operator regions. Care should be taken when drawing conclusions from this data.

3.11 'Flight Handling' was either the first or second most frequently assigned primary causal factor for all operator regions apart from Oceania. Primary causal factors involving the Flight Crew tended to dominate for most operator regions.

3.12 Results for Oceania operators should be treated with caution due to the low number of fatal accidents for this region.

CHAPTER 4

Analysis of All Causal Factors

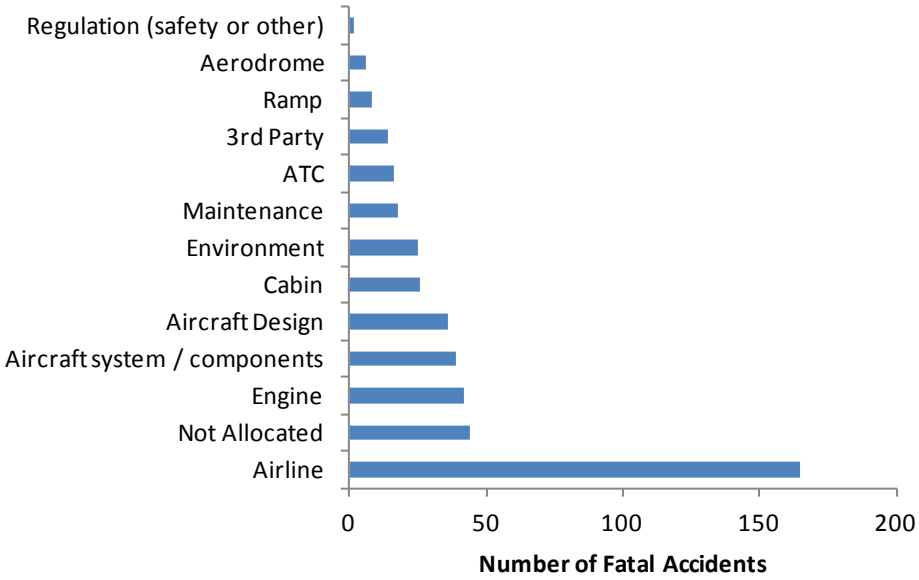
Causal Groups

4.1 Any number of causal factors may have been allocated for each fatal accident. Frequently, an accident results from a combination of causal factors and it is important to see the whole picture rather than just focus on the single primary causal factor. For the purposes of this study, primary causal factors have been included with the other causal factors in this Chapter.

4.2 Of the 250 fatal accidents that formed the whole dataset, 206 (82%) had sufficient information to allow allocation of at least one causal factor. The average number of causal factors allocated per fatal accident was 3.6 and the largest number for one fatal accident was 13. A complete list of all causal factors together with the number of times they were allocated can be found in Appendix F.

4.3 Figure 25 shows the number of fatal accidents allocated at least one causal factor from each of the causal groups. The causal groups are not mutually exclusive as each fatal accident could have been allocated a causal factor from more than one causal group. At least one causal factor from the 'Airline' group was assigned to 66% of all fatal accidents. 38% of all fatal accidents involved at least one airworthiness related causal factor, which includes Maintenance issues, System/Component failures, Engine failures and problems with aircraft design. The aircraft types most commonly assigned an airworthiness related causal factor were the Antonov An-12 and the Let L-410 Turbolet. 45% of the fatal accidents involving these aircraft types were assigned at least one Airworthiness related causal factor, 56% of which were the causal factor "Engine failure/malfunction".

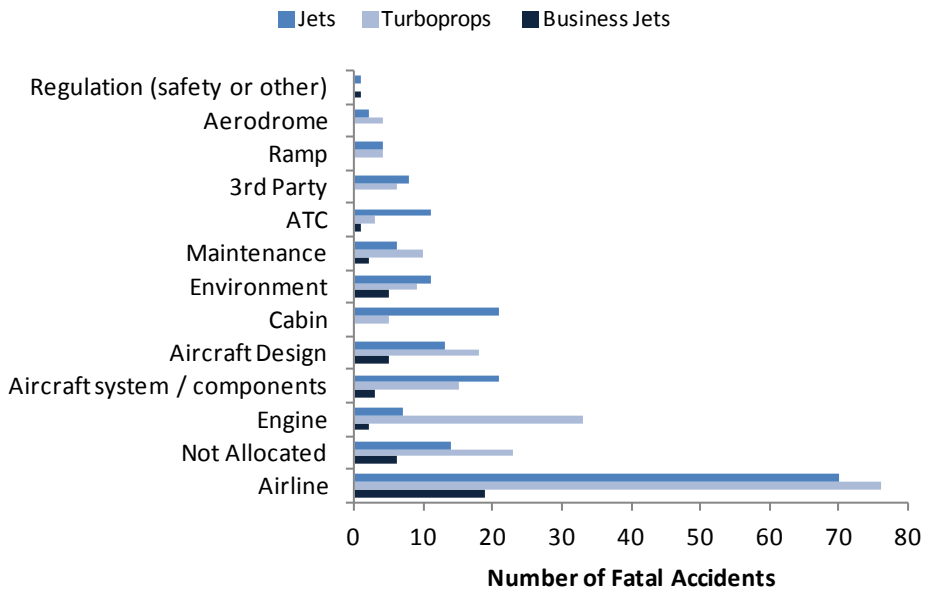
Figure 25 Breakdown of all fatal accidents by causal group (for all causal factors) for the ten-year period 2002 to 2011



Note: These causal groups are not mutually exclusive.

4.4 Figure 26 shows a breakdown, by aircraft class, of the proportion of fatal accidents allocated at least one causal factor from each of the causal groups.

Figure 26 Breakdown of fatal accidents by aircraft class and causal group (for all causal factors) for the ten-year period 2002 to 2011



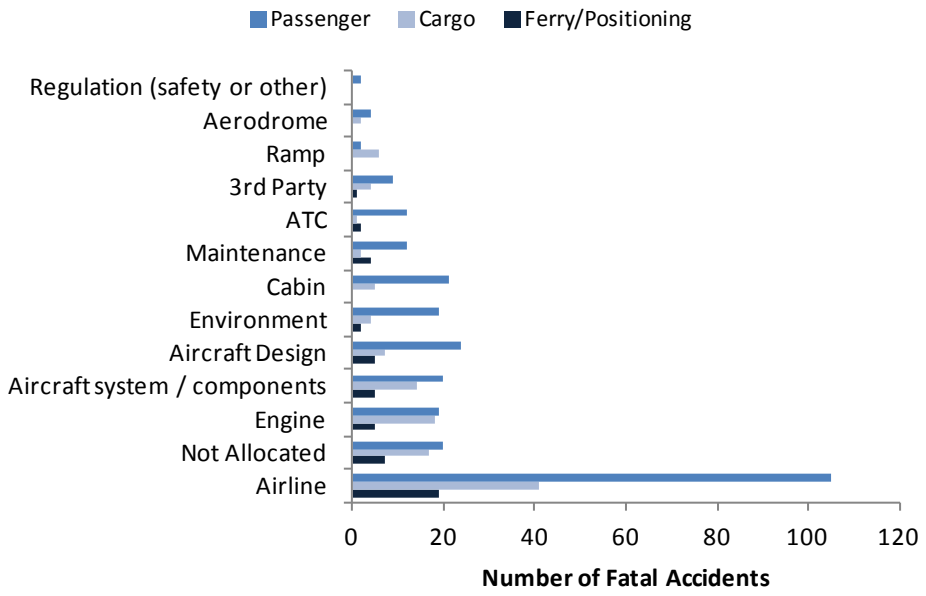
Note: These causal groups are not mutually exclusive.

4.5 Airline related causal factors were the most frequently allocated for all aircraft classes.

4.6 Figure 27 shows a breakdown, by nature of flight, of the proportion of fatal accidents allocated at least one causal factor from each of the causal groups.

4.7 Again, causal factors associated with the 'Airline' group were the most frequently allocated for all natures of flight. Passenger flights had a higher proportion of 'Aircraft Design' related causal factors assigned, whereas Cargo flights had 'Engine' related causal factors as the second most common group.

Figure 27 Breakdown of fatal accidents by nature of flight and causal group (for all causal factors) for the ten-year period 2002 to 2011



Note: These causal groups are not mutually exclusive.

Causal Factors

Causal Factors for All Fatal Accidents

4.8 Table 13 shows the top-ten individual causal factors allocated for all fatal accidents, together with the causal group to which they belong. These causal factors accounted for 68% of all fatal accidents and 83% of those that had at least one causal factor allocated. The causal factors are not mutually exclusive as each fatal accident could have been allocated more than one causal factor.

4.9 All but three of the top-ten causal factors came from the Airline group. The most frequently allocated causal factors were "Flight-handling" and "Omission of action or inappropriate action".

4.10 "Flight Handling" generally related to events in which the aircraft was controllable (including single engine failures in twin engine aircraft), however the flight crew's mishandling of the aircraft or poor manual flying skills lead to the catastrophic outcome.

4.11 "Omission of action or inappropriate action" generally related to flight crew continuing their descent below the decision height or minimum

descent/safety heights without visual reference, failing to fly a missed approach or omitting to set the correct aircraft configuration for take-off.

4.12 Approximately 8% if the fatal accidents involved fatal injuries sustained during a "Post crash fire" with the deceased having survived the initial impact.

Table 13 Top-ten causal factors allocated for all fatal accidents for the ten-year period 2002 to 2011

Rank	Causal Group	Causal Factor	No. Fatal Accidents	Percentage
1	Airline	Flight Crew Perception and Decision-making – Omission of action or inappropriate action	70	28%
1	Airline	Flight Crew Handling/Skill – Flight handling	70	28%
3	Airline	Flight Crew Perception and Decision-making – Poor professional judgement or airmanship	60	24%
4	Airline	Flight Crew Situational Awareness – Lack of positional awareness – in air	56	22%
5	Airline	Flight Crew Use of automation or tools – Failure in CRM (cross-check/co-ordinate)/TRM	52	21%
6	Engine	Engine failure/malfunction or loss of thrust	36	14%
7	Airline	Flight Crew Perception and Decision-making – "Press-on-itis"	25	10%
8	Aircraft Design	Design shortcomings (including documentation that forms part of the approved design standard)	23	9%
9	Cabin	Fire/smoke resulting from impact	20	8%
10	Airline	Flight Crew Handling/Skill – Slow and/or low on approach	18	7%

4.13 Table 14 shows the top-ten individual causal factors in terms of the number of onboard fatalities incurred.

Table 14 Top-ten causal factors, in terms of onboard fatalities, allocated for all fatal accidents for the ten-year period 2002 to 2011

Rank	Causal Group	Causal Factor	Onboard Fatalities	Percentage
1	Airline	Flight Crew Perception and Decision-making – Omission of action or inappropriate action	3,094	43%
2	Airline	Flight Crew Use of automation or tools – Failure in CRM (cross-check/co-ordinate)/TRM	2,654	37%
3	Airline	Flight Crew Handling/Skill – Flight handling	2,402	34%
4	Airline	Flight Crew Perception and Decision-making – Poor professional judgement or airmanship	2,229	31%
5	Airline	Flight Crew Situational Awareness – Lack of positional awareness – in air	1,858	26%
6	Cabin	Fire/smoke resulting from impact	1,380	19%
7	Airline	Flight Crew Perception and Decision-making – "Press-on-itis"	1,051	15%
8	Aircraft Design	Design shortcomings (including documentation that forms part of the approved design standard)	1,013	14%
9	Airline	Flight Crew Situational Awareness – Lack of awareness of circumstances in flight	933	13%
10	Airline	Flight Crew Use of automation or tools – Interaction with automation	905	13%

Causal Factors by Aircraft Class

4.14 Table 15 shows the top-five individual causal factors allocated for each aircraft class. Data shown includes rank, number of fatal accidents allocated with the causal factor and percentage of all fatal accidents that this represents.

Table 15 Top-five causal factors allocated by aircraft class for the ten-year period 2002 to 2011

	All Classes	Jets	Turboprops	Business Jets
Flight Crew Perception and Decision-making – Omission of action or inappropriate action	1 [70] [28%]	1 [38] [40%]	5 [22] [18%]	1 [10] [34%]
Flight Crew Handling/Skill – Flight handling	1 [70] [28%]	4 [26] [27%]	1 [34] [27%]	1 [10] [34%]
Flight Crew Perception and Decision-making – Poor professional judgement or airmanship	3 [60] [24%]	3 [28] [29%]	4 [24] [19%]	3 [8] [28%]
Flight Crew Situational Awareness – Lack of positional awareness – in air	4 [56] [22%]	5 [24] [25%]	3 [27] [22%]	5 [5] [17%]
Flight Crew Use of automation or tools – Failure in CRM (cross-check/co-ordinate)/TRM	5 [52] [21%]	2 [32] [33%]	6 [14] [11%]	4 [6] [21%]

Note: These causal factors are not mutually exclusive.

4.15 "Flight handing" was the most frequently assigned causal factor for Turboprops and "Omission of action or inappropriate action" was the most common causal factor for Jets. Business Jets were assigned these two causal factors equally.

Causal Factors by Nature of Flight

4.16 Table 16 shows the top-five causal factors allocated for each aircraft class. Data shown includes rank, number of fatal accidents allocated with the causal factor and percentage of all fatal accidents that this represents.

Table 16 Top-five causal factors allocated by nature of flight for the ten-year period 2002 to 2011

	All Natures of Flight	Passenger	Cargo	Ferry/ Positioning
Flight Crew Perception and Decision-making – Omission of action or inappropriate action	1 [70] [28%]	1 [47] [33%]	5 [11] [14%]	1 [12] [40%]
Flight Crew Handling/Skill – Flight handling	1 [70] [28%]	1 [47] [33%]	1 [16] [21%]	4 [7] [23%]
Flight Crew Perception and Decision-making – Poor professional judgement or airmanship	3 [60] [24%]	4 [38] [26%]	4 [13] [17%]	2 [9] [30%]
Flight Crew Situational Awareness – Lack of positional awareness – in air	4 [56] [22%]	5 [33] [23%]	3 [14] [18%]	2 [9] [30%]
Flight Crew Use of automation or tools – Failure in CRM (cross-check/co-ordinate)/TRM	5 [52] [21%]	3 [39] [27%]	6 [6] [8%]	4 [7] [23%]

Note: These causal factors are not mutually exclusive.

4.17 "Flight handling" was the most frequently assigned causal factor for Cargo flights whereas Ferry/Positioning flights were most commonly allocated "Omission of action or inappropriate action". Passenger flights were assigned these two causal factors equally. With the exception of "Engine Failure/Malfunction", which was the second most common causal factor for cargo flights, all other top-five causal factors came from the Airline causal group.

Causal Factors by Operator Region

4.18 Table 17 shows the top-five individual causal factors allocated for each operator region. Data shown includes rank, number of fatal accidents allocated with the causal factor and percentage of all fatal accidents that this represents.

Table 17 Top-five causal factors allocated by operator region for the ten-year period 2002 to 2011

Causal Factor	All Regions	Africa	Asia and Middle East
Flight Crew Perception and Decision-making – Omission of action or inappropriate action	1 [70] [28%]	5 [9] [13%]	2 [15] [35%]
Flight Crew Handling/Skill – Flight handling	1 [70] [28%]	1 [19] [27%]	2 [15] [35%]
Flight Crew Perception and Decision-making – Poor professional judgement or airmanship	3 [60] [24%]	3 [15] [21%]	4 [13] [30%]
Flight Crew Situational Awareness – Lack of positional awareness – in air	4 [56] [22%]	4 [10] [14%]	1 [16] [37%]
Flight Crew Use of automation or tools – Failure in CRM (cross-check/co-ordinate)/TRM	5 [52] [20%]	6 [8] [11%]	5 [12] [28%]

Causal Factor	Caribbean, Central and South America	Europe	North America	Oceania
Flight Crew Perception and Decision-making – Omission of action or inappropriate action	2 [9] [27%]	1 [18] [33%]	1 [16] [36%]	1 [3] [60%]
Flight Crew Handling/Skill – Flight handling	4 [8] [24%]	3 [10] [18%]	2 [15] [34%]	1 [3] [60%]
Flight Crew Perception and Decision-making – Poor professional judgement or airmanship	2 [9] [27%]	6 [8] [15%]	3 [13] [30%]	4 [2] [40%]

Causal Factor	Caribbean, Central and South America	Europe	North America	Oceania
Flight Crew Situational Awareness – Lack of positional awareness – in air	1 [10] [30%]	4 [9] [16%]	4 [10] [23%]	4 [1] [20%]
Flight Crew Use of automation or tools – Failure in CRM (cross-check/co-ordinate)/TRM	4 [8] [24%]	2 [12] [22%]	4 [10] [23%]	9 [2] [40%]

Note 1: Accident reporting criteria are not consistent throughout the world, so the number of factors assigned to fatal accidents may vary widely amongst the different operator regions. Care should be taken when drawing conclusions from this data.

Note 2: These causal factors are not mutually exclusive.

4.19 Although "Flight Handling" was the most frequently assigned causal factor for all regions, it was only the top (or joint top) causal factor for Africa and Oceania. Europe, North America and Oceania each had "Omission of action or inappropriate action" as the either the most frequently or joint most frequently assigned causal factor. Both the Asia and Middle East, and Caribbean, Central and South America regions were most frequently allocated the "Lack of positional awareness – in air" causal factor, which was 4th for all regions.

CHAPTER 5

Analysis of Circumstantial Factors

Circumstantial Factors for All Fatal Accidents

5.1 A circumstantial factor is an event or aspect, which is not directly in the causal chain of events but could have contributed to the fatal accident. A fatal accident may have been allocated any number of circumstantial factors in any combination.

5.2 Of the 250 fatal accidents that formed the whole dataset, 169 (or 68%) had at least one circumstantial factor. The average number of circumstantial factors allocated per fatal accident was 2.5 and the largest number for one fatal accident was eight. A complete list of all circumstantial factors together with the number of times they were allocated can be found in Appendix F.

5.3 Table 18 shows the top-ten individual circumstantial factors allocated for all fatal accidents. These circumstantial factors accounted for 62% of all fatal accidents and 91% of those that had at least one circumstantial factor allocated. The circumstantial factors are not mutually exclusive as each fatal accident could have been allocated more than one circumstantial factor.

Table 18 Top-ten circumstantial factors allocated for all fatal accidents for the ten-year period 2002 to 2011

Rank	Circumstantial Factor	No. Fatal Accidents	%
1	Poor visibility or lack of external visual reference	65	26%
2	Weather general	55	22%
3	Non-fitment of presently available safety equipment (GPWS, EGPWS, TCAS, windshear warning, etc.)	49	20%
4	Inadequate regulatory oversight	40	16%
5	Time allocated to task by company inadequate	37	15%
6	Flight Crew Use of automation or tools – Failure in CRM (cross-check/co-ordinate)/TRM	28	11%
7	Lack of or inadequate qualification, training or experience	21	8%
8	Incorrect or inadequate procedures	17	7%
8	Non-precision approach flown	17	7%
10	Inadequate regulation	15	6%

Note: These circumstantial factors are not mutually exclusive.

5.4 The most frequently allocated circumstantial factor was "Poor visibility or lack of external visual reference". In the majority of cases this circumstantial factor was assigned, the accident occurred during a period of thick fog. The second most frequently assigned circumstantial factor "Weather general" mainly referred to accidents which occurred during heavy rain/snow, high winds or icing conditions.

5.5 "Non-fitment of presently available safety equipment" was the third most common circumstantial factor. Of the 49 fatal accidents that were assigned this circumstantial factor, 36 (73%) referred to non-fitment of the latest Terrain Awareness and Warning Systems (TAWS), such as the Enhanced Ground Proximity Warning System (EGPWS). This circumstantial factor was used even if an aircraft was not required to have the safety equipment fitted, or if the equipment was not available at the time of the accident. The intention was to identify fatal accidents where the use of more advanced technology or extending the coverage of requirements for an existing technology might have helped to prevent the catastrophic outcome.

5.6 Table 19 shows the top-ten individual circumstantial factors in terms of the number of onboard fatalities incurred.

Table 19 Top-ten circumstantial factors, in terms of onboard fatalities, allocated for all fatal accidents for the ten-year period 2002 to 2011

Rank	Circumstantial Factor	Onboard Fatalities	%
1	Poor visibility or lack of external visual reference	2,329	33%
2	Weather general	2,121	30%
3	Non-fitment of presently available safety equipment (GPWS, EGPWS, TCAS, windshear warning, etc.)	1,398	20%
4	Time allocated to task by company inadequate	1,293	18%
5	Inadequate regulatory oversight	1,226	17%
6	Lack of or inadequate qualification, training or experience	1,084	15%
7	Flight Crew Use of automation or tools – Failure in CRM (cross-check/co-ordinate)/TRM	902	13%
8	Non-precision approach flown	770	11%
9	Pre-existing inoperative aircraft systems (for example inoperative thrust reverser known about prior to flight)	605	8%
10	Non-fitment of presently available ATC system or equipment (e.g. MSAW)	564	8%

Note: These circumstantial factors are not mutually exclusive

Circumstantial Factors by Aircraft Class

5.7 Table 20 shows the top-five individual circumstantial factors allocated for each aircraft class. Data shown includes rank, number of fatal accidents allocated with the circumstantial factor and percentage of all fatal accidents that this represents.

Table 20 Top-five circumstantial factors allocated by aircraft class for the ten-year period 2002 to 2011

Circumstantial Factor	All Classes	Jets	Turboprops	Business Jets
Poor visibility or lack of external visual reference	1 [65] [26%]	1 [27] [28%]	1 [30] [24%]	1 [8] [28%]
Weather general	2 [55] [22%]	2 [26] [27%]	3 [24] [19%]	3 [5] [17%]
Non-fitment of presently available safety equipment (GPWS, EGPWS, TCAS, windshear warning, etc.)	3 [49] [19%]	3 [19] [20%]	2 [25] [20%]	3 [5] [17%]
Inadequate regulatory oversight	4 [40] [16%]	4 [16] [17%]	4 [21] [17%]	4 [3] [10%]
Time allocated to task by company inadequate	5 [37] [15%]	4 [16] [17%]	5 [18] [14%]	4 [3] [10%]

5.8 "Poor visibility or lack of external visual reference" was the most frequently assigned circumstantial factor for all three aircraft classes. The causal factors "Weather general" and "Non-fitment of presently available equipment" were the second and third most commonly assigned circumstantial factors for Jets, vice-versa for Turboprops, and the joint third most frequent for Business Jets.

Circumstantial Factors by Nature of Flight

5.9 Table 21 shows the top-five individual circumstantial factors allocated for each nature of flight. Data shown includes rank, number of fatal accidents allocated with the circumstantial factor and percentage of all fatal accidents that this represents.

Table 21 Top-five circumstantial factors allocated by nature of flight for the ten-year period 2002 to 2011

Circumstantial Factor	All Natures of Flight	Passenger	Cargo	Ferry/ Positioning
Poor visibility or lack of external visual reference	1 [65] [26%]	1 [42] [29%]	1 [15] [19%]	1 [8] [27%]
Weather general	2 [55] [22%]	2 [38] [26%]	4 [12] [16%]	5 [5] [17%]
Non-fitment of presently available safety equipment (GPWS, EGPWS, TCAS, windshear warning, etc.)	3 [49] [19%]	3 [30] [21%]	3 [13] [17%]	2 [6] [20%]
Inadequate regulatory oversight	4 [40] [16%]	4 [23] [16%]	4 [12] [16%]	2 [6] [20%]
Time allocated to task by company inadequate	5 [37] [15%]	5 [19] [13%]	2 [14] [18%]	5 [5] [17%]

5.10 "Poor visibility or lack of external visual reference" was the most commonly allocated circumstantial factor for all natures of flight. The "Weather general" circumstantial factor featured more highly for passenger than for cargo or ferry/positioning flights.

Circumstantial Factors by Operator Region

5.11 Table 22 shows the top-five individual circumstantial factors allocated for each operator region. Data shown includes rank, number of fatal accidents allocated with the circumstantial factor and percentage of all fatal accidents that this represents.

5.12 "Poor visibility or lack of external visual reference" and "Non-fitment of presently available safety equipment" featured in the top-five circumstantial factors for all operator regions.

5.13 Weather related circumstantial factors were involved in 39% of all fatal accidents.

5.14 Results for Oceania operators should be treated with caution due to the low number of fatal accidents for this region.

Table 22 Top-five circumstantial factors allocated by operator region for the ten-year period 2002 to 2011

Circumstantial Factor	All Regions	Africa	Asia and Middle East
Poor visibility or lack of external visual reference	1 [65] [26%]	2 [14] [20%]	1 [11] [26%]
Weather general	2 [55] [22%]	1 [16] [23%]	1 [11] [26%]
Non-fitment of presently available safety equipment (GPWS, EGPWS, TCAS, windshear warning, etc.)	3 [49] [19%]	5 [7] [10%]	3 [7] [16%]
Inadequate regulatory oversight	4 [40] [16%]	3 [12] [17%]	5 [6] [14%]
Time allocated to task by company inadequate	5 [37] [15%]	4 [11] [15%]	7 [5] [12%]

Circumstantial Factor	Caribbean, Central and South America	Europe	North America	Oceania
Poor visibility or lack of external visual reference	2 [7] [21%]	1 [19] [35%]	3 [11] [25%]	1 [3] [60%]
Weather general	2 [7] [21%]	2 [13] [24%]	6 [6] [14%]	3 [2] [40%]
Non-fitment of presently available safety equipment (GPWS, EGPWS, TCAS, windshear warning, etc.)	1 [13] [39%]	3 [9] [16%]	1 [12] [27%]	5 [1] [20%]
Inadequate regulatory oversight	13 [1] [3%]	5 [8] [15%]	1 [12] [27%]	3 [2] [40%]
Time allocated to task by company inadequate	5 [3] [9%]	5 [8] [15%]	4 [10] [23%]	5 [1] [20%]

Note 1: Accident reporting and investigation criteria are not consistent throughout the world, so the number of factors assigned to fatal accidents may vary widely amongst the different operator regions. Care should be taken when drawing conclusions from this data.

Note 2: These circumstantial factors are not mutually exclusive.

CHAPTER 6

Analysis of Consequences

Consequences for All Fatal Accidents

6.1 A list of consequences was used to record the outcomes of the fatal accidents. Although the consequences are not part of the cause of an accident, they are relevant to a complete understanding of the accident history, and in many cases the outcome is all that is known about an accident.

6.2 At least one consequence was allocated for 244 of the 250 fatal accidents. The remaining 6 fatal accidents had insufficient information to determine a consequence. The average number of consequences allocated per fatal accident was 1.7 and the largest number for one fatal accident was four. A complete list of all consequences together with the number of times they were allocated can be found in Appendix F.

6.3 Table 23 shows the top-ten consequences allocated for all fatal accidents and Figure 28 shows the same information but in a graphical format. These consequences accounted for 92% of all fatal accidents.

Table 23 Top-ten consequences for all fatal accidents for the ten-year period 2002 to 2011

Rank	Consequence	No. Fatal Accidents	%
1	Fire/Smoke resulting from impact	91	36%
2	Loss of aircraft control (non-technical failure)	52	21%
3	Controlled Flight into Terrain (CFIT)	47	19%
4	Runway Excursion	35	14%
5	Loss of aircraft control (technical failure)	32	13%
6	Collision with obstacle(s), during take-off or landing	31	12%
7	Collision with obstacle(s) while taxiing	24	10%
8	Forced landing on land or water	20	8%
9	Fire or smoke in or on the aircraft during operation	12	5%
10	Runway undershoot or overshoot	10	4%
10	Emergency evacuation difficulties	10	4%

6.4 "Fire/Smoke resulting from impact" was the most frequently allocated consequence with 36% of all fatal accidents involving some kind of fire/smoke resulting from impact.

6.5 The "Loss of control in flight" consequence was broken down into four subcategories, three of which ("Following technical failure", "Following non-technical failure" and "Following icing") reflect the loss of control categories used in the CAA Safety Plan. Both "Loss of control in flight following non-technical failure" and "Loss of control in flight following technical failure" featured in the top-ten most frequently assigned consequences, in 2nd and 5th place respectively.

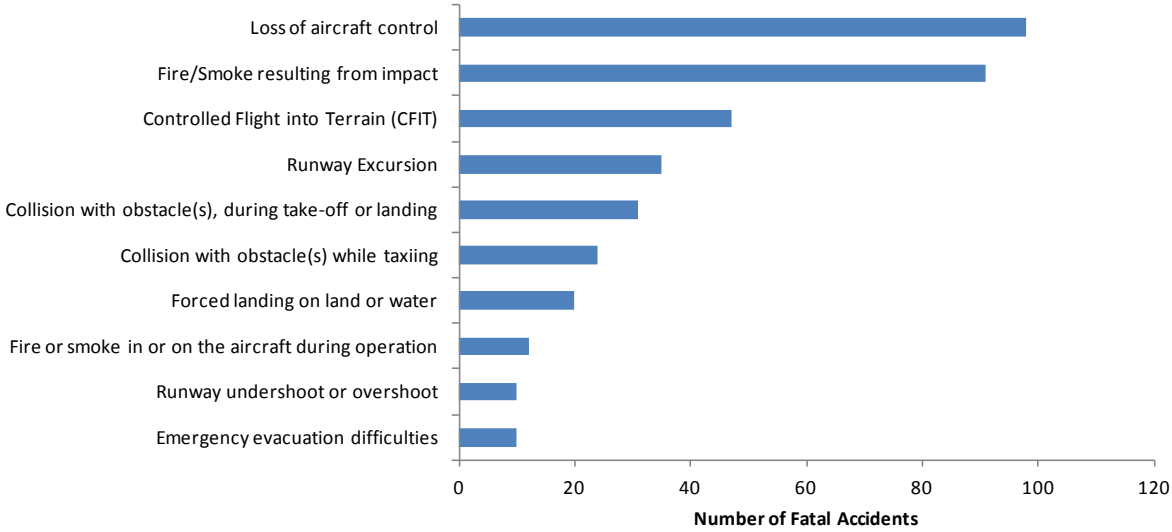
6.6 Nearly 40% of all fatal accidents involved some kind of loss of control, making this the most frequent type of accident. Loss of control events were broken down into four categories – following technical failure, following non-technical failure, following icing, and following unknown reasons. Of these four, non-technical failures (for example flight crew failing to correctly respond to a warning) were the predominant cause of loss of control accidents.

6.7 Roughly half of all fatal accidents in which the pilot(s) lost control following a non-technical failure resulted in a post-crash fire, making this the most common post-crash fire precursor.

6.8 Over a third of all fatal accidents involved a post-crash fire; however this was always in conjunction with, or as a result of another consequence rather than in its own right. Fires in flight were far less common, accounting for 5% of all fatal accidents.

6.9 "Controlled Flight into Terrain (CFIT)" was the third most common consequence, accounting for 19% of all fatal accidents.

Figure 28 Top-ten consequences for all fatal accidents for the ten-year period 2002 to 2011

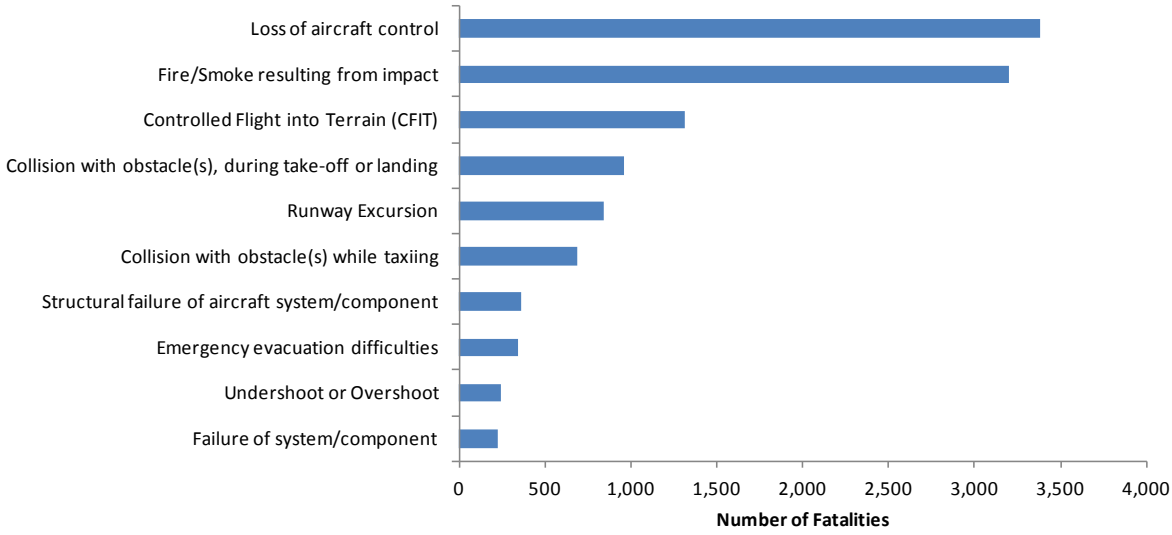


Note: These consequences are not mutually exclusive (apart from the "Loss of control in flight" subcategories).

6.10 Figure 29 shows the top-ten consequences allocated for all fatal accidents in terms of the number of onboard fatalities. The three most common consequences were the same as in Figure 28. "Fire/Smoke resulting from impact" was a consequence, although not necessarily a cause, in accidents resulting in 3,199 onboard fatalities (or 45% of the total number on onboard fatalities). The equivalent values for "Loss of aircraft control (non-technical failure)" and "Controlled Flight into Terrain" were 2,027 (28%) and 1,318 (18%) respectively.

6.11 The main difference in Figure 29, compared to Figure 28, was the elevation of "Structural failure of aircraft system/component". This consequence was allocated in 3% of all fatal accidents but was involved in 5% of all onboard fatalities.

Figure 29 Top-ten consequences for all fatal accidents for the ten-year period 2002 to 2011 in terms of the number of onboard fatalities



Note: These consequences are not mutually exclusive (apart from the "Loss of control in flight" subcategories).

6.12 A notable consequence that does not feature in either Figure 28 or Figure 29 was "Mid-air collision". There were three fatal mid-air collision accidents, which resulted in 227 onboard fatalities.

Consequences by Aircraft Class

6.13 Table 24 shows the top-five individual consequences allocated for each aircraft class. Data shown includes rank, number of fatal accidents allocated with the consequence and percentage of all fatal accidents that this represents.

6.14 "Fire/Smoke resulting from impact" was the most frequently identified consequence for all three aircraft classes. "Loss of control following a non-technical failure" featured in a higher proportion of fatal accidents involving Business Jets than for the other aircraft classes.

Table 24 Top-five consequences allocated by aircraft class for the ten-year period 2002 to 2011

Consequence	All Classes	Jets	Turboprops	Business Jets
Fire/Smoke resulting from impact	1 [91] [36%]	1 [43] [45%]	1 [33] [26%]	1 [15] [52%]
Loss of aircraft control during flight following non-technical failure	2 [52] [21%]	3 [21] [22%]	4 [20] [16%]	2 [11] [38%]
Controlled Flight into Terrain (CFIT)	3 [47] [19%]	4 [17] [18%]	2 [25] [20%]	4 [5] [17%]
Runway Excursion	4 [35] [14%]	2 [21] [22%]	7 [8] [6%]	3 [6] [21%]
Loss of aircraft control during flight following technical failure	5 [32] [13%]	8 [6] [6%]	3 [23] [18%]	6 [3] [10%]

Note: These consequences are not mutually exclusive (apart from the "Loss of control in flight" subcategories).

Consequences by Nature of Flight

6.15 Table 25 shows the top-five individual consequences allocated for each nature of flight. Data shown includes rank, number of fatal accidents allocated with the consequence and percentage of all fatal accidents that this represents.

6.16 "Fire/Smoke resulting from impact" was the most frequently allocated consequence for all three natures of flight. Both Cargo and Ferry/Positioning flights were assigned "Loss of aircraft following non-technical failure" as their second most common consequence, whereas Passenger flights were more frequently assigned "Controlled Flight into Terrain".

Table 25 Top-five consequences allocated by nature of flight for the ten-year period 2002 to 2011

	All Natures of Flight	Passenger	Cargo	Ferry/ Positioning
Fire/Smoke resulting from impact	1 [91] [36%]	1 [55] [38%]	1 [26] [34%]	1 [11] [37%]
Loss of aircraft control during flight following non-technical failure	2 [52] [21%]	3 [27] [19%]	2 [18] [23%]	2 [7] [23%]
Controlled Flight into Terrain (CFIT)	3 [47] [19%]	2 [29] [20%]	4 [12] [16%]	3 [6] [20%]
Runway Excursion	4 [35] [14%]	3 [26] [18%]	7 [6] [8%]	6 [3] [10%]
Loss of aircraft control during flight following technical failure	5 [32] [13%]	5 [17] [12%]	5 [9] [12%]	3 [6] [20%]

Note: These consequences are not mutually exclusive (apart from the "Loss of control in flight" subcategories).

Consequences by Operator Region

6.17 Table 26 shows the top-five individual consequences allocated for each operator region. Data shown includes rank, number of fatal accidents allocated with the consequence and percentage of all fatal accidents that this represents.

6.18 "Fire/Smoke resulting from impact" was the most frequently assigned consequence for all operator regions. "Loss of control following non-technical failure" was the second most common circumstance for both European and North American operators, whereas a high proportion of Asian and Middle Eastern operators were allocated "Controlled Flight into Terrain".

Table 26 Top-five consequences allocated by operator region for the ten-year period 2002 to 2011

	All Regions	Africa	Asia and Middle East
Fire/Smoke resulting from impact	1 [91] [36%]	1 [25] [35%]	1 [15] [35%]
Loss of aircraft control during flight following non-technical failure	2 [52] [21%]	4 [12] [17%]	4 [5] [12%]
Controlled Flight into Terrain (CFIT)	3 [47] [19%]	6 [8] [11%]	2 [12] [28%]
Runway Excursion	4 [35] [14%]	3 [12] [17%]	3 [7] [16%]
Loss of aircraft control during flight following technical failure	5 [32] [13%]	7 [7] [10%]	4 [5] [12%]

	Caribbean, Central and South America	Europe	North America	Oceania
Fire/Smoke resulting from impact	1 [7] [21%]	1 [22] [40%]	1 [21] [48%]	1 [2] [40%]
Loss of aircraft control during flight following non-technical failure	3 [5] [15%]	2 [15] [27%]	2 [14] [32%]	4 [1] [20%]
Controlled Flight into Terrain (CFIT)	1 [7] [21%]	3 [8] [15%]	3 [11] [25%]	4 [1] [20%]
Runway Excursion	4 [4] [12%]	5 [5] [9%]	4 [7] [16%]	N/A
Loss of aircraft control during flight following technical failure	6 [3] [9%]	3 [8] [15%]	4 [7] [16%]	1 [2] [40%]

Note 1: These consequences are not mutually exclusive (apart from the "Loss of control in flight" subcategories).

Note 2: Accident reporting criteria and investigation are not consistent throughout the world, so the number of consequences assigned to fatal accidents may vary widely amongst the different operator regions. Care should be taken when drawing conclusions from this data.

Consequential Analysis

Introduction

6.19 It is recognised that accidents are generally the consequence of a chain of events, and not the result of just one causal factor. The consequences allocated in the ten-year period have been broken down by 'Significant Seven' and shown in terms of the most commonly assigned causal and circumstantial factors for those fatal accidents.

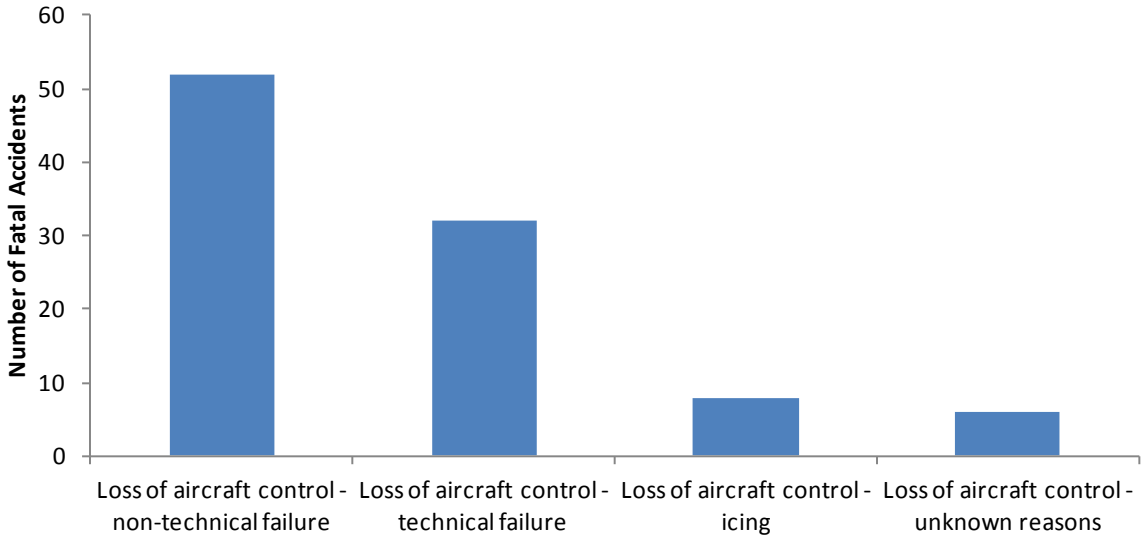
Loss of Control

6.20 This section includes the following consequences:

- "Loss of aircraft control or deviation from intended flightpath during flight following non-technical failure"
- "Loss of aircraft control or deviation from intended flightpath during flight following technical failure"
- "Loss of aircraft control or deviation from intended flightpath during flight following icing"
- "Loss of aircraft control or deviation from intended flightpath during flight for unknown reasons"

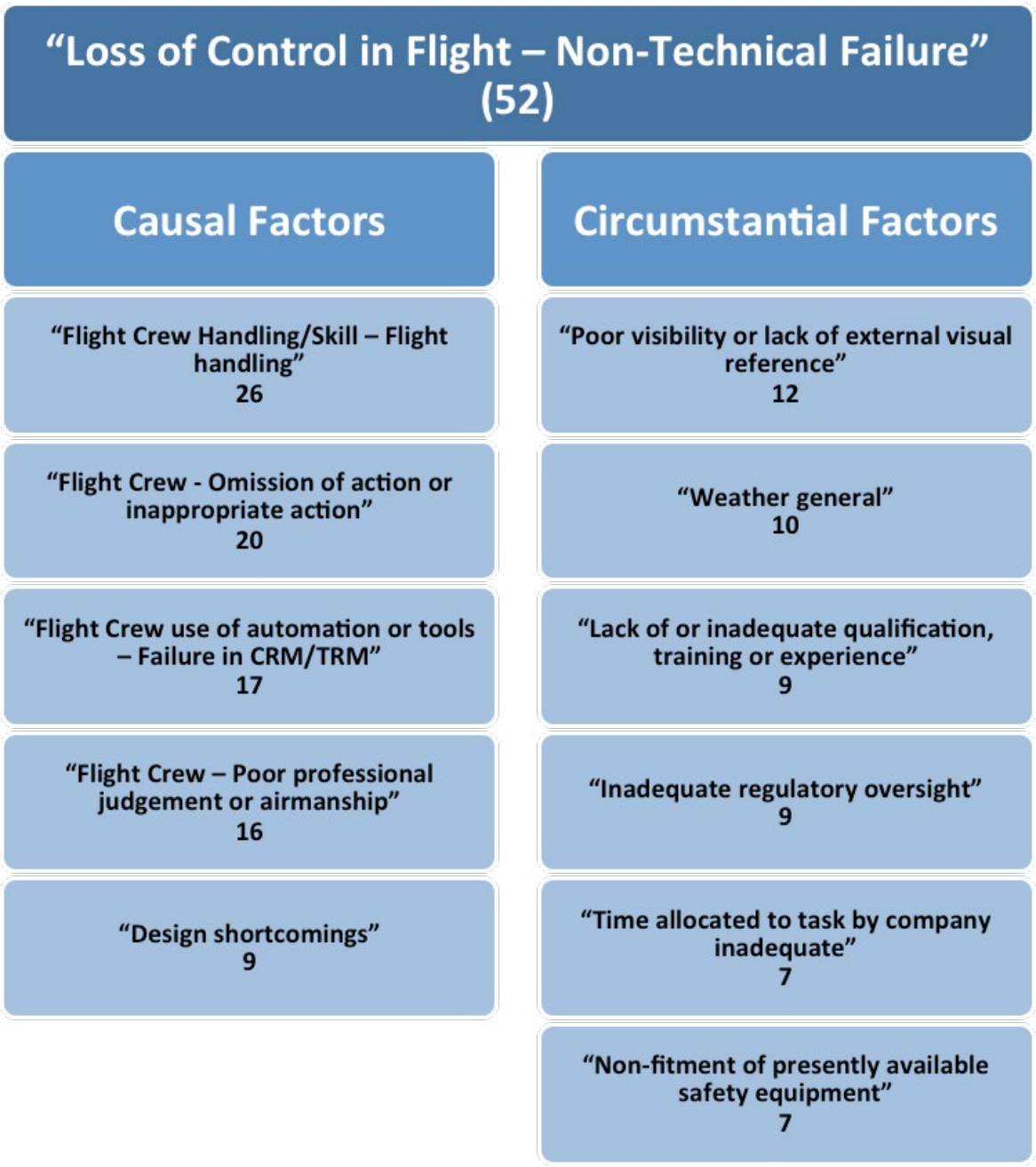
6.21 Figure 30 shows that significantly less fatal accidents were assigned the causal factors "Loss of aircraft control due to icing" and "Loss of aircraft control for unknown reasons" than "Loss of control due to non-technical failure" and "Loss of control due to technical failure". As such, this section will focus on those fatal accidents resulting in loss of control due to technical and non-technical reasons.

Figure 30 Number of fatal accidents per specific loss of control consequence



6.22 Figure 32 shows the most common causal and circumstantial factors allocated for all fatal accidents with a "Loss of control in flight following technical failure" consequence. The numbers under each causal and circumstantial factor refer to the number of fatal accidents allocated with that factor and consequence.

Figure 31 Top-five causal and circumstantial factors associated with fatal accidents with a "Loss of control in flight following a non-technical failure" consequence

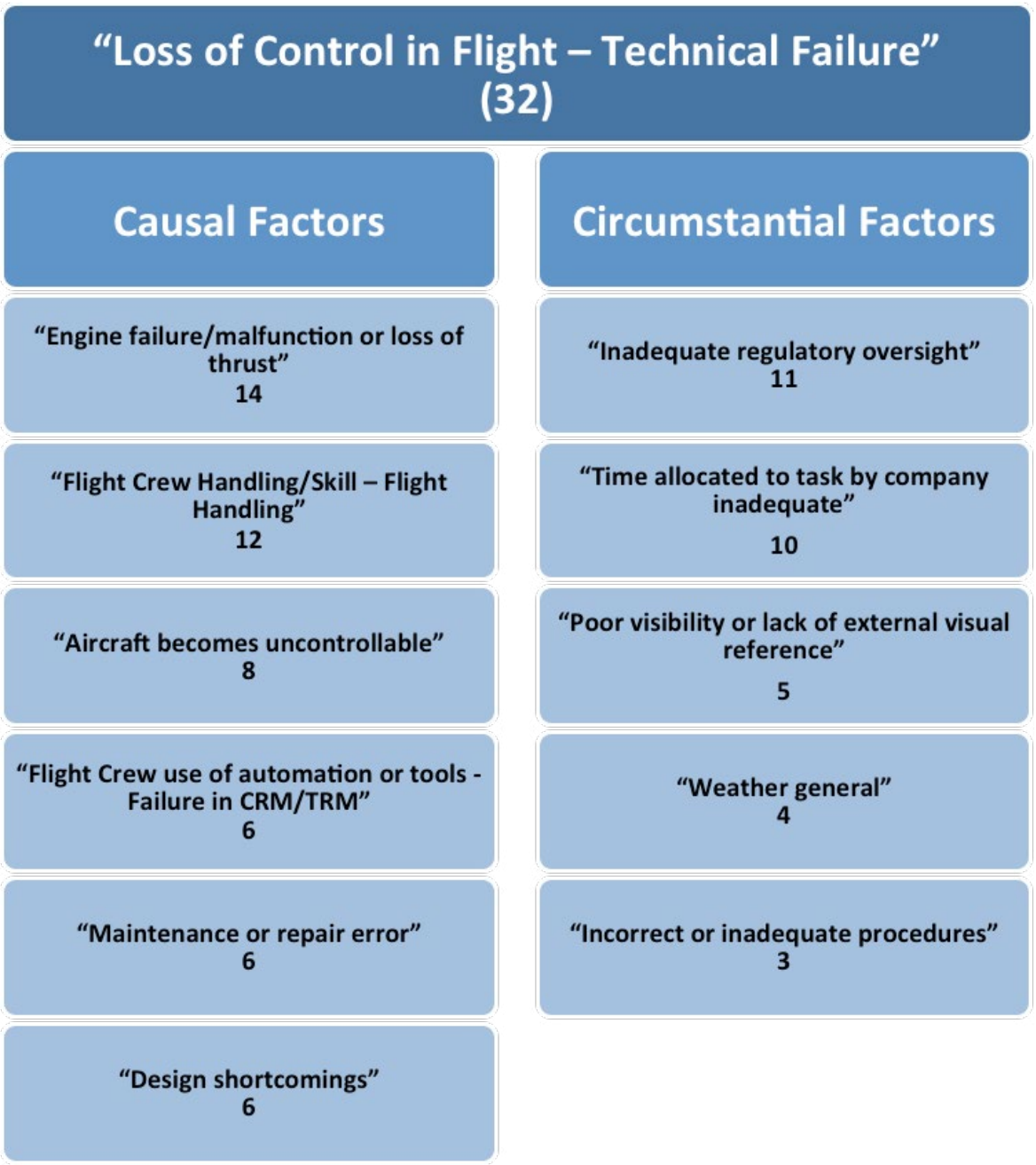


6.23 75% of all "Loss of control in flight following a non-technical failure" events were assigned a flight crew related casual factor.

6.24 The top causal factor "Flight Crew Handling" was allocated for 50% of all "Loss of control in flight following a non-technical failure" related accidents. This generally related to events in which the Flight Crew failed to recover from under-speed/over-speed or a stall.

6.25 The second most commonly assigned causal factor was "Flight Crew omission of action or inappropriate action". This was assigned to 38% of the "Loss of control in flight following a non-technical failure" fatal accidents and covered cases where the Flight Crew did not adhere to standard operating procedures. This was commonly assigned to accidents in which the Flight Crew either failed to correctly respond to a warning (for example a "Stick-shaker" warning) or had incorrectly configured the aircraft (for example incorrect flap usage).

Figure 32 Top-five causal and circumstantial factors associated with fatal accidents with a "Loss of control in flight following technical failure" consequence



6.26 "Engine failure/malfunction or loss of thrust" was the most common causal factor for "Loss of control in flight following a technical failure" accounting for 44% of these types of events. Often "Loss of control in flight following a technical failure" events involve a combination of a technical failure and the flight crew mishandling the situation in some way. As such, 63% of these accidents were assigned a flight crew related causal factor.

6.27 Figure 31 shows the most common causal and circumstantial factors allocated for all fatal accidents with a "Loss of control in flight following a non-technical failure" consequence.

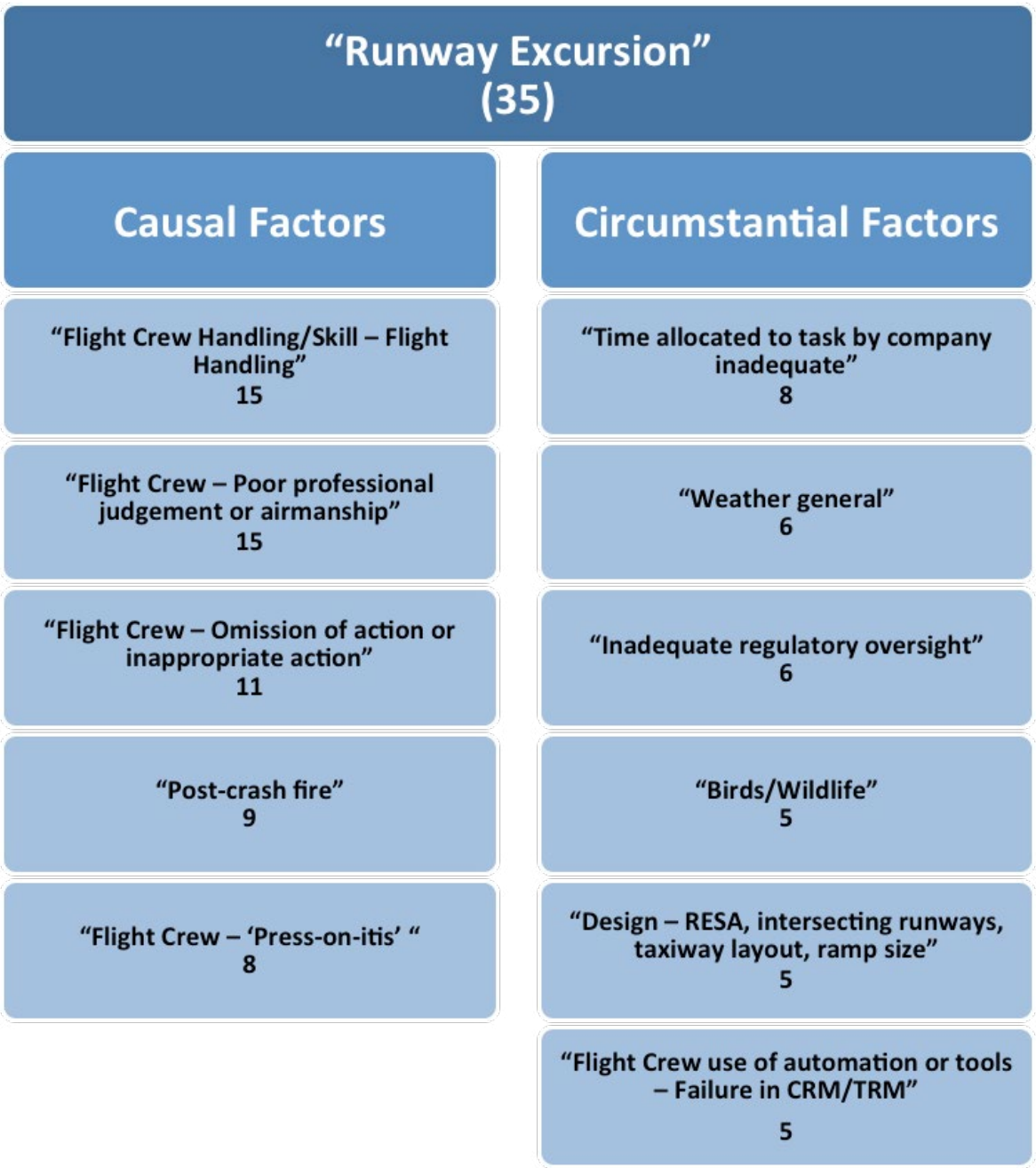
Runway Excursion

6.28 This includes the following consequence:

- "Runway Excursion"

6.29 Figure 33 shows the most common causal and circumstantial factors allocated for all fatal accidents with a "Runway Excursion" consequence.

Figure 33 Top-five causal and circumstantial factors associated with fatal accidents with a "Runway Excursion" consequence



Note: 'Press-on-itis' is defined as the tendancy to 'press on' in circumstances where the conditions dictate a review of that decision.

6.30 Four out of the top five causal factors associated with Runway Excursion events were related to the Flight Crew. These four causal factors were mostly associated with either a failure to initiate or correctly execute a go-around, or failing to initiate or correctly execute an aborted take-off.

6.31 Aircraft in the landing phase of flight accounted for 54% of all Runway Excursion events, and those in the take-off flight phase accounted for 43%. The remaining 3% occurred as the aircraft was attempting a go-around. Of the Runway excursions during the landing phase, 40% took place at some stage in a non-precision approach.

6.32 77% of the fatal Runway Excursion accidents involved an aircraft overrunning the end of the runway, often colliding with obstacles. The remaining 23% involved aircraft veering off the side of the runway, the majority of which were as a result of an unstable landing.

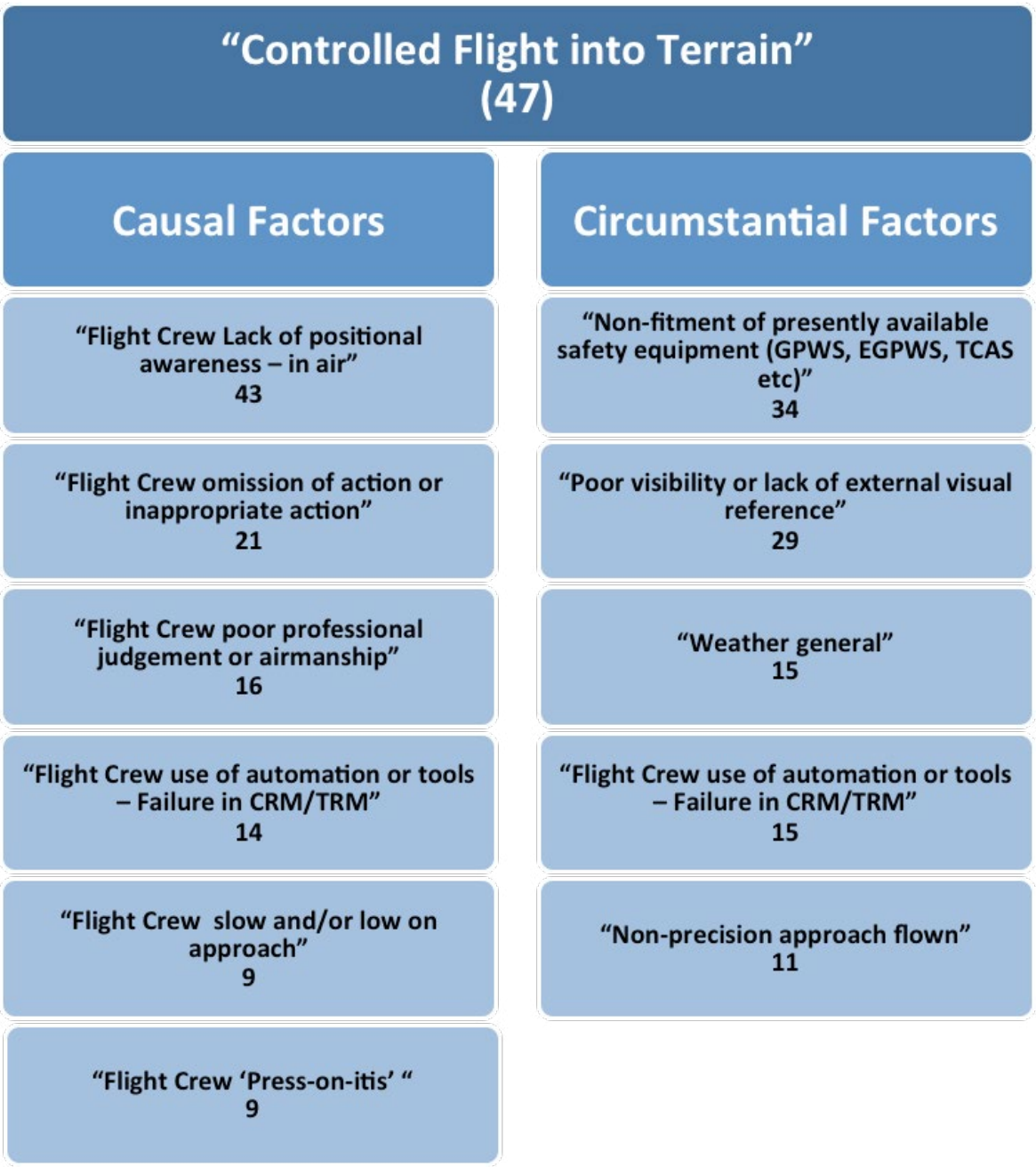
Controlled Flight into Terrain

6.33 This includes the following consequence:

- "Controlled Flight into Terrain (CFIT)"

6.34 Figure 34 shows the most common causal and circumstantial factors allocated for all fatal accidents with a "Controlled Flight into Terrain" consequence.

Figure 34 Top-five causal and circumstantial factors associated with fatal accidents with a "Controlled Flight into Terrain" consequence



Note: 'Press-on-itis' is defined as the tendancy to 'press on' in circumstances where the conditions dictate a review of that decision.

6.35 66% of all CFIT events occurred during the approach phase of flight, 4% occurred during take-off and the remaining 30% occurred during the climb, descent and en-route flight phases. Of the events which occurred during the approach flight phase, 77% took place whilst the aircraft was flying a non precision approach.

6.36 Over 60% of all CFIT events occurred during daylight, however 58% of these were assigned the 'Poor visibility or lack of external visual reference' circumstantial factor.

6.37 34 (72%) of all CFIT events were assigned the Circumstantial factor "Non-fitment of presently available safety equipment (GPWS, EGPWS, TCAS etc)". Of the remaining 13 events, two involved aircraft which were fitted with EGPWS but the Pilots did not follow the warnings. One event involved an aircraft which was fitted with GPWS but was in the landing configuration.

6.38 Due to lack of information it was not possible to determine if the aircraft in the remaining 10 accidents were fitted with either GPWS or EGPWS, although ICAO Annex 6 states that as of 1st January 2007 all turbine-engine aircraft with MTWA over 5700kg should be retrospectively fitted with EGPWS. Of the 47 aircraft involved in a CFIT accident, 15% were aged ten years or less. This means that the majority of aircraft involved in CFIT events would have needed to have EGPWS retrofitted. However, the information available would suggest that there has yet to be a fatal "CFIT" accident involving an EGPWS equipped aircraft, with MTWA above 5,700kg in which a genuine warning was received and not ignored.

Runway Incursion

6.39 During the period 2002 to 2011, there was one fatal accident which involved a Runway Incursion. In 2006, a CRJ Regional Jet overran the end of the runway at Blue Grass Airport in Kentucky, whilst attempting to take-off from the wrong runway. The captain, flight attendant, and all passengers were killed, and the first officer received serious injuries. The aircraft was destroyed by impact forces and post crash fire.

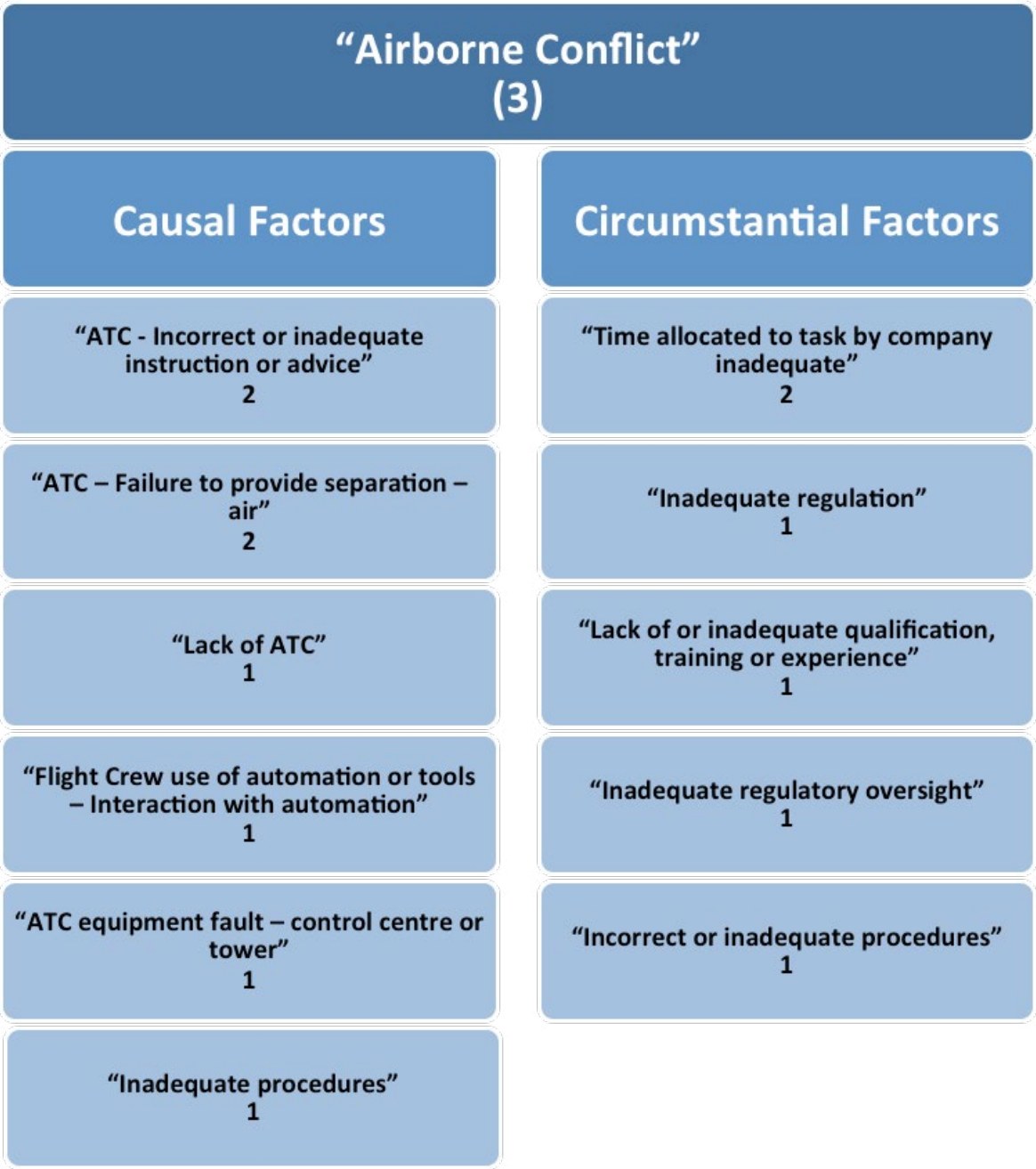
Airborne Conflict

6.40 This includes the following consequence:

- "Mid-air collision"

6.41 Figure 35 shows the most common causal and circumstantial factors allocated for all fatal accidents with an "Airborne Conflict" consequence.

Figure 35 Top-five causal and circumstantial factors associated with fatal accidents with an "Airborne Conflict" consequence



"Controller situational awareness"
1

"Caused by other aircraft or vehicle"
1

"Incorrect, inadequate or misleading information to crew"
1

"Flight Crew omission of action or inappropriate action"
1

"System/component failure"
1

"Flight Crew poor professional judgement or airmanship"
1

"Flight Crew use of automation or tools – Failure in CRM/TRM"
1

6.42 During the ten-year period 2002 to 2010 there were three mid air collisions.

1. In 2002 a Tupolev Tu-154 collided with a Boeing 757 Freighter near Uberlingen, Germany. All 69 passengers and crew onboard the Tupolev and the two pilots in the B757 were killed.
2. In 2004 two company Let L-410 cargo aircraft collided whilst flying in formation over Kenya. One aircraft was able to make a forced landing, however both crewmembers onboard the other aircraft were killed.
3. In 2006 a Boeing 737 collided with an Embraer Legacy 600 business jet near Peixote Azevedo in Brazil. The occupants of the business jet survived after making a forced landing, however all 154 people onboard the B737 were killed.

6.43 As the number of mid-air collisions during the ten-year period is much lower than the other consequences, care should be taken when drawing conclusions from the causal and circumstantial factors above. Although the small number of fatal mid-air collisions would imply that they are very rare events, analysis of mid-air collision pre-cursors would suggest that the risk is higher than the number of fatal accidents suggest.

Ground Handling

6.44 There were no fatal accidents during the ten-year period 2002 to 2011 assigned a consequence relating to Ground Handling.

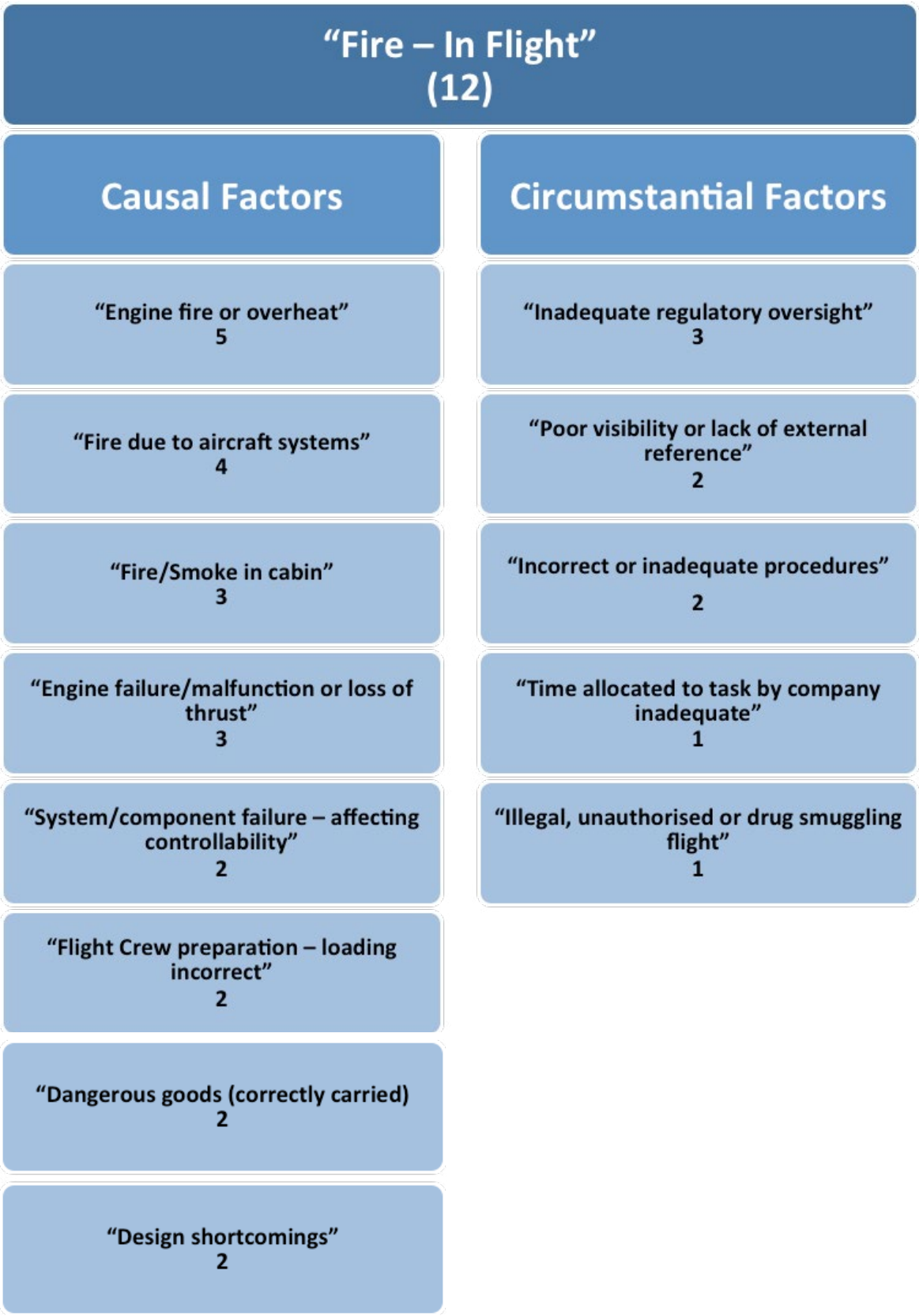
Fire

6.45 This includes the following consequences:

- "Fire or smoke in aircraft, in flight or on the ground, which is not the result of impact"
- "Fire/Smoke resulting from impact"

6.46 Figure 36 shows the most common causal and circumstantial factors allocated for all fatal accidents with an "In flight Fire" consequence.

Figure 36 Top-five causal and circumstantial factors associated with fatal accidents with an "In-flight Fire" consequence

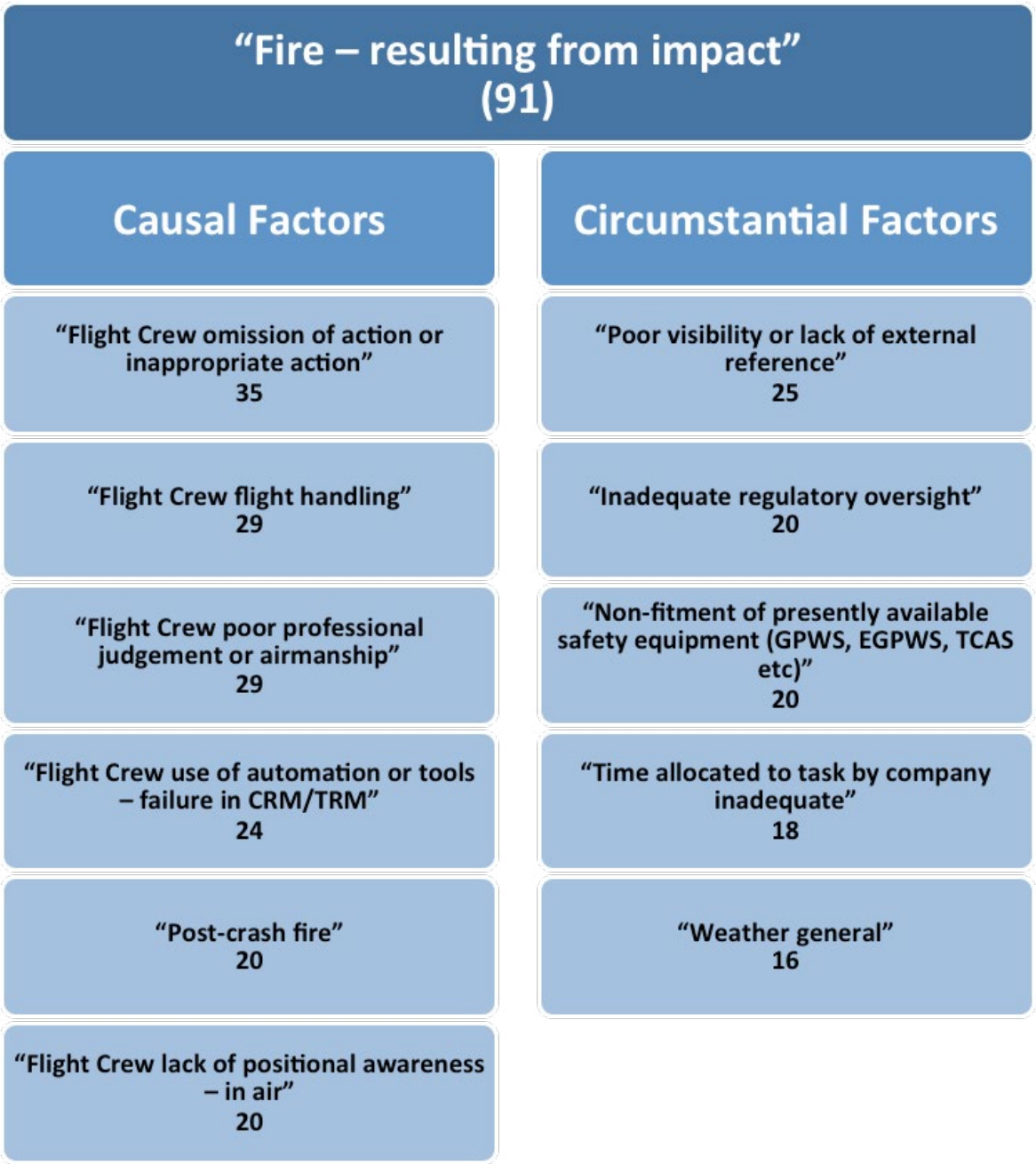


6.47 Five of the in-flight fires involved an engine fire, three were electrical fires, one was as a result of a fuel leak and one occurred during an in flight breakup due to overstress of the aircraft. The reasons for the in-flight fires in the remaining two accidents are unknown; however both aircraft in question were carrying lithium batteries.

6.48 Of the 12 aircraft that had an in-flight fire, two were less than 20 years old, and the average age of aircraft was 31.

6.49 Figure 37 shows the most common causal and circumstantial factors allocated for all fatal accidents with a "Fire/Smoke resulting from impact" consequence.

Figure 37 Top-five causal and circumstantial factors associated with fatal accidents with a "Fire/Smoke resulting from impact" consequence



6.50 Of the 91 fatal accidents involving a "Fire/Smoke resulting from impact" consequence, 56% were inbound to an airport, 37% were outbound and 7% were en-route.

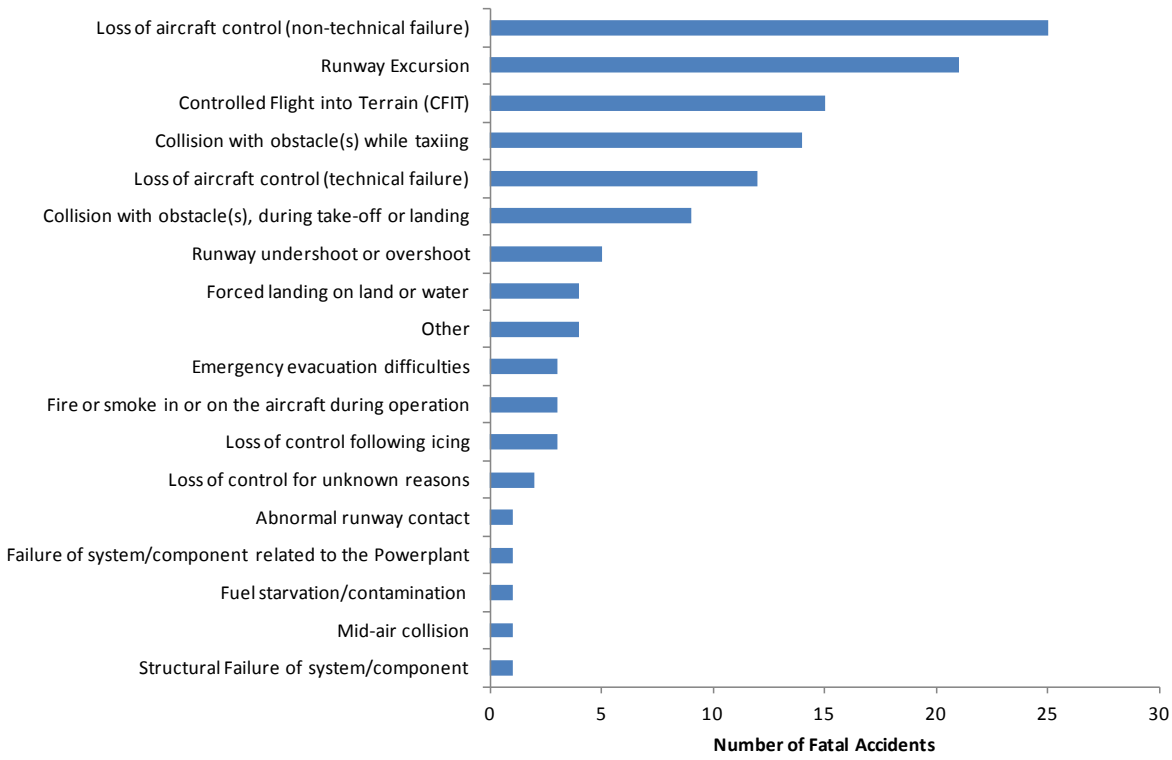
6.51 Every accident assigned the "Fire/Smoke resulting from impact" consequence was also assigned at least one other consequence. Figure 38 shows the consequences that were assigned in conjunction with "Fire/Smoke resulting from impact" for the 91 fatal accidents

in question. The consequence most commonly assigned with "Fire/ Smoke resulting from impact" was "Loss of aircraft control following a non-technical failure". 48% of all "Loss of aircraft control following a non-technical failure" events resulted in a fire resulting from impact.

6.52 Two of the three fatal accidents assigned "Fire or smoke in or on the aircraft during operation" in conjunction with "Fire/Smoke resulting from impact" involved in-flight engine fires (one due to a bird strike and the other due to unknown reasons), which in both cases led to the aircraft crashing and subsequently being destroyed in an intense post-crash fire. The other fatal accident assigned a combination of the two fire consequences involved in-flight smoke in the cockpit and various equipment failures which led to the aircraft crashing and a post-crash fire.

6.53 The fatal accident assigned "Fuel Starvation/contamination" in conjuction with "Fire/Smoke resulting from impact" involved an aircraft crash landing due to fuel starvation. The resulting post-crash fire was suspected to be due to an electrical short circuit, but was limited to the cockpit and wings due to the little or no fuel on the aircraft.

Figure 38 Other consequences assigned in conjunction with Fire/smoke resulting from impact



CHAPTER 7

Summary

7.1 The Global Fatal Accident Review 2002 to 2011 was carried out to provide a ten-year overview of worldwide fatal accidents involving large jet and turboprop aeroplanes engaged in passenger, cargo and ferry/positioning flights. The key findings are summarised below:

Worldwide Fatal Accident Numbers

7.2 There were a total of 250 worldwide fatal accidents, which resulted in 7,148 fatalities to passengers and crewmembers onboard the aircraft. The proportion of aircraft occupants killed in these fatal accidents was 70% which indicates that, on average, 30% of occupants survived.

7.3 There was an overall decreasing trend in both the number of fatal accidents and fatalities, although there was more fluctuation in the number of fatalities.

7.4 Jets were involved in 38% of all fatal accidents and accounted for 78% of the onboard fatalities, whilst turboprops were involved in 50% of the fatal accidents and accounted for 21% of the onboard fatalities. The equivalent values for business jets were 12% of all the fatal accidents and 1% of the onboard fatalities.

7.5 Passenger flights were involved in 57% of all the fatal accidents and accounted for 93% of the onboard fatalities whilst cargo flights were involved in 31% of all fatal accidents and 5% of the onboard fatalities. The equivalent values for ferry/positioning flights were 12% of all the fatal accidents and 2% of the onboard fatalities.

7.6 The approach, landing and go-around phases accounted for 47% of all fatal accidents and 46% of all onboard fatalities. Take-off and climb accounted for a further 31% of the fatal accidents and 28% of the onboard fatalities.

Worldwide Aircraft Utilisation

7.7 In the ten-year period 2002 to 2011, the number of flights flown increased by 22%, which equates to an average annual growth of 1.9%.

The equivalent values for hours flown were 36% for overall growth and 3.0% for average annual growth.

7.8 In the ten-year period 2002 to 2011, the number of flights flown by jets increased by 35%, which equates to an average annual growth of 2.9%. However, in the same period, the number of flights flown by turboprops decreased by 14%, which equates to an average annual reduction of 1.4%.

7.9 In the ten-year period 2002 to 2011, the number of passenger flights flown increased by 23%, which equates to an average annual growth of 2.1%. In the same period, the number of cargo flights flown increased by 6% which equates to an average annual growth of 0.4%.

Worldwide Fatal Accident Rates

7.10 The overall fatal accident rate for the ten-year period 2002 to 2011 was 0.6 fatal accidents per million flights flown or 0.4 when expressed as per million hours flown. The corresponding onboard fatality rate for the same period was 22.0 fatalities per million flights flown or 12.7 when expressed as per million hours flown[9].

7.11 There was a decreasing trend in both the overall rate of fatal accidents and onboard fatalities.

7.12 On average, the fatal accident rate for turboprops was four times that for jets, based on flights flown, and nine times greater when using hours flown as the rate measure.

7.13 The fatal accident rate for jets has remained relatively stable; however there was a peak in the onboard fatality rate for jets for the three-year period ending 2007. The fatal accident and fatality rates for Turboprops fluctuated during the ten-year period but show an increasing trend in the last three years.

7.14 On average, the fatal accident rate for aircraft with MTWA below 15 tonnes was three times that for aircraft with MTWA above 27 tonnes, based on flights flown, and nine times greater when using hours flown as the rate measure.

9 These values included jets and turboprops and passenger and cargo flights only due to lack of equivalent utilisation data for business jets and ferry/positioning flights.

7.15 On average, the fatal accident rate for cargo flights was eight times greater than for passenger flights, based on flights flown, and seven times greater when using hours flown as the rate of measure.

7.16 On average, an aircraft occupant could expect to travel on a passenger flight every day for over 8,500 years before being killed in a fatal accident.

7.17 The fatal accident rate for passenger flights has remained relatively stable; however the onboard fatality rate shows a decreasing trend in the last 5 years. Both the fatal accident rate and onboard fatality rate for cargo flights showed a slight decreasing trend.

7.18 The fatal accident rate for African operators was over seven times greater than that for all operators combined. North America had the lowest fatal accident rate of all the regions with 0.1 fatal accidents per million flights flown.

Primary Causal Factors

7.19 Of the 250 fatal accidents that formed the dataset, 185 (74%) had sufficient information to allow allocation of primary causal factors and 129 (52%) involved an Airline related primary causal factor.

7.20 The most frequently identified primary causal factor was "Flight Crew Handling/Skill – Flight handling" which was allocated in 14% of all fatal accidents. This generally related to events in which the aircraft was controllable (including single engine failures on twin engine aircraft), however the flight crews' mishandling of the aircraft or poor manual flying skills lead to the catastrophic outcome.

All Causal Factors

7.21 Two thirds of all fatal accidents involved at least one airline related causal factor. The most frequently allocated causal factors were "Flight-handling" and "Omission of action or inappropriate action".

7.22 "Flight Handling" generally related to events in which the aircraft was controllable (including single engine failures on twin engine aircraft), however the flight crew's mishandling of the aircraft or poor manual flying skills led to the catastrophic outcome.

7.23 "Omission of action or inappropriate action" generally related to flight crew continuing their descent below the decision height or minimum

descent/safety heights without visual reference, failing to fly a missed approach or omitting to set the correct aircraft configuration for take-off.

7.24 38% of all fatal accidents involved at least one airworthiness related causal factor, which includes Maintenance issues, System/Component failures, Engine failures and problems with aircraft design. The aircraft types most commonly assigned an airworthiness related causal factor were the Antonov An-12 and the Let L-410 Turbolet. 45% of the fatal accidents involving these aircraft types were assigned at least one Airworthiness related causal factor, 56% of which were the causal factor "Engine failure/malfunction".

Circumstantial Factors

7.25 The most frequently allocated circumstantial factor was "Poor visibility or lack of external visual reference". In the majority of cases this circumstantial factor was assigned, the accident occurred during a period of thick fog. The second most frequently assigned circumstantial factor "Weather general" mainly referred to accidents which occurred during heavy rain/snow, high winds or icing conditions.

7.26 "Non-fitment of presently available safety equipment" was the third most common circumstantial factor. Of the 49 fatal accidents that were assigned this circumstantial factor, 36 (73%) referred to non-fitment of the latest Terrain Awareness and Warning Systems (TAWS), such as the Enhanced Ground Proximity Warning System (EGPWS).

Consequences

7.27 Nearly 40% of all fatal accidents involved some kind of loss of control, making this the most frequent type of accident. Loss of control events were broken down into four categories – following technical failure, following non-technical failure, following icing, and following unknown reasons. Of these four, non-technical failures (for example flight crew failing to correctly respond to a warning) were the predominant cause of loss of control accidents.

7.28 Roughly half of all fatal accidents in which the pilot(s) lost control following a non-technical failure resulted in a post-crash fire, making this the most common post-crash fire precursor.

7.29 Over a third of all fatal accidents involved a post-crash fire; however this was always in conjunction with, or as a result of another consequence

rather than in its own right. Fires in flight were far less common, accounting for 5% of all fatal accidents.

7.30 Mid-air collisions accounted for three out of the 250 fatal accidents (1%).

APPENDIX A

The CAA Accident Analysis Group (AAG)

Introduction

A1 The AAG was established by the CAA early in 1996 to systematically review worldwide fatal accidents to identify the foremost global aviation risks. The primary aim of the analysis was to extract safety related information from past accidents so that strategies could be developed to help reduce the worldwide fatal accident rate in the future.

A2 The AAG decided to assess all worldwide fatal accidents, unlike other studies that only reviewed accidents with sufficient information. This was done to avoid any bias in the analysis towards accidents that had occurred in nations with more mature accident investigation processes.

A3 The AAG initially comprised of seven experts each bringing to the group extensive aeronautical experience gained both inside and outside the regulatory environment. Areas of expertise included: commercial airline flying, flight testing, handling and performance, systems and structural design, human factors and flight desk design, maintenance, risk and safety analysis, cabin safety and survivability and regulatory/legal procedures.

A4 The AAG originally analysed worldwide fatal accidents involving jet and turboprop aeroplanes above 5,700kg maximum take-off weight for the period 1980 to 1996. The original study covered public transport operations and business flights, as well as commercial training and ferry/positioning flights. The main output of this analysis was "CAP 681 Global Fatal Accident Review 1980-1996", which is still published on the CAA website.

A5 Post CAP 681 the criteria for inclusion of fatal accidents in the study dataset changed in order to align with other CAA documents involving statistical analysis of accidents. This led to the production of "CAP 776 Global Fatal Accident Review 1997-2006" which is also published on the CAA website. The differences are listed in Appendix 1 of CAP 776.

A6 Following the production of both CAP 681 and CAP 776, the AAG has continued to meet on an annual basis to analyse the worldwide fatal accidents from the previous year and the output forms a key part of the

CAA Safety Planning process. The AAG's membership has expanded to include representation from the UK Air Accidents Investigation Branch (AAIB), who provide invaluable insight into the accident analysis process as well as an additional source of useful information. A representative from EASA attended the AAG meeting for the first time in 2012 which will allow the analysis findings to be taken into account in future EASA produced aviation safety publications.

AAG Working Methodology

A7 The AAG's assessment process consisted of three main parts: causal factors, circumstantial factors and consequences. This was accompanied by an evaluation of the level of confidence in the information available. These assessment criteria are detailed below and the complete list of factors and consequences can be found in Appendix F List of Factors and Consequences Attributed to Worldwide Fatal Accidents 2002 to 2011.

Causal Factors

A8 A causal factor is an event or item, which is judged to be directly instrumental in the causal chain of events leading to the accident. An event may have been cited in an accident summary as having been a causal factor or it may have been implicit in the text. Whenever an official accident report was quoted in an accident summary, the AAG used any causal factors stated for consistency. Additionally, it was agreed that the AAG would select one primary causal factor for each accident. Occasionally, it was difficult for the AAG to reach a decision on which of the causal factors involved was the primary causal factor. In such cases, the group agreed to take a particular approach as a matter of policy, and then applied this policy consistently for all other similar cases that arose.

A9 The causal factors were listed in groups such as "Airline" and then divided further into specific factors such as "Flight Crew Situational Awareness – Lack of positional awareness – in air". An accident may have been allocated any number of causal factors from any one group, and any combination of groups. There was a total of 132 causal factors to choose from.

Circumstantial Factors

A10 A circumstantial factor is an event or item, which is judged not to be directly in the causal chain of events but could have contributed to the accident. These factors were present in the situation and were felt to be potentially relevant to the accident, although were not directly causal.

A11 For example, it was useful to note when an aircraft had been involved in a Controlled Flight Into Terrain (CFIT) accident and it was not fitted with a Ground Proximity Warning System (GPWS). Although GPWS was not mandatory for all aircraft considered in the study, the non-fitment of GPWS could be deemed circumstantial, but not causal, in a CFIT type accident.

A12 The circumstantial factors were listed in the same groups as the causal factors, and an accident may have been allocated any number of circumstantial factors from any one group, and any combination of groups.

Consequences

A13 A list of consequences was used to record the outcomes of the fatal accident in terms of loss of control, fire, CFIT, runway excursion, structural failure and other events. It was important to keep a record of the consequences as all fatal accidents consist of a chain of events with a final outcome resulting in fatalities.

A14 In some cases, it can be just as important to know what happened rather than why or how it happened as a particular combination of causal factors on one day may lead to a fatal accident whilst on another day it may only result in a minor incident. In many cases, the consequence is all that is known about a particular event. An accident may have been allocated any number of consequences. There was a total of 25 consequences to choose from.

Levels of Confidence

A15 The AAG also recorded the level of confidence for each accident. This may have been "High", "Medium" or "Low" and reflected the group's confidence in the completeness of the accident information and therefore the factors allocated. It was not a measure of confidence in the allocation of individual factors but of the group's analysis of the accident as a whole. Alternatively, if the group felt that there was not enough substantive information, then there was a fourth level of confidence, "Insufficient Information".

A16 The breakdown of level of confidence for the 250 fatal accidents in the study is shown below:

Level of Confidence	Number of Fatal Accidents	%
High	89	36%
Medium	68	27%
Low	54	22%
Insufficient Information	39	15%

Limitations of the AAG Data

A17 It should be noted that as only fatal accidents were included in this study, some important events, such as non-fatal hull losses (for example the Boeing B777 undershoot at Heathrow in 2008), have not been represented.

A18 The information contained in the Ascend (formerly Airclaims) accident summaries was believed to be accurate but in some cases was quite brief. These summaries may have not included sufficient information for all relevant factors to be identified. Therefore, care should be taken not to dismiss particular factors as being irrelevant to accident risk as there could have been an element of incomplete data. This was particularly true of flight crew related factors such as CRM and fatigue, which may have been subject to under-reporting by some agencies, not actually apparent to the investigators, or simply not thought to be worthy of inclusion in a summary report.

A19 In this report, the analysis of the data was performed on groups of accidents, rather than individual accidents. It was considered that aggregation of the data would help to lessen the effect of any random errors introduced by inaccurate factor allocation.

A20 Accident reporting criteria are not consistent throughout the world so the number of factors assigned to accidents can vary widely. As with all statistics, care must be taken when drawing conclusions from this report.

Differences to CAP 776 Global Fatal Accident Review 1997 – 2006

A21 The main difference between this document and CAP 776 is the change to the AAG taxonomy that was made in 2011. The list of causal factors was expanded to bring a more even balance between those available for flight crew related causes (which dominated the old taxonomy) and other causes. This change also brought a greater level of fidelity in the type of causal factor that can be attributed to non-flight crew related causes. The other two major changes to the taxonomy were the alignment of the list of causal and circumstantial factors (previously a separate, smaller list of circumstantial factors was used), and a revision of the list of consequences to replicate the CAST-ICAO Common Taxonomy Team (CICTT) occurrence categories[10].

A22 The other significant difference between the two documents is the expansion of the consequential analysis chapter to cover the causal and circumstantial factors associated with the CAA 'Significant Seven': Loss of Control, Runway Excursion, CFIT, Runway Incursion, Airborne Conflict, Ground Handling and Fire.

10 See http://www.intlaviationstandards.org/ for more information about the CICTT.

APPENDIX B

THREAT

B1 THREAT stands for 'The High Risk Events Analysis Team'. The team complete detailed analysis of high-severity occurrences involving UK aircraft in the UK and overseas and foreign aircraft in the UK. They also determine whether any lessons could be learnt from the analysis and make observations and propose mitigating actions on issues that are of potential on-going safety concern.

B2 THREAT data is based on the following criteria:

- A or B graded Mandatory Occurrence Reports as assessed by CAA Safety Data
- G-registered or UK operated (AOC) aircraft events occurring worldwide
- Non G-registered and non-UK operated aircraft events occurring in the UK
- Jet and Turboprop aeroplanes with maximum take-off weight above 5,700kg
- Turbine-powered helicopters with maximum take-off weight above 3,175kg
- Passenger and cargo operation only

B3 For each qualifying occurrence, THREAT attempts to:

- Allocate causal and circumstantial factors using a slightly modified version of the CAA Accident Analysis Group taxonomy.
- Identify which, if any, of the main catastrophic accident categories (CFIT, loss of control in flight, mid-air collision, collision on the ground, fire and structural failure) the occurrence was a precursor to and determine the proximity to such an outcome in terms of likelihood (high, medium or low)
- Identify which, if anything, prevented a more severe outcome
- Identify safety and/or organisational observations

B4 For each aggregated group of occurrences, THREAT attempts to:

- Identify *generic* safety and/or organisational observations
- Propose actions to mitigate risks associated with these generic observations
- THREAT is an integral part of the CAA's safety risk management process. The output of the analysis is visible to the CAA's Safety Action Group and Safety Review Board with actions potentially ending up in the Safety Plan.

APPENDIX C

Definitions

Accident (Fatal)

C1 The ICAO Annex 13 definition for a fatal accident is used: An occurrence associated with the operation of an aircraft, which takes place between the time any person boards the aircraft with the intention of flight until such time as all such persons have disembarked, in which: A person is fatally injured as a result of:

- being in the aircraft, or
- direct contact with any part of the aircraft, including parts which have become detached from the aircraft, or
- direct exposure to jet blast,

except when the injuries are from natural causes, self-inflicted or inflicted by another person, or when the injuries are to stowaways hiding outside the areas normally available to the passengers and crew.

Note 1: For statistical uniformity only, an injury resulting in death within 30 days of the date of the accident is classified as a fatal injury by ICAO.

Note 2: An additional requirement for this particular study is that there must have been at least one fatality to an aircraft occupant (this is not an ICAO condition).

Causal Factor

C2 An event or item, which was directly instrumental in the causal chain of events leading to the fatal accident.

Circumstantial Factor

C3 An event or item, which was not directly instrumental in the causal chain of events but could have contributed to the fatal accident.

Consequence

C4 An outcome of the fatal accident.

Level of Confidence

C5 The level of confidence in the fatal accident summary and the consequent factors allocated by the CAA's Accident Analysis Group.

Operator Region

C6 The world region from which the aircraft operator originates.

Press-on-Itis

C7 A causal factor defined as the tendancy to 'press on' in circumstances where the conditions dictate a review of that decision e.g. continuing an approach in deteriorating weather instead of diverting/performing a go-around.

Primary Causal Factor

C8 The dominant causal factor of the fatal accident as judged by the CAA's Accident Analysis Group.

Regions

Africa

C9 The countries included in the African region are taken from the ICAO Safety Indicators Study Group regional definitions, and are as follows:

Algeria	Gabon	Nigeria
Angola	Gambia	Reunion
Benin	Ghana	Rwanda
Botswana	Guinea	Saint Helena
British Indian Ocean Territory	Guinea-Bissau	Sao Tome and Principe
Burkina Faso	Ivory Coast	Senegal
Burundi	Kenya	Seychelles
Cameroon	Lesotho	Sierra Leone
Cape Verde Islands	Liberia	Somalia
Central African Republic	Libya	South Africa
Chad	Madagascar	Sudan
Comoros	Malawi	Swaziland
Congo	Mali	Tanzania
Congo (Democratic Republic)	Mauritania	Togo
Djibouti	Mauritius	Tunisia
Egypt	Morocco	Uganda
Equatorial Guinea	Mozambique	Western Sahara
Eritrea	Namibia	Zambia
Ethiopia	Niger	Zimbabwe

Asia

C10 The countries included in the Asian region are taken from the ICAO Safety Indicators Study Group regional definitions, and are as follows:

Afghanistan	Kazakhstan	Philippines
Bangladesh	Kyrgyzstan	Singapore
Bhutan	Laos	South Korea
Brunei	Macau	Sri Lanka
Cambodia	Malaysia	Taiwan
China	Maldives	Tajikistan
East Timor	Mongolia	Thailand
Hong Kong	Myanmar	Turkmenistan
India	Nepal	Uzbekistan
Indonesia	North Korea	Vietnam
Japan	Pakistan	

Central America and Caribbean

C11 The countries included in the Central American and Caribbean region are taken from the ICAO Safety Indicators Study Group regional definitions, and are as follows:

Belize	Bermuda	Puerto Rico
Costa Rica	Cayman Islands	Saint Barthélemy
El Salvador	Cuba	Saint Kitts and Nevis
Guatemala	Dominica	Saint Kitts and Nevis
Honduras	Dominican Republic	Saint Lucia
Mexico	French Antilles	Saint Martin
Nicaragua	Grenada	Saint Vincent and the Grenadines
Panama	Guadeloupe	Trinidad and Tobago
Anguilla	Haiti	Turks and Caicos Islands
Antigua and Barbuda	Jamaica	Virgin Islands (British)
Aruba	Martinique	Virgin Islands (US)
Bahamas	Montserrat	
Barbados	Netherlands Antilles	

Europe

C12 The countries included in the European region are taken from the ICAO Safety Indicators Study Group regional definitions, and are as follows (the original 15 European Union member states are shown in bold text and the additional 12 accession states in italic text):

Albania	France	Montenegro
Andorra	Georgia	Netherlands
Armenia	Germany	Norway
Austria	Gibraltar	Poland
Azerbaijan	Greece	Portugal
Azores	Greenland	Romania
Belarus	Hungary	Russia
Belgium	Iceland	San Marino
Bosnia-Herzegovina	Ireland	Serbia
Bulgaria	Italy	Slovak Republic
Canary Islands	Latvia	Slovenia
Croatia	Liechtenstein	Spain
Cyprus	Lithuania	Sweden
Czech Republic	Luxembourg	Switzerland
Denmark	Macedonia	Turkey
Estonia	Madeira	Ukraine
Faroe Islands	Malta	United Kingdom
Federation of Serbia and Montenegro	Moldova	
Finland	Monaco	

Middle East

C13 The countries included in the Middle Eastern region are taken from the ICAO Safety Indicators Study Group regional definitions, and are as follows:

Bahrain	Kuwait	Republic of Yemen
Iran	Lebanon	Saudi Arabia
Iraq	Oman	Syria
Israel	Palestine	United Arab Emirates
Jordan	Qatar	Yemen

North America

C14 The countries included in the North America region are taken from the ICAO Safety Indicators Study Group regional definitions, and are as follows:

Canada	Saint Pierre and Miquelon	USA

Oceania

C15 The countries included in the Oceania region are taken from the ICAO Safety Indicators Study Group regional definitions, and are as follows:

American Samoa	Marshall Islands	Pitcairn Island
Australia	Micronesia	Solomon Islands
Cook Islands	Midway	Tonga
Easter Island	Nauru	Tuvalu
Fiji	New Caledonia	Vanuatu
French Polynesia	New Zealand	Wake Island
Guam	Niue	Wallis and Futuna Islands
Johnston Island	Northern Marianas Islands	Western Samoa
Kiribati	Palau	
Line Island	Papua New Guinea	

South America

C16 The countries included in the South American region are taken from the ICAO Safety Indicators Study Group regional definitions, and are as follows:

Argentina	Ecuador	Peru
Bolivia	Falkland Islands	Suriname
Brazil	French Guiana	Uruguay
Chile	Guyana	Venezuela
Colombia	Paraguay	

APPENDIX D

Glossary

AAIB	Air Accidents Investigation Branch
AAG	Accident Analysis Group
ATC	Air Traffic Control
ATS	Air Traffic Service
CAA	Civil Aviation Authority
CAP	Civil Aviation Publication
CFIT	Controlled Flight Into Terrain
CRM	Crew Resource Management
DH	Decision Height
EGPWS	Enhanced Ground Proximity Warning System
EU	European Union
GPS	Global Positioning System
GPWS	Ground Proximity Warning System
ICAO	International Civil Aviation Organisation
MDH	Minimum Descent Height
MSA	Minimum Safe Altitude
MSAW	Minimum Safe Altitude Warning
MTWA	Maximum Take-off Weight Authorised
SISG	Safety Indicators Study Group
TAWS	Terrain Awareness and Warning System

APPENDIX E

Aircraft Types Included in Study

E1 Table 27, Table 28 and Table 29 show the aircraft types that were considered to be jets, turboprops and business jets, respectively. The tables also show how many times each individual aircraft type featured in a fatal accident. A zero entry, for jets and turboprops only, signifies that the aircraft was not involved in a fatal accident during the study period, but it contributed to the flights and hours flown, and hence the calculation of the rates.

E2 One of the conditions for an aircraft to be included in the fatal accident dataset was that the MTWA must be over 5,700kg. For the purposes of this study, the original certified MTWA determined whether an aircraft was included or not. For example, the Embraer Bandeirante was excluded, although there are individual aircraft that have MTWA above 5,700kg.

Jets

Table 27 Jet aircraft that featured in the fatal accident dataset and utilisation

Aircraft Type	No. Fatal Accidents	Aircraft Type	No. Fatal Accidents
Aerospatiale Caravelle	0	Boeing 747	4
Airbus A300-600	0	Boeing 747-8	0
Airbus A300B2/B4	1	Boeing 757	1
Airbus A310	3	Boeing 767	1
Airbus A318	0	Boeing 777	0
Airbus A319	0	Boeing 787	0
Airbus A320	3	Bombardier (Canadair) CRJ Regional Jet	5
Airbus A321	1	Bombardier (Canadair) CRJ1000 Regional Jet	0
Airbus A330	2	Bombardier (Canadair) CRJ700 Regional Jet	0

Aircraft Type	No. Fatal Accidents	Aircraft Type	No. Fatal Accidents
Airbus A340	0	Bombardier (Canadair) CRJ900 Regional Jet	0
Airbus A380	0	Embraer 170	0
Antonov An-124	0	Embraer 175	0
Antonov An-148	0	Embraer 190	1
Antonov An-225	0	Embraer 195	0
Antonov An-72	0	Embraer ERJ-135	0
Antonov An-74	0	Embraer ERJ-140	0
Avro RJ Avroliner	1	Embraer ERJ-145	0
BAE SYSTEMS (BAC) One-Eleven	1	Fairchild/Dornier 328JET	0
BAE SYSTEMS (BAC)/ Aerospatiale Concorde	0	Fokker 100	0
BAE SYSTEMS (HS) 146	2	Fokker 70	0
Boeing (McDonnell-Douglas) DC-10	0	Fokker F.28	1
Boeing (McDonnell-Douglas) DC-8	0	Ilyushin Il-62	1
Boeing (McDonnell-Douglas) DC-9	4	Ilyushin Il-76	12
Boeing (McDonnell-Douglas) MD-11	2	Ilyushin Il-86	1
Boeing (McDonnell-Douglas) MD-80	5	Ilyushin Il-96	0
Boeing (McDonnell-Douglas) MD-90	0	Lockheed L-1011 TriStar	0
Boeing 707	3	Sukhoi Superjet 100	0
Boeing 717	0	Tupolev Tu-134	2
Boeing 720	0	Tupolev Tu-154	7
Boeing 727	5	Tupolev Tu-204	0
Boeing 737 (CFMI)	7	VFW 614	0

Aircraft Type	No. Fatal Accidents	Aircraft Type	No. Fatal Accidents
Boeing 737 (JT8D)	12	Yakovlev Yak-40	1
Boeing 737 (NG)	6	Yakovlev Yak-42	2
		Total	97

Turboprops

Table 28 Turboprop aircraft that featured in the fatal accident dataset and utilisation

Aircraft Type	No. Fatal Accidents	Aircraft Type	No. Fatal Accidents
Aerospatiale 262	0	CASA/IPTN 212	4
Antonov An-12	19	CASA/IPTN CN-235	0
Antonov An-140	2	Embraer EMB-120 Brasilia	3
Antonov An-22	0	Fairchild (Swearingen) Metro	8
Antonov An-24	9	Fairchild F-27	0
Antonov An-26	7	Fairchild FH-227	1
Antonov An-28	6	Fairchild/Dornier 228	1
Antonov An-3	0	Fairchild/Dornier 328	0
Antonov An-30	0	Fokker 50	2
Antonov An-32	4	Fokker F.27	3
Antonov An-38	0	General Dynamics (Convair) 580	4
Antonov An-8	0	General Dynamics (Convair) 600	0
ATR 42	3	General Dynamics (Convair) 640	0
ATR 72	4	Grumman Turbine Mallard	1
BAe (Bristol) Britannia	0	Gulfstream Aerospace Gulfstream I	1
BAe (HS) 748	2	Handley Page Herald	0

Aircraft Type	No. Fatal Accidents	Aircraft Type	No. Fatal Accidents
BAe (HS) ATP	0	Handley Page Jetstream	0
BAe (Vickers) Viscount	0	IAI Arava	0
Beech 1900	11	Ilyushin Il-114	0
Boeing (McDonnell-Douglas) Turbine DC-3	0	Ilyushin Il-18	0
Bombardier (Canadair) CL-215	0	Jetstream 31	2
Bombardier (Canadair) CL-44	0	Jetstream 41	1
Bombardier (DHC) Dash 7	0	Let L-410 Turbolet	21
Bombardier (DHC) Dash 8-100/200	1	Lockheed Hercules	2
Bombardier (DHC) Dash 8-300	0	Lockheed L-188 Electra	0
Bombardier (DHC) Dash 8-400	1	NAMC YS-11	0
Bombardier (DHC) DHC-5 Buffalo	0	Saab 2000	0
Bombardier (Shorts) 330	0	Saab 340	1
Bombardier (Shorts) 360	0	SAC Y-8	0
Bombardier (Shorts) SC.5 Belfast	0	Transall C-160	0
Bombardier (Shorts) SC.7 Skyvan	0	XAC Y-7	0
CAIC MA60	1	Total	125

Business Jets

Table 29 Business jet aircraft that featured in the fatal accident dataset

Aircraft Type	No. Fatal Accidents
Aero Commander Jet Commander 1121	2
Canadair CL-600 Challenger	2
Cessna 550 Citation II	3
Cessna 650 Citation VI	1
Gulfstream Aerospace Gulfstream III	1
HS 125	4
Learjet 24	2
Learjet 25	2
Learjet 35	6
Learjet 45	1
Learjet 60	1
M.B.B. HFB 320 Hansa	1
Rockwell Sabreliner	3
Total	29

Note: Utilisation data was not available for business jet aircraft, which is why Table 29 only includes business jet aircraft types that featured in at least one fatal accident.

E3 The sum, by individual aircraft type, of the number of fatal accidents was 251, one more than the total number of fatal accidents stated earlier in this document. This was due to the inclusion of both jet aircraft involved in the Uberlingen mid-air collision that occurred on 1st July 2002 (a Boeing 757 and a Tupolev TU-154). This mid-air collision was counted as one fatal accident in the overall statistics.

APPENDIX F

List of Factors and Consequences Attributed to Worldwide Fatal Accidents 2002 to 2011

F1 The AAG taxonomy is shown below in Table 30, Table 31 and Table 32 complete with the number of times each causal factor, circumstantial factor and consequence was allocated. These factors and consequences are not mutually exclusive[11] as each fatal accident generally involves more than one factor or consequence.

Table 30 List of Causal Factors attributed to Worldwide Fatal Accidents – 2002 to 2011

	Causal Factor	Primary	Other	Total
Aircraft Design	Design shortcomings (including documentation that forms part of the approved design standard)	1	22	23
	Structural overload	0	0	0
	Corrosion or fatigue	1	1	2
	Overload failure	0	3	3
	Flutter	0	0	0
	Aircraft becomes uncontrollable	1	15	16
Aircraft system/ components	System/component failure – affecting controllability	2	7	9
	System/component failure – flight deck information	2	6	8
	System/component failure – other	4	7	11
	Fire due to aircraft systems	2	2	4
	Unable to maintain speed or height or achieve scheduled performance	2	10	12
	Manufacturing/production defect	0	1	1

11 With the exception of primary causal factors, of which only one was allocated per fatal accident.

	Causal Factor	Primary	Other	Total
	Non-fitment of presently available safety equipment (GPWS, EGPWS, TCAS, windshear warning, etc.)	0	1	1
	Failure or inadequacy of aircraft safety equipment	0	1	1
	Pre-existing inoperative aircraft systems (for example inoperative thrust reverser known about prior to flight)	0	0	0
Engine	Engine failure/malfunction or loss of thrust	5	31	36
	Propeller failure	2	0	2
	Damage due to non-containment	0	0	0
	Fuel contamination	0	0	0
	Engine failure simulated	0	0	0
	Engine fire or overheat	2	6	8
	Manufacturing/production defect (engine)	0	0	0
Maintenance	Failure to carry-out due maintenance	1	1	2
	Maintenance or repair error	7	4	11
	Maintenance or repair oversight	0	1	1
	Inadequate maintenance or repair	0	7	7
	Unapproved modification	0	0	0
	Bogus parts	0	0	0
	Lack of or inadequate qualification, training or experience	0	0	0
	Planning	0	0	0
	Competence	0	0	0
	Human performance (e.g. fatigue)	0	0	0
	Perception and Decision-making	0	0	0
	Situational Awareness	0	0	0
	Use of automation/tools/equipment	0	0	0

	Causal Factor	Primary	Other	Total
ATC	ATC Equipment fault – control centre or tower	0	5	5
	ATC equipment fault – navigation	0	1	1
	Inadequate procedures	0	1	1
	Incorrect or inadequate instruction or advice	1	8	9
	Misunderstood or missed communication	0	0	0
	Failure to provide separation – air	1	1	2
	Failure to provide separation – ground	0	0	0
	Standard separation not adequate	0	0	0
	Wake turbulence – loss of separation	0	0	0
	Runway condition unknown to crew	0	2	2
	Lack of ATC	0	1	1
	Lack of ground aids	0	1	1
	Non-fitment of presently available ATC system or equipment (e.g. MSAW)	0	0	0
	Non-precision approach flown	0	1	1
	Lack of or inadequate qualification, training or experience	0	0	0
	Controller Preparation	0	0	0
	Controller Competence	0	0	0
	Controller Human performance	0	0	0
	Controller Perception and Decision-making	0	0	0
	Controller Situational Awareness	0	0	0
	Controller Use of automation or tools	0	0	0

	Causal Factor	Primary	Other	Total
3rd Party	Incorrect, inadequate or misleading information to crew	0	11	11
	Caused by other aircraft or vehicle	1	1	2
	Unsafe action by other personnel (not associated with operation of aircraft, ATC or airport)	1	0	1
Aerodrome	Design – RESA, intersecting runways, taxiway layout, ramp size	0	0	0
	Location/aerodrome environment – surrounding terrain, altitude (inc. density altitude), obstacles, wildlife	0	1	1
	Inadequate aerodrome support – RFFS and other airfield cover	0	3	3
	Inadequate signals, signs, markings (e.g. in the case of a runway incursion)	0	0	0
	Incorrect performance of ancillary equipment	0	2	2
	Inadequate/unavailable equipment (snow clearance, stand entry guidance, perimeter fence etc)	0	0	0
	Inadequate or incorrect airport departure or arrival procedure design	0	1	1
	Contaminated operational areas (runway, taxiway etc)	0	0	0
	Safety features not to national or international standards (e.g. RESA)	0	0	0
	Slow response time (e.g. RFFS, Ambulance, on airfield only)	0	0	0
	Poor management of fuel installations on aerodrome	0	0	0
	Planning	0	0	0
	Competence	0	0	0
	Human performance (e.g. fatigue)	0	0	0

	Causal Factor	Primary	Other	Total
	Perception and Decision-making	0	0	0
	Situational Awareness	0	0	0
	Use of automation/tools/equipment	0	0	0
Ramp	Loading error (includes load insecure, incorrectly distributed, inaccurately measured, or external door not secured)	4	2	6
	Dangerous goods error (incorrectly stowed/packaged, not notified, prohibited from carriage, counterfeit goods etc)	0	0	0
	Dangerous goods (correctly carried)	0	2	2
	Ramp rash	0	0	0
	Incorrect fuel uplift	0	0	0
Cabin	Evacuation difficulties	0	1	1
	Fire/Smoke in cabin	1	2	3
	Unsecured objects	0	0	0
	Non-adherence to cabin safety procedures	0	2	2
	Fire/smoke resulting from impact	1	19	20
	Fire other cause	1	0	1
	Lack of or inadequate qualification, training or experience	0	0	0
Airline	Time allocated to task by company inadequate	0	0	0
	Other commercial pressure	0	1	1
	Lack of or inadequate qualification, training or experience	0	14	14
	Incorrect or inadequate procedures	0	0	0
	Company management failure	0	3	3
	Low fuel state	0	0	0

	Causal Factor	Primary	Other	Total
	Flight Crew Preparation – Loading incorrect (includes external door not secured, where flight crew have responsibility for this action)	3	7	10
	Flight Crew Preparation – Inadequate pre-flight planning or preparation	0	4	4
	Flight Crew Handling/Skill – Flight handling	35	35	70
	Flight Crew Handling/Skill – Fast and/or high on approach	1	8	9
	Flight Crew Handling/Skill – Slow and/or low on approach	0	18	18
	Flight Crew Human performance – Disorientation or visual illusion	3	10	13
	Flight Crew Human performance – Fatigue	0	13	13
	Flight Crew Human performance – State of mind	0	1	1
	Flight Crew Human performance – Incapacitation, medical or other factors reducing crew performance	0	6	6
	Flight Crew Perception and Decision-making – "Press-on-itis"	2	23	25
	Flight Crew Perception and Decision-making – Poor professional judgement or airmanship	20	40	60
	Flight Crew Perception and Decision-making – Deliberate non-adherence to procedures	6	10	16
	Flight Crew Perception and Decision-making – Slow or delayed action	0	13	13
	Flight Crew Perception and Decision-making – Omission of action or inappropriate action	30	40	70

	Causal Factor	Primary	Other	Total
	Flight Crew Perception and Decision-making – Unintended flight into IMC	0	1	1
	Flight Crew Situational Awareness – Lack of positional awareness – in air	26	30	56
	Flight Crew Situational Awareness – Lack of positional awareness – on ground	0	1	1
	Flight Crew Situational Awareness – Lack of awareness of circumstances in flight	2	10	12
	Flight Crew Situational Awareness – Failure in look-out	0	0	0
	Flight Crew Use of automation or tools – Incorrect selection on instrument or navaid	0	0	0
	Flight Crew Use of automation or tools – Action on wrong control or instrument	1	3	4
	Flight Crew Use of automation or tools – Interaction with automation	0	11	11
	Flight Crew Use of automation or tools – Failure in CRM (cross-check/co-ordinate)/TRM	0	52	52
Environment	Weather general	5	5	10
	Wind shear, upset or turbulence	1	1	2
	Cross-wind	0	0	0
	Icing	5	3	8
	Lightning	0	2	2
	Poor visibility or lack of external visual reference	0	0	0
	Volcanic ash, sand, precipitation, etc.	0	2	2
	Runway or taxiway condition (ice, slippery, standing water, debris, etc.)	0	1	1
	Wake turbulence – correct separation	2	1	3

	Causal Factor	Primary	Other	Total
	Birds/Wildlife	0	0	0
Regulation (safety or other)	Illegal, unauthorised or drug smuggling flight	0	0	0
	Inadequate regulation	0	2	2
	Incorrect regulation	0	0	0
	Inadequate regulatory oversight	0	1	1
	Non-safety related restrictions	0	0	0

Table 31 List of Circumstantial Factors attributed to Worldwide Fatal Accidents – 2002 to 2011

	Circumstantial Factor	Total
Aircraft Design	Design shortcomings (including documentation that forms part of the approved design standard)	0
	Structural overload	0
	Corrosion or fatigue	0
	Overload failure	0
	Flutter	0
	Aircraft becomes uncontrollable	0
Aircraft system/ components	System/component failure – affecting controllability	0
	System/component failure – flight deck information	0
	System/component failure – other	1
	Fire due to aircraft systems	0
	Unable to maintain speed or height or achieve scheduled performance	0
	Manufacturing/production defect	0
	Non-fitment of presently available safety equipment (GPWS, EGPWS, TCAS, windshear warning, etc.)	49
	Failure or inadequacy of aircraft safety equipment	2
	Pre-existing inoperative aircraft systems (for example inoperative thrust reverser known about prior to flight)	6
Engine	Engine failure/malfunction or loss of thrust	0
	Propeller failure	0
	Damage due to non-containment	0
	Fuel contamination	0
	Engine failure simulated	0
	Engine fire or overheat	0
	Manufacturing/production defect (engine)	0
Maintenance	Failure to carry-out due maintenance	0
	Maintenance or repair error	0
	Maintenance or repair oversight	0

	Circumstantial Factor	Total
	Inadequate maintenance or repair	0
	Unapproved modification	0
	Bogus parts	0
	Lack of or inadequate qualification, training or experience	0
	Planning	0
	Competence	0
	Human performance (e.g. fatigue)	0
	Perception and Decision-making	0
	Situational Awareness	0
	Use of automation/tools/equipment	0
ATC	ATC equipment fault – control centre or tower	0
	ATC equipment fault – navigation	0
	Inadequate procedures	1
	Incorrect or inadequate instruction or advice	0
	Misunderstood or missed communication	0
	Failure to provide separation – air	0
	Failure to provide separation – ground	0
	Standard separation not adequate	0
	Wake turbulence – loss of separation	0
	Runway condition unknown to crew	0
	Lack of ATC	1
	Lack of ground aids	14
	Non-fitment of presently available ATC system or equipment (e.g. MSAW)	10
	Non-precision approach flown	17
	Lack of or inadequate qualification, training or experience	0
	Controller Preparation	0
	Controller Competence	0
	Controller Human performance	0
	Controller Perception and Decision-making	0

	Circumstantial Factor	Total
	Controller Situational Awareness	0
	Controller Use of automation or tools	0
3rd Party	Incorrect, inadequate or misleading information to crew	2
	Caused by other aircraft or vehicle	0
	Unsafe action by other personnel (not associated with operation of aircraft, ATC or airport)	0
Aerodrome	Design – RESA, intersecting runways, taxiway layout, ramp size	11
	Location/aerodrome environment – surrounding terrain, altitude (inc. density altitude), obstacles, wildlife	2
	Inadequate aerodrome support – RFFS and other airfield cover	0
	Inadequate signals, signs, markings (e.g. in the case of a runway incursion)	0
	Incorrect performance of ancillary equipment	0
	Inadequate/unavailable equipment (snow clearance, stand entry guidance, perimeter fence etc)	0
	Inadequate or incorrect airport departure or arrival procedure design	0
	Contaminated operational areas (runway, taxiway etc)	0
	Safety features not to national or international standards (e.g. RESA)	0
	Slow response time (e.g. RFFS, Ambulance, on airfield only)	0
	Poor management of fuel installations on aerodrome	0
	Planning	0
	Competence	0
	Human performance (e.g. fatigue)	0
	Perception and Decision-making	0
	Situational Awareness	0
	Use of automation/tools/equipment	0

	Circumstantial Factor	Total
Ramp	Loading error (includes load insecure, incorrectly distributed, inaccurately measured, or external door not secured)	0
	Dangerous goods error (incorrectly stowed/packaged, not notified, prohibited from carriage, counterfeit goods etc)	0
	Dangerous goods (correctly carried)	0
	Ramp rash	0
	Incorrect fuel uplift	0
Cabin	Evacuation difficulties	0
	Fire/Smoke in cabin	0
	Unsecured objects	0
	Non-adherence to cabin safety procedures	0
	Fire/smoke resulting from impact	0
	Fire other cause	0
	Lack of or inadequate qualification, training or experience	0
Airline	Time allocated to task by company inadequate	37
	Other commercial pressure	0
	Lack of or inadequate qualification, training or experience	21
	Incorrect or inadequate procedures	17
	Company management failure	4
	Low fuel state	4
	Flight Crew Preparation – Loading incorrect (includes external door not secured, where flight crew have responsibility for this action)	0
	Flight Crew Preparation – Inadequate pre-flight planning or preparation	0
	Flight Crew Handling/Skill – Flight handling	0
	Flight Crew Handling/Skill – Fast and/or high on approach	0
	Flight Crew Handling/Skill – Slow and/or low on approach	0
	Flight Crew Human performance – Disorientation or visual illusion	0

	Circumstantial Factor	Total
	Flight Crew Human performance – Fatigue	0
	Flight Crew Human performance – State of mind	0
	Flight Crew Human performance – Incapacitation, medical or other factors reducing crew performance	1
	Flight Crew Perception and Decision-making – "Press-on-itis"	0
	Flight Crew Perception and Decision-making – Poor professional judgement or airmanship	0
	Flight Crew Perception and Decision-making – Deliberate non-adherence to procedures	0
	Flight Crew Perception and Decision-making – Slow or delayed action	0
	Flight Crew Perception and Decision-making – Omission of action or inappropriate action	0
	Flight Crew Perception and Decision-making – Unintended flight into IMC	0
	Flight Crew Situational Awareness – Lack of positional awareness – in air	1
	Flight Crew Situational Awareness – Lack of positional awareness – on ground	0
	Flight Crew Situational Awareness – Lack of awareness of circumstances in flight	0
	Flight Crew Situational Awareness – Failure in look-out	0
	Flight Crew Use of automation or tools – Incorrect selection on instrument or navaid	0
	Flight Crew Use of automation or tools – Action on wrong control or instrument	0
	Flight Crew Use of automation or tools – Interaction with automation	0
	Flight Crew Use of automation or tools – Failure in CRM (cross-check/co-ordinate)/TRM	28
Environment	Weather general	55
	Wind shear, upset or turbulence	4

	Circumstantial Factor	Total
	Cross-wind	0
	Icing	1
	Lightning	0
	Poor visibility or lack of external visual reference	65
	Volcanic ash, sand, precipitation, etc.	3
	Runway or taxiway condition (ice, slippery, standing water, debris, etc.)	0
	Wake turbulence – correct separation	0
	Birds/Wildlife	6
Regulation (safety or other)	Illegal, unauthorised or drug smuggling flight	3
	Inadequate regulation	15
	Incorrect regulation	0
	Inadequate regulatory oversight	40
	Non-safety related restrictions	0

Table 32 List of Consequences attributed to Worldwide Fatal Accidents – 2002 to 2011

Consequences	Total
Aerodrome design/service/functionality	0
Abrupt Manoeuvre	0
Abnormal Runway Contact	4
Occurrences involving Air Traffic Management (ATM) or communications, navigation, or surveillance (CNS) service issues.	0
Collisions with birds or wildlife	0
Miscellaneous occurrences in the passenger cabin of transport category aircraft	0
In-flight collision or near collision with terrain, water, or obstacle without indication of loss of control	47
Collision with obstacle(s), during take-off or landing whilst airborne.	31
Occurrence where either; (a) person(s) are injured during an evacuation; (b) an unnecessary evacuation was performed; (c) evacuation equipment failed to perform as required; or (d) the evacuation contributed to the severity of the occurrence.	10
Occurrences during or as a result of external load or external cargo operations.	0
Fire or smoke in or on the aircraft, in flight or on the ground, which is not the result of impact.	12
Forced landing on land or water (note that this is not a CICTT code)	20
Fire/Smoke resulting from impact.	91
One or more powerplants experienced reduced or no power output due to fuel exhaustion, fuel starvation/mismanagement, fuel contamination/ wrong fuel, or carburettor and/or induction icing.	5
Collision while taxiing to or from a runway in use – aircraft	0
Collision while taxiing to or from a runway in use – vehicle, animal, person or object	24
Premature release, inadvertent release or non-release during towing, entangling with towing, cable, loss of control, or impact into towing aircraft/winch.	0
Accumulation of snow, ice, freezing rain, or frost on aircraft surfaces that adversely affects aircraft control or performance	0

Consequences	Total
Low Altitude Operations. Collision or near collision with obstacles/ objects/terrain while intentionally operating near the surface (excludes takeoff or landing phases).	0
Loss of aircraft control while the aircraft is on the ground	0
Loss of aircraft control or deviation from intended flightpath during flight following non-technical failure	52
Loss of aircraft control or deviation from intended flightpath during flight following icing	8
Loss of aircraft control or deviation from intended flightpath during flight following technical failure	32
Loss of aircraft control or deviation from intended flightpath during flight for unknown reasons	6
Landing en-route due to loss of lifting conditions (applies only to aircraft that rely on static lift to maintain or increase flight altitude – gliders, hang gliders, paragliders)	0
Mid-air collision. Airprox, ACAS alerts, loss of separation as well as near collisions or collisions between aircraft in flight.	3
Any occurrence not covered under another category.	8
Occurrences during (or as a result of) ground handling operations	0
Runway Excursion. A veer off or overrun off the runway surface.	35
Runway Incursion – Animal. Collision with, risk of collision, or evasive action taken by an aircraft to avoid an animal on a runway or on a helipad/helideck in use.	0
Runway Incursion – Vehicle, Aircraft, Person. Any occurrence at an aerodrome involving the incorrect presence of an aircraft, vehicle or person on the protected area of a surface designated for the landing and take-off of aircraft.	1
Failure or malfunction of an aircraft system or component – other than the powerplant.	1
Structural failure or malfunction of an aircraft system or component	7
Failure or malfunction of an aircraft system or component – related to the powerplant.	3
Criminal/Security acts which result in accidents or incidents (per the International Civil Aviation Organization [ICAO] Annex 13).	0

Consequences	Total
In-flight turbulence encounter	0
Unintended Flight in Instrument Meteorological Conditions (IMC)	0
Insufficient information exists to categorize the occurrence.	5
Undershoot or overshoot: a touchdown off the runway/helipad/helideck surface.	10
Flight into windshear or thunderstorm.	0