Safety Regulation Group

Civil Aviation Authority

CAA Paper 2009/03

Business Jet Safety Research

A Statistical Review and Questionnaire Study of Safety Issues Connected with Business Jets in the UK

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Contents

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Glossary

AAG .... Accident Analysis Group
AAIB .... Air Accidents Investigation Branch
AOC .... Air Operators Certificate
APU .... Auxiliary Power Unit
ASSI............... Air Safety Support International
ATC .... Air Traffic Control
ATCO............. Air Traffic Control Officer
ATPL............. Airline Transport Pilots Licence
BBGA............. British Business and General Aviation Association
CAA .... Civil Aviation Authority
CFIT .... Controlled Flight Into Terrain
CPL................ Commercial Pilots Licence
CRM .... Crew/Cockpit Resource Management
EASA .... European Aviation Safety Agency
EBAA............. European Business Aviation Association
ERA .... European Regions Airline Association
ERG .... Economic Regulation Group
EU.................. European Union
FAA .... Federal Aviation Administration
FDM .... Flight Data Monitoring
FDP................ Flight Duty Periods
FITS .... FAA Industry Training Standards
FMS............... Flight Management System
FODCOM ...... Flight Operations Department Communication
FORCE........... Flight Operations Research Centre of Excellence
FTL .... Flight Time Limitations
GA .... General Aviation
GAMA............ General Aviation Manufacturers Association
GASIL .... General Aviation Safety Information Leaflet
IBAC .... International Business Aviation Council
IFR................. Instrument Flight Rules
IGA-CA........... International General Aviation and Corporate Aviation
IGA-CARA...... International General Aviation and Corporate Aviation Risk Assessment
IR................... Instrument Rating

IS-BAO........... International Standard – Business Aircraft Operations
JAA................ Joint Aviation Authorities
JAR................ Joint Aviation Requirements
LPC................ Licence Proficiency Check
MCC .... Multi Crew Co-Operation
MORS............ Mandatory Occurrence Reporting Scheme
MTOW........... Maximum Take-Off Weight
NLR .... National Aerospace Laboratory
NTSB .... National Transportation Safety Board
OPC............... Operator Proficiency Check (Base Check)
RTO .... Rejected Take Off
RVSM .... Reduced Vertical Separation Minimum
SAFE.............. System for Aircrew Fatigue Evaluation
SID................. Standard Instrument Departure
SMS............... Safety Management Systems
SOP .... Standard Operating Procedure
SRG .... Safety Regulation Group
STAR .... Standard Terminal Arrival Route
TCAS .... Traffic Alert and Collision Avoidance System
TRTO .... Type Rating Training Organisations
VLJ .... Very Light Jet

Executive Summary

Analysis by the UK CAA of worldwide fatal accidents to large jet and turboprop aeroplanes, as described in CAP 776 Global Fatal Accident Review, revealed that business jets[1] appeared to be involved in a disproportionate number of fatal accidents. The potential for growth in this sector prompted further study, which included an analysis of safety data supplemented by externally contracted research that involved personal industry visits and a questionnaire sent to operators and pilots to obtain feedback on any safety related issues. The main findings of the study, which have been endorsed by the Business Aviation Safety Partnership (BASP)[2] are presented below.

1 Data Analysis

1.1 The estimated worldwide fatal accident rate for all civil operated business jets for the eight-year period 2000 to 2007 was approximately 1.7 (per million hours flown) compared with 0.2 for large western built jets (excluding business jets), 0.8 for large western built turboprops and 0.3 for jets and turboprops combined.

1.2 The CAA does not hold data that allows a fatal accident rate for business jets to be produced in terms of flights flown. However, industry sources showed that the average flight duration for business jets was 1.4 hours compared to 1.9 hours for large western built jets and 0.9 hours for turboprops. A fatal accident rate expressed in terms of flights flown will reduce the difference between business jets and other large aeroplanes to some extent, but the change is not substantial.

1.3 Over a third of the business jet fatal accidents involved ferry or positioning flights (21 out of the 59 fatal accidents in the dataset).

1.4 The CAA does not hold data that allows the fatal accident rate for business jets to be broken down into individual operation types. However, data supplied by the International Business Aviation Council (IBAC) *(Reference 1)* revealed that there is a large variation for different types of business jet operation. Corporate operations achieved a fatal accident rate of 0.2 (per million hours flown) for the period 2003 to 2007, which is comparable to large western built aeroplanes, whereas air taxi operations, as a whole, had a far higher rate of 3.5 (per million hours flown).

1.5 Adoption of industry best practice, such as IBAC's 'International Standard for Business Aircraft Operations' (IS-BAO) *(Reference 2)*, was felt to be a significant factor behind the good safety record achieved by corporate operators.

1.6 The higher overall fatal accident rate for air taxi operations may justify further analysis. European operators are subject to direct regulatory oversight under EU-OPS, the same as for regular public transport, whereas in the USA air taxi operations are overseen by the less demanding Part 135 regulations. It is believed that EU-OPS regulated air taxi operations may demonstrate a far better safety record than the overall figure would suggest. This is a recommended area for further study.

1. See Appendices 1 and 2 for the definition of business jets used in this study and a full list of aircraft types included.
2. BASP membership includes: BBGA, CAA, DfT, EBAA, FAA, Flight Safety International, Gates & Partners, NATS, TAG Aviation and UK FSC.

2 Main Safety Issues and Recommendations

2.1 Flight Crew Training:

Findings suggested that pilots might have incomplete understanding or variable ability in areas such as use of auto-flight modes (particularly in relation to vertical guidance), energy management and poor weather operations. Limited use of simulation for recurrent training reduces opportunities for practice, lack of pre-course preparatory material reduces training effectiveness and lack of training in additional duties peculiar to business jet operations may cause such tasks to distract pilots from primary flying tasks. There was concern regarding the limited ability of pilots to conduct safe flight without a serviceable FMS.

Recommendations:

- Promote simulator utilisation for recurrent training; explore low cost options.
- Improve pilot training: develop a system to record the performance of student pilots based on analysis of simulator flight data, aggregate the records of students and examine this pooled performance data to identify areas for improvement in the training course.
- Review the training principles currently being trialled for automation training in large aeroplanes *(Reference 3)* for applicability to improve training for business jets.
- Inform major training organisations of pilot feedback concerning 'whole task' training and pre-course study materials.

2.2 Regulator Interaction:

Industry respondents reported difficulty interfacing with the CAA (particularly when trying to identify appropriate contacts), lack of information concerning the CAA/EASA/JAA situation and a perceived lack of interest by the regulator in the business aviation community.

Recommendations:

- Provide an information leaflet specifically targeted at the business jet community containing information on the regulatory situation with regard to CAA/EASA/JAA, clarification of contact points and providing sources of 'best practice' advice and guidance on the operational issues listed below.
- Improve two-way communications between the CAA and the business aviation associations to exchange operational intelligence and regulatory advice.

2.3 Operational Issues:

Issues included flight crew fatigue/tiredness, commercial pressure (particularly in air taxi operations), de-icing service providers, SOP standardisation in small operators *(the increasing adoption of IS-BAO should help in this regard)*, runway length/performance issues, runway contamination and poor reporting culture.

Recommendations:

- Make the System for Aircrew Fatigue Evaluation (SAFE) software model available to business jet operators to raise awareness of flight crew fatigue issues.
- Inform operators of available web-based training materials (e.g. ice and snow operations).

2.4 **Air Traffic Control:**

Respondents highlighted a lack of ATC appreciation of business jet performance (particularly climb/descent rates and their relationship to speed restrictions) and difficulties were caused by late changes (particularly departure clearances) and the high level of radio transmissions during critical stages of flight. NATS event data showed that business jets were involved in a disproportionate number of level busts, lateral non-compliance events and runway incursions. NATS are actively addressing some of these issues through ongoing joint initiatives with the business aviation industry.

Recommendations:

- Jointly with NATS, support an industry forum on the safety of business jet operations and promote ATC awareness to:
  - Minimise the number of radio transmissions/frequency changes during critical stages of flight;
  - Recognise impact on workload during single pilot operations (e.g. last minute clearance changes);
  - Highlight performance characteristics of this group of aircraft.

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Report

1 Introduction and Background

Analysis by the UK Civil Aviation Authority (CAA) of worldwide fatal accidents to large jet and turboprop aeroplanes, as described in CAP 776 Global Fatal Accident Review, revealed that business jets appeared to be involved in a disproportionate number of fatal accidents.

The potential for growth in this sector prompted further study, which included an analysis of safety data supplemented by externally contracted research that involved personal industry visits and a questionnaire sent to operators and pilots to obtain feedback on any safety related issues. The results of this study, which have been consulted with and endorsed by the Business Aviation Safety Partnership (BASP)[1], are described in detail in this report.

The BASP, in its former guise as the Business Aviation Safety Working Group, was established in January 2007 as a joint partnership between the CAA, NATS and the business aviation industry to identify safety issues affecting this sector and to develop and support the implementation of safety initiatives. The CAA would like to thank BASP members for their invaluable feedback and contribution of safety statistics during the production of this report.

There have been a number of other recent studies carried out on the business aviation sector and it was felt important to acknowledge two in particular:

1.1 International General Aviation and Corporate Aviation Risk Assessment

In 2005, Air Safety Support International (ASSI)[2] commissioned Cranfield University (Department of Air Transport) to carry out a risk assessment of international general aviation and corporate aviation. The result was the International General Aviation and Corporate Aviation Risk Assessment (IGA-CARA) report *(Reference 4)*, which revealed that Part 135 air taxi-type operations had the largest risks and suggested that the low accident rate for corporate aviation was due to the use of up-to-date aircraft, professional pilots and pre-existing company procedures. Recommendations included the introduction of a “no-blame” incident reporting system, due to a perceived reluctance to report errors, and a review of the feasibility of Flight Data Monitoring (FDM) for exceedence and incident monitoring.

1.2 Accident Analysis of Jet and Turboprop Business Aircraft 1998-2003 and the Potential Impact of IS-BAO

The International Business Aviation Council (IBAC) commissioned a study to assess the potential impact of the International Standard for Business Aircraft Operations (IS-BAO). This study involved classifying a set of business aircraft accident data, from 1998 to 2003, against several criteria in an attempt to determine the probability of prevention had IS-BAO been implemented and also to obtain a comprehensive view of the factors involved. The resulting report *(Reference 5)* revealed that between 35% and 55% of the accidents could have certainly or probably been prevented by implementation of IS-BAO.

1. BASP membership includes: BBGA, CAA, DfT, EBAA, FAA, Flight Safety International, Gates & Partners, NATS, TAG Aviation and UK FSC.
2. ASSI is a not-for-profit, wholly owned, subsidiary company of the UK CAA, established under directions from the UK Department for Transport. The company's primary objective is to help provide a more cohesive system of civil aviation safety regulation in the UK Overseas Territories.

2 Statistical Information

Although this report concentrates on UK registered and operated aircraft, worldwide figures are included for comparative purposes. These statistics, which include comparison between business jets and large western built aeroplanes, are presented in the following section.

2.1 Fatal Accident Statistics (Worldwide Operations)

Data Criteria

The following criteria were used to generate the worldwide dataset:

- Data sources: Ascend (formerly Airclaims) and National Aerospace Laboratory (NLR).
- Fatal accidents involving at least one fatality to an aircraft occupant.
- Excluding accidents caused by violent acts (e.g. terrorism).
- Business jets, as classified by Ascend (see Appendix 1 for a complete list of aircraft types): all civil usage except experimental/test flights.
- Public transport aircraft: western built jet and turboprop aeroplanes with MTOW exceeding 5,700 kg on passenger and cargo flights only.
- Date range: 1 January 2000 to 31 December 2007 (inclusive).

2.1.1 Fatal Accident Statistics

Tables 2.1 and 2.2 show a comparison of the number of fatal accidents, the number of hours flown and the fatal accident rate (per million hours flown) between business jets (all civil usage) and large western built aeroplanes (excluding business jets) on revenue passenger and cargo flights only. Hours were used as a rate measure due to the lack of readily available worldwide data on the number of business jet flights (or departures). It is acknowledged that rates measured in terms of flights are sometimes more appropriate than rates measured in hours.

Worldwide utilisation data for large western built aeroplanes is readily available and of relatively high accuracy. However, data with a similar level of accuracy is not readily available for business jets, and had to be estimated. The method of estimation is described in detail in Appendix 3, but essentially involved taking the average number of hours flown for an individual aircraft type (obtained from an accurate worldwide sample) and multiplying it by the number of such aircraft in service at the end of a given year. **Due to the possible errors associated with this estimation, any results that use hours flown by business jets should be treated with an element of caution.**

It is relatively common for an individual business jet aircraft to be used in different roles from day to day, and as such, it was not possible to estimate the number of business jet hours flown on specific types of operation. This means that business jet aircraft utilisation refers to all civil usage. However, industry sources have been able to estimate utilisation for specific types of operation and their data will be used to illustrate differences between these operation types.

Table 2.1 Comparison of number of fatal accidents and hours flown: Business jets (all civil usage) vs western built jets and turboprops (passenger and cargo flights only)

Year	Western Built Jets		Western Built Turboprops		Business Jets (all civil usage)	
	No. of Fatal Accidents	No. of Hours Flown	No. of Fatal Accidents	No. of Hours Flown	No. of Fatal Accidents	No. of Hours Flown
2000	9	37,413,247	8	7,570,609	7	3,594,460
2001	8	37,671,792	5	7,087,417	9	3,857,120
2002	8	37,820,727	8	6,413,272	5	4,113,305
2003	7	38,884,717	5	5,997,777	9	4,283,100
2004	4	43,368,069	8	5,922,736	7	4,433,485
2005	8	45,509,142	4	5,793,290	6	4,614,613
2006	7	47,814,025	4	5,780,481	7	4,922,866
2007	8	50,974,343	0	5,939,240	9	5,324,713
Total	**59**	**339,456,061**	**42**	**50,504,822**	**59**	**35,143,661**

Table 2.2 Comparison of fatal accident rate (per million hours flown): Business jets (all civil usage) vs western built jets and turboprops (passenger and cargo flights only)

Year	Fatal Accident Rate (per million hours flown)		
	Western Built Jets	Western Built Turboprops	Business Jets (all civil usage)
2000	0.24	1.06	1.95
2001	0.21	0.71	2.33
2002	0.21	1.25	1.22
2003	0.18	0.83	2.10
2004	0.09	1.35	1.58
2005	0.18	0.69	1.30
2006	0.15	0.69	1.42
2007	0.16	0.00	1.69
Total	**0.17**	**0.83**	**1.68**

The overall fatal accident rate for the eight-year period 2000 to 2007 for business jets was 1.7 (per million hours flown) compared with 0.2 for western built jets, 0.8 for western built turboprops and 0.3 for jets and turboprops combined. It should be re-emphasised, however, that the business jet statistics referred to all civil usage, which included, inter alia, corporate/executive use, ferry/positioning, emergency services, commercial training and private flying as well as passenger and cargo flights, whereas the western built aeroplane statistics covered passenger and cargo flights only. Figure 2a shows the three-year moving average fatal accident rate (per million hours flown) for business jets (all civil usage) and western built aeroplanes (excluding business jets) on passenger and cargo flights.

The fatal accident rates for all civil operated business jets and large western built aeroplanes (excluding business jets) were compared using a Chi-Square statistical test with a 95% level of confidence. The results showed that the fatal accident rate for business jets was statistically significantly higher than that for large western built aeroplanes (excluding business jets).

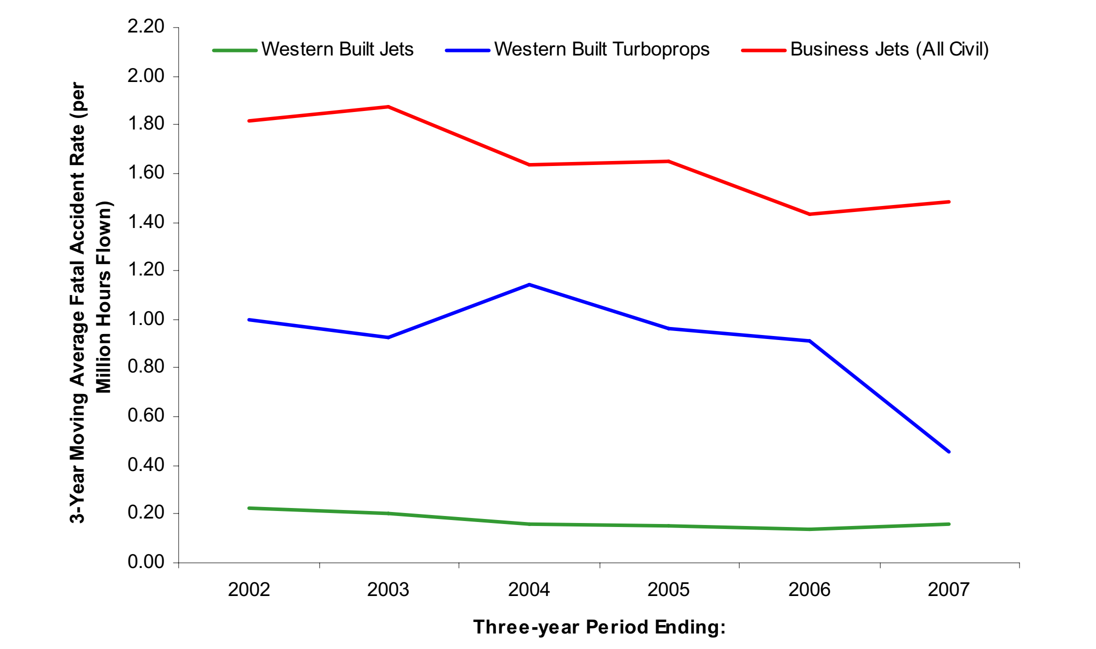

Figure 2a Comparison of three-year moving average fatal accident rate (per million hours flown): Business jets (all civil usage) vs western built jets and turboprops (passenger and cargo flights only)

IBAC *(Reference 1)*, through Robert Breiling & Associates, has been able to demonstrate that there is a wide variation in fatal accident rates (FARs) achieved by different types of business jet operation. Corporate aviation achieved a FAR that was comparable to regular large public transport aeroplanes, whereas air taxi operations had a significantly higher FAR. This variation is illustrated in Figure 2b.

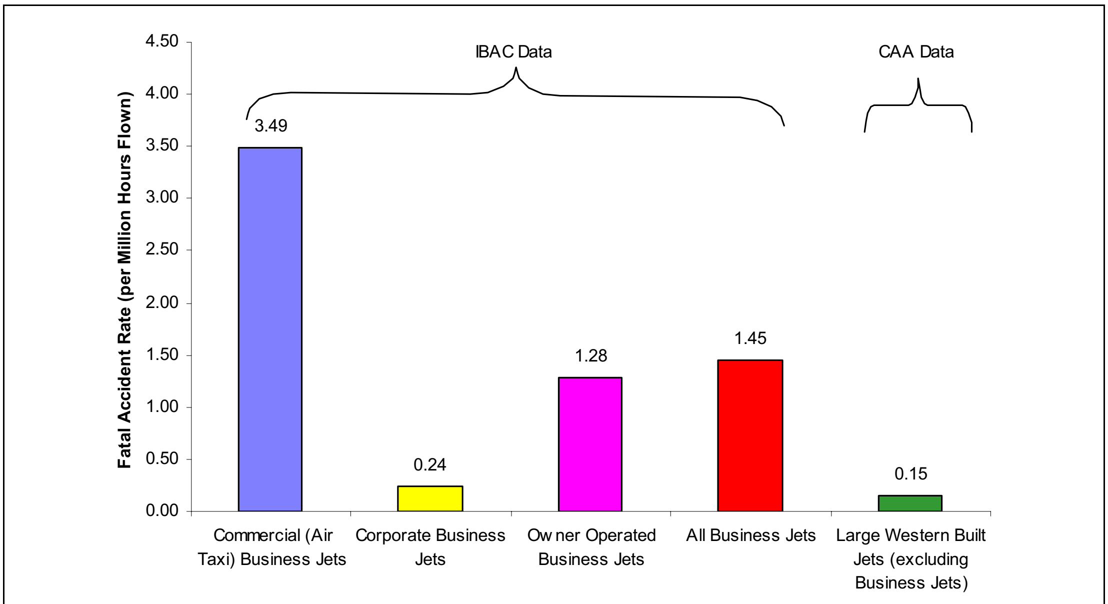

Figure 2b Global fatal accident rates (per million hours flown) for different types of business aviation for 2003 to 2007 (source: IBAC) with large western built jets (excluding business jets) added for comparison (source: CAA)

Tables 2.3 and 2.4 show a breakdown of the 59 worldwide fatal accidents involving all civil operated business jets between 2000 and 2007 by operation type and phase of flight. Over a third of the fatal accidents involved ferry or positioning flights and over half occurred during approach and landing.

Table 2.3 Breakdown of fatal accidents (2000-2007) involving business jets by type of operation

Operation Type	No. of Fatal Accidents
Ferry/Positioning	21
Private/Business	17
Cargo	6
Passenger	5
Air Ambulance	4
Training	3
Other	3

Table 2.4 Breakdown of fatal accidents (2000-2007) involving business jets by phase of flight

Phase of Flight	No. of Fatal Accidents
Taxi	1
Take-off	8
Climb	11
En-route	1
Flight	1
Descent	4
Approach	19
Landing	12
Go-around	2

Variants of the Learjet accounted for 18 (or 31%) of all fatal accidents involving business jets. However, it was estimated that these aircraft contributed approximately 15% of all hours flown by business jets and 16% of the worldwide fleet.

2.1.2 **Fatal Business Jet Accidents involving UK Operated/Registered Aircraft or Foreign Aircraft in UK Airspace**

Two of the 59 worldwide fatal accidents to business jets involved UK operated/ registered aircraft or foreign aircraft in UK airspace. Details of these two fatal accidents are provided in Table 2.5.

Since this study was completed a further nine fatal accidents to business jets had occurred in 2008, of which one involved a Cessna Citation aircraft that crashed shortly after take-off from Biggin Hill Airport, UK.

Table 2.5 Fatal accidents involving UK operated/registered business jets anywhere in the world and foreign business jets in UK airspace (2000–2007)

02 May 2000	**Learjet 35A**	**G-MURI**	**Lyon, France**	**On-demand Air Charter**
Aircraft wing struck ground just before touchdown following diversion due to engine failure.				
French BEA: The accident resulted from a loss of yaw and then roll control, which appears to be due to a failure to monitor flight symmetry at the time of the thrust increase on the right engine. The hastiness exhibited by the Captain, and his difficulty in coping with the stress following the engine failure, contributed to this situation.				

04 Jan 2002	**Challenger 604**	**N90AG**	**Birmingham, UK**	**Corporate**
Aircraft crashed following loss of control immediately after take-off.				
The UK AAIB investigation identified the following causal factors: 1. The crew did not ensure that N90AG's wings were clear of frost prior to takeoff; 2. Reduction of the wing stall angle of attack, due to the surface roughness associated with frost contamination, to below that at which the stall protection system was effective; and 3. Possible impairment of crew performance by the combined effects of a non-prescription drug, jet lag and fatigue. Possible contributory factors were; the inadequate warnings on the drug packaging, FAA guidance material suggesting that polished wing frost was acceptable and melting of the frost on the right wing by Auxiliary Power Unit (APU) exhaust gas.				

2.1.3 Fatal Accident Factors for Business Jets

The SRG Accident Analysis Group (AAG) analyses worldwide fatal accidents involving large, turbine-powered aeroplanes, including business jets, and allocates causal factors, circumstantial factors and consequences. For more information on the AAG working methodology, see CAP 776 Global Fatal Accident Review, which can be found on the CAA website (www.caa.co.uk/CAP776).

Table 2.6 shows the top-five primary causal factors allocated for worldwide fatal business jet accidents (note: a primary causal factor was selected for all but seven of the 59 fatal accidents). The percentages refer to the proportion of all fatal accidents that had a particular primary causal factor allocated. A primary causal factor from the flight crew related group was allocated in 78% of the fatal accidents.

It is recognised that flight crew errors may arise for many reasons and should not necessarily imply that the pilot was to blame. Most fatal accidents were the result of a combination of causal and circumstantial factors, which often involved more than one party. However, allocation of causal factors in accidents helps to recognise the crucial importance of pilot performance in flight safety. This in turn draws attention to the importance of supporting pilot performance by continued attention to providing good training and support, and minimising the possibility of adverse effects from influences such as fatigue, distraction or commercial pressure.

Table 2.6 Top-five primary causal factors for worldwide fatal accidents (2000–2007) involving all civil operated business jets

AAG Primary Causal Factor	No. of Fatal Accidents
Flight Crew: Flight handling	16 (27%)
Flight Crew: Lack of positional awareness - in air	11 (19%)
Flight Crew: Omission of action/inappropriate action	9 (15%)
Flight Crew: Poor professional judgement/airmanship	4 (7%)
Flight Crew: Disorientation or visual illusion	2 (3%)

Table 2.7 shows the top-ten causal factors allocated for worldwide fatal business jet accidents (note: a causal factor was allocated for all but seven of the 59 fatal accidents and more than one causal factor could be allocated for each fatal accident).

Table 2.7 Top-ten causal factors for worldwide fatal accidents (2000-2007) involving all civil operated business jets ** these are NOT mutually exclusive **

AAG Causal Factor	No. of Fatal Accidents
Flight Crew: Omission of action/inappropriate action	25 (42%)
Flight Crew: Flight handling	22 (37%)
Flight Crew: Lack of positional awareness – in air	17 (29%)
Flight Crew: Poor professional judgement/airmanship	16 (27%)
Flight Crew: Failure in CRM (cross check/co-ordinate)	11 (19%)
Flight Crew: Press-on-itis	8 (14%)
Flight Crew: Slow and/or low on approach	6 (10%)
Aircraft Performance/Control: Unable to maintain speed/height or achieve scheduled performance	5 (8%)
Environmental: Icing	5 (8%)
Flight Crew: Lack of/inadequate qualification/training/experience	5 (8%)
Flight Crew: Slow/delayed action	5 (8%)

Table 2.8 shows the top-ten circumstantial factors allocated for worldwide fatal business jet accidents (note: more than one circumstantial factor could be allocated for each fatal accident).

Table 2.8 Top-ten circumstantial factors for worldwide fatal accidents (2000-2007) involving all civil operated business jets ** these are NOT mutually exclusive **

AAG Circumstantial Factor	No. of Fatal Accidents
Environmental: Poor visibility or lack of external visual reference	21 (36%)
Aircraft Systems: Non-fitment of presently available safety equipment	19 (32%)
Flight Crew: Failure in CRM (cross-check/co-ordinate)	16 (27%)
Environmental: Other weather	15 (25%)
Infrastructure: Company management failure	8 (14%)
Flight Crew: Training inadequate	5 (8%)
Infrastructure: Inadequate regulatory oversight	5 (8%)
ATC/Ground Aids: Lack of ground aids	4 (7%)
ATC/Ground Aids: Non-fitment of presently available ATC system or equipment	4 (7%)
ATC/Ground Aids: Non-precision approach flown	4 (7%)

Table 2.9 shows the top-ten consequences allocated for worldwide fatal business jet accidents (note: a consequence was allocated for all 59 fatal accidents and more than one consequence could be allocated for each fatal accident).

Table 2.9 Top-ten consequences for worldwide fatal accidents (2000-2007) involving all civil operated business jets ** these are NOT mutually exclusive **

AAG Consequence	No. of Fatal Accidents
Post crash fire	33 (56%)
Loss of control in flight	30 (51%)
Controlled flight into terrain (CFIT)	15 (25%)
Ground collision with object/obstacle	9 (15%)
Runway excursion	9 (15%)
Collision with terrain/water/obstacle	2 (3%)
Structural failure	2 (3%)
Forced landing - land or water	1 (2%)
Ground collision with other aircraft	1 (2%)
Mid-air collision	1 (2%)
Undershoot	1 (2%)

2.2 Accident and Occurrence Statistics (UK Operations)

The statistics presented in this section refer only to UK registered or operated aircraft.

Data Criteria

The following criteria were used to generate the UK dataset:

- Data sources: UK CAA Mandatory Occurrence Reporting Scheme (MORS) database, UK CAA Aircraft Register database and UK CAA-Economic Regulation Group (ERG) Airline Statistics.
- Business jets, as classified by Ascend: UK operated/registered.
- Public transport aircraft: UK operated/registered aeroplanes on public transport flights (i.e. passenger, cargo, air ambulance, police support and search and rescue); large (exceeding 5,700 kg MTOW) and small (not exceeding 5,700 kg MTOW).
- Date range: 1 January 2000 to 31 December 2007 (inclusive).

2.2.1 Fatal Accident Statistics

Tables 2.10 and 2.11 show a comparison of the number of fatal accidents, the number of hours flown and the fatal accident rate (per million hours flown) between business jets and public transport aeroplanes (excluding business jets).

Table 2.10 Comparison of number of fatal accidents and hours flown: UK public transport aeroplanes (excluding business jets) vs business jets

Year	Large Public Transport Aeroplanes (> 5,700 kg)		Small Public Transport Aeroplanes (≤ 5,700 kg)		All UK Registered Business Jets		Public Transport Business Jets[1]	
	No. Fatal Accidents	No. Hours Flown	No. Fatal Accidents	No. Hours Flown	No. Fatal Accidents	No. Hours Flown	No. Fatal Accidents	No. Hours Flown
2000	1	2,431,063	1	37,647	1	34,324	1	12,223
2001	1	2,494,942	0	35,610	0	31,617	0	11,304
2002	0	2,399,596	0	37,244	0	31,778	0	9,143
2003	0	2,462,784	0	37,005	0	30,823	0	11,061
2004	0	2,613,152	0	43,242	0	37,947	0	13,165
2005	0	2,722,411	0	42,647	0	37,962	0	14,972
2006	0	2,891,120	0	38,919	0	44,947	0	20,511
2007	0	2,971,446	0	39,483	0	54,058	0	33,103
Total	**2**	**20,986,514**	**1**	**311,797**	**1**	**303,455**	**1**	**125,482**

1. Public transport business jets are a subset of all UK registered business jets.

The number of hours flown by large public transport aeroplanes (excluding business jets) was some 69 times greater than that for all business jets and 167 times greater than for public transport operated business jets. Business jets operated on public transport flights accounted for approximately 41% of all hours flown by UK registered business jets. The majority (92%) of public transport business jet hours (i.e. airline and air taxi) were flown by air taxi operators (defined as small airlines, none of whose aircraft capacities exceeds 20 seats, or sole use charter flights utilising aircraft of MTOW not exceeding 15,000 kg).

Table 2.11 Comparison of fatal accident rate (per million hours flown): UK public transport aeroplanes (excluding business jets) vs business jets

Year	Fatal Accident Rate (per million hours flown)			
	Large Public Transport Aeroplanes (> 5,700 kg)	**Small Public Transport Aeroplanes (≤ 5,700 kg)**	**All UK Registered Business Jets**	**Public Transport Business Jets**
2000	0.41	26.56	29.13	81.81
2001	0.40	0.00	0.00	0.00
2002	0.00	0.00	0.00	0.00
2003	0.00	0.00	0.00	0.00
2004	0.00	0.00	0.00	0.00
2005	0.00	0.00	0.00	0.00
2006	0.00	0.00	0.00	0.00
2007	0.00	0.00	0.00	0.00
Total	**0.10**	**3.21**	**3.30**	**7.97**

The fatal accident rates for small public transport aeroplanes and business jets should be treated with caution due to the relatively low amount of utilisation accumulated and the low number of fatal accidents. There was an element of statistical uncertainty as to whether the observed fatal accident rates were representative of the true underlying values.

2.2.2 Serious Event and Low Level Event Statistics

Serious events were defined, for the purposes of this study, as: fatal accidents, non-fatal reportable accidents, serious incidents and Mandatory Occurrence Reports (MORs) graded at risk category A or B.

Low level events were defined, for the purposes of this study, as: MORs graded at risk category C or D that do not fall into the serious event category.

Tables 2.12 and 2.13 show a comparison of the number of serious/low level events and the serious/low level event rate (per million hours flown) between business jets and public transport aeroplanes (excluding business jets). Table 2.14 contains a list of all the serious events involving UK registered business jets.

Figures 2c and 2d show the three-year moving average serious and low level event rates per million hours flown for business jets and public transport aeroplanes (excluding business jets).

Table 2.12 Comparison of number of serious/low level events: UK public transport aeroplanes (excluding business jets) vs business jets

Year	Number of Serious/Low Level Events							
	Large Public Transport Aeroplanes (> 5,700 kg)		Small Public Transport Aeroplanes (≤ 5,700 kg)		All UK Registered Business Jets		Public Transport Business Jets	
	Serious	Low Level	Serious	Low Level	Serious	Low Level	Serious	Low Level
2000	78	4,016	5	37	1	44	1	5
2001	46	3,812	4	35	1	51	0	4
2002	51	3,908	2	58	2	76	1	12
2003	50	4,072	4	63	0	63	0	18
2004	43	4,429	3	72	5	76	4	13
2005	38	4,435	1	109	2	87	1	13
2006	48	5,416	3	68	0	80	0	23
2007	37	5,486	3	79	2	93	0	35
Total	**391**	**35,574**	**25**	**521**	**13**	**570**	**7**	**123**

The ratio between low level and serious events could provide a general indication of reporting culture. The larger the ratio, the better the perceived reporting culture. Where a serious event has occurred, by its nature it is more likely that a report will be filed and therefore contribute to the statistical data available. However, in the case of low level events it could be argued that a significant number may go unreported because of the perceived lack of importance or reluctance of the crew/operator to submit the necessary paperwork. Whilst this is purely a subjective proposition, a certain number of responses received from the questionnaires mailed to pilots and operators for the production of this report suggest that this might be the case. The ratios of numbers of low level to serious events are listed below for each category of aircraft.

Ratio of Numbers of Low Level to Serious Events

Large Public Transport Aeroplanes	91:1
Small Public Transport Aeroplanes	21:1
All UK Registered Business Jets	44:1
Public Transport Business Jets	18:1

Table 2.13 Comparison of serious/low level event rate (per million hours flown): UK public transport aeroplanes (excluding business jets) vs business jets

Year	Serious/Low Level Event Rate (per million hours flown)							
	Large Public Transport Aeroplanes (> 5,700 kg)		Small Public Transport Aeroplanes (≤ 5,700 kg)		All UK Registered Business Jets		Public Transport Business Jets	
	Serious	Low Level	Serious	Low Level	Serious	Low Level	Serious	Low Level
2000	32	1,652	133	983	29	1,282	82	409
2001	18	1,528	112	983	32	1,613	0	354
2002	21	1,629	54	1,557	63	2,392	109	1,312
2003	20	1,653	108	1,702	0	2,044	0	1,627
2004	16	1,695	69	1,665	132	2,003	304	987
2005	14	1,629	23	2,556	53	2,292	67	868
2006	17	1,873	77	1,747	0	1,780	0	1,121
2007	12	1,846	76	2,001	37	1,720	0	1,057
Total	**19**	**1,695**	**80**	**1,671**	**43**	**1,878**	**56**	**980**

The serious event rates for small public transport aeroplanes and business jets (all UK registered and public transport operated) should be treated with an element of caution due to the relatively low amount of utilisation accumulated and the low number of serious events.

Nevertheless, a comparison using a Chi-Square statistical test with a 95% level of confidence (which took into account the number of events and utilisation) showed that public transport operated business jets had a **statistically** significantly higher serious event rate than large public transport aeroplanes. However, the comparison between public transport operated business jets and small public transport aeroplanes (which included smaller turboprop and piston-engine aeroplanes) showed that there was statistically no difference in the serious event rate.

Table 2.14 Serious events involving all UK registered business jets (2000-2007)

Date	Aircraft Type	Location	Operation Type	Summary
02 May 2000	Learjet 35	Lyon, France	Passenger	UK Reportable Accident: Aircraft caught fire on landing, following diversion due to engine problems en-route. 5 Persons On Board (POB), 2 crew fatalities, 3 passenger minor injuries. French BEA investigation.
02 Sep 2001	Learjet 35	Burgas, Bulgaria	Positioning	Rejected take-off due to engine failure. Extensive damage. The failure was due to mis-assembly of the combustor liner to the inner transition liner.
15 Mar 2002	Learjet 45	Rome, Italy	Passenger	Aircraft control difficulty. MAYDAY declared. Diversion. Yaw Interface Unit and Rudder Servo replaced. AAIB Field investigation.
22 Aug 2002	HS125-800	Northolt, UK	Positioning	UK Reportable Accident: Heavy landing, left wing tip contacted runway. Substantial damage. No injuries to 3 POB. AAIB Field investigation.
23 Apr 2004	HS125-800	Kenley, UK	Passenger	UK Airprox 60/2004: HS125 and K8 Glider at Kenley Airfield at approximately 1,900ft.
02Jun 2004	HS125-800	Henley, UK	Passenger	UK Airprox 95/2004: HS125 and a Beech 76 1nm Northeast of Henley at 2,000ft.
16 Sep 2004	Cessna C560 Citation V	London City, UK	Unknown	UK Reportable Accident: Falcon 50 under marshaller assistance hit nose cone of parked Citation 560XL with its RH wing.
25 Nov 2004	Cessna C550 Citation II	Teesside, UK	Passenger	AAIB Serious Incident: C550 left the paved area during take-off run. Rejected take-off. Aircraft returned to Stand. Two runway side lights damaged.
01 Dec 2004	Gulfstream IV	Teterboro, USA	Passenger	UK Reportable Accident: Aircraft departed runway on landing following inadvertent auto-throttle re-engagement. Substantial damage. No injury to 9 POB. NTSB investigation.
18 Feb 2005	Cessna C525 CitationJet	Munich, Germany	Passenger	AAIB Serious Incident: Both engines fuel filters blocked. Aircraft diverted to Munich and landed safely. Extent of damage unknown. No injuries to 2 POB. Subject to German BFU investigation.
16 Jun 2005	Cessna C560 Citation V	Biggin Hill, UK	Positioning	UK Airprox 92/2005: PA-28 and a C560 on final approach to runway 21 at Biggin Hill at 400ft.
20 Jan 2007	Falcon 900	7nm SW Worthing, UK	Ferry	UK Reportable Accident: MAYDAY declared due to nr3 engine fire. Aircraft diverted to Gatwick and landed safely.
14 Apr 2007	HS125-800	Heathrow, UK	Private	Aircraft entered severe wake turbulence and rolled right through 90 deg whilst following B747.

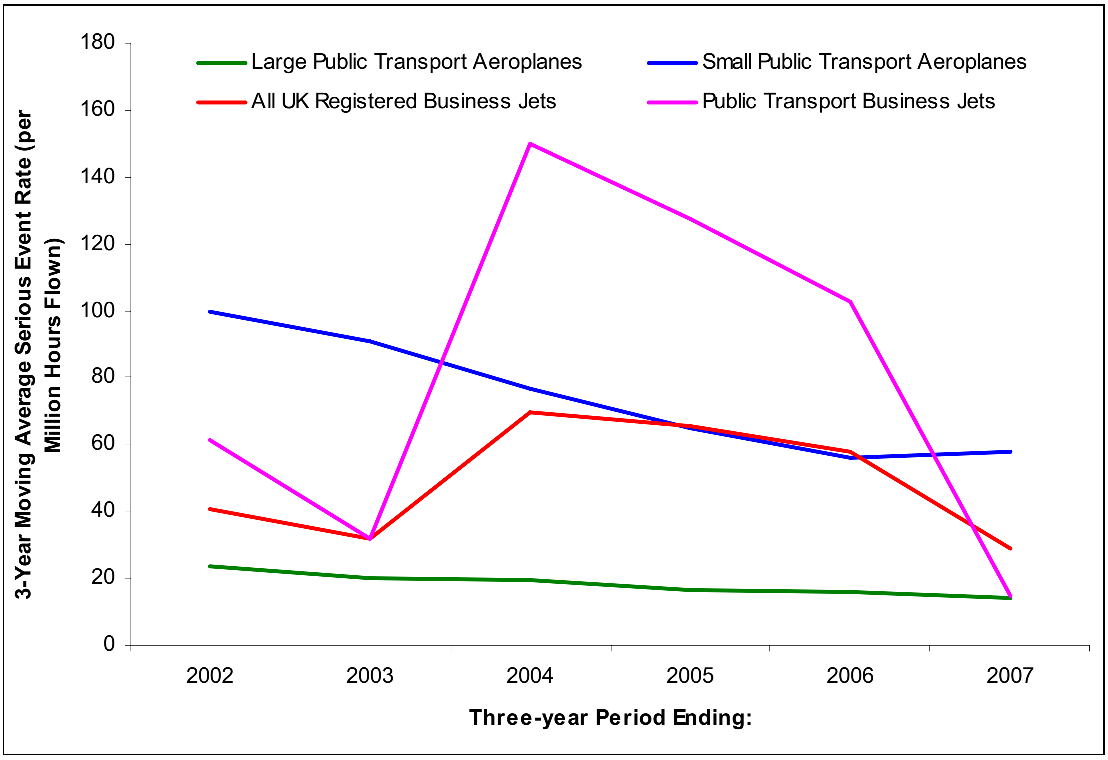

Figure 2c Comparison of three-year moving average serious event rate (per million hours flown): UK public transport aeroplanes (excluding business jets) vs business jets

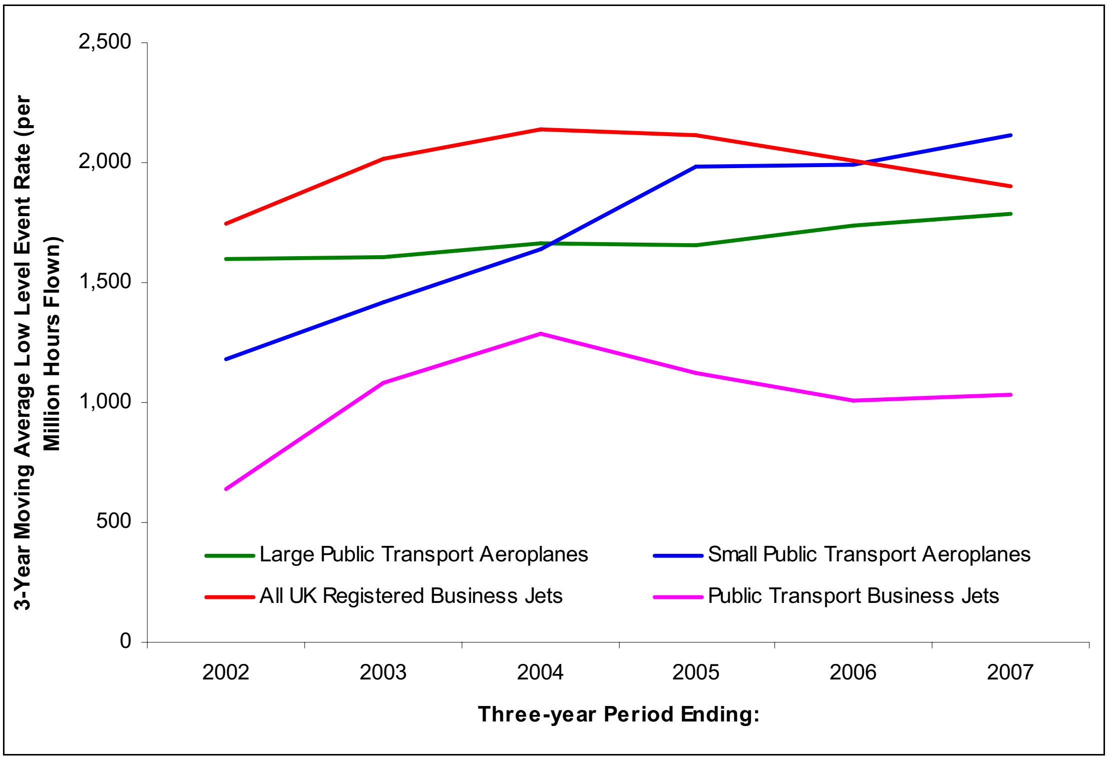

Figure 2d Comparison of three-year moving average low level event rate (per million hours flown): UK public transport aeroplanes (excluding business jets) vs business jets

Public transport operated business jets had the smallest low level event rate, which could be a reflection of the reporting culture for this type of operation.

3 Data Received from Pilot and Operator Questionnaires

Two questionnaires were produced to gather the confidential and impartial opinions of respondents with regard to various areas of business jet operations, including, but not exclusive to, training, experience levels, operating practices, regulation, etc. One was designed to ask opinions of the operator and the other aimed more specifically at the individual pilot. These questionnaires were mailed to all operators listed on the BuchAir business jet aircraft operator database and to private operators known to have bases in the UK or that were known to operate in the UK. A total of 11 completed questionnaires on behalf of operators were returned plus 39 questionnaires from individual pilots. The percentage of respondents in the 'operator' category was 15% and the 'pilot' category estimated at 12%. However, due to the difficulty of establishing the number of crews employed with each operator, the percentage of pilot questionnaires returned was thought to be considerably higher than the figures would suggest, as it was decided to send out more questionnaires than were probably required. Whilst the number of returned questionnaires suggested a relatively small sample size, it was nevertheless sufficient to draw useful conclusions.

The questions contained in each questionnaire were designed to cover as many areas as possible and were a combination of free text and multi choice responses. Where deemed appropriate, additional comments boxes were included so that personal views/concerns could be aired. All questionnaires were anonymous, with no operator details requested.

A summary of the responses received from both questionnaires is outlined below. Of course, questionnaires were completed by individuals with their own opinions and the aviation community does not necessarily speak with a single, homogenous voice. However, the messages that emerged from the questionnaires were presented as data received directly from industry respondents, with the caution that it may not represent the views of every member of the industry on all points.

3.1 Pilot Questionnaire

3.1.1 Pilot Demographics

The majority of responses, 65%, were received from pilots operating aircraft in the light and medium weight classes (see Appendix 1 for aircraft categories). 85% of these pilots were aged between 30 and 50 years and had an average experience of over 2,800 hours on business jets holding either FAA or CAA ATPL licences (approximately a 50:50 ratio). Few pilots had previous experience in other types of jet aircraft (approximately 20%) with the majority coming straight from piston engine operations.

3.1.2 Training

Approximately 30% of questions on the paper targeted training methods that pilots currently undergo, to try to establish whether any areas should be examined more closely.

Although most, but not all operators used full motion simulators for initial training, a much lower percentage continued to use them for recurrent training, particularly in the light/medium aircraft category. One reason cited was the fact that there were currently aircraft types, (Citation Excel, Citation II for example) for which there was no availability of simulators in the UK. However, this might change in the future. Questions were asked on a variety of training issues and the large majority of respondents were happy with the way in which their initial and recurrent training was conducted, with a few notable exceptions. There were many comments received requesting an improvement in the standard of pre-course study material available as many felt they were under prepared on commencement of the type rating course.

Additionally, it was noted that some pilots felt that they were also not adequately prepared for the task in hand once the initial type rating had been completed. This included not being allowed, by some employers, to observe flights before starting on line themselves, a situation made worse by the fact that there are no jump seats on smaller aircraft. Also only 40% of respondents had completed a Multi Crew Co-operation (MCC) course.

In areas of human performance, the great majority of replies expressed concerns over the mistakes that can and sometimes were made when using the auto-flight system available on most aircraft, particularly with regard to vertical and lateral navigation modes. Another area of concern was the late changes sometimes issued by ATC on SIDs/STARs and general departure and arrival routes, particularly when requiring last minute changes and inputs to the flight guidance systems, in some cases once lined up for departure. Several comments were received aligning this with fatigue, compounding the potential risk of error. This particular area is elaborated upon later in this report.

Finally, in this section, it was noted that training varied little from year to year unless company SOPs were changed or there had been an incident associated with a particular aircraft type initiating the operator to introduce a modification.

3.1.3 Information

A small selection of questions asked, addressed the information received by pilots and their organisations relating to safety and ancillary issues.

The main sources of safety information used, over and above amendments from the aircraft manufacturer and changes to regulatory material were: UK CAA Flight Operations Department Communications (FODCOMs) and the General Aviation Safety Information Leaflet (GASIL), with very little coming from EASA and other organisations. 85% of respondents thought that the UK CAA safety information was most relevant followed by the manufacturers and finally EASA, with the majority believing that information received from the CAA was generally clear and concise and applicability to their operation was easy to ascertain.

Questions were also asked with regard to the use of the CAA website with 80% of replies stating that they used it occasionally and found it fairly easy to use. However, it was thought that the search engine was not user friendly.

Finally, in this section, questions were asked regarding the main safety issues facing business jet operations and by far the greatest number cited flight crew fatigue as their main concern, followed by operation in poor weather, the quality and reliability of ground de-icing service providers, inability to cope without flight management systems and commercial pressure. Once again, these issues will be elaborated on later in this report. This data is presented graphically in Figure 3a.

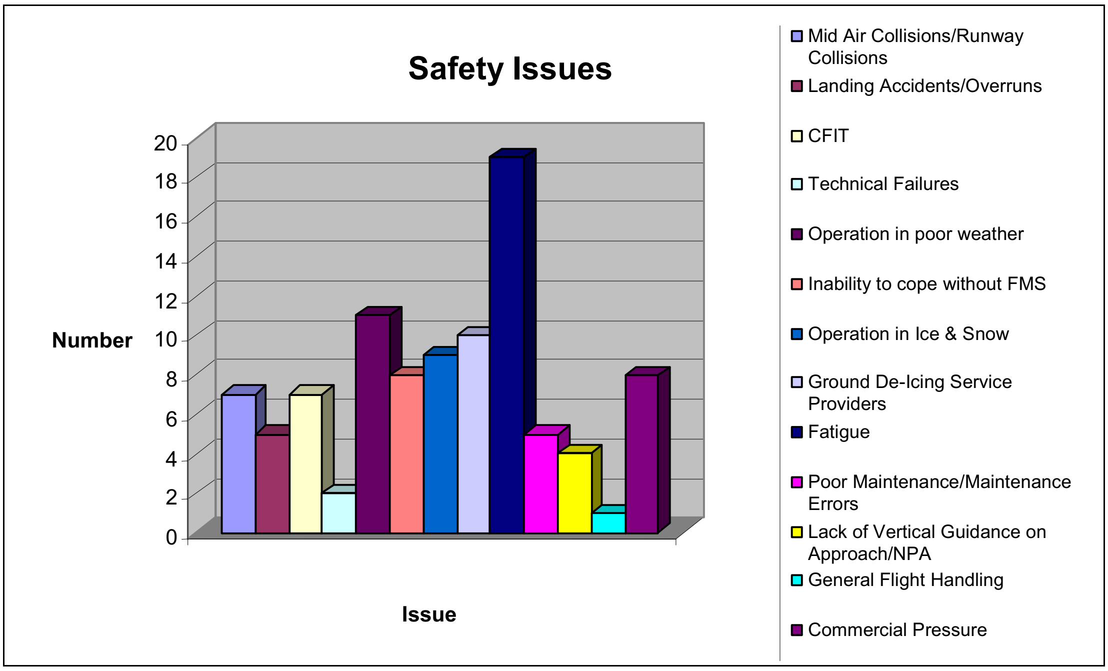

Figure 3a Main safety issues facing business jet operations as expressed by respondents to pilots questionnaire

3.1.4 Air Traffic

Approximately 50% of questionnaires returned stated that ATC either over or under estimated business jet aircraft performance and issues raised appear later in this report.

Another area investigated was the operation into airports that pilots were less familiar with and whether this gave any cause for concern. Whilst the majority of pilots operated in and out of very familiar airports (60%), there were many operations into airports that were visited perhaps only once every six months or even less. Most operators had no specific procedures for flying into airports with non-precision approaches although 50% considered there was a need for more approaches with vertical guidance. Where performance limiting runways were concerned, the majority of operators had specific restrictions regarding strong cross-winds, category B and C airports, steep approaches, etc. with most being Captain-only landings or crews having to have visited the airfield at least once, before being allowed to carry out the landing.

3.1.5 Standard Operating Procedures (SOPs)

The majority of replies (55%) indicated that most pilots were operating to SOPs that specify in some detail all normal and emergency operating procedures and that crews were trained to accomplish these and to adhere to them.

However, others stated that there were no detailed procedures in place and each Captain operated his own version of SOPs, including how tasks were split between him and the First Officer. Some stated that although operating to company SOPs, they were not documented in any great detail, also a small number stated that, as they only had a few pilots, they did not believe formal SOPs were necessary.

Finally, a small number, approximately 8%, stated that although formal SOPs were in place, custom and practice was for flight crews to operate to their own methods.

A question was asked requesting information on whether flights operating outside an AOC used practices that would not be permissible under AOC conditions. Although no particular situations were detailed, over 40% of pilots stated that this happened regularly.

3.1.6 **Duty/Rest Periods**

The majority of pilots questioned (80%) flew between 25 and 50 hours per month, with the average flying time being 40 hours. Duty/attendance time averaged 100 hours supplemented by an additional 20 hours of travel per month.

Questions were asked regarding how tasks were split between flight crew and operations staff whilst operating sectors both from their home base and away from base. The areas of interest included refuelling, flight planning, catering, arranging servicing and maintenance. As could be reasonably expected, flight crews had a higher workload in nearly all areas when away from base. These included arranging hotel accommodation, cleaning the aircraft, de-icing and dealing with customer special requests. One respondent stated that frequently, no crew meals were provided down route.

Notwithstanding the above, flight crews stated that pre and post flight duty times were the same whether at home or away from base. These were split approximately 1.0 to 1.5 hours pre-flight and 0.5 to 1.0 hours post flight.

Rosters were not deemed to be generally predictable, with only 33% stating that this was the case with their company. Some pilots said that they never had a fixed roster, although most (over 65%), stated that they were fixed between one and seven days ahead. 10% considered their rosters were fixed either 14 to 28 days or more than 28 days ahead. Also, 66% of pilots said that rest days were not predictable and that many received calls on their days off.

3.1.7 **Pilots comments**

The final question asked pilots to comment on any issues that they considered of value in reviewing safety in the business jet sector. A selection of the responses received are listed below.

Main Safety Issues

- "Standby periods not included in duty time when flights allocated. Standby days becoming retrospective days off. Rostering within company was introduced three years ago, but some fleets still have no roster. Rostering significantly improved perceived pressure to fly – particularly amongst more experienced pilots. It seems to me that new/younger employees still feel obliged to be available on their days off. Poor Crew Management – e.g. threats to deduct items from salary such as tax paid on fuel, airport extension fees (for early/late arrivals), host carnet cards and other incidentals. Threats of suspension and endless rude/demoralising e-mails addressed to all crews."
- "I believe flight time limitations should be taught as a subject, possibly with pilots and flight ops personnel together, rather than being issued reading material."
- "Bureaucratic pressure from ever changing controlling authorities (CAA, JAA, EASA) place VERY HEAVY financial and man hour requirements to ensure compliance with. ALMOST always the bureaucracy does NOT help flight safety but merely add annoyance and frustration. These pressures (especially) small companies mean many find it difficult to make ends meet."
- "The most demanding aspect is the ever increasing paperwork burden."

- “The whole industry has a "go now" "don't ask questions" mentality, from making duty work to making baggage fit the load sheet forces. The power of the industry is in the hands of "brokers" or flight brokers who are not regulated and are not pressured enough into making the passengers responsible for providing accurate info on their travel plans. The pilots generally do a sterling task under these pressures (including serving the food and drink!!!) but business aviation is a growing and immature industry with all the associated problems of operating under tight budget constraints.”

ATC/Aircraft Performance

- “However, we are sometimes left high and close to our destination which can cause us to have to descend more rapidly than we would like, or extend our time in the air.”
- “Sometimes requested to maintain higher speed than aircraft limits (e.g. "Maintain 290 knots or greater” – Max speed is 270 knots for C550).”
- “Overestimates of vertical performance – climb and descent. Specification of high rate of descent coincident with low speed restriction.”
- “ATC set a speed limit (e.g. 250 knots) and a rate of descent (e.g. 3000 fpm), which is often unfeasible above 20,000 ft.”
- “This does not happen very often, but sometimes we get asked to fly faster than the aircraft is capable of or climb at a rate greater than aircraft capable of (only high levels). Typically on a STAR.”
- “Asking for rapid descent and then asking for large speed reduction.”
- “ATC not always aware of performance capabilities, which can be used to their advantage.”
- “More recently (within the last year) aircraft can get start or even taxi clearance as far as the runway holding point – then to be told that the flight plan has "dropped out of the system, please call your operations department". This is a ridiculous scenario – especially when sometimes "the pilot is the operations department” – i.e. Does not have 24 hour back up. Is it not possible for ATC to be more helpful?”

General Comments

- “I believe that the abuse of flight duty times, AOC or private, is a major cause for concern in the safety of operating in the business jet sector.”
- “Enforcing AOC Flight Duty Periods (FDPs) on private flights.”
- “We as pilots are held completely accountable for safe operation of our aircraft and passengers. We now live and operate in the most confusing environment. When I started my career we were accountable to the CAA and would operate globally according to the law of whichever country we were in. Nowadays if you ask most pilots we do not know where the goal posts are as they are constantly moving. CAA-JAA-EASA this is the real issue of safety and who we are accountable to it is a mess as to who makes the rules changes the rules and applies the rules. We need to know sooner rather than later, please drop the egos and sort out the protocol.”
- “Annual simulator check as a requirement. Observation flight for raw recruits, i.e. with no line flying experience.”
- “Flight Time Limitation (FTL) monitoring takes a disproportionate time to monitor and check.”

- "CAA returns take a hugely disproportionate time to collate especially as the resultant fee is small. (I am not saying raise the fees; rather gather the statistics by an alternative method)."
- "My greatest criticism – the inflexibility and extremely onerous method of maintenance oversight and control ensures that maintenance costs are increased and downtime is increased without particularly increasing safety or serviceability."
- "Spare parts are still returned to the pod with no fault found only to fail on a subsequent flight. Spares are changed with no flexibility on calendar times with no fault – extensions do not seem to be possible."
- "I would have no hesitation putting members of my family on a company flight. In my experience everyone is under pressure to provide more than normally required in terms of time and effort. I personally complete unpaid extra work on a weekly basis and do not hold a management position. Operations staff seems to work 12 to 14 hour days regularly although a shift system was recently introduced. Ours is a growing parallel industry to the airlines. Business operators use aircraft which are comparable to later airliners in every way except size and more understanding is required from authorities to appreciate the methods of operation. I hope this questionnaire is a first step in that direction".

3.2 Fleet Operators Questionnaire

Additional questions were asked in this questionnaire targeting areas such as regulation that would hopefully be more relevant to an operator.

One of the initial questions asked was whether there was a belief that the level of activity in the business jet sector was likely to see an increase over the next five years. 80% of operators believed that it would, with only one expecting to see a decline.

Pilot demographics were also an area of interest and questions were asked on the types of aircraft operated, pilot age and experience. Approximately 50% of operators stated that they were operating aircraft in the medium category (see Appendix 1) and employed pilots mostly in the 40-year plus age range. The number of flight hours each aircraft type operated per annum varied, but in the light/medium-heavy categories, averaged over 1,000 hours per year in approximately 850 sectors.

3.2.1 Training

All operators stated that full motion simulators were used on initial ratings but not all used them for recurrent training. Again, training was considered to be of a high standard and currently focused in the right areas with very few comments received that raised any particular shortcomings. For example, only one operator stated that pilots were not being adequately prepared for all aspects of the operational task. However, the ability to be able to use simulators for all recurrent training was a desire in some cases as it was deemed that not all the required scenarios can be shown on the aircraft. This may be due to a variety of reasons including safety, cost, and availability of correct types, also the practicality of carrying out certain procedures on the aircraft. Once again, very few changes were made to training programs from year to year.

The areas of concern regarding potential human errors again highlighted the auto-flight system, particularly in vertical navigation modes. Also, input errors to the FMS, energy management in descent and weight and balance calculations featured highly.

Finally, the question was asked relating to the perceived standards of newly type rated pilots. 60% stated that there was no improvement/difference in general, with equal numbers indicating an increase and decline.

3.2.2 Information

As with the pilots' version, some questions addressed the safety related information received by pilots and their organisations relating to safety and ancillary issues.

Again, the main sources of safety information used, over and above amendments from the aircraft manufacturer and changes to regulatory material were the UK CAA FODCOMs and GASIL, with very little coming from EASA and other organisations. Safety information received from the CAA was deemed to be the most applicable along with manufacturers' circulars. This was also considered clear and concise with only a small number of respondents stating that they received too much information, which could increase the likelihood of their missing something important. 60% used the CAA website regularly and found it fairly easy to use.

The sharing of information between operators and a number of other sources was discussed, with very little communication appearing to take place in some areas. The majority of information sharing would seem to take place between operators and the aircraft manufacturer, operators of the same aircraft type and other operators with similar operations to the respondent. Very little, if any communication would appear to take place between operators and organisations such as the British Business and General Aviation Association (BBGA), IBAC, Flight Safety Foundation (FSF), European Regions Airline Association (ERA), etc.

The final question in this section addressed the main safety issues that faced business jet operations. The highest concern was over operation in ice and snow (45%); closely followed by the inability of pilots to cope without flight management systems; landing accidents/overruns; and flight crew fatigue. This data is presented graphically in Figure 3b.

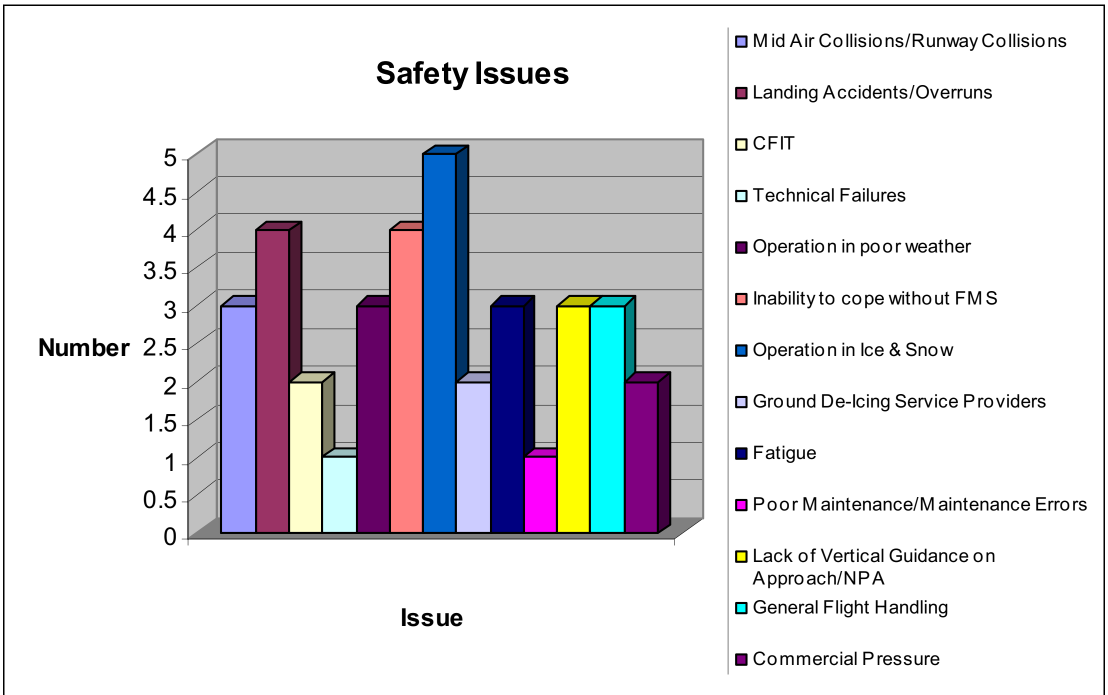

Figure 3b Main safety issues facing business jet operations as expressed by respondents to fleet operators questionnaire

3.2.3 Air Traffic

Over 50% of operators questioned stated that it was their belief that ATC either over or under estimated business jet performance.

The concerns expressed included delays in clearing aircraft into controlled airspace not experienced by the heavy jets and turboprops, landing and approach speeds, request for high rate of descent with low speed restriction and aircraft type differences resulting in unattainable requests.

The large majority of operator responses indicated that aircraft were normally operated into and out of familiar airfields, with only 20% of operations taking place in and out of less familiar or rarely visited airports. However, less than 50% stated that they operated any company specific procedures if flying non-precision approaches although in the case of performance limiting runways it was generally a Captain-only landing.

3.2.4 Standard Operating Procedures

Most operators replied that there were written operating procedures that specified in some detail all normal and emergency operating procedures and crews were trained to accomplish these and to adhere to them. Only a few stated that crews were trained to company SOPs although they were not documented in any great detail. Finally, in this section, 20% stated that flights operating outside an AOC used practices that would not be permissible under AOC conditions.

3.2.5 Duty/Rest Periods

Most operators stated that their pilots flew between 25 and 50 hours per month with only one in the 50 to 75 hour category.

Once again questions were asked regarding how tasks were split between flight crew and operations staff whilst operating sectors both from their home base and away from base. The areas of interest included refuelling, flight planning, catering, arranging servicing and maintenance, etc. As could be reasonably expected, flight crews had a higher workload in nearly all areas when away from base. Pre and post flight duty times were the same whether at home or away from base. These were split approximately 1.0 to 2.0 hours pre-flight and 0.5 to 1.0 hours post flight.

Rosters were again not deemed to be generally predictable, with only 20% stating that this was the case with their company. Standby days per month were between one and seven in the majority of cases.

The final question in this section asked what material difference operating under an AOC made and a selection of the responses included:

- "Regulated structure, incentive to maintain standards, however, excessive limitations to performance in some instances (e.g. runway landing distance required)."
- "For our company very little. Similar training not required by AOC but we do it. From operational standpoint AOC versus non-AOC is very similar."
- "FTL are a minefield and if I worked as much as I was allowed would consider it dangerous for any long term fatigue."
- "Runway landing distance required (very conservative). ISTL Scheme (more respective), recurrent crew training more frequent. Crew paperwork internally audited. 60+ crew do not fly together."

Although not specifically in evidence from questionnaire responses, it could also be considered that if pilots are at times spending long periods on standby or off duty, although remaining current on type according to hours flown, this lack of consistency may lead to an initial inferior performance on returning to flying duty.

3.2.6 **Regulation/Registration**

Approximately half of operators indicated that they operated aircraft that were not on the UK register. The main reason would appear to be that it was a management decision and no further reasons were generally given. Questions were then asked on the applications process within the CAA and most considered that it was too complicated unless you knew how the system worked. 90% had direct experience of this. A single point of contact was the preferred system, in place of the multi-contact procedure currently in place. Comments received included:

- "Too many departments, difficult to get firm decisions from one person. Occasionally get different answers from different people."
- "Fragmentation with respect to sources of info/data/requirements - EASA, CAA, FAA, JAR etc."
- "In particular in gaining RVSM approval when the aircraft had already received European approval but on a previous register."

The changes in certification requirements (EASA) were seen to have helped 50% of operators with the remaining stating that the requirements had either hindered their operation or there was no impact.

Most respondents did not believe that there was any need for further training in UK regulatory requirements but if there were to be, then the CAA could adopt an 'oversight' approach and direct operators to the necessary sources of information/ requirements. It was also believed that the extent of any oversight should be adjusted according to the maturity of the operator's internal controls. Finally it was believed that there was a place for a safety management system within the business jet sector (this is a strong feature of IBAC's IS-BAO code of practice, which requires an SMS to be in place).

3.2.7 **Operators Comments**

As with the pilot's questionnaire, the final question asked operators to comment on any issues that they considered of value in reviewing safety in the business jet sector. A selection of the responses received follows:

- "Good to be asked what we think. Business aviation is really no longer the poor relation (certainly at the top end). As our flights operate as closely as possible to AOC standards. The only area we have difficulty in is with runway performance issues. There are some places we cannot land using a factored (1.67) landing distance as the runways are too short. Hence the interest in runway issues. Common sense on rest is a much better way to operate than the FTL scheme. It is too easy to legally do a huge amount of flying and end up exhausted. Training – please make simulator training compulsory and allow us to do all testing in them. Aircraft are complex and expensive – the simulator is much better."
- "More vigorous pursuit of illegal charters by private and often non-UK registered operators would prevent our legitimate business from being undermined but has anyone in the authority the courage to address this? All UK based private jet operators should be sent a simple guide on legalities."
- "An integrated, transparent and effective quality and safety system is one of the best things we've introduced as a company. We now learn from mistakes, share findings with other operators and generally use the info to provide us with better safety standards and procedures than we've ever had before."

4 Expert Opinion

The comments and opinions in the following paragraphs were received from various interviewees and were not the opinion of any one individual or organisation.

4.1 Operators/Training Organisations

4.1.1 Training

Concerns were voiced by both individual pilots and the leading training organisations that the training of pilots in this sector could be reviewed in various areas. It was also noted that many new pilots were starting type rating courses with very little, if any, pre-course study carried out before course commencement, resulting in extra training being required to achieve the required standard. This situation was considered to be an increasing problem.

The current type ratings available in the UK, whilst JAA approved, were all based on a US model with one leading organisation carrying out approximately 75% of all business jet training. Whilst the initial type rating teaches the pilot to fly the aircraft it was voiced that it may not necessarily prepare him/her for the 'task'. The business jet pilot has more non-flying duties to consider than the airline pilot, particularly the pre/post flight responsibilities and passenger interaction. There was no course available on awareness of the corporate environment and the additional duties required of the corporate pilot. Some trainers voiced an interest in the development of a suitable course, possibly in association with the CAA and considered that this type of addition, perhaps to the current type rating or as a stand alone exam, would be beneficial to all concerned. Additionally, during discussion, training organisations expressed a desire to have in place a system (to be further investigated) that enables instructors and their supervisors to easily record and monitor a student's progress during training. This would be in addition to the current system of maintaining student records, as it would enable instructors and the training organisation itself, to not only monitor an individual's performance but also pick up any errors in training to the system. This would in itself be a subject worthy of individual study.

Another serious concern voiced by trainers was that some pilots did not have a 'Plan B' in the event of a failure at critical stages of flight, such as an FMS failure shortly after take off, as these things 'never happen'. It was suggested that follow up Licence Proficiency Check (LPC)/Operator Proficiency Check (OPC) should include more 'non-standard' situations and a renewal skills test should be required every three years instead of five years as was the current situation.

There were a small number of aircraft included in this study that were able to be operated as 'single-pilot'. Examples were:

Cessna 500 Citation I: Single-pilot approved for flights conducted wholly outside controlled airspace. For flights conducted partially or wholly within controlled airspace: one pilot and one other crew member but if a serviceable auto-pilot with altitude and heading hold modes is available at the commencement of the flight, this second crew member need not be carried.

Cessna 501 Citation I/SP: For all flights: one pilot plus equipment specified in the Airplane Flight Manual, or two pilots.

Whilst only a small number of aircraft in this category were authorised for single-crew operation, it was the opinion of some that single-crew jet aircraft operations should not be permitted. The reasons being, that whilst normally there were no problems, if a failure should occur at a critical stage of flight when the pilot had a high workload, this was then exacerbated and could lead to errors and possibly an incident. It was suggested that perhaps a qualified, but not type rated pilot (minimum CPL/IR) could act as safety pilot.

However, with the introduction of VLJs, many of which were expected to be operated as single-pilot aircraft, this opinion may have limited practical application. The potential issues raised by the introduction into service of these aircraft are covered later in this report.

4.1.2 **Aircraft Categorisation**

It had been suggested that there could be a review of aircraft categorisation. An exceeding 10,000 kg category was suggested, thereby excluding some of the larger business aircraft from MOR statistics that include a large variety of aircraft, and that may show misleadingly high incident rates for this aircraft group.

4.1.3 **Regulation/Registration**

It was the opinion of every contact in the operator/training sector that this area of aviation was generally over-regulated, particularly with regard to the transfer of aircraft registration. It may be a consideration that the reason for so many of the aircraft operating in the UK remaining on foreign registers (particularly the American and Cayman), was for tax reasons. This generally appeared not to be the case. Several opinions had been voiced that the process of transfer should be less costly and, in the opinion of many, was also far too time consuming and needlessly complicated. If this process could be streamlined respondents considered that far more aircraft would be on the UK register. It was also noted that certain licensing issues (pilots), were more easily resolved if the aircraft was on the FAA register and the pilots FAA rated. Comments were voiced that where a ‘problem’ occurred this could usually be dealt with by one phone call to the relevant authority. However, with the UK system, it was often necessary to contact several departments.

4.1.4 **Crew Co-Operation**

Some contributors suggested that there may be a problem when a pilot who was used to single-pilot operations was placed in a two-crew environment and that duties would not be correctly apportioned. Whilst MCC training was designed to overcome this, it was noted by some trainers that this was still an issue in the business jet sector where an experienced Captain was paired with a newly qualified First Officer. Another possible contributing factor may be that, as shown in the responses to the questionnaires, only 40% of respondents had completed an MCC training course prior to going on line.

4.1.5 **Flight Time Limitations**

Whilst aircraft operating under an AOC had strictly enforced FTLs the single-pilot, owner/operator, etc. could not realistically apply these, considering all the other duties they had to carry out prior/post flight. Pilots in the business jet sector may spend many hours carrying out non-flying related duties which, if included would take them well outside normal FTLs. It was suggested that perhaps a new set of guideline FTLs be drawn up for the non-AOC operator. Pressures could also be levied on pilots and managers by the owners of aircraft who were unaware of FTLs, aircraft maintenance schedules, etc. However, operators consulted stated that generally, after explanation, this was not a major issue.

4.1.6 **ATC/Airport Issues**

Several comments had been received that ATC and even the airport itself could be unco-operative towards business jets/GA and were also unaware of the performance/ capabilities/limitations of this type of aircraft. Climb and descent profiles and speed capabilities were a particular concern and respondents to the questionnaires indicated that this often resulted in a Traffic Advisory (TA) from the Traffic Alert and Collision Avoidance System (TCAS) on board. A suggestion was made that there should be a requirement for radar qualified controllers to undertake a number of jump seat trips as part of their rating, thereby gaining an insight into the way this aircraft type was operated. It was also suggested that business jet pilots spend some time observing ATC as part of their ratings. The practicalities of these suggestions, however, were yet to be considered.

4.1.7 CAA Consultation

All of the contributors contacted would welcome the opportunity to meet, on a regular basis, with the CAA to discuss their concerns. It was felt that this was an area of aviation to which the CAA did not pay enough attention. By embarking on such a programme of consultation it was the opinion of the operators that both the CAA and the Operator would benefit from each other's views.

4.2 CAA Flight Operations

The comments and opinions in the following paragraphs were received from various interviewees and were not the opinion of any one individual.

4.2.1 Airline/Business Jet Operation Comparison

There were a number of comparisons that had been made between the two types of operation. These are detailed in the following paragraphs.

4.2.2 Airline Operations

It was generally the opinion that there were a number of benefits enjoyed by the airline industry over the business jet market and that these may contribute to a better overall service. There was a considerably higher catchment area for suitably trained airline pilots than there was for the business jet sector and also a good hierarchy for promotion within the relative companies. The routes flown were familiar to the pilots and there was generally a simple route structure. If an unfamiliar route was to be flown, suitable training would be given by the operator and this may not be the case within the business jet sector.

Airlines were required to adhere strictly to SOPs, which again, were not necessarily applied in other markets. Training and simulator costs were high but were deemed to give better value in that the pilots were trained to higher standards and not just passing a type rating. Training should also be controlled by the management and not the trainer, again this involved higher costs that smaller operators may not be able to absorb. Within the airline market as an operation expanded, then the associated management structure had to grow accordingly and this had not always been observed outside this industry. Smaller operators could often expand their fleet but without the necessary management augmentation, resulting in an inefficient and overworked department.

4.2.3 Business Jet Operations

The management infrastructure of small operators gave the major cause for concern. It was felt that due to the obvious associated costs that it was not to the standard it could always be.

There was also a concern regarding the selection of pilots by owners of high performance aircraft. They may not be necessarily the best for the type of aircraft being operated. Also, the training concentrated too much on passing a type rating and was not tailored towards specific requirements of individual operators and not enough emphasis was placed on line training. This also could mean that there was poor CRM compared to that demonstrated by the airlines.

Although more were currently being installed, there were still relatively few business jet simulators available in the UK. In many cases this resulted in pilots being trained by instructors that were not familiar with European airspace and associated regulations and practices. It was felt that perhaps there was not currently sufficient control over the associated Type Rating Training Organisations (TRTOs) and if there were more interaction between the regulator and the trainer that there could be considerable improvement in these areas.

Aircraft design was another concern. Some business jets (excluding the more modern designs) were not as well designed from a human factors point of view and this could also lead to mistakes at critical stages of flight leading to a possible incident.

5 NATS Event Data

The business jet community is also undergoing examination by NATS as part of a study into level busts and general non-compliance events. Key results of this study showed that, for the period 2005 to 2007 (inclusive), business jets were involved in approximately 7.4% of all incidents recorded by NATS. A more detailed breakdown revealed the following statistics (shown graphically in Figure 5).

Business jets were involved in:

- approximately 6% of all recorded accidents
- approximately 9% of all recorded Airprox
- approximately 21% of all level busts
- 13% of all lateral non-compliance events
- 10% of runway incursions
- 20% of incidents with a root cause of ‘altimeter setting error’
- 16% of incidents with a root cause of ‘correct read-back followed by incorrect action’

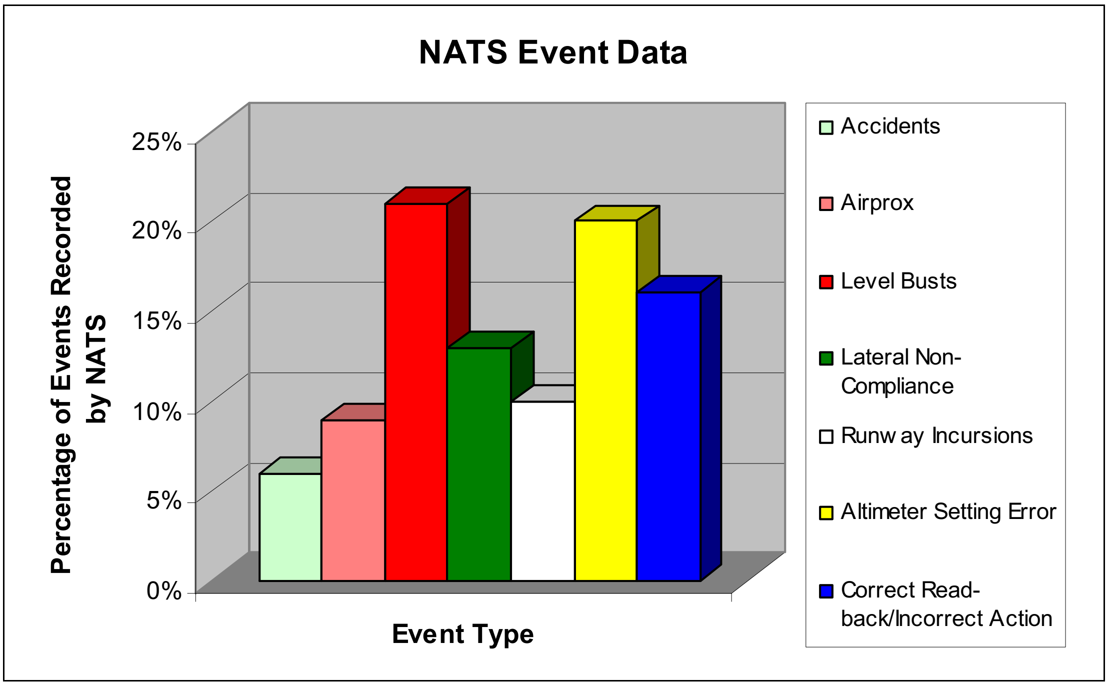

Figure 5 Percentage of events recorded by NATS involving business jets

The business jet sector needs to be targeted for action as they are having a disproportionate number of events. Whilst they currently accounted for just over 7% of traffic, they contributed to 21% of level busts, 13% of all lateral non-compliance events and 10% of runway incursions.

Some of these issues are being addressed as part of an ongoing safety initiative involving the CAA, NATS and the business aviation industry.

6 Very Light Jets

In addition to the forgoing, the introduction of Very Light Jets (VLJs) offers further challenges and potential safety concerns to the business jet community. The BBGA share the concern and have set up a VLJ working group to monitor and advise on modern VLJs.

VLJ manufacturers and the FAA recognised a number of years ago that the introduction of ‘affordable’ jet performance to GA demanded a rethink of training standards for non-professional pilots. Between them they produced a set of training guidelines named FAA Industry Training Standards (FITS), an optional training program that attempts to address the additional demands placed on the pilots of such aircraft, which the basic non-professional qualifications do not meet. Although the training is optional it is understood that customers purchasing such aircraft will have their orders cancelled if they do not agree to complete the training. Training for VLJs can now be conducted on full motion flight simulators, certified as ‘Level D’ simulators.

As jet aircraft are more efficient at high altitudes this also means that VLJs will be operating in the same upper airspace as airliners, although far slower, cruising at around 350 kt. This will be the first time that general aviation aircraft, in potentially large numbers, have been able to bid for their share of this airspace and this will also put a demand on air navigation service providers.

With a number of aircraft now already operating in the US, VLJs will likely expand into the UK and Europe. EUROCONTROL predict the number of VLJs operating in European airspace per day will rise by 300 aircraft each year in the period 2008-2015, although this number is subject to variation depending on the underlying global financial climate.

7 Conclusions and Recommendations

7.1 Flight Crew Training

The area causing by far the greatest concern to all interviewees and also respondents to the questionnaires was that of the current training programs available to business jet pilots. This was not to say that the various training organisations were at fault, but perhaps that the content of the courses available should be re-examined to address areas where there were felt to be deficiencies.

7.1.1 Course Content

Of particular concern would appear to be the lack of any training in the area of the pre/post flight responsibilities and passenger interaction and also on awareness of the corporate environment and additional duties required of the corporate pilot. Whilst these may not impact safety directly, there was a risk that crew attention could be distracted from the flying task by concerns and uncertainty about supplementary duties. It may be useful to explore opportunities available to promote training for the ‘whole task’.

The questionnaire evidence indicated that it would be beneficial to review the effectiveness of current training in the use of auto-flight modes, particularly in relation to vertical guidance. This was an area that appeared to be causing a disproportionate number of errors, as indicated by the number of level busts being recorded by ATC. Additional training incorporated in the Type Rating on FMS modes and characteristics might better prepare crew for complex operational situations. Other areas that could be improved included energy management and operation in poor weather.

CAA Paper 2004/10 *(Reference 3)* suggested an alternative to the current training methods in use for highly automated aeroplanes. This had focused on larger jets but there may be parallels in business jet training. The paper presented an experimental syllabus that was structured to better reflect fundamental principles of training i.e. teach the pilot how to fly the aircraft first then teach him how to achieve the same task but using the auto-flight system. Then, introduce the element of navigation and how the flight management system can assist the pilot by optimising the long term goals and strategies. Importantly, the theoretical aspects of CRM and human factors of interaction with automation were introduced before the pilot moved on to the more traditional areas of systems operations and control.

7.1.2 **Simulation**

Availability and use of simulators for recurrent training should be reviewed. It had become clear that training on the aircraft could not, for reasons of flight safety and practicality, replicate a full range of scenarios. These needed to be presented to the pilot to enable him to maintain the required high level of competency in dealing with emergency situations. The use of a form of low cost, fixed base simulator in addition to current expensive full motion types should be further explored as this may offer operators a better opportunity to maintain required standards whilst keeping recurrent training costs to a minimum.

7.1.3 **Feedback System**

Investigation into the practicalities of a system, which enables instructors and their supervisors to easily record and monitor student's progress during training, is recommended. This would be in addition to the current system of maintaining student records, and would involve simulator outputs plus mis-selections and other errors made by students. It would enable instructors and the training organisation itself, to not only monitor an individual's performance but also to pool student information and pick up any weakness in the training programme. Any particular areas causing continued problems would be easily identified. Currently this would not easily come to prominence, as student performance was normally considered individually. With the number of instructors and students, and pressures of time and cost (especially within the major training organisations), there was not usually the facility to record and pool data nor provide general feedback to the training regime.

In summary, there was an opportunity to investigate standards currently being achieved in flight training programs, in association with the major training organisations, in order to explore the potential to enhance flight safety within the business jet sector. This could initially focus on the areas that have been suggested as possibilities for improvement.

Recommendations:

- Promote simulator utilisation for recurrent training; explore low cost options.
- Improve pilot training: develop a system to record the performance of student pilots based on analysis of simulator flight data, aggregate the records of students and examine this pooled performance data to identify areas for improvement in the training course.

- Review the training principles currently being trialled for automation training in large aeroplanes *(Reference 3)* for applicability to improve training for business jets.
- Inform major training organisations of pilot feedback concerning 'whole task' training and pre-course study materials.

7.2 **Regulator Interaction**

During discussion, the frustration within the business jet sector of the apparent lack of a single point of contact within the CAA to deal with operator queries/requests became apparent. Although the website was not thought particularly difficult to use, at the same time it was not considered to be user friendly and the required information was not always available.

The current situation relating to the relationship between the CAA, JAA and EASA was not generally understood, nor was its relevance to the business jet sector. Many operators also voiced concern that they had always felt as if this market was not embraced by the regulatory authority as were the major airlines.

It was recommended that the CAA, perhaps in association with NATS, and other regulatory bodies, should issue a guidance leaflet explaining the relationship between EASA, JAA, CAA and the relevance to business jet operations. Also, a single point of contact should be established and the contact details be made known, that could deal specifically with enquiries from business jet operators.

This leaflet could also contain other pertinent information, such as advantages of MCC training, fatigue management, use of simulators, the potential impact of commercial pressure, the advantages of occurrence reporting and any icing/de-icing issues that had specific relevance to business jet operations. It could direct operators to available information sources such as web based training and could even offer access to the CAA SAFE software model to enable improved evaluation of flight crew fatigue.

Although various safety sense leaflets did exist, it was recommended that one combined communication should be produced as it became clear that the many communications available were not always deemed relevant within this sector. It would also promote the feeling that there was now a specific interest, of a positive nature, being shown by the regulatory authorities.

Recommendations:

- Provide an information leaflet specifically targeted at the business jet community containing information on the regulatory situation with regard to CAA/EASA/JAA, clarification of contact points and providing sources of 'best practice' advice and guidance on the operational issues listed below.
- Improve two-way communications between the CAA and the business aviation associations to exchange operational intelligence and regulatory advice.

7.3 **Operational Issues**

Whilst examining data retrieved from pilot and operator questionnaires, it was noticeable that issues regarding flight crew fatigue/tiredness, runway contamination and aircraft icing/de-icing/operation in ice and snow were of significant concern to all parties.

There had been recent high profile accidents with causal factors being apportioned to ice contamination and further investigation was recommended into the promotion of pilot awareness in this area. As previously mentioned, this could take the form of a specifically business jet focused safety communication within a contact document. Recommended areas of attention included: performance of smooth wing aircraft in icing conditions, freezing residues on non-powered flight controls, runway contamination, ground de-icing procedures, visual inspection and judging the severity of weather conditions.

Again, whilst there had been many communications covering the above topics, nothing, to date had been specifically aimed at business jet operations. This was a further opportunity to raise awareness and enhance flight safety in an area where many operators may only encounter such conditions infrequently. New information presented for business jet operators should also direct them to the web-based training on icing that was freely available and was produced with CAA participation.

Recommendations:

- Make the System for Aircrew Fatigue Evaluation (SAFE) software model available to business jet operators to raise awareness of flight crew fatigue issues.
- Inform operators of available web-based training materials (e.g. ice and snow operations).

7.4 Air Traffic Control

It was apparent, from discussions with NATS, operators, pilots and responses from questionnaires that it would be beneficial to raise ATCO awareness of business jet issues, with particular regard to aircraft performance such as requests for high rates of descent with low speed, last minute changes to flight plans/SIDs (particularly at times of high workload/single-pilot operations), waypoint identification, etc. Business jet pilots appeared, in some cases, to be unaware of ATC expectations, for example, when a continuous descent was requested. If high rates of climb and descent were made, far in excess of other types of civilian air traffic (as many of these aircraft were capable of), multiple vertical levels would need to be allocated to this single aircraft, thus further increasing the ATCO’s workload.

Capacity of pilots may be impacted by late changes to departure clearances particularly where there were many additional considerations to take into account. This situation was exacerbated when there were an unnecessarily high number of radio transmissions, particularly during critical stages of flight such as issuing a heading change followed by a level change only a few seconds apart. This was of particular concern in single-pilot operations. Operating in and out of unfamiliar airfields may exacerbate the heavy workload pilots would encounter in these situations. Many SIDs involved platform heights, automatic frequency changes on departure, etc. Coupled with any commercial pressure to depart on time and not enabling crews sufficient time to properly brief, these scenarios compounded potential human errors that may lead to an incident.

NATS are actively addressing some of these issues through ongoing joint initiatives with the business aviation industry.

Recommendations:

- Jointly with NATS, support an industry forum on the safety of business jet operations and promote ATC awareness to:
  - Minimise the number of radio transmissions/frequency changes during critical stages of flight.
  - Recognise impact on workload during single pilot operations (e.g. last minute clearance changes).
  - Highlight performance characteristics of this group of aircraft.

8 Summary

Overall, this report found that the data justified intervention specifically directed at business jet operations, recommending actions in the areas of improved training, ATCO education and a targeted communication from the CAA.

The recommended actions were identified to specifically target both the causal factors that were apparent in the fatal accident statistics, and the concerns that had been highlighted by this study. Many of the findings support ongoing safety initiatives related to this sector of the industry.

The information gathered and feedback received indicated that operators and pilots alike had a willingness to engage with the CAA and considered this study to be a positive step in the promotion of enhanced flight safety in the business jet sector.

Appendix 1 Business Jet Definition and List

Ascend (formerly Airclaims) classify business jets as those types for which the majority of the production is intended for the business/corporate market, but excluding any civilian built airliners, which are operated in a business or VIP configuration. Table A1 shows a list of aircraft that Ascend consider to be business jets

Table A1 List of business jet aircraft as used by Ascend

Ascend Business Jet Category	Aircraft Type
Very Light Jet	Adam Aircraft Industries A700
	Century Aerospace Century Jet
	Cessna Citation Mustang
	Chichester Miles Leopard
	Diamond Aircraft Industries D-JET
	Eclipse Aviation Eclipse 400
	Eclipse Aviation Eclipse 500
	Embraer Phenom 100
	Epic Aircraft Elite
	Epic Aircraft Victory
	Eviation Jets (VisionAire) EV-20
	Eviation Jets (VisionAire) VA-10 Vantage
	Excel-Jet Sport-Jet
	Honda HondaJet
	Piper PiperJet
	Spectrum Aeronautical Freedom S-40
	Spectrum Aeronautical Independence S-33
Entry Level	Aerospatiale Corvette
	Bombardier (Learjet) Learjet 23
	Bombardier (Learjet) Learjet 24
	Cessna Citation I
	Cessna CJ1/CJ2
	Hawker Beechcraft Beechcraft Premier I
	M.B.B. HFB 320 Hansa
	Morane Saulnier Paris
	Piaggio-Douglas PD-808
	Sino Swearingen SJ30

Table A1 List of business jet aircraft as used by Ascend (Continued)

Ascend Business Jet Category	Aircraft Type
Light	Aero Commander Jet Commander 1121
	Bombardier (Learjet) Learjet 25
	Bombardier (Learjet) Learjet 28
	Bombardier (Learjet) Learjet 29
	Bombardier (Learjet) Learjet 31
	Bombardier (Learjet) Learjet 35
	Bombardier (Learjet) Learjet 36
	Bombardier (Learjet) Learjet 40
	Cessna Citation Bravo
	Cessna Citation Encore
	Cessna Citation II
	Cessna Citation S/II
	Cessna Citation T-47
	Cessna Citation Ultra
	Cessna Citation V
	Cessna CJ3/CJ4
	Dassault Aviation Falcon 10/100
	Embraer Legacy 500
	Embraer Phenom 300
	Grob Aerospace SPn Utility Jet (G180)
	Hawker Beechcraft Beechjet 400
	Mitsubishi MU-300 Diamond
Light/Medium	BAe (Hawker) 125
	Bombardier (Learjet) Learjet 45
	Bombardier (Learjet) Learjet 55
	Bombardier (Learjet) Learjet 60
	Cessna Citation Excel
	Cessna Citation III
	Cessna Citation Sovereign
	Cessna Citation VI
	Cessna Citation VII
	Cessna Citation XLS
	Dassault Aviation Falcon 20/200
	Hawker Beechcraft Hawker 450

Table A1 List of business jet aircraft as used by Ascend (Continued)

Ascend Business Jet Category	Aircraft Type
Light/Medium (continued)	Israel Aerospace Industries Astra/G100
	Israel Aerospace Industries Gulfstream G150
	Israel Aerospace Industries Westwind
	Rockwell Sabreliner
Medium	Bombardier (Canadair) Challenger
	Bombardier (Canadair) Challenger 300
	Cessna Citation Columbus
	Cessna Citation X
	Dassault Aviation Falcon 2000
	Dassault Aviation Falcon 50
	Dassault Aviation Falcon 900
	Embraer Legacy 450
	Hawker Beechcraft Hawker 4000
	Israel Aerospace Industries Gulfstream G200 (Galaxy)
	Lockheed JetStar
Heavy	Aerion Corporation SSBJ
	Bombardier (Canadair) Global 5000
	Bombardier (Canadair) Global Express
	Bombardier (Learjet) Learjet 85
	Dassault Aviation Falcon 7X
	Gulfstream Aerospace Gulfstream G300
	Gulfstream Aerospace Gulfstream G350
	Gulfstream Aerospace Gulfstream G400
	Gulfstream Aerospace Gulfstream G450
	Gulfstream Aerospace Gulfstream G500
	Gulfstream Aerospace Gulfstream G550
	Gulfstream Aerospace Gulfstream G650
	Gulfstream Aerospace Gulfstream II
	Gulfstream Aerospace Gulfstream III
	Gulfstream Aerospace Gulfstream IV
	Gulfstream Aerospace Gulfstream V

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Appendix 2 Business Jets on the UK Register

Table A2 shows the business jet aircraft on the UK register as at 12 August 2008 (source: UK CAA Aircraft Register Database).

Table A2 Business jet aircraft on the UK register

Ascend Business Jet Category	Aircraft Type	No. on UK Register
Very Light Jet	Cessna 510 Citation Mustang	6
Entry Level	Cessna 500 Citation I	4
	Cessna 501 Citation I/SP	1
	Cessna 525 CJ1	15
	Cessna 525A CJ2	11
	Raytheon 390 Premier I	8
Light	Cessna 525B CJ3	2
	Cessna 550 Citation II	25
	Cessna 551 Citation II/SP	1
	Cessna 560 Citation V	4
	Dassault Aviation Falcon 10	1
	Raytheon Hawker 400XP	2
Light/Medium	BAe (HS) 125	10
	Cessna 560XL Citation Excel/XLS	18
	Cessna 680 Citation Sovereign	8
	Dassault Aviation Falcon 20	16
	Learjet 45	19
	Learjet 60	3
	Raytheon Hawker 800XP	6
	Raytheon Hawker 850XP	2
	Raytheon Hawker 900XP	1
Medium	Bombardier BD-100-1A10 Challenger 300	3
	Canadair CL600 Challenger	22
	Cessna 750 Citation X	3
	Dassault Aviation Falcon 900/900EX	11
	Dassault Aviation Falcon 2000/2000EX	7
Heavy	Bombardier BD-700-1A10 Global Express	2
	Gulfstream Aerospace Gulfstream G-IV	2
	Gulfstream Aerospace Gulfstream G450	1
	Gulfstream Aerospace Gulfstream G550	5
	Total number of business jets on UK Register	**219**

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Appendix 3 Methodology to Estimate Worldwide Business Jet Utilisation

A method was devised to estimate annual utilisation data for all business jets worldwide, as this data was previously unavailable. Some data that was already available and would aid the estimation was average annual utilisation for a particular aircraft type and variant.

These averages were calculated using accurate exposure data for approximately 30% of all individual business jet aircraft worldwide, which was obtained from the NLR Air Safety Database. The time period used to produce these averages was all the years for which data was available for each given aircraft type.

The number of business jets in operation at the end of a given year was obtained from the Ascend (formerly Airclaims) CASE database. All military aircraft and aircraft primarily used on experimental/test flights were excluded from the aircraft counts.

The above two sources of data allowed an estimate to be made of annual utilisation data for business jets worldwide. This was achieved by finding the product of the average utilisation (for a given type) and the number of such aircraft in operation for a particular year. This process was repeated for each aircraft type. The total utilisation for all aircraft types produced the annual utilisation for all business jets, for a particular year.

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- BuchAir UK
- Dutch National Aerospace Laboratory
- European Business Aviation Association
- Flight Safety International, Farnborough
- International Business Aviation Council
- Jet Club UK
- NATS
- TAG Aviation

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