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Business Aviation Safety Brief

Summary of Global Accident Statistics

2007-2011



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1.0 Introduction

Business Aviation has established a record as one of the world's safest forms of transportation. Professionally flown aircraft of all sizes are operated on unscheduled routes to all corners of the globe, yet the safety record continues to be excellent in spite of the very challenging operating environment.

The exemplary safety record of business aviation can be attributed to professionalism and attention to safe operating practices. The business aviation community promotes safety through industry standards and good training, as well as through monitoring and analysing safety information to facilitate continuous improvement. The business aviation representative associations assist operators by providing safety data and programs in their respective countries. The Council representing the national and regional associations at the global level, the International Business Aviation Council (IBAC), has in turn developed a program to collect and analyse worldwide information. To that end, IBAC has contracted with Robert Breiling and Associates to develop global data on business aircraft accidents.

Summary information presented in this Brief is taken from the analysis conducted by Robert Breiling and Associates in 2012. Breiling's detailed Report contains information on accidents from all regions of the world.

This Business Aviation Safety Brief covers a five year period from 2007 to 2011. IBAC will update the Brief annually and the IBAC Planning and Operations Committee (POC) will review the information continuously to determine useful trend data. In addition, the IBAC Governing Board has determined that the Safety Brief will be scrutinized from time to time by independent organizations and feedback will be considered by IBAC's POC.

This summary data includes all accidents involving aircraft when used in conducting business operations. It does not include accidents of business aircraft when used in airshows and other non-business related flying.

Listings of Business Jet and Turboprop accidents that occurred in the preceding calendar year (i.e. 2011) are contained in Appendices A & B.

The compilation, analysis and publication of safety data is an essential foundation for the development of measures to prevent accidents and thus, is not a means unto itself. In this regard, and as a separate IBAC initiative, the International Standard for Business Aircraft Operations (IS-BAO) was introduced in 2002 and was designed to raise the safety bar by codifying safety best practices.

Recognizing that it will be many, many years before safety data will reflect the impact of the IS-BAO, IBAC commissioned an independent, retrospective analysis to subjectively assess the extent to which (i.e. in terms of probability) had the IS-BAO been implemented by the operator concerned the accident could have been prevented. A synopsis of the findings of this study are presented in Section 5.0.

This edition provides, for the first time, an Analysis of Landing Accidents (see Appendix D).

2.0 Business Aviation Community

2.1 Number of Turbine Aircraft

The Breiling Report contains data covering a five year period for the global population and the distribution of aircraft by region. A summary of the aircraft population in 2010, the last year covered by the report, is as follows:

2011 Global Business Aircraft Population	
Business Jets	18,460
Turbo Props	13,381
All Turbine Business A/C	31,841

Table 2.1a

Analysis

Business aircraft in North America represent 61.2% of the global fleet. South and Central America have approximately 11.6% and Europe 13.0% of the world's fleet. Other regions account for the remaining 14% of the fleet.

2.2 Number of Flight Hours

The 2011 summarized flight hour totals are as follows:

2011 Global BusAv Flight Hours	
Business Jets	5,699,403
Turbo Props	4,872,227
All Turbine Business A/C	10,571,630

Table 2.2a

Analysis

For the period 2007-2011, flying hours in North America represents 60.0% of the total, Europe 13.0%, Central/South America 14.0%, and the rest of the world 13%.

2.3 Number of Departures

The number of business aviation departures in the 2011 year is as follows:

2011 Global BusAv Departures	
Business Jets	4,084,078
Turbo Props	3,314,576
All Turbine Business A/C	7,398,654

Table 2.3a

(Note: These are derived figures based on flight hours and sector durations typical for each category of jet and turboprop aircraft.)

2.4 Organization of the Community

Business Aircraft operations are classified into three (3) separate categories:

1. Business Aviation Commercial

Aircraft flown for business purposes by an operator having a commercial operating certificate (generally on-demand charters).

2. Corporate

Non-commercial operations with professional crews employed to fly the aircraft.

3. Owner Operated

Aircraft flown for business purposes by the owner of the business.

(Note : Consult IBAC for formal definitions of the three categories. Two additional classifications are included in the Breiling Report, namely Government (public operations) and Manufacturer aircraft. These are not, by their use, considered to be "business aircraft", but are included in the data for completeness.)

3.0 Business Aircraft Global Accident Data (5 year period 2007 – 2011)

3.1 Accidents by Operator Type

A summary of the total accidents over five (5) years by type of operator is as follows:

Accidents by Operator Type - Jet Aircraft				
Business Jet Aircraft	Total Accidents (5 yrs)	Fatal Accidents (5 yrs)	Average Total Accidents per year	Average Fatal Accidents per year
Commercial	93	24	18.6	4.8
Corporate	35	1	7.0	0.2
Owner Operated	14	2	2.8	0.4
Government	5	1	1	0.2
Fractional	6	0	0	0
Manufacturer	0	0	0	0

Table 3.1a

Accidents by Operator Type - Turbo Prop Aircraft				
Turbo Prop Aircraft	Total Accidents	Fatal Accidents	Average Total Accidents per year	Average Fatal Accidents per year
Commercial	270	74	54.0	14.8
Corporate	32	12	6.4	2.4
Owner Operated	95	33	19.0	6.6
Government	15	6	3.0	1.2
Manufacturer	2	0	0.4	0

Table 3.1b

(Note: No analysis provided for **Fractional** operations conducted with **Turbo Prop Aircraft**.)

Analysis

The majority of business aircraft accidents occur in the commercial category, where operations are governed by commercial regulations (such as FAA Part 135 and JAR OPS 1). The next most frequent number of accidents occurs with aircraft flown by business persons. Accidents of corporate aircraft remain rare.

3.2 Accident Summary by Phase of Flight

Five (5) year totals by phase of flight are as follows:

Accident Summary by Phase of Flight									
	Taxi	T/O	Climb	Cruise	Desc't	Man'v	App	Land	Total
Business Jets	17 10.9%	17 6.9%	13 8.3%	5 3.2%	4 2.6%	1 0.6%	13 8.3%	86 52.2%	156 100%
Turbo Props	16 4.1%	26 6.6%	44 11.2%	32 8.1%	11 2.8%	19 4.8%	68 17.3%	178 45.1%	394 100%

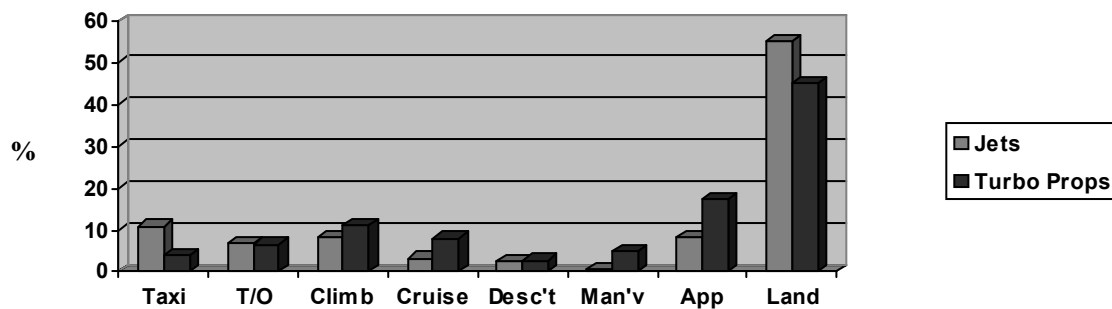


Table 3.2a

Analysis

The trend over a period of 35 years demonstrates a substantive decrease in the percentage of taxi accidents, and a notable decrease in accidents in the landing phase, although landing accidents remain as the most prevalent.

The trend indicates an increase in the number of accidents occurring in the approach phase. The percentage of accidents in the climb phase has also increased substantively for turbo prop aircraft. The distribution of accidents in the other phases has remained relatively unchanged.

(Note: Supplementary data collected by Robert Breiling over a 35 year period was used to develop this trend.)

4.0 Global Accident Rate Data

4.1 Accident Rate by Aircraft Type

The accident rate per 100,000 flight hours for each year over a five year period, as well as for the total, is as follows:

Accident Rate per 100,000 hours by Aircraft Type												
	2007		2008		2009		2010		2011		5 Year Total	
	Acc Rate	Fatal Rate	Acc Rate	Fatal Rate	Acc Rate	Fatal Rate	Acc Rate	Fatal Rate	Acc Rate	Fatal Rate	Acc Rate	Fatal Rate
Business Jets	0.63	0.13	0.69	0.14	0.37	0.08	0.48	0.10	0.44	0.07	0.63	0.13
Turbo props	1.6	0.56	2.11	0.78	0.70	0.46	1.64	0.29	1.72	0.51	1.76	0.51
All Bus A/C	1.05	0.32	1.29	0.38	0.90	0.24	0.99	0.18	1.03	0.27	1.15	0.31

Table 4.1a

Note: Some of the above figures have been re-stated as a result of the availability of subsequently published accident investigation reports and/or additional information.

4.2 Accident Rate by Operator Type

Global data for the numbers of aircraft in each of the business aviation operational categories (commercial, corporate and owner-operated) proved difficult to obtain as few States collect this information. Similarly, flight hours by type of operation are not available. Due to the lack of good exposure data, it was not possible to calculate, without some error, the rate of each category of operation. Additionally, the operational status of a single airframe may legally vary from flight to flight (i.e., an aircraft may be commercial on one flight and private on a flight made later on the same day or vice versa).

Nevertheless, by applying US data relevant to the division between categories of operator, and by making the assumption that the division is relatively similar for the rest of the world, an estimate of the rate by operator type can be made. Given that the North American data represents approximately 64% of the global total, it is unlikely that the distortion generated by the assumption will be very large.

The percentage of flight hours for each of the three categories in the USA is as follows:

Commercial (Air Taxi)	30.4%
Corporate	55.3%
Owner-operated	14.3%

Ed note:

Additional information is provided at Appendix C. The profiling for the above three categories has changed significantly from that in all Safety Briefs prior to Issue 7. Consequently the data presented in the tables which follow cannot be directly compared with that in the same tables in previous edition of the Safety Brief, and vice versa.

Assuming a similar division globally, the accident rates per 100,000 flight hours are as follows (based on data over 5 years):

Global Accident Rates by Operator Type (Extrapolated) (per 100,000 flight hours) All Business Aircraft					
Operator Type	Hours of Operation (5 yrs)	Total Accidents	Fatal Accidents	Total Accident Rate	Fatal Accident Rate
Commercial (Air Taxi)	14,972,234	363	98	2.42	0.65
Corporate	27,235,677	67	13	0.25	0.05
Owner-operated	7,042,605	109	35	1.54	0.50
*All Business Aircraft	49,250,773	567	153	1.15	0.31

Table 4.2a

*Note: *This line includes the three lines above it, plus Government, Manufacturers and Fractional aircraft operators. Also included are accidents involving operators for which insufficient information was available to assign the operator type.*

Global Accident Rates by Operator Type (Extrapolated) (per 100,000 flight hours) Jet Aircraft					
Operator Type	Hours of Operation (5 yrs)	Total Accidents	Fatal Accidents	Total Accident Rate	Fatal Accident Rate
Commercial (Air Taxi)	8,030,022	93	24	1.16	0.30
Corporate	14,607,243	35	1	0.24	0.01
Owner-operated	3,777,280	14	2	0.37	0.05
*All Business Aircraft	26,414,545	153	28	0.58	0.11

Table 4.2b

Note: *This line includes the three lines above it, plus **Government, Manufacturers and Fractional** aircraft operators. Also included are accidents involving operators for which insufficient information was available to assign the operator type.

Global Accident Rates by Operator Type (Extrapolated) (per 100,000 flight hours) Turbo Prop Aircraft					
Operator Type	Hours of Operation (5 yrs)	Total Accidents	Fatal Accidents	Total Accident Rate	Fatal Accident Rate
Commercial (Air Taxi)	6,942,213	270	74	3.89	1.07
Corporate	12,628,434	32	12	0.25	0.10
Owner-operated	3,265,581	95	33	2.91	1.01
*All Business Aircraft	22,836,228	414	125	1.81	0.55

Table 4.2c

Note: *This line includes the three lines above it, plus **Government, Manufacturers and Fractional** aircraft operators. Also included are accidents involving operators for which insufficient information was available to assign the operator type.

Analysis

The accident rates calculated in Table 4.2 include both turbo-prop and jet aircraft. The rate data indicates an excellent level of safety in corporate operations, whereas the accident rates in the commercial sector warrants increased attention by the business aviation community.

4.3 Accident Rate by Departures

There is a growing trend for organizations reporting safety data to do so using accident rates per number of departures given that safety exposure is greatest during departure and arrival. Accidents of aircraft en-route are rare except for flights in low level flight in marginal visual conditions. Accident rates per departure, or flight segment or cycle, therefore provide more realistic safety correlations.

Ed note:

Additional information is provided at Appendix C. The profiling for the above three categories has changed significantly from that in all Safety Briefs prior to Issue 7. Consequently the data presented in the tables which follow cannot be directly compared with that in the same tables in previous edition of the Safety Brief, and vice versa.

The accident rate per 100,000 departures is as follows:

Business Jet Accident and Rate by Departures (per 100,000 departures)					
Accident Rate	Departures	Accidents (5 Years)		Accident Rate	
		Total	Fatal	Total	Fatal
Large Jet Aircraft	4,671,761	39	5	0.83	0.11
Medium Jet Aircraft	5,412,299	43	10	0.79	0.18
Light Business Jets	8,844,074	85	20	0.96	0.23
*All Business Jets	18,928,134	167	35	0.88	0.18

Table 4.3a

Business Turbo Prop Accidents and Rates by Departures (per 100,000 departures)					
	Departures	Accidents (5 Years)		Accident Rate	
		Total	Fatal	Total	Fatal
Large Turbo Prop	693,533	64	21	9.22	3.02
Medium Turbo Prop	13,938,544	291	78	2.08	0.56
Light Turbo Prop	903,143	47	17	5.20	1.88
All Turbo Prop	15,535,220	402	116	2.59	0.75

Table 4.3b

All Business Turbine Accidents and Rates by Departures (per 100,000 departures)					
	Departures	Accidents (5 Years)		Accident Rate	
		Total	Fatal	Total	Fatal
All Business Aircraft	34,463,354	567	153	1.65	0.44

Table 4.3c

If an assumption is made that the distribution of departures for operator types of commercial (30.4%), corporate (55.3%) and owner-operated (14.3%) is relatively the same as the distribution between flight hours, the accident rates by type of operation can be calculated as follows:

Business Aircraft Accident Rates by Operator Type (Extrapolated) (per 100,000 departures)					
Operator Type	Departures (5 yrs)	Total Accidents	Fatal Accidents	Total Accident Rate	Fatal Accident Rate
Commercial (Air Taxi)	10,476,859	363	98	3.46	0.94
Corporate	19,058,234	67	13	0.35	0.07
Owner-operated	4,928,596	108	35	2.19	0.71
*All Business Aircraft	34,463,354	567	153	1.65	0.44

Table 4.3d

Business Aircraft Accident Rates by Operator Type (Extrapolated) (per 100,000 departures) Jet Aircraft					
Operator Type	Departures (5 yrs)	Total Accidents	Fatal Accidents	Total Accident Rate	Fatal Accident Rate
Commercial (Air Taxi)	5,754,153	93	24	1.62	0.42
Corporate	10,467,258	35	1	0.33	0.01
Owner-Operated	2,706,723	14	2	0.52	0.07
*All Business Aircraft	18,928,134	153	28	0.81	0.15

Table 4.3e

Business Aircraft Accident Rates by Operator Type (Extrapolated) (per 100,000 departures) Turbo Prop Aircraft					
Operator Type	Departures (5 yrs)	Total Accidents	Fatal Accidents	Total Accident Rate	Fatal Accident Rate
Commercial (Air Taxi)	4,722,008	270	74	5.71	1.58
Corporate	8,590,977	32	12	0.37	0.14
Owner-Operated	2,174,931	95	33	4.37	1.52
*All Business Aircraft	15,535,220	414	125	2.66	0.80

Table 4.3f

Analysis

A number of assumptions have been made related to the distribution of exposure data, and as a result the data should be used with some caution. Nevertheless, no other rate data is known to exist for worldwide business aviation. The results of the extrapolation should be sufficiently accurate to provide a reasonable comparison with accident information from other aviation sectors.

4.4 Comparison With Other Aviation Sectors

IBAC is experiencing increasing difficulty in drawing meaningful comparisons of business aviation safety data i.e. accident rates per 100,000 departures with those developed and published for other sectors of the aviation community. The incongruencies inhibiting such comparisons include; operational classification i.e. commercial vs. non-commercial, classification of accidents involving fatalities i.e. passengers only or crew, hull loss accidents, range of aircraft MCTOM encompassed by the data, lack of disaggregation by power plant i.e. turbojet, turbo-prop or reciprocating etc. While it is unlikely that these incongruencies can ever be fully reconciled, IBAC is making every effort to understand and identify these factors and will continue to promote international recognition of the IBAC safety data.

Aviation Sector	Fatal Accident Rate (per 100,000 departures)
All Business Aircraft (Jet and Turbo Prop)*	0.44
Corporate Aviation (Jets)**	0.01
Corporate Aviation (Jet and Turbo Prop)***	0.07
All Business Jets****	0.18
Boeing Annual Report – Jet aircraft MCTOM over 60,000lbs engaged in commercial scheduled passenger operations.*****	0.034

Table 4.4a

* Per Table 4.3c. IBAC rate is 5 year average.

** Per Table 4.2b. IBAC rate is 5 year average.

*** Per Table 4.3d. IBAC rate is 5 year average.

**** Per Table 4.3a. IBAC rate is 5 year average.

***** Boeing – Statistical Summary of Commercial Jet Airplane Accidents, Worldwide Operations 1959-2011, dated July 2012. Rate is for Scheduled Commercial Passenger Operations for a 10 year period, 2002-2010

4.5 Accident Rate Trend

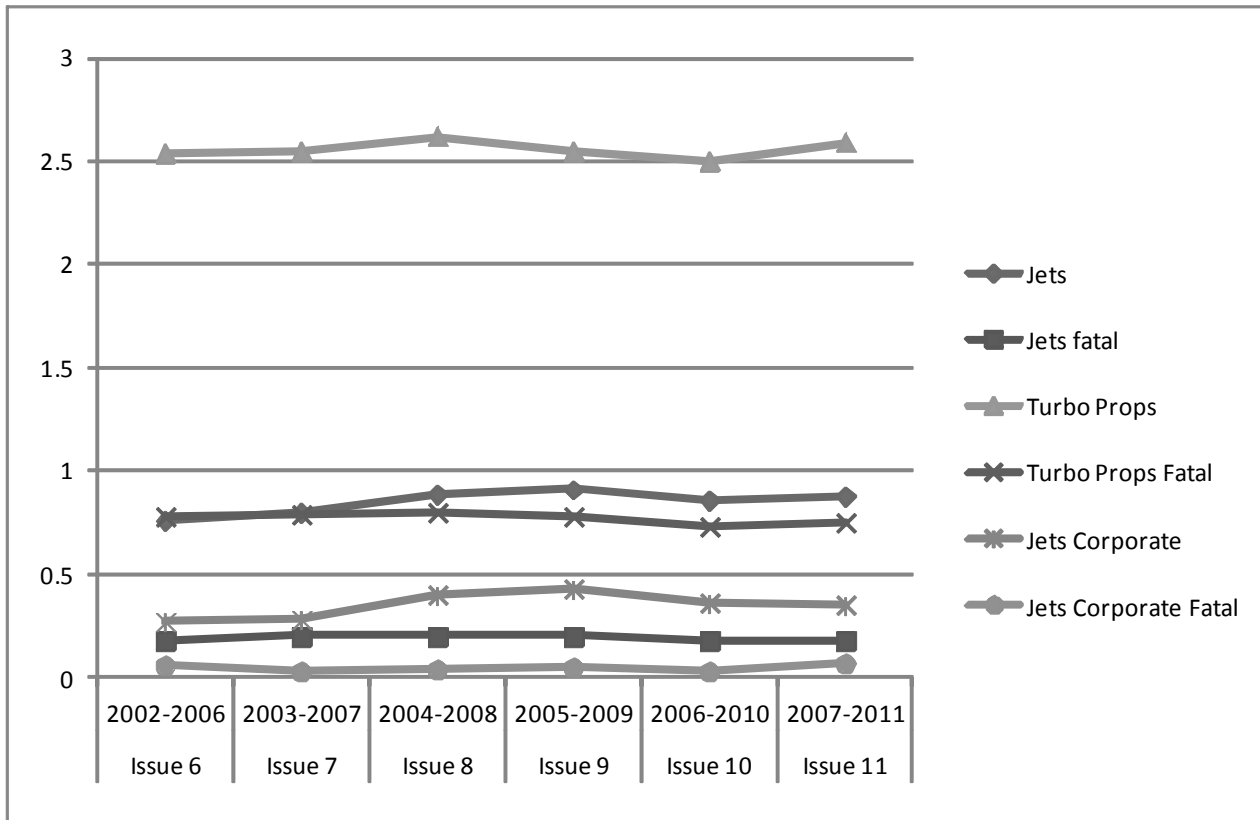


Table 4.5a
Accident rate per 100,000 departures

5.0 IS-BAO Safety Value

A Code of Practice

The International Standard for Business Aircraft Operations (IS-BAO) is an industry safety standard introduced in 2002 as the industry's code of practice designed to raise the safety bar by codifying safety best practices. Given that there are very few accidents in the business aviation community, it will be many years before a determination can be made regarding whether or not the IS-BAO is making a safety impact. Therefore, to assess the safety value a study was initiated based on historical accident data.

An analysis of past accidents required a considerable amount of subjective assessment as the analysts had to review the details of accidents against a full understanding of the IS-BAO to make a value judgment regarding whether the accident may have been avoided if the IS-BAO had been implemented.

The study was conducted by an independent analyst who reviewed a total of 500 accidents covering the period between 1998 and 2003. A total of 297 accidents of the 500 were considered to contain sufficient information to be further assessed. The study against the provisions of the IS-BAO standard was performed to determine a level of probability that if the flight department had known about and implemented the IS-BAO the accident may have been avoided. The data was classified and analyzed to determine the potential impact of the IS-BAO and the accidents were rated on a five point scale ranging from certainty of prevention to no effect.

Two assessments were made. First, the analysts made the assumption based on indicators that the flight department may have implemented the IS-BAO, and if implemented, the potential for accident avoidance. The accidents were then further analyzed to determine the potential outcome given that the IS-BAO was implemented in full before the accident. An audit by an accredited auditor leading to an IBAC Certificate of Registration is the recommended means of demonstrating full implementation.

As part of the analysts' work, the accidents were classified in a number of different ways to see if there were any meaningful trends in the prevention probability between the different factors. Classification methodologies applied include:

1. Simple Four Factors – Human, Technical, Environmental and Management.
2. Events – or significant type of accident (such as loss of control).
3. Breakdown on Human Factors.
4. Boeing Accident Prevention Strategies.

Probabilities were calculated for all accidents, phase of flight, type of accident, four factors (per above), type of operation, Commercial or non-commercial, fatalities and single versus two pilot operations.

A further step in the methodology included a quality assurance analysis by a group of current pilots through an assessment of a random selection of twelve accidents as a means of verifying the results of the analysts.

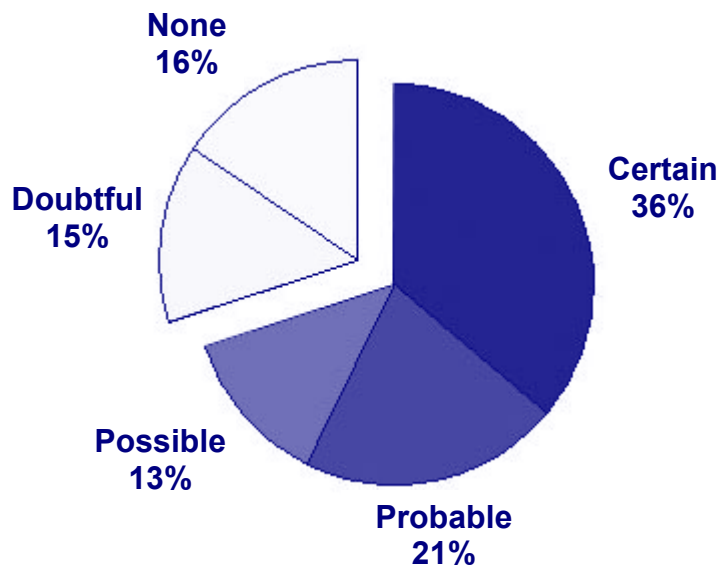
Results of Analysis

Criteria A

Assumes Operators Had Completely Implemented IS-BAO Prior to the Occurrence.

This part of the analysis made the assumption that the operator had implemented the IS-BAO standard in full. An assessment was then made regarding the potential that the accident could have been prevented. The following were the results of the assessment.

Certain of prevention	36.0% (107 of 297 accidents)
Probable prevention	21.2% (63 of 297)
Possible prevention	12.8% (38 of 297)
Doubtful of prevention	14.5% (43 of 297)
No prevention possibility	15.5% (46 of 297)



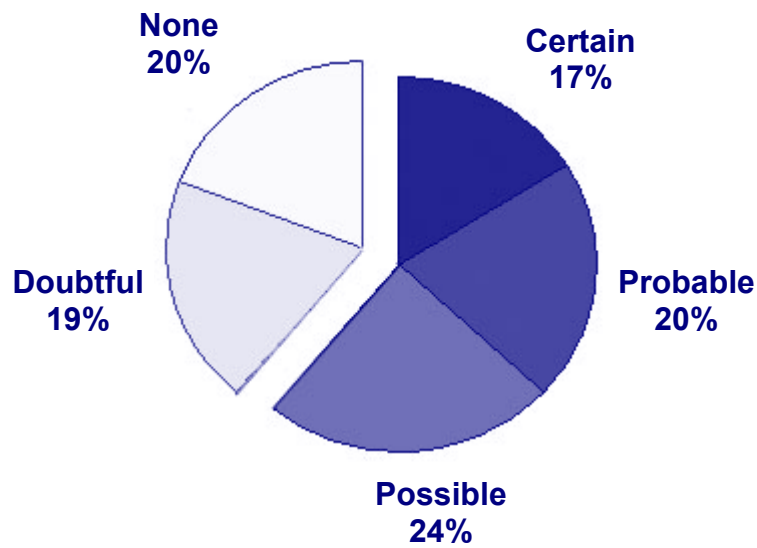
Conclusion - The probability of prevention is 57.2%, with a further 12.8% possible for a total of 70% potential that the aircraft accident could have been avoided.

Criteria B

Takes into Account Operators Background and Probability of Introduction of IS-BAO.

The assessment of whether the accident may have been prevented if the flight department had known about the IS-BAO, and if the operator was sufficiently responsible to implement the standard and had done so thoroughly, produced the following results:

Certain of prevention	17.2% (51 of 297 accidents)
Probable prevention	20.2% (60 of 297)
Possible prevention	23.9% (71 of 297)
Doubtful of prevention	19.2% (57 of 297)
No prevention possibility	19.5% (58 of 297)



Conclusion - The probability of prevention is 37.4%, with a further 23.9% possible for a total of 61.3% potential that the aircraft accident could have been avoided.

Criteria C

Probability of Prevention by Types of Operation and Aircraft.

The analysis showed that there is a greater probability that the accident could have been prevented for jet aircraft type accidents versus turboprop. This was a trend consistent through most methods of analysis and type of accident, although in some cases there was little to distinguish between jet and turboprop probabilities. For example, for the landing accidents (the most common type of accident) the probability of prevention was much greater for jets than turboprop aircraft. Yet, for loss of control accidents there was substantially no difference. The reason for the difference considered by the analysts was that there would be a greater potential for prevention in two pilot operations more typical in jet aircraft.

As would be expected there was a significantly greater probability of prevention related to Management Factors compared to Environmental factors, whereas Technical Factors and Human Factors ranked in the middle of these two.

There was no significant difference between the probability of prevention of commercial operations (air taxi) versus non-commercial. Evidence indicates that there is a higher probability that IS-BAO implementation would prevent accidents with two pilot operations versus one pilot.

Accidents with causal factors related to human performance totaled 232, and were broken down into the following;

1. Knowledge Based (no standard solution)	37
2. Rule Based (need to modify behaviour)	46
3. Skill Based (routine practiced tasks)	149

There was no significant difference between the probability of prevention between these three categories.

Conclusion

The study by an independent analyst indicates that the IS-BAO standard has considerable potential to improve safety. The extent of potential benefit depends significantly on the commitment of the operator to implement and adhere to the standard.

Appendix A

2011 Business Jet Accidents

U.S. Registered						
Date	Model	Description	Location	Phase	Operator	Fatalities
1/6/2011	L-35A	Aircraft landed hard in day, VMC conditions	IL	Landing	Comm	No
2/14/2011	G-VSP	Runway overrun due reported hydraulic malfunction, day, VMC	WI	Landing	Corp	No
3/23/2011	DA-100	Aircraft went off runway side during landing	IN	Landing	Comm	No
4/2/2011	G-650	Aircraft crashed on takeoff during certification flight test	NM	Takeoff	Mfgr	Yes
4/21/2011	Global Exp	Wing struck runway during landing at Teterboro, NJ	NJ	Landing	Comm	No
5/5/2011	HS-700A	Aircraft ditched during initial climb due mechanical problems	U.S.	Climb	Comm	No
5/9/2011	NA-265	Gear failed to extend, aircraft landed with gear retracted	FL	Landing	Corp	No
5/25/2011	Phenom 100	Aircraft skidded off runway end into a ravine during landing	AZ	Landing	Comm	No
6/1/2011	Eclipse 500	Landed with gear retracted, aborted and re-landed	AK	Landing	Pvt / Bus	No
6/15/2011	CE-525A	Runway overshoot landing at Nashville, TN	TN	Landing	Pvt / Bus	No
7/12/2011	L-35	Wing tip struck runway during landing, reported wind shear	FL	Landing	Corp	No
9/17/2011	L-35	Aircraft substantially damaged landing at Carabobo, Venezuela	Venezuela	Landing	Comm	No
10/12/2011	L-60	Aircraft went off taxiway into a ditch	IN	Taxi	Comm	No
10/31/2011	G-150	Brake maif/failure landing, runway overshoot, gear collapsed	FL	Landing	Corp	No
12/28/2011	CE-650	Takeoff aborted, aircraft overshoot through fence, nose gear coll.	FL	Takeoff	Corp	No
Non-US Registered						
Date	Model	Description	Country	Phase	Operator	Fatalities
2/4/2011	HS-850XP	Crashed after takeoff, darkness, snow, clouds, IMC	Iraq	Climb	Comm	Yes
2/16/2011	CE-525-1	Acft. overshoot 3,280 ft. runway on takeoff and became airborne	Switzerland	Takeoff	Comm	No
2/18/2011	L-24	Aircraft lost control landing and hit a building, day, VMC	Mexico	Landing	Comm	Yes
3/2/2011	CE-551 SP	Control lost on takeoff and aircraft veered off runway side, IMC	Italy	Takeoff	Comm	No
3/4/2011	L-25D	Aircraft struck lights and localizer antenna ldg. in IMC, Texas	Mexico	Landing	Comm	No
3/14/2011	2 HS-800's	2 HS-800's destroyed in Japan by Tsunami, Japan registered	Japan	Static	-	No
3/28/2011	CE-550 II	Aircraft disappeared while on local fam. flight in China	China	Maneuver	Comm	Yes
6/17/2011	DA-10	Aircraft landed to right of runway centerline and went off side	Canada	Landing	Comm	No
7/10/2011	HS-700	Aircraft overshoot the runway landing at Benin City, Nigeria	Nigeria	Landing	Comm	No
10/3/2011	DA-20F	Brakes failed, aircraft rolled down embankment while taxiing	Mexico	Taxi	Comm	No
10/7/2011	CE-550	Runway overshoot during landing	Brazil	Landing	Corp	No
12/17/2011	CE-750XL	Aircraft veered off runway side into a ravine during landing	Indonesia	Landing	Comm	Yes

Appendix B

2011 Business Turbo Prop Accidents

U.S. Registered						
Date	Model	Description	Location	Phase	Operator	Fatalities
1/6/2011	CE-208B	Pilot landed long to avoid a bump but aircraft overshot	AK	Landing	Comm	No
1/9/2011	PA-46TP500	On landing, nose gear shimmy forced aircraft off runway side	AZ	Landing	Pvt/Bus	No
1/9/2011	PA-46TPcvn	Control lost in cruise, aircraft seen in steep dive, IMC, day	CO	Cruise	Pvt/Bus	Yes
2/8/2011	BE-90B	Aircraft landed with landing gear retracted	PA	Landing	Pvt/Bus	No
2/15/2011	BE-90E	Rt. aileron departed the aircraft in climb after maintenance	IA	Climb	Corp	No
2/24/2011	AC-690D	Aircraft veered off runway and the nose gear collapsed	Venezuela	Landing	Comm	No
2/27/2011	G-21AG	Turbo Goose crashed after takeoff, dark night	S.Arabia	Takeoff	Comm	Yes
3/8/2011	DHC-6	Aircraft crashed into a wooded area after departure on test flt.	GA	Approach	Comm	Yes
3/8/2011	PA-46TP500	Aircraft veered off runway side during landing, day, VMC	Switz	Landing	Comm	No
3/10/2011	CE-208B	Brakes failed taxiing, aircraft hit parked vehicles	CA	Taxi	Comm	No
3/10/2011	SA-227AC	Aircraft slid off runway side during landing, VMC strong gusts	WA	Landing	Comm	No
3/16/2011	BE-200	Aircraft crashed on takeoff, possible engine loss, day, VMC	CA	Takeoff	Corp	Yes
3/28/2011	CE-425	Aircraft landed hard and went off runway side	TX	Landing	Pvt / Bus	No
3/31/2011	CE-208B	Aircraft damaged by tornado at Sun N Fun airshow	FL	Static	Pvt / Bus	No
4/10/2011	BE-99	Aircraft landed with one main landing gear retracted	GA	Landing	Pvt / Bus	No
4/26/2011	CE-208B	Wind blew aircraft over during taxi for takeoff	TX	Taxi	Comm	No
5/3/2011	PA-46TP-500	Takeoff aborted due tire failure caused wing/aileron damage	WY	Takeoff	Pvt / Bus	No
5/16/2011	BE-200B	Forced landing 7 miles from airport	AK	Landing	Public	No
5/18/2011	BE-90E	Lost both engines after takeoff, damaged during forced landing	U.K.	Landing	Comm	No
5/19/2011	TBM-850	Aircraft landed short attempting a landing abort in crosswind	OH	Landing	Pvt / Bus	No
5/24/2011	BE-90C	Aircraft crashed during approach in Nigeria, daylight	Nigeria	Landing	Corp	Yes
5/27/2011	BE-90C	Moderate to severe turbulence encountered damaged aircraft	SC	Cruise	Comm	No
6/10/2011	BE-200	Aircraft struck by lightning during descent thru 16,000 in IMC	CA	Descent	Comm	No
6/15/2011	BE-100	Aircraft experienced inflight upset in icing conditions	TN	Cruise	Comm	No
6/27/2011	PA-31T	Aircraft landed gear up, no other information	CO	Landing	Pvt / Bus	No

Appendix B

2011 Business Turbo Prop Accidents, continued

U.S. Registered Con't						
Date	Model	Description	Location	Phase	Operator	Fatalities
8/6/2011	PA-46TP cvn	Aircraft landed with landing gear retracted	NC	Landing	Pvt / Bus	No
8/19/2011	PA-46TP500	When nose gear was lowered to runway, acft veered off side	VA	Landing	Pvt / Bus	No
9/2/2011	CE-208B	Mid air with CE-207 during formation fit. VMC/day, low ceiling	AK	Maneuver	Comm	Yes
9/5/2011	TBM-850	Reported engine problems, aircraft crashed in a field	WI	Landing	Pvt / Bus	Yes
9/17/2011	BE-90L	Acft. undershot runway, left gear collapsed, acft. went off side	TX	Landing	Pvt / Bus	No
9/23/2011	DHC-3TP	Aircraft crashed on approach to Kodiak, AK, daylight	AK	Approach	Comm	Yes
9/28/2011	MU-2B-25	Nose gear collapsed landing, damaging pressure bulkhead	GA	Landing	Corp	No
10/12/2011	TBM-700	Aircraft damaged on forced ldg. on highway, fuel exhaustion	FL	Landing	Pvt / Bus	No
11/8/2011	PA-31T	Cabin door separated from fuselage in flight	WY	Climb	Comm	No
11/9/2011	TBM-700	Aircraft crashed on final app. at the Lyon Brom Apt., France	France	Approach	Pvt / Bus	No
11/16/2011	P-180	During landing, aircraft went off runway side and rolled over	MI	Landing	Frax	No
11/24/2011	PA-46TP cvn	Aircraft successfully ditched due power loss in cruise	Caribbean	Cruise	Pvt / Bus	No
11/25/2011	AC-690A	Aircraft crashed into mountain cliff east of Phoenix. VMC day	AZ	Cruise	Pvt / Bus	Yes
11/27/2011	MU-2	Nose gear collapsed on landing, wing and fuselage damaged	MS	Landing	Pvt / Bus	No
12/2/2011	BE-90F	Aircraft impacted a house on short app., possible power loss	TX	Approach	Pvt / Bus	No
12/17/2011	CE-208	Aircraft overran runway ldg. onto a golf course, gear collapse	NV	Landing	Pvt / Bus	No
12/20/2011	TBM-700	Aircraft lost control & crashed during climb into reported icing	NJ	Climb	Pvt / Bus	Yes
12/22/2011	CE-441	Aircraft crashed in wooded area in PA on flight from CA to PA	PA	Descent	Pvt / Bus	Yes

Appendix B

2011 Business Turbo Prop Accidents, continued

Non-U.S. Registered						
Date	Model	Description	Country	Phase	Operator	Fatalities
1/3/2011	BE-200B	Main wheel hit snow, caused aircraft to veer off runway	Canada	Landing	Public	No
1/7/2011	BE-200	Main gear failed to extend, aircraft landed with it retracted	France	Landing	Comm	No
1/14/2011	BE-200B	Aircraft crashed 6 mi. short on approach, IMC, heavy rain	Brazil	Approach	Comm	Yes
1/18/2011	DHC-3TP	Aircraft destroyed in a hangar fire	Canada	Static	Comm	No
1/19/2011	CE-208B	Power lost initial climb, aircraft damaged in force landing	Sudan	Climb	Comm	No
1/21/2011	CE-208B	Aircraft damaged in off airport emergency landing due mech.	Brazil	Landing	Comm	No
1/22/2011	BE-1900C	Acft. landed gear up after crew tried all means to extend	Guinea	Landing	Comm	No
2/8/2011	PC-12	Aircraft crashed during attempted go-around in thick fog	S.Africa	Climb	Comm	Yes
2/12/2011	PC-12	Runway overshoot, nose gear collapsed landing in Switzerland	Belgium	Landing	Comm	No
2/12/2011	CASA 212	Aircraft crashed during flight following one engine replacement	Indonesia	Cruise	Comm	Yes
2/24/2011	CE 208B	Aircraft diverted due wx. Nose gear collapsed during landing	Colombia	Landing	Public	No
2/27/2011	SA-227AC	One main gear failed to extend, landed with it retracted	Bolivia	Landing	Comm	No
3/5/2011	BE-200	Aircraft overshoot the landing on a short runway	Venezuela	Landing	Comm	No
3/6/2011	BE-200	Power loss left engine, nose gear collapsed on landing	Colombia	Landing	Comm	No
3/11/2011	4 Aircraft	s destroyed by tsunami in Japan	Japan	Static	Corp	No
3/12/2011	CE-208B	Aircraft veered off runway side into a ditch due to tire failure	Indonesia	Landing	Comm	No
3/31/2011	DHC-3TP	Aircraft collided with terrain, day, marginal IMC	Canada	Maneuver	Comm	Yes
4/1/2011	CASA-212	Aircraft crash landed on a road, possible power loss	Canada	Landing	Comm	Yes
4/15/2011	PA-31T	Runway overshoot on landing, day VMC, wind calm	Chile	Landing	Comm	No
5/3/2011	CE-208B	Runway overshoot landing on a 2,175 ft. dirt strip, day VMC	Nepal	Landing	Comm	No
5/4/2011	CE-208B	Aircraft overshoot the runway during landing	India	Landing	Comm	No
5/25/2011	PC-12	Acft. crashed app.in dust storm, night, 10 plus 3 on ground flt.	India	Approach	Comm	Yes
5/27/2011	CE-208B	Runway overshoot landing, Cabo San Lucas, Mexico	Mexico	Landing	Comm	No
5/27/2011	CE-208B	Runway overshoot following abort takeoff, fire followed	Brazil	Takeoff	Comm	No
6/9/2011	CE-208	Runway overshoot causing gear to collapse, Newfoundland	Canada	Landing	Comm	No

Appendix B

2011 Business Turbo Prop Accidents, continued

Non-U.S. Registered						
Date	Model	Description	Country	Phase	Operator	Fatalities
7/4/2011	CE-208B	Runway overshoot during late takeoff abort, day, fire followed	Canada	Takeoff	Comm	Yes
7/5/2011	Shorts 330	Aircraft ran off runway side landing at Yukon, AK, on charter	Canada	Landing	Airline	No
7/11/2011	BE-90C	Fuel exhaustion, aircraft crash landed in field	Mexico	Landing	Comm	No
7/23/2011	CE-208	Aircraft damaged landing on down sloping runway, S. Africa	Chile	Landing	Military	No
7/28/2011	DHC-3TP	Float equipped aircraft landed with gear down in water, flipped	Canada	Landing	Comm	No
8/2/2011	CE-208B	Aircraft crashed enroute, strong winds, heavy rain	Brazil	Maneuver	Military	Yes
8/3/2011	CV-580	Nose gear collapsed landing on soft ground, NW territory	Canada	Landing	Comm	No
9/2/2011	CASA 212	Acft. crashed into the ocean on approach in gusting winds	Chile	Approach	Military	Yes
9/5/2011	CE-441	Rt. main landing gear collapsed during taxi after landing	Peru	Taxi	Comm	No
9/6/2011	Metro III	Aircraft crashed short during approach in poor weather	Bolivia	Approach	Comm	Yes
9/9/2011	CE-208B	Aircraft crashed in marginal wx. in mountainous terrain	Indonesia	Maneuver	Comm	Yes
9/20/2011	BE-99A	Aircraft crashed enroute during heavy rain and poor weather	Haiti	Approach	Comm	Yes
9/22/2011	DHC-6	Aircraft impacted building and wires during approach to lake	Canada	Approach	Comm	Yes
9/24/2011	CE-208B	Aircraft overshoot runway landing, a U.S. aircraft based in U.K.	U.K.	Landing	Comm	No
9/25/2011	BE-1900	Aircraft crashed on approach in low cloud, overcast	Nepal	Approach	Comm	Yes
10/4/2011	CE-208B	Aircraft crashed enroute to Yellowknife from Lutselk, AK, IMC	Canada	Maneuver	Comm	Yes
10/14/2011	CE-208B	Aircraft crashed shortly after takeoff due power loss, VMC	Botswana	Climb	Comm	Yes
10/27/2011	BE-100	Aircraft crashed short of runway landing at Vancouver	Canada	Approach	Comm	No
10/28/2011	PA-31T	Aircraft crashed on final approach to Toulouse, FR, IMC	Austria	Approach	Corp	Yes
11/10/2011	CE-208	Forced landing due mechanical problem, gear wings damaged	China	Landing	Public	No
11/16/2011	BE-200	Aircraft landed with right main gear retracted	S.Africa	Landing	Corp	No
11/21/2011	CE-208B	Aircraft veered off runway side landing and caught fire	Nepal	Landing	Comm	No
11/23/2011	CE-208B	Aircraft crashed on 2nd app. to Sugapa Airport, Indonesia	Indonesia	Approach	Comm	Yes
11/30/2011	BE-1900	Aircraft veered off runway side during landing, day, VMC	Bolivia	Landing	Military	No
12/4/2011	BE-A100	Aircraft stalled on approach due limited vis. And landed hard	Congo	Landing	Comm	No
12/6/2011	DHC-6	ircraft landed hard collapsing the right main landing gear	Canada	Landing	Comm	No

Appendix C

Methodology

1. Annual Accident Assessment

IBAC contracts annually to Robert Breiling and Associates to assess and collate business aviation accidents. The Breiling Report provides IBAC with operating hours for each aircraft type as well as accident statistics by aircraft type, by operator type and by area of the world. IBAC uses the information to publish a summary report in the annual *Business Aviation Safety Brief*.

To date the Brief has provided only limited information on accident by operator type due to the lack of acceptable exposure data in terms of hours of operation for each operator type.

It has always been recognized that achieving safety improvement is highly reliant on the knowledge base and understanding of the operations of greater risk so that mitigation can be determined and applied. As an indicator applied to assessing risk, business aviation places importance on statistical comparisons of the accident rate between the different business aviation operational types, namely accident rates for operations of corporate aviation, on-demand commercial and owner operated. Given the difficulty in obtaining exposure data for the hours attributed to each operational type, in the past it has been difficult to obtain with any degree of confidence the accident rates for each operation. However, with recent changes in the methodology and accuracy of an annual survey of general aviation and on-demand Part 135 operators by the US Federal Aviation Administration, IBAC has now concluded that data developed from the Survey is sufficiently accurate to serve as a methodology to provide a global perspective of the difference in rates between the operator types.

Percentage of Operations by Operator Type

The following distribution by operator type is applied to the business aviation hour and departure data to determine exposure by operator used to calculate accident rates: (See Attachment for methodology)

	Jet Average	TP Average	Total
Corporate	60.7%	43.2%	55.3%
Owner Operator	11.3%	21.1%	14.3%
Commercial On-Demand	28.0%	35.7%	30.4%

Table C-1

2. Availability of Exposure Data

The US FAA annually completes a survey of US operators, including hours of flight by operator type. Prior to 2006 IBAC was concerned that the gap between the total flying hours calculated by Robert Breiling was different from those of the FAA. However, over the last couple of years the gap has closed to the point that there is increased confidence in the survey results and IBAC has now concluded that the survey information is sufficiently accurate to provide a reasonable assessment of the differences between accident rates for each operator type.

The FAA survey is sent to 100% of general aviation and on-demand commercial operators of turbine aircraft in the US and follows up three times with operators that do not respond immediately. Submissions are made annually by approximately 45% of the US turbine operator population. The US business aviation fleet consists of 65% of the world fleet and the distribution between operator types is considered representative of the global fleet with the exception of the European fleet. The global distribution and an assessment of each region is as follows;

United States	65%	
North America without the US	8%	Distribution considered similar to the US
South America	7%	Distribution considered similar to the US
Europe	11%	Probable higher percent of on-demand commercial operations.
Rest of the World	9%	Different rule structures but most would be similar to the US

FAA survey data was applied over a three year period to develop an average distribution by aircraft type (Jet, Turbo-Prop and Combined) and operator type (Commercial On-demand, Corporate and Owner-Operated). The data in Table C-1 was applied to the total business aviation hours to calculate the number of flying hours for each operational type.

3. Rate Calculation

Accident rates per operator type were calculated using accident data in the Safety Brief, along with exposure data as explained in S2 above. Tables were developed for both 100,000 flying hours and 100,000 departures.

4. Assumptions

IBAC recognizes that there is error built into the methodology, but given the lack of options the data is considered as accurate as anything available. The following assumptions that give rise to some error are:

The breakdown by operator types is derived from an FAA survey of US operators. An assumption is made that the remainder of the world will have an operator distribution similar to the US. Given that the US consists of approximately 65% of the global fleet, it is unlikely that the error due to this assumption will be very significant.

The FAA survey captured approximately 50% of the total global flying hours. It is assumed that the 50% is representative of the distribution for the complete population.

5. Sensitivity Analysis

As noted above, an assumption is made that the US distribution by operator type is representative of the global fleet distribution and yet it was also concluded that the European fleet distribution is likely different than that of the US. Given the potential that this may result in an unacceptable error, a sensitivity analysis was completed to determine the impact of a higher percentage of the European fleet being operated as on-demand charters.

Two samples for European distribution were selected to test the impact.

Operator Type	Baseline per US Survey	Sample 1	Sample 2
Commercial On-Demand	31%	60%	70%
Corporate	55%	30%	25%
Owner Operated	14%	10%	5%

Results of the analysis demonstrate a very small change when the sample data for Europe is applied. Typically, the sensitivity analysis tables conclude a difference ranging from .01% to .08% in the fatal accident rates, which demonstrates acceptable level of error for the comparison purposes intended by the statistics.

The following Table shows the results of applying to the Safety Brief Issue 6 data the two Sample distributions to the combined jet and turbo-prop fleets.

	Baseline (31/55/14 %)		Sample 1 (Europe 60/30/10 %)		Sample 2 (Europe 70/25/5 %)	
	Total	Fatal	Total	Fatal	Total	Fatal
Commercial On-demand	2.28	0.66	2.48	0.71	2.58	0.74
Corporate	0.18	0.04	0.19	0.04	0.19	0.04
Owner Operated	1.86	0.64	1.85	0.63	1.92	0.64
Combined	1.08	0.31	1.08	0.31	1.08	0.31

Appendix D

Landing Accident Analysis

The IBAC Safety Strategy identifies the need to assess data on runway accidents of business aviation aircraft given the proportionally high number of accidents in that phase of operations.

In addition, the International Civil Aviation Organization (ICAO) is placing priority on determining causes and mitigation for global aviation runway accidents in recognition that these accidents are occurring too often.

ICAO convened a Global Runway Safety Symposium in Montreal in May 2011 at which IBAC made a presentation. That presentation was subsequently reviewed and updated for delivery at the EBACE 2012 Safety Day in Geneva on 13 May 2012. This Appendix provides the information presented at the latter event and some additional background.

A detailed analysis of accident data was compiled for a three year period and analysed to determine most frequent causal factors

Analysis of Landing BA Jet Accidents

1. Average landing accidents per year	19.3%
2. Wet or snow covered runways	55%
3. Landed Long	19%
4. Ran off the runway end	22%
5. Hard Landing	19%
6. Hit snow berms	17.2%
7. IFR conditions	46%
8. Runway longer than 5000 ft	88%
9. Malfunction	20.6%
10. Crew related	62%

Conclusions

Jets

Overall fewer accidents but, high percentage in the landing phase (55%).

Turbo Prop

Gear malfunction a frequent cause.

Significant number of single pilot operations.

Conclusions – General

Applicable to Jet and Turbo Prop aircraft

- Poor speed control and unstable approaches most prevalent cause.
- Incorrect or lack of reported runway conditions were a frequent factor.
- Crosswind and gusts were also frequent.
- Poor runway conditions and snow clearance frequent factors.

Overall Conclusions

- Runway length was seldom a factor.
- Fatigue did not appear as an issue.
- Pilot experience was not an evident problem.
- Low ceilings and visibility not prevalent.
- Day/night not a factor.

Mitigation

- Adherence to operations manual and aircraft flight manual.
- SMS and FDA will help.
- Improved runway condition reporting.
- Accelerate implementation of vertical guidance approaches.