ACCIDENT ANALYSIS

JET AND TURBOPROP BUSINESS AIRCRAFT 1998-2003

POTENTIAL IMPACT OF IS-BAO

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May 2006

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EXECUTIVE SUMMARY

This study reviews 297 jet and turboprop business aircraft accidents (total loses and serious damage only) for the five year period 1998 to 2003. The initial data was supplied by IBAC, but the analysis was limited to those accidents with reports found on State Aviation Safety web sites. This data was classified and analyzed to determine the potential impact of the International Standard for Business Aircraft Operations (IS-BAO). It was concluded that between 35% and 55% of the accidents could have certainly or probably been prevented by implementation of IS-BAO.

In addition, further analysis suggested that certain associated causal factors were significant as regard to accident reduction potential of IS-BAO.

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1 INTRODUCTION

This study was commissioned by IBAC to assess the potential impact of the International Standard for Business Aircraft Operations (IS-BAO). It involved classifying a set of business aircraft accident data spanning the years 1998 to 2003. These were classified 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, and the contribution of operator management practices.

2 DATA

The IBAC data for the period under review consisted of 552 aircraft accidents and incidents. However, in the preliminary jet and turboprop studies, only a small number of official accident reports were available. Thus assessments had to be based on the interpretation of limited and sometimes unreliable information. Fortunately, by the time of the final study, many more official reports had been published, enabling the analysis to be restricted to those supported by such reports or equivalent data.

Thus, the final sample consisted of 297 accidents.These comprised aircraft "Destroyed" (125) or "Seriously Damaged" (172), and which had reports on a State Aviation Safety Web site[1], or had adequate information from other sources. All data was entered in a Cardbox-Plus database[2], which allowed the easy modification of data fields and indexing.

3 METHODOLOGY

A set of descriptive classification lexicons was developed from a number of sources that have proved valuable in past accident assessments. The accidents were then reviewed and subjective assessments made against these lexicons, linking the results to probability of prevention. One-line descriptors based on the accident narratives were developed, together with brief statements explaining the reason for the probability assessment made. Because these assessments were essentially subjective, a group of 6 business aviation pilots were given a sample set of 12 accidents and asked to make similar reviews.

At this point, two schools of thought emerged regarding the classification criteria. The first (criteria A) assumed that all operators would fully implement IS-BAO as specified and faithfully follow its principles. The second (criteria B) took account the evidence available on the operator or pilot involved, and where appropriate gave consideration to the way in which he approached existing rules and regulations. The difference is best illustrated by the accident to the owner operator who deliberately falsified his medical records and suffered a heart attack in the air.

The average difference between criteria A and B assessments for all the accidents was a ranking of 1 point (i.e., a classification of “certain” (1) would become one of “probable”(2), and a classification of ‘Possible”(3) would become one of “doubtful”(4) etc. The difference is illustrated in more detail in the table below. This shows for each criterion (A and B) the number of times the highest classification

[1] Most of the accident reports were associated with one State. Very few official reports were easily available from other sources. Note there is usually a 2 to three year delay before the official accident reports are available.

[2] Cardbox-Plus, Scriventon House, Speldhurst, Kent U.K., TN3 0TU

minus the lowest classification was zero, 1, 2 or 3 (i.e. complete agreement to a difference of three rankings).

	Highest classification minus lowest classification.			
Difference	**Same**	**1 difference**	**2 differences**	**3 differences**
Criteria A	1	8	0	1
Criteria B	1	6	3	3

The increased variability in classifications with criteria B (considering the background of the operator or pilot), indicates the additional degree of judgment involved compared with criteria A (strict implementation by all operators of IS-BAO). However, this increased variability has to be balanced against the possibly simplistic assumption that all operators are equal. The difference between the two criteria thus represents the upper and lower limits of the probability of prevention.

4 CLASSIFICATION LEXICONS

The data was already classified by a number of factors. These included phase of flight, jet or turboprop, type of operation and purpose of flight, Part 91 or 135, fatalities, crew, severity of damage (destroyed, serious damage or minor). Additional information obtained from the Accident Reports included part 91/135 information, and in many cases pilot hours and age (neither of which proved significant factors). Additional classification factors were added as follows:

4.1 Simple 4 factor classification

A simple assessment of four basic factors involved in each accident was made as follows"

- Human (actions associated with the flight crew)
- Technical (any failure of aircraft or its systems)
- Environmental (any factors outside the control of the flight crew)
- Management (any factors that can be attributed to management)

4.2 Events

The data was classified against a subset of the Event lexicon in the ICAO Accident and Reporting Manual (ADREP), ICAO Doc 8146.

4.3 Human factors classification.

The analysis of human factors was based on that described by Reason, Maurino, Johnston and Lee in their book Beyond Aviation Human Factors. This involves use of a flow-chart to identify the failures involving the flight crew. These factors are then related to the probability of prevention.

Acknowledgement is made to Professor James Reason, Professor Emeritus, Manchester University who devised the flowcharts that have been used to identify the performance failure classes and associated error types. Full details are included in Appendix A.

4.4 Probability of prevention classification.

A subjective assessment was made of the probability of prevention of these accidents. A five point scale was used: certain, probable, possible, doubtful and no effect.

4.5 Boeing accident prevention strategies.

The accidents were also assessed against the "accident prevention strategies" developed by Boeing[3]. The probability of prevention was then related to the most significant strategies identified.

5 Analysis

The primary tool used in the analysis was a statistical clustering program[4] which examines the fields of a database and displays tree clusters of statistically significant relationships. Only those subsets of the data whose significance exceeded 95% were examined further i.e. subsets whose probability of occurring by chance was less than 5 in 100 (or 1 in 20). Thus, the report excludes those data that do not affect the probability of prevention.

To give subjective meaning to the data, brief one-line accident descriptions were developed and are included at Appendix B, sorted by jets and turboporops, subdivided into skill based, rule based and knowledge based errors. In addition, selected comments from the original accident reports were extracted and included at Appendix C, sorted by type of violation – deliberate, erroneous or mistakes/lapses as assessed during the classification.

Both Appendix B and C were sorted by the main significant "Events" as assessed during the classification.

Note: Unless otherwise stated, all charts show percentages of the individual categories within the chart.

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3 Accident Prevention Strategies, 1982-91, Airplane Safety Engineering, Boeing Commercial Airplane Group

4 Knowledge Seeker, Angoss Software International Inc. 1993

5.1 Probability of prevention, all accidents

Taking all accidents, the probability of prevention was assessed using a five point scale (1 = certain prevention, 5 = none) against the two classification criteria:

A: That there was universal adoption and complete implementation of IS-BAO.
B: That weight was given to background of the operator or pilot.

Criteria A **Criteria B**

1	(107)	36.0%
2	(63)	21.2%
3	(38)	12.8%
4	(43)	14.5%
5	(46)	15.5%
	297	

1_Certain	(51)	17.2%
2_Probable	(60)	20.2%
3_Possible	(71)	23.9%
4_doubtful	(57)	19.2%
5_None	(58)	19.5%
	297	

Thus, it could be concluded that between 35% and 55% of accidents could certainly or probably have been prevented by implementation of IS-BAO.

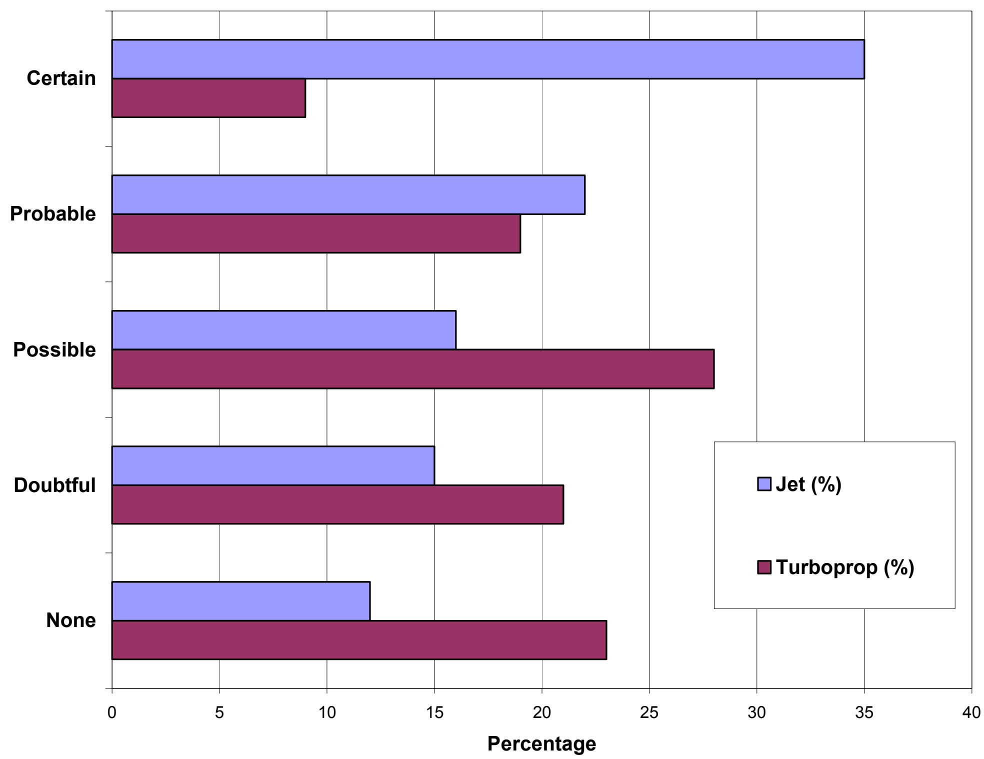
Because the following detailed analysis of the accidents involves an examination of the way in which the operators or pilots involved have responded to existing criteria and regulations, the remainder of this report is based on Criteria B.

5.2 Jet and turboprop operations

There was a statistically significant difference between jet and turboprop aircraft as follows:

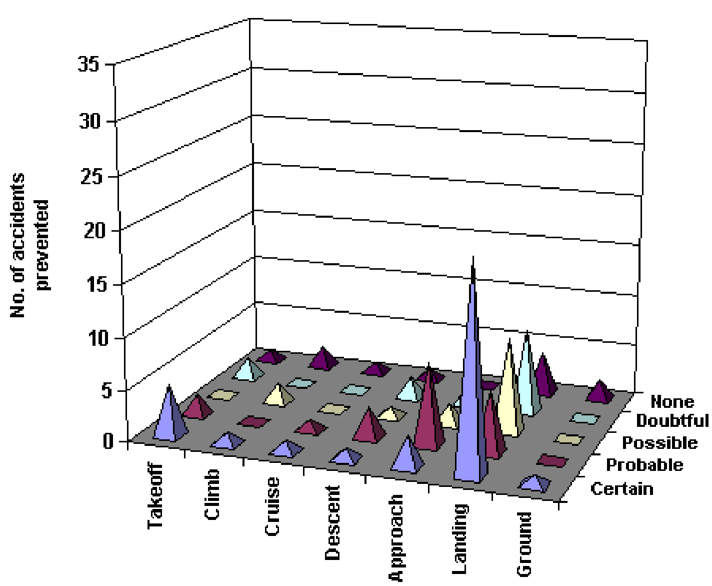
	Certain	Probable	Possible	Doubtful	None
Jet (%)	35	22	16	15	12
Turboprop (%)	9	19	28	21	23

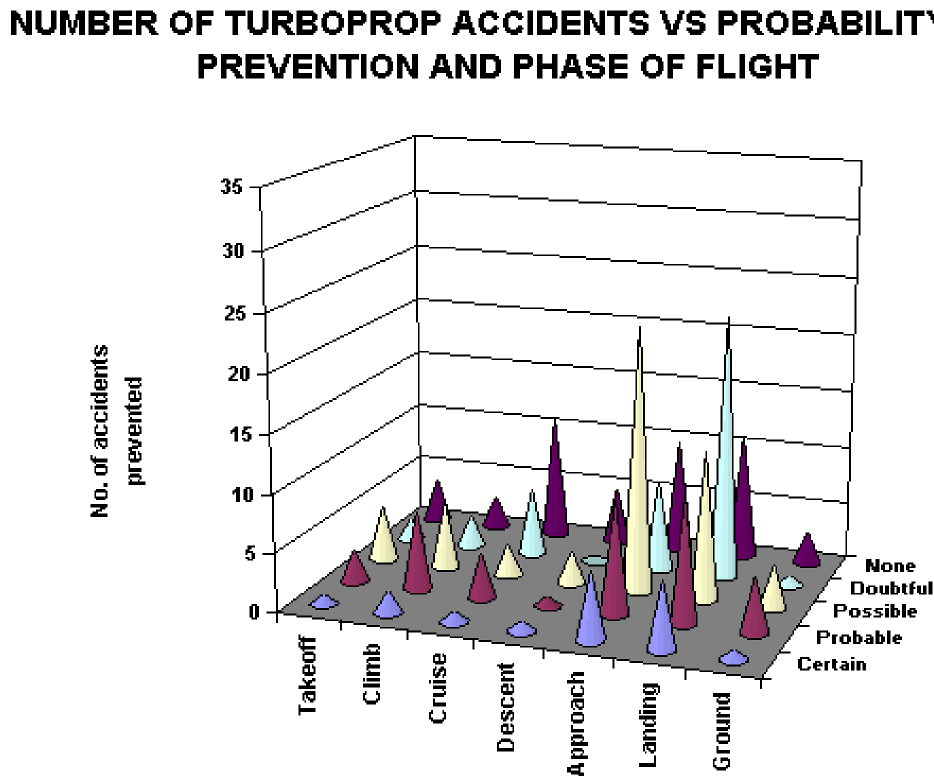
The difference between jet and turboprop appear to be due to the large number of single pilot operations in the turboprop category compared with the jet category.



5.3 Probability of prevention vs. phase of flight

The jet and turboprop data was analyzed by phase of flight (takeoff, climb, cruise, descent, approach, landing and taxi/parked) as follows:





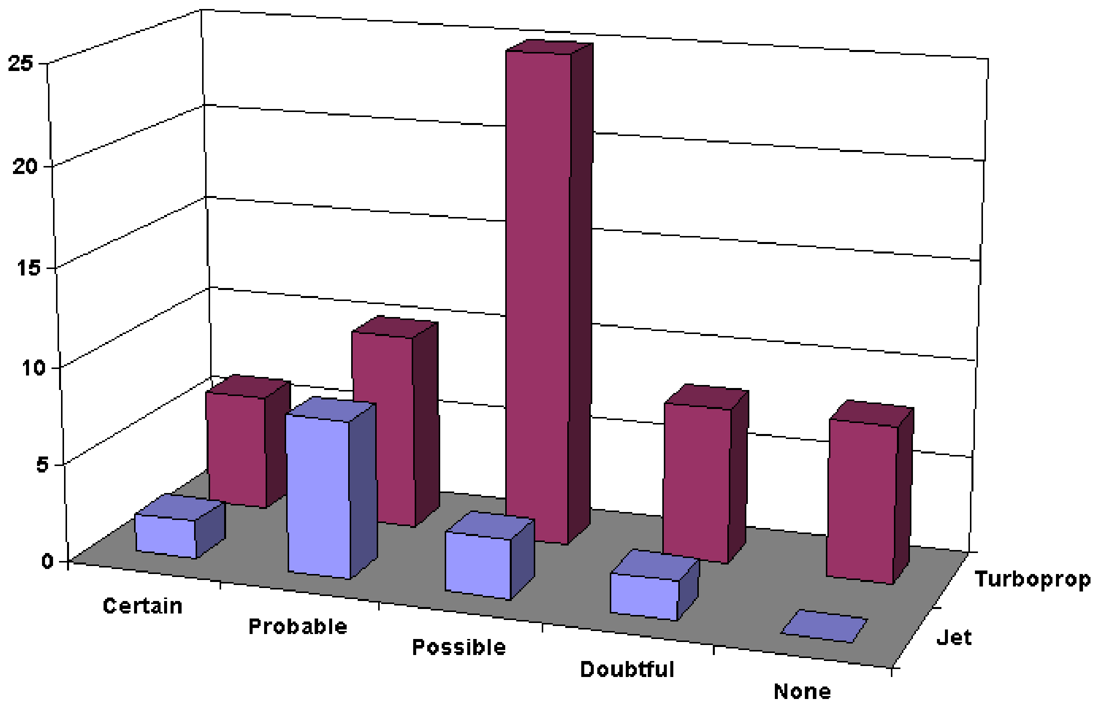
The most significant differences for phase of flight were between turboprop and jets in the approach and landing phases of flight. There were 72 approach accidents (15 jet and 57 turboprop) and 111 landing accidents (47 jets and 64 turboprops).

This is illustrated on the following page.

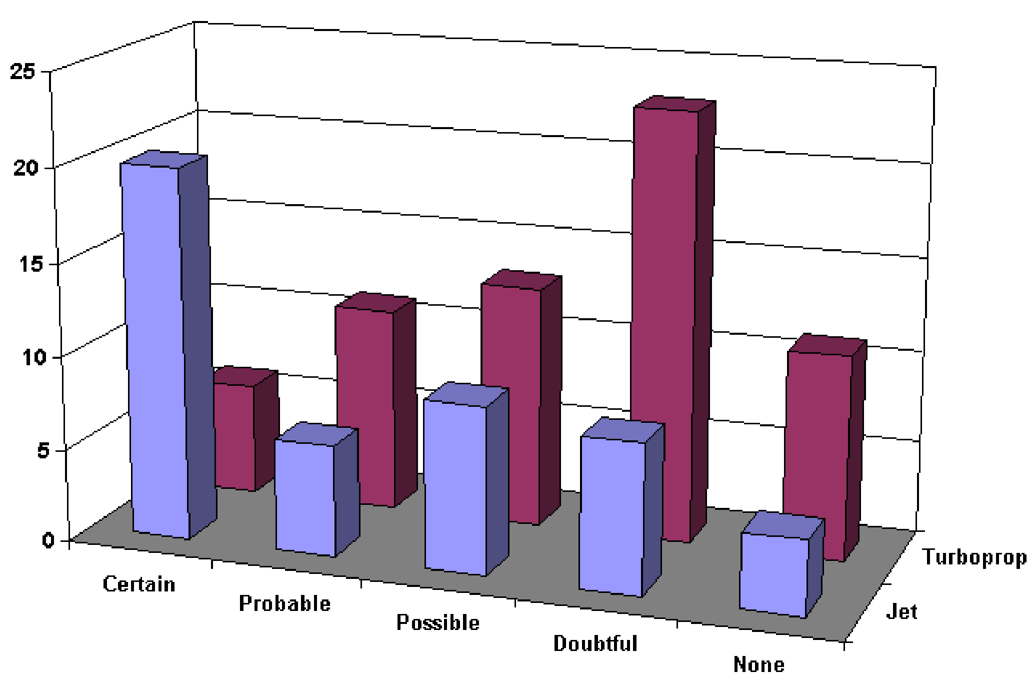
Of interest in the approach accidents is the better potential for prevention in the jet category compared with the turboprops (see the peak for the smaller number of jet accidents is in the "Probable" category, whereas the peak in the larger number of turboprop accidents is in the "Possible" category). It is possible that this is connected with the added monitoring with the predominately two pilot jet operation.

The difference between jets and turboprops is more evident in the landing accidents, where the peak in the jet accidents is in the "Certain" category, whereas the peak in the turboprops is in the "Doubtful" category.

NUMBER OF APPROACH ACCIDENTS VS PROBABILITY OF PREVENTION AND AIRCRAFT CATEGORY



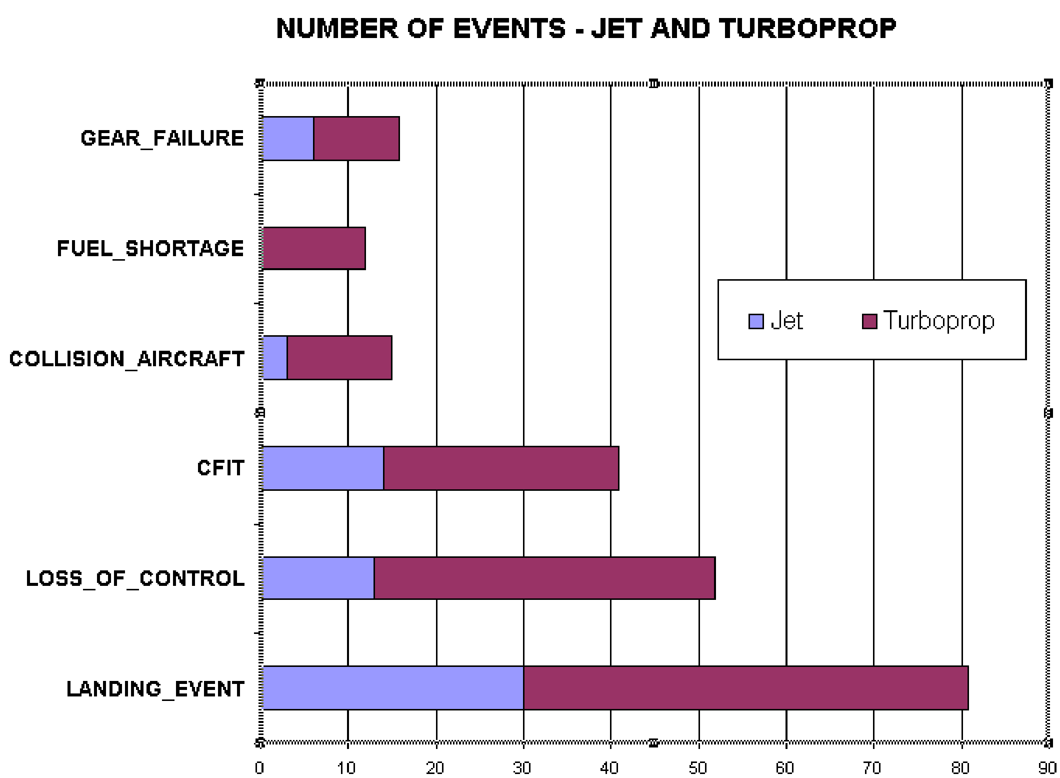
NUMBER OF LANDING ACCIDENTS VS PROBABILITY OF PREVENTION AND AIRCRAFT CATEGORY



5.4 Probability of prevention vs. events

By discounting events occurring less than 5% of the events in each class, it was possible to group them under five main headings:

TURBOPROP AND JET No of EVENTS	Jet	Turboprop
LANDING_EVENT	30	51
LOSS_OF_CONTROL	13	39
CFIT	14	27
COLLISION_AIRCRAFT	3	12
FUEL_SHORTAGE	0	12
GEAR_FAILURE	6	10



5.4.1 Landing events

There was a significant difference in the probability of prevention for the 31 jet and 37 turboprop landing accidents:

Turboprop (37)

1_Certain : (3) 8.1%
2_Probable: (8) 21.6%
3_Possible: (6) 16.2%
4_doubtful: (16) 43.2%
5_None : (4) 10.8%
37

Jet (31)

1_Certain : (15) 48.4%
2_Probable: (4) 12.9%
3_Possible: (7) 22.6%
4_doubtful: (4) 12.9%
5_None : (1) 3.2%
31

5.4.2 Loss of control

1_Certain : (8) 12.5%
2_Probable: (5) 7.8%
3_Possible: (18) 28.1%
4_doubtful: (18) 28.1%
5_None : (15) 23.4%
64

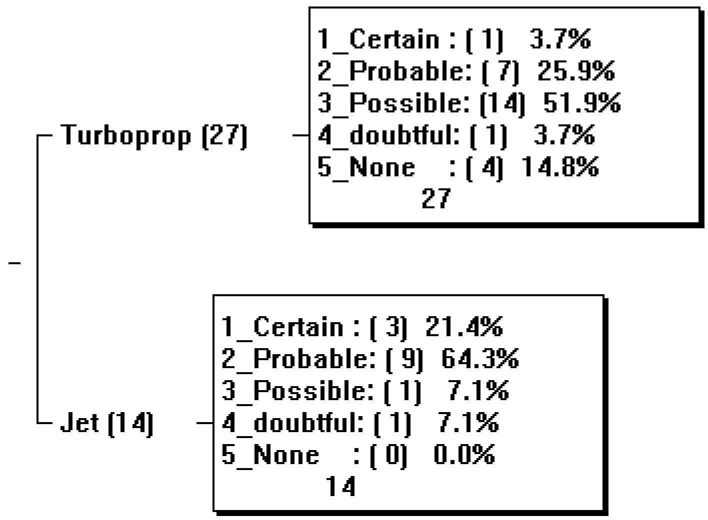
There was no significant difference in probability of prevention between 13 jet and 51 turboprop loss of control accidents.

It appeared that in most cases, loss of control involved spatial disorientation. In some cases this was linked with flying without or with suspect qualifications. In some cases pilots had been assessed as having poor IF skills during training courses, but no action had been taken to remove their instrument rating.

In many cases loss of control was associated with an emergency of some kind, during which the cardinal principle of 'fly the airplane first' was not followed. There were a number of occasions associated with AC system failures.

5.4.3 CFIT

There was a significant difference in probability of prevention between the 14 jet and 27 turboprop CFIT accidents as follows:



The relatively poor prospects of prevention for the turboprops reflect the predominantly single pilot / owner pilot operations.

5.4.4 Other events

There were no significant differences between turboprop and jet operations involving:

Gear failure (16 events).
Collisions, aircraft (15)
Wheels up unintentional (14)
Collisions objects, birds, animals (12)
Fuel shortage (12)
Damage to aircraft (9)
RTO, overrun, off side (6)
Wheels up intentional (6)
Weather (5)

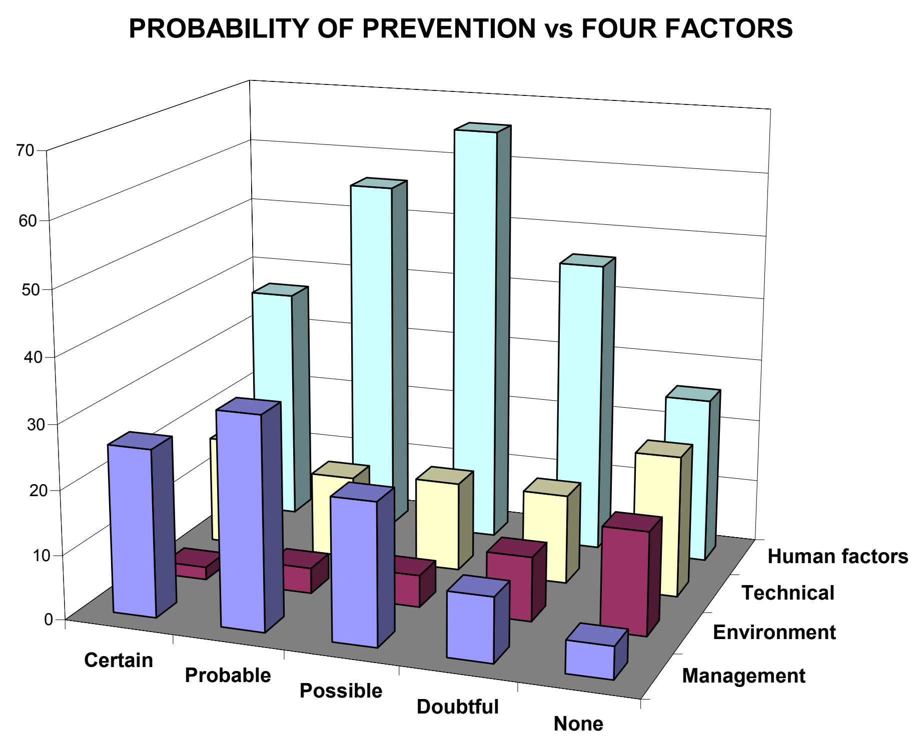
All cases of fuel shortage were confined to turboprop operations.

5.5 Probability of prevention vs. simple 4 factor analysis

The simple 4 factor analysis identifies HUMAN (flight crew related actions), TECHNICAL (technical failures or malfunctions), ENVIRONMENT (those events outside the control of the flight), and MANAGEMENT.

Regarding the effect of IS-BAO the probability of prevention for each factor were assessed as:

	Certain	Probable	Possible	Doubtful	None
Management	26	33	22	10	5
Environment	2	4	5	10	16
Technical	17	13	14	14	22
Human factors	37	56	66	46	26



Note that many events were classified in two or more sub-categories, thus the totals exceed the number of accidents reviewed.

5.6 Probability of prevention vs. 4 factors (H, T, E & M)

The results for Human, Technical, Environment and Management factors were as follows:

H

1_Certain :	[40]	17.5%
2_Probable:	[55]	24.0%
3_Possible:	[61]	26.6%
4_doubtful:	[46]	20.1%
5_None :	[27]	11.8%
	229	

T

1_Certain :	[17]	21.5%
2_Probable:	[13]	16.5%
3_Possible:	[14]	17.7%
4_doubtful:	[13]	16.5%
5_None :	[22]	27.8%
	79	

E

1_Certain :	[2]	5.4%
2_Probable:	[4]	10.8%
3_Possible:	[5]	13.5%
4_doubtful:	[10]	27.0%
5_None :	[16]	43.2%
	37	

M

1_Certain :	[28]	28.9%
2_Probable:	[32]	33.0%
3_Possible:	[21]	21.6%
4_doubtful:	[11]	11.3%
5_None :	[5]	5.2%
	97	

Note that the number of factors exceeds the number of accidents because the factors are not mutually exclusive.

5.6.1 Human factors

There was a significant difference between the 58 jet and 163 turboprop for human factors:

Turboprop (163)

1_Certain :	[12]	7.4%
2_Probable:	[36]	22.1%
3_Possible:	[53]	32.5%
4_doubtful:	[38]	23.3%
5_None :	[24]	14.7%
	163	

Jet (68)

1_Certain :	[28]	41.2%
2_Probable:	[19]	27.9%
3_Possible:	[10]	14.7%
4_doubtful:	[8]	11.8%
5_None :	[3]	4.4%
	68	

It appears possible that this reflects the difference between single pilot vs. two pilot operations.

5.6.2 Technical Factors

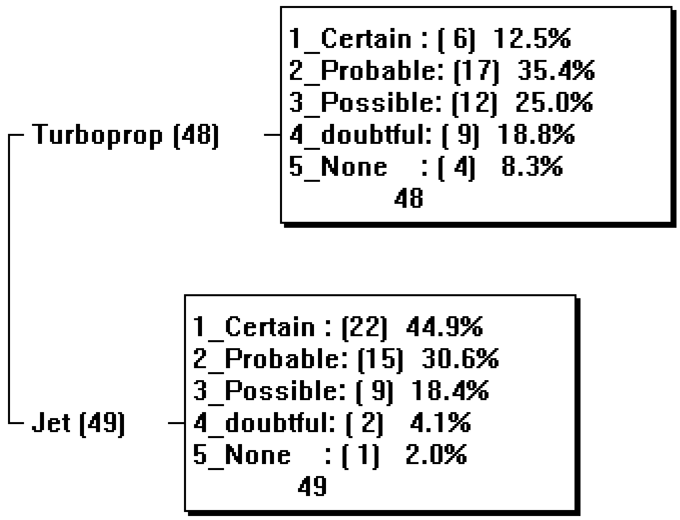
There was no significant difference between jets and turboprops for the 79 technical factors.

5.6.3 Environmental factors

There was no significant difference between jets and turboprops in the 37 environmental factors.

5.6.4 Management factors

There was a significant difference between the 49 jet and 48 turboprop management factors:



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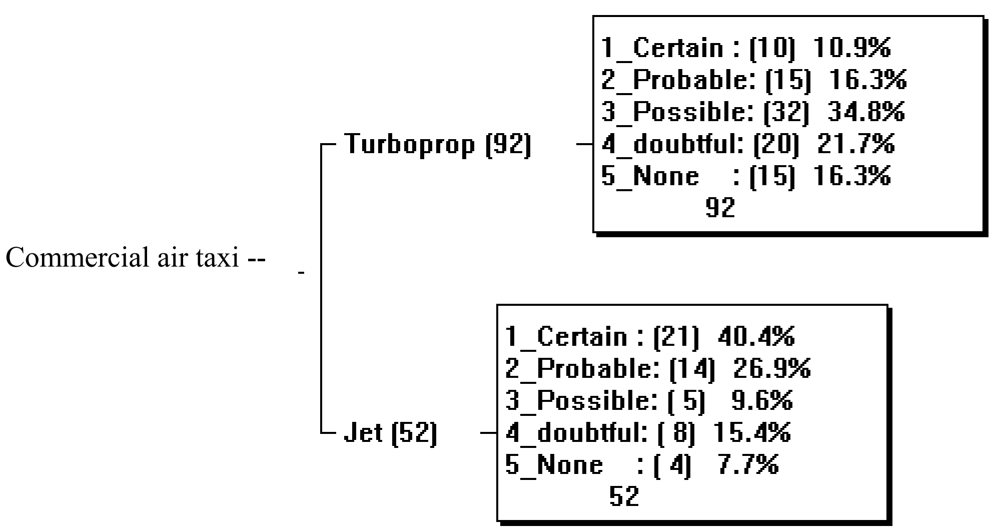
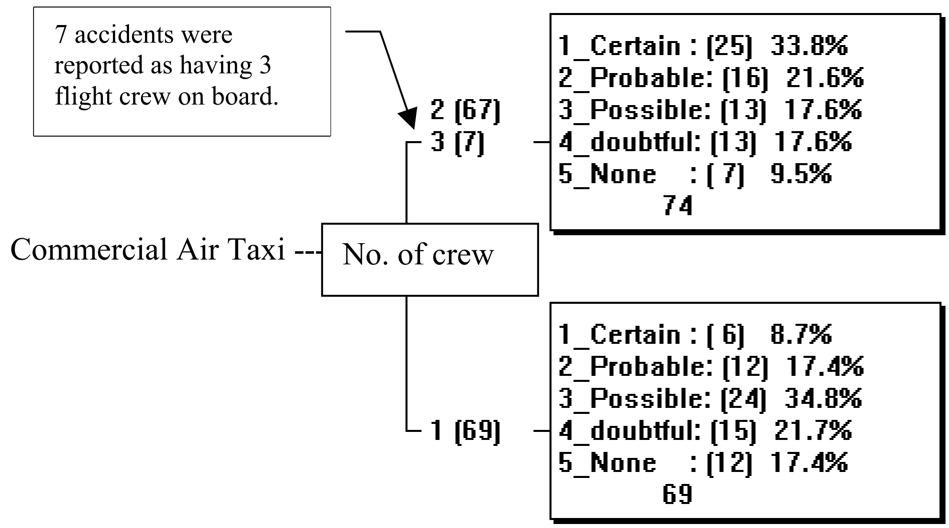
5.7 Probability of prevention vs. type of Operation

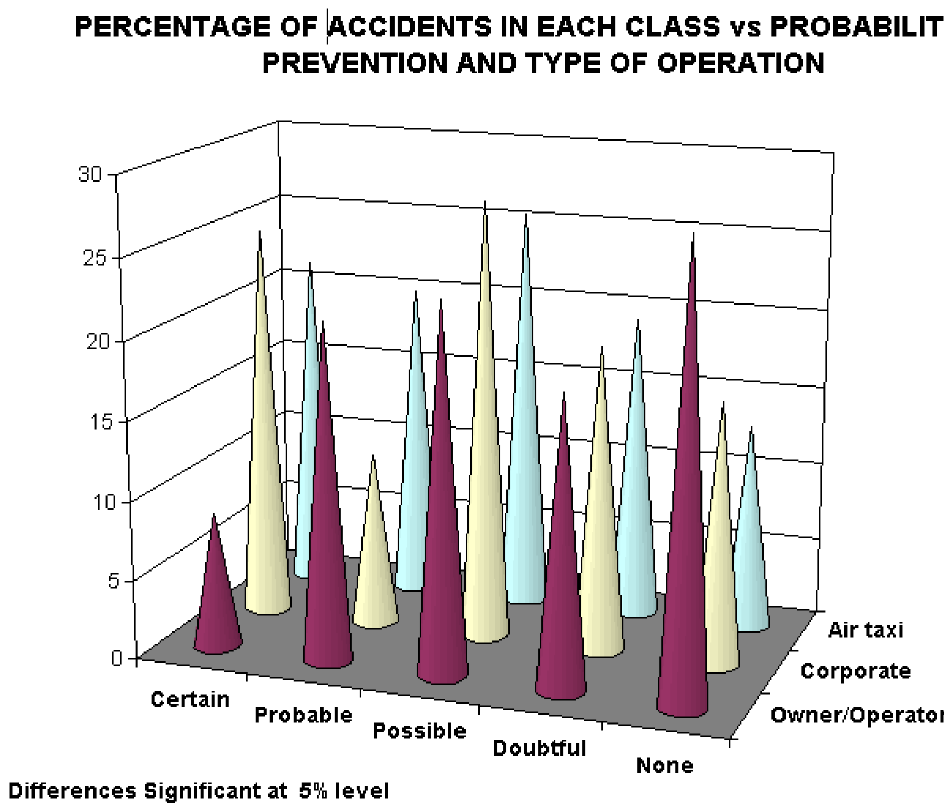
There was a significant difference (95% level) in the probability of prevention between the three main operations recognized by IBAC (Owner/Operator, Corporate and Air Taxi). However, for the commercial air taxi class there was a very significant difference between the 52 jet and 92 turboprop operations.



Within the Air Taxi class, there was a further significant split between 1 and 2 pilot operation:



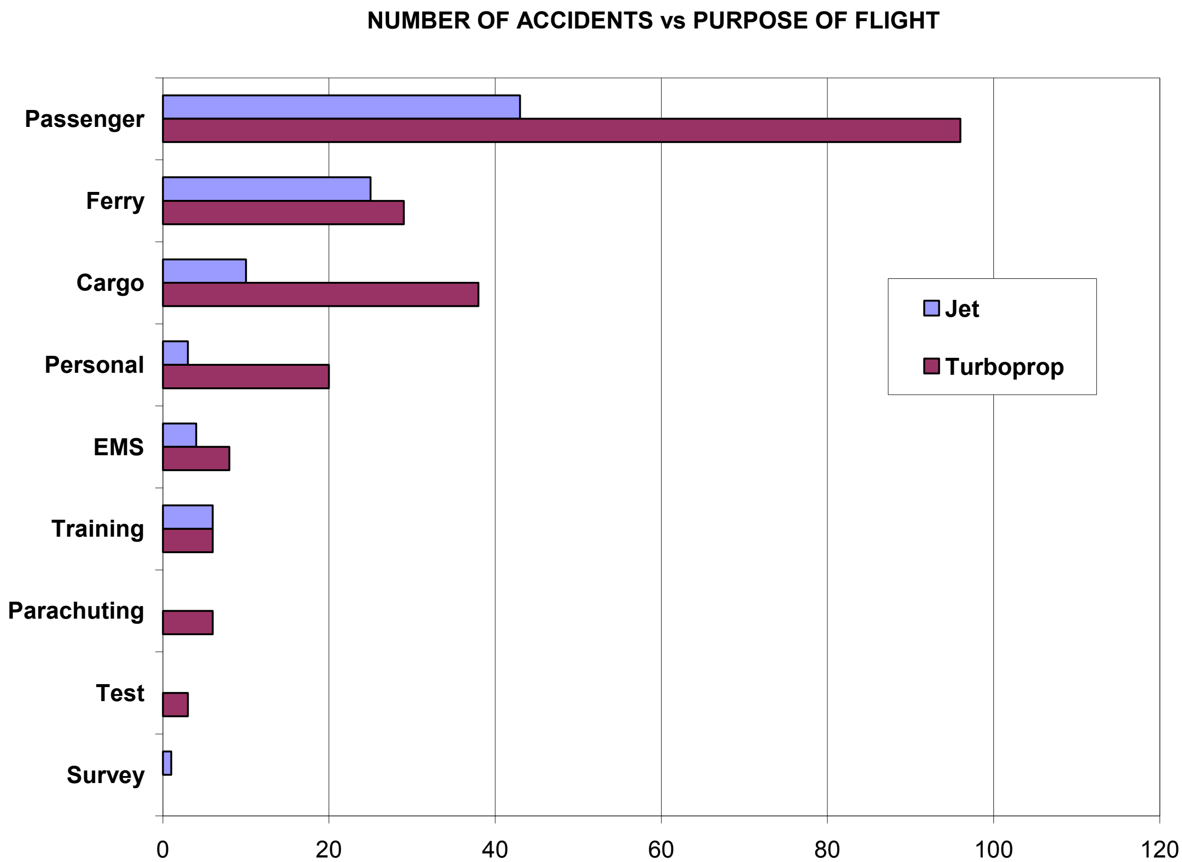
The figure below shows the percentage of accidents in each class (Air taxi 144, Corporate 36, Owner/Operator 103), vs. the probability of prevention:



5.8 Probability of prevention vs. purpose of flight

The number of accidents is shown as follows:

Purpose	Jet	Turboprop
Passenger	43	96
Ferry	25	29
Cargo	10	38
Personal	3	20
EMS	4	8
Training	6	6
Parachuting	0	6
Test	0	3
Survey	1	0



The purpose of flight had no significant influence on the probability of prevention. However, the sub-groups of 138 passenger and 54 ferry accidents gave significantly different results between jet and turboprop operations. (See next page)

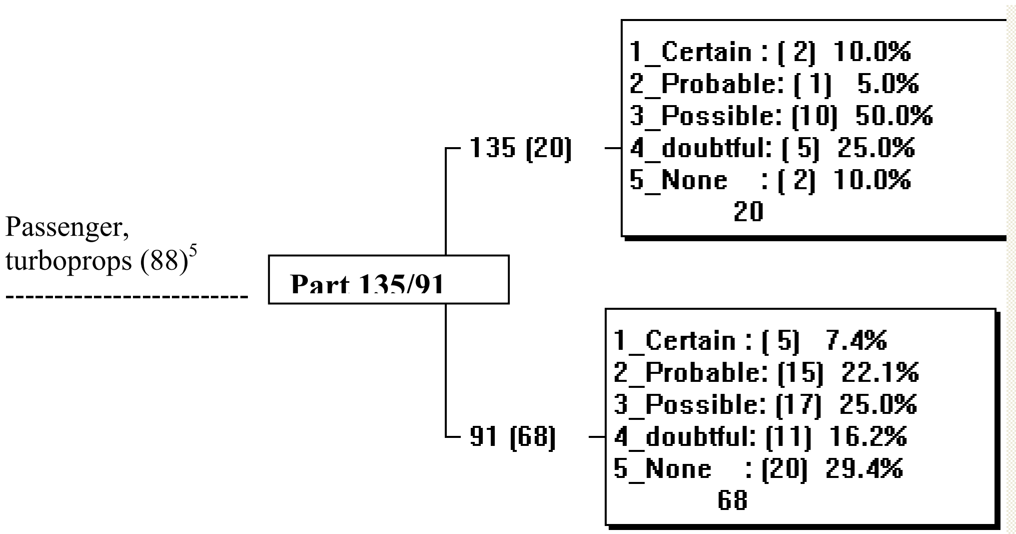
Passenger (138)---------
accidents

- Turboprop (96)
  - 1_Certain : (8) 8.3%
  - 2_Probable: (18) 18.8%
  - 3_Possible: (27) 28.1%
  - 4_doubtful: (18) 18.8%
  - 5_None : (25) 26.0%
  - 96
- Jet (42)
  - 1_Certain : (13) 31.0%
  - 2_Probable: (11) 26.2%
  - 3_Possible: (8) 19.0%
  - 4_doubtful: (6) 14.3%
  - 5_None : (4) 9.5%
  - 42

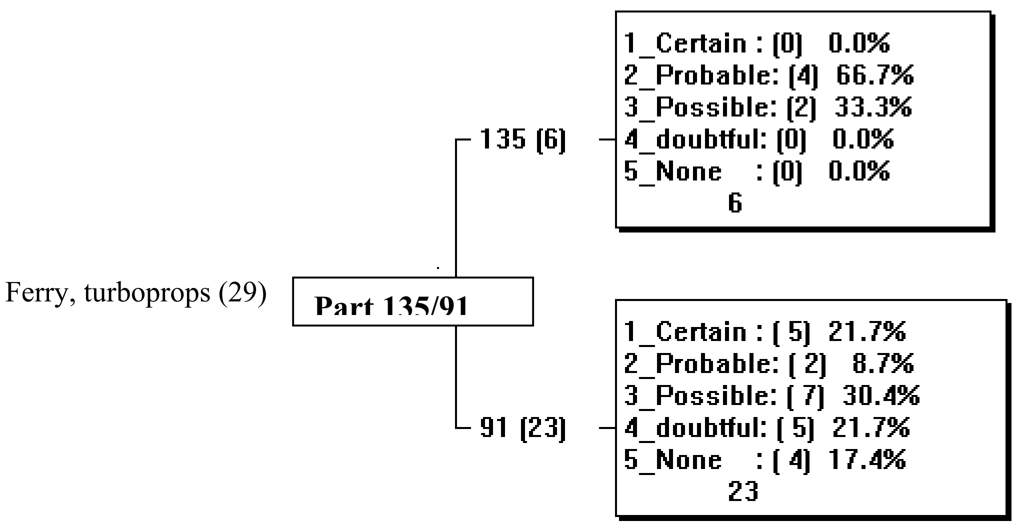
Ferry (54)--------------
accidents

- Turboprop (29)
  - 1_Certain : (5) 17.2%
  - 2_Probable: (6) 20.7%
  - 3_Possible: (9) 31.0%
  - 4_doubtful: (5) 17.2%
  - 5_None : (4) 13.8%
  - 29
- Jet (25)
  - 1_Certain : (13) 52.0%
  - 2_Probable: (6) 24.0%
  - 3_Possible: (2) 8.0%
  - 4_doubtful: (0) 0.0%
  - 5_None : (4) 16.0%
  - 25

The passenger subset was not significant regarding single pilot/two pilot operating. There was a significant difference in the 88 turboprop passenger operations in respect of the class of operation (Part 91 vs. 135). operations.



A similar feature applied to the ferry categories again reflect the ferry turboprop sub-category.



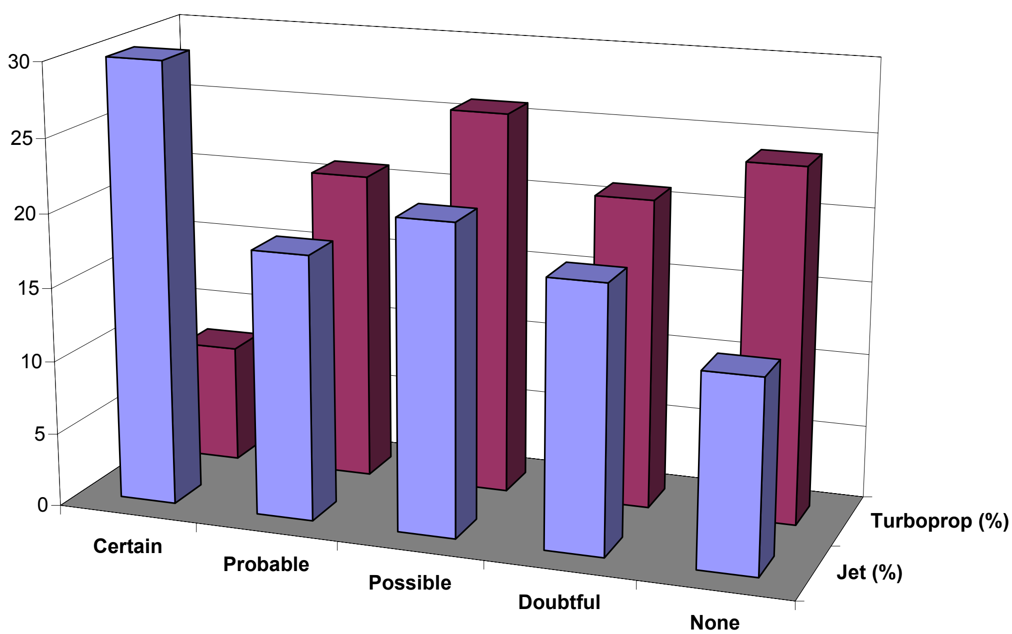
5 The numbers do not match because not all the accidents were classified by the Part number under which they were operated.

5.9 Probability of prevention vs. Part 91 and 135

There were 191 accidents under Part 91 operations and 78 under Part 135 operations. There was no significant difference in the probability of prevention between them. However, for the Part 91 operations, there was a significant difference in probability of prevention between the 56 jet and 135 turboprop accidents.

Part 91 operations	Certain	Probable	Possible	Doubtful	None
Jet %	30	18	21	18	13
Turboprop %	8	21	26	21	24

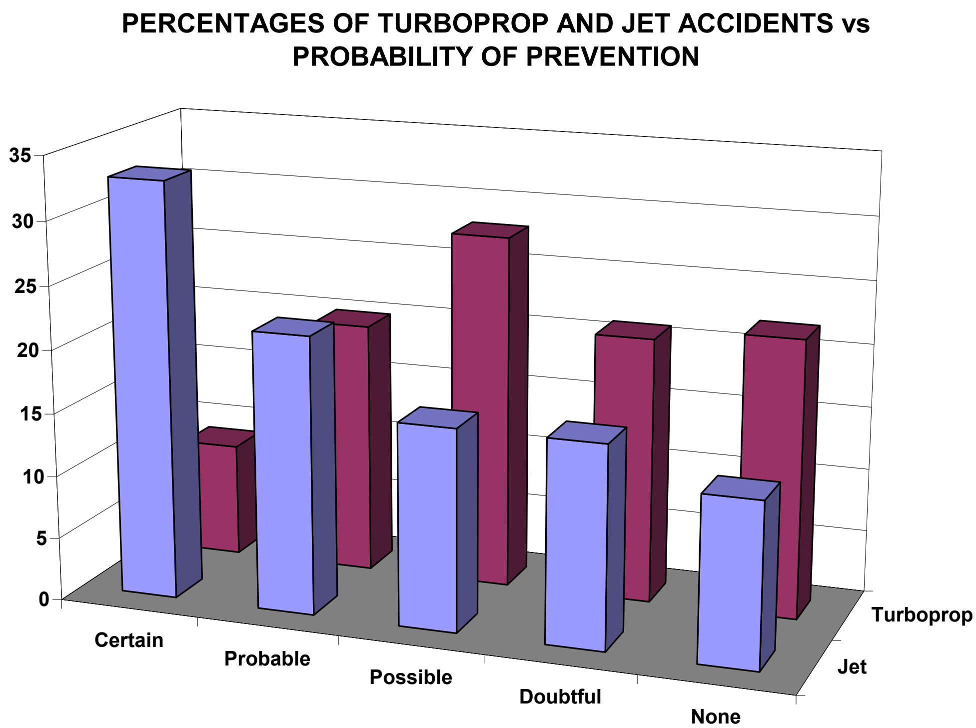
PART 91 OPERATIONS vs PROBABILITY OF PREVENTION COMPARED FOR JETS AND TURBOPROPS



5.10 Probability of prevention vs. fatalities

There were 101 fatal accidents (27 jets and 74 turboprops) and 197 non-fatal accidents (65 jets and 132 turboprops) in the 298 accidents reviewed. A total of 312 persons were killed (137 crew and 298 passengers). As in the basic data, there was a significant difference in the probability of prevention between jets and turboprops:

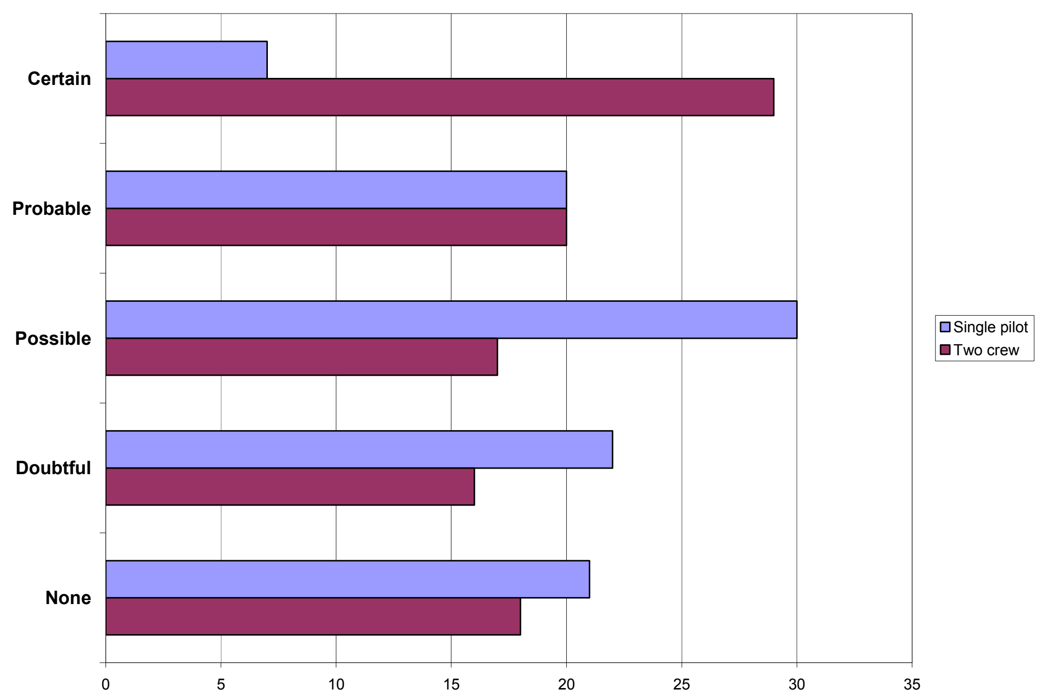
Fatal accidents	Certain	Probable	Possible	Doubtful	None
Jet (%)	33	22	16	16	13
Turboprop (%)	9	20	28	21	22



5.11 Probability of prevention vs. single crew operation

Taking only the 171 single and 124 two pilot operation criteria, there was a very significant difference in the probability of prevention:

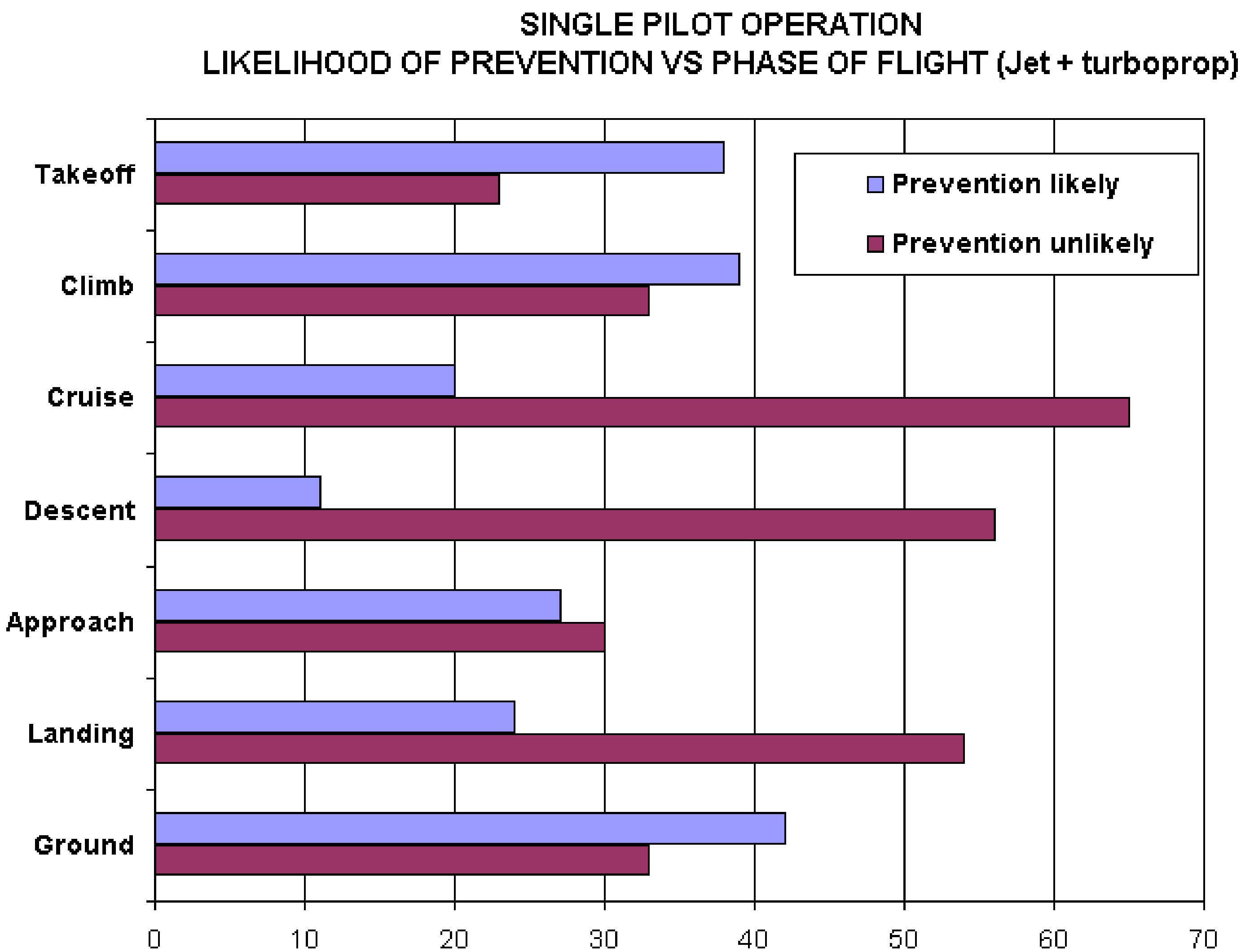
	Certain	Probable	Possible	Doubtful	None
Single pilot (%)	7	20	30	22	21
Two crew (%)	29	20	17	16	18



The difference between jet and turboprop operations was not significant.

There were no significant differences for phase of flight for two crew operations. However, for single pilot operations there were significant differences. Dividing the single pilot results into two classes (%Certain + %Probable) and (%Doubtful + %None) gave the following significant results:

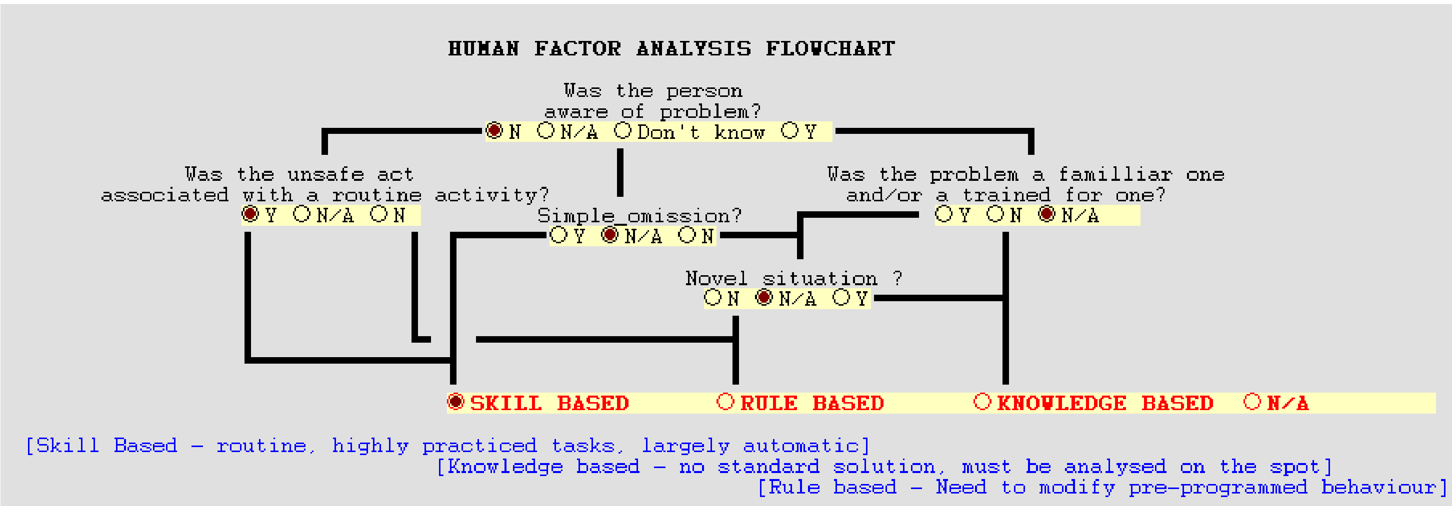
Jet + Turboprop single pilot	Takeoff	Climb	Cruise	Descent	Approach	Landing	Ground
Prevention likely	38	39	20	11	27	24	42
Prevention unlikely	23	33	65	56	30	54	33



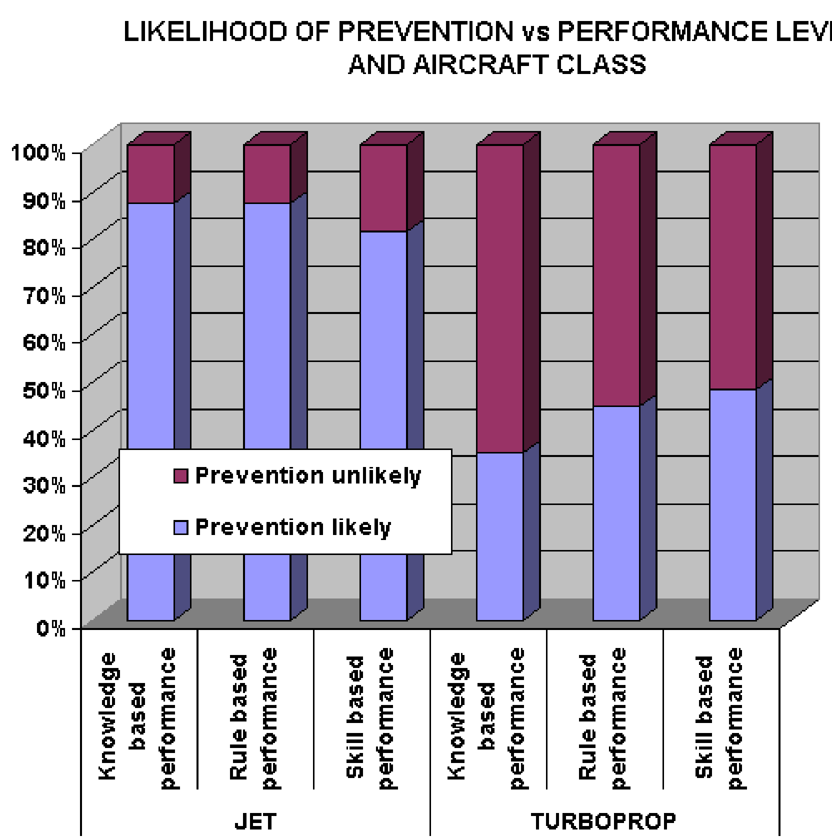
When checked against “Purpose of flight” and “Type of operation”, there were no significant differences between single and two crew operations.

6 Probability of prevention vs. Human factors

6.1 Performance level



The prevention probabilities for the 37 knowledge based, 46 rule based, and 149 skill based results plus the non-human factor accidents were statistically different. Dividing the single pilot results into two classes (%Certain + %Probable) and (%Doubtful + %None) gave the following significant results:



6.2 Knowledge based performance

There was a significant difference in prevention probability between the 11 jet and 26 turboprop accidents.

Knowledge based performance	Certain	Probable	Possible	Doubtful	None
Jet (%)	46	18	27	9	0
Turboprop (%)	8	19	23	31	19

6.3 Rule based performance

There was a significant difference in prevention probability between the 13 jet and 33 turboprop accidents

Rule based performance	Certain	Probable	Possible	Doubtful	None
Jet (%)	46	18	27	9	0
Turboprop (%)	0	27	40	18	15

6.4 Skill based performance

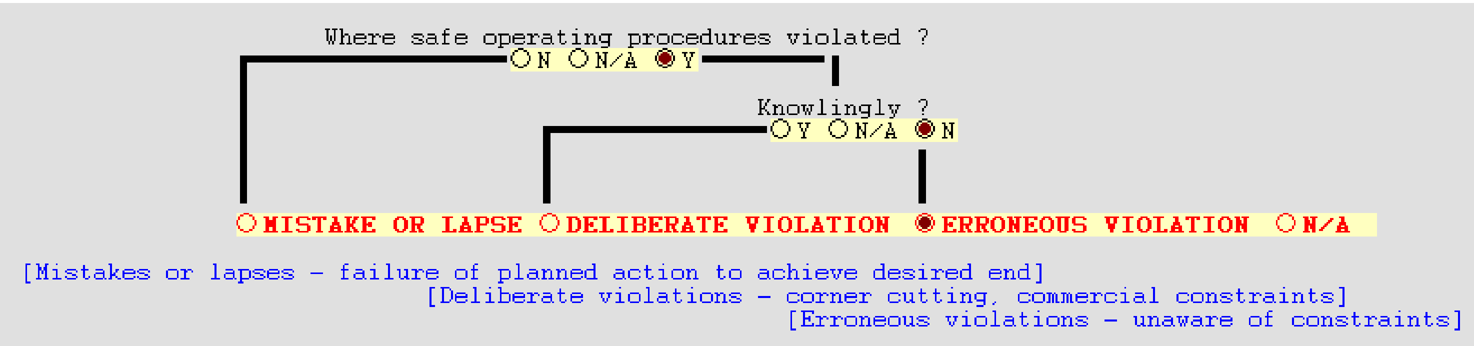
6.4.1 Jet vs. turboprop operations

There was a significant difference in prevention probability between the 45 jet and 104 turboprop accidents

Skill based performance	Certain	Probable	Possible	Doubtful	None
Jet (%)	38	33	13	7	9
Turboprop (%)	9	23	34	22	12

6.4.2 Deliberate violations, inadvertent violations and mistakes

The annotated flow chart showing the method used to analyze the data is illustrated below.

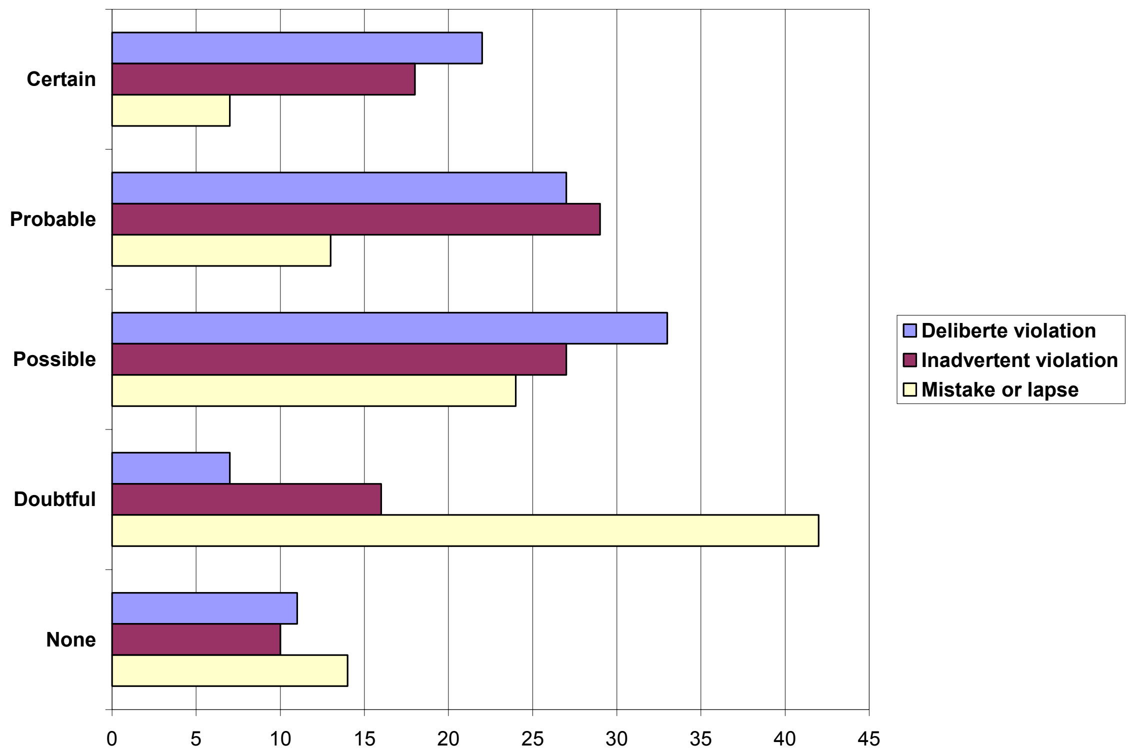


However, taken associated with all performance levels, there was a significant relationship between violations / mistakes and probability of prevention:

All accidents	**Certain**	**Probable**	**Possible**	**Doubtful**	**None**
Deliberate violation (%)	22	27	33	7	11
Inadvertent violation (%)	18	29	27	16	10
Mistake or lapse (%)	7	13	24	42	14

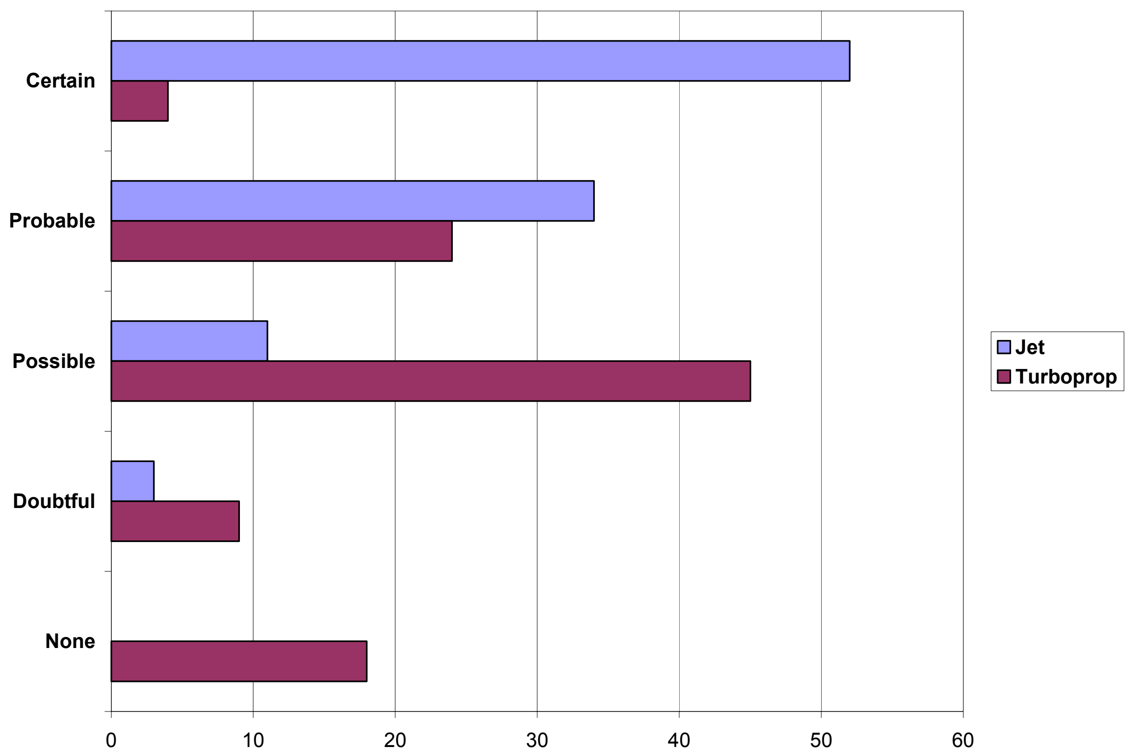
When associated with each individual performance level, only the Skill based level revealed a significant difference in prevention probabilities between deliberate violations, inadvertent violations and mistakes:

Skill based performance	**Certain**	**Probable**	**Possible**	**Doubtful**	**None**
Deliberate violation (%)	22	31	33	5	9
Inadvertent violation (%)	21	30	28	11	10
Mistake or lapse (%)	7	15	22	42	15



There were no significant findings for erroneous violations and mistakes, but the probability of prevention for deliberate violations differed significantly between the 35 jets and 55 turboprops in this sub-category:

Deliberate violations (%)	**Certain**	**Probable**	**Possible**	**Doubtful**	**None**
Jet (%)	52	34	11	3	0
Turboprop (%)	4	24	45	9	18



7 Accident prevention strategies in relation to IS-BAO

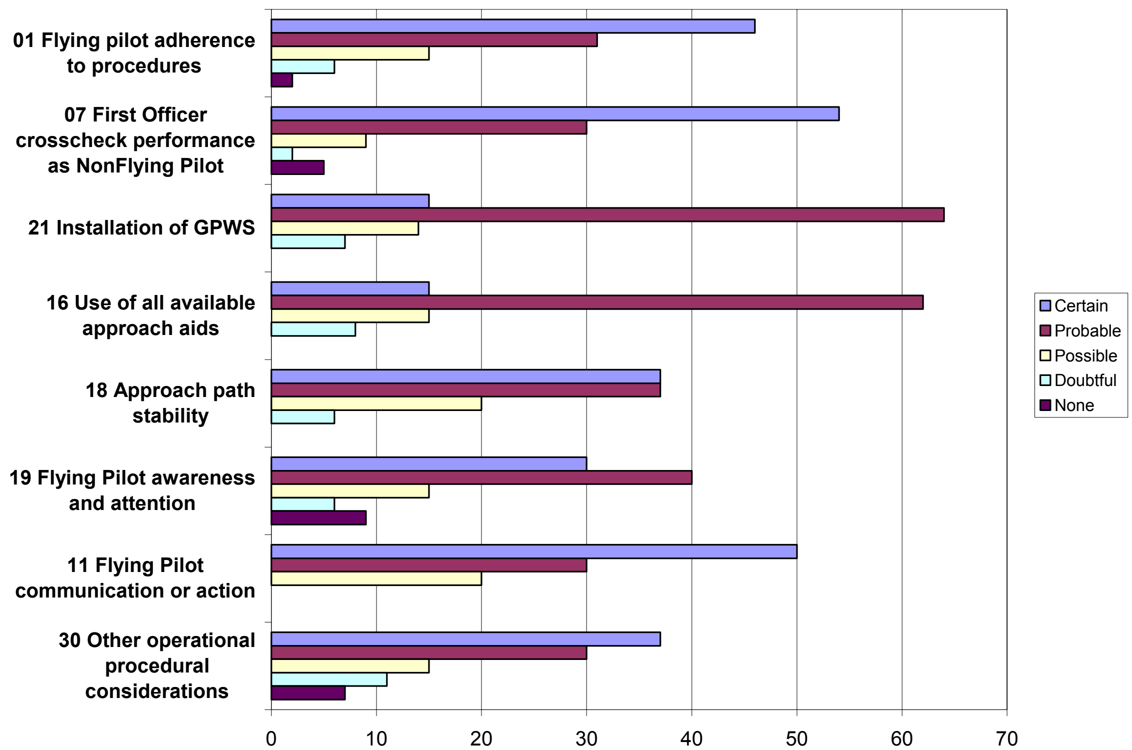
The Boeing "Prevention strategies" study was based on a detailed analysis of some 250 full accident reports carried out by seven trained accident investigators. They narrowed down the number of strategies to some 43 items. The authors of the Boeing Study note that "Other operational procedural considerations" covered the various management factors involved in the accidents. It was noted that they appeared in nearly as many events as the pilot related strategies.

7.1 Strategies for jet operation

The most effective prevention strategies for jet operations are listed as follows, from the most significant to the least significant.

JET	Certain	Probable	Possible	Doubtful	None
01 Flying pilot adherence to procedures (%)	46	31	15	6	2
07 First Officer crosscheck performance (%) as Non Flying Pilot	54	30	9	2	5
21 Installation of GPWS (%)	15	64	14	7	0
16 Use of all available approach aids (%)	15	62	15	8	0
18 Approach path stability (%)	37	37	20	6	0
19 Flying Pilot awareness and attention (%)	30	40	15	6	9
11 Flying Pilot communication or action (%)	50	30	20	0	0
30 Other operational procedural considerations (%)	37	30	15	11	7

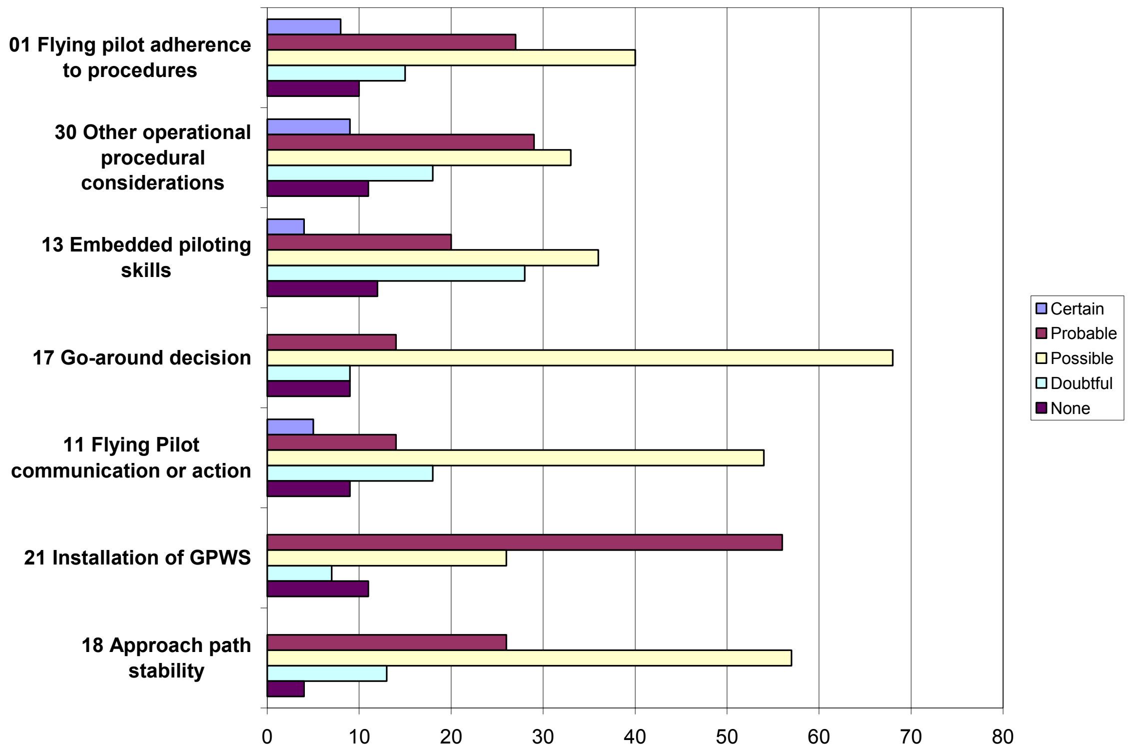
JET	Number
01 Flying pilot adherence to procedures	54
30 Other operational procedural considerations	54
07 First Officer crosscheck performance as Non-Flying Pilot	43
19 Flying Pilot awareness and attention	33
18 Approach path stability	30
11 Flying Pilot communication or action	20
21 Installation of GPWS	14
16 Use of all available approach aids	13



7.2 Strategies for turboprop operations

TURBOPROP	Certain	Probable	Possible	Doubtful	None
01 Flying pilot adherence to procedures (%)	8	27	40	15	10
30 Other operational procedural considerations (%)	9	29	33	18	11
13 Embedded piloting skills (%)	4	20	36	28	12
17 Go-around decision (%)	0	14	68	9	9
11 Flying Pilot communication or action (%)	5	14	54	18	9
21 Installation of GPWS (%)	0	56	26	7	11
18 Approach path stability (%)	0	26	57	13	4

TURBOPROP	Number
30 Other operational procedural considerations	114
01 Flying pilot adherence to procedures	110
13 Embedded piloting skills	80
11 Flying Pilot communication or action	44
21 Installation of GPWS	27
17 Go-around decision	22
18 Approach path stability	23



8 Conclusion

This report assesses the probabilities of prevention associated with the factors examined. It is evident that IS-BAO will have considerable impact on accident statistics, although the effect will be greater in certain operations than in others. Given the wide spectrum of these operations, and the motivation of the participants, this seems inevitable. Nevertheless, the additional material in the analysis should enable business jet and turboprop operators to review their own management, operations, safety, training and maintenance practices against the probability of accident prevention, and better assess the benefits of a pro-active quality assurance scheme such as IS-BAO.

end

BRIEF DESCRIPTIONS SORTED BY HUMAN PERFORMANCE LEVELS (KNOWLEDGE, RULE AND SKILL BASED PERFORMANCE)

1 JETS

1.1 Knowledge based performance

- Slid off side of runway during landing roll
- Crashed during aborted landing - reverser(s) deployed
- Attempted single engine takeoff/air start, stalled on T/O
- Severe turbulence, crew problem with pitch feel system operation
- Decompression during climb, crew incapacitation
- Overshot runway landing, ice/slush covered runway, hydroplaning
- RTO above V1 - trim incorrectly set
- Stalled following distraction by rear canopy failure
- Acft. hit building during climb - had declared emerg. - IMC
- Acft descended into ground after TO in IMC, fog, darkness
- Gear up landing, crew confusion after emergency return

1.2 Rule based performance

- Slid off side of runway during landing roll
- Crashed during aborted landing.- reverser(s) deployed
- Attempted single engine takeoff/air start, stalled on T/O
- Severe turbulence, crew problem with pitch feel system operation
- Decompression during climb, crew incapacitation
- Overshot runway landing, ice/slush covered runway, hydroplaning
- RTO above V1 - trim incorrectly set
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- Gear up landing, crew confusion after emergency return

1.3 Skill based performance

- Landed fast, late touchdown - overran - hit aircraft and hangar
- Left main gear collapsed during landing
- Impacted mountain during initial descent (CFIT)
- Landed late, fast and over-ran runway and hit ditch, destroyed
- Control loss takeoff - ran off runway
- Crashed during descent in IMC - fog - rain (CFIT)
- Landed gear up - crew failed to extend gear
- Crashed during DME arc app., night, IMC, fog (CFIT)
- Overrun - touched down late and fast on wet runway

- Landed with gear in transit, collapsed landing
- CFIT - Descended below GP, GP RX problem, crew problems
- CFIT - Undershot Ldg., sank in lake 1 mile short of rwy
- Excessive speed, late touchdown, landing overrun
- Forgot to extend landing gear before landing
- Mid air collision with VFR CE-172 during IFR climb
- Incorrect emergency brake operation, runway overrun
- CFIT Undershot ILS by 6 mi., rain, fog, night, IMC
- Failed to complete checklist, electrical problem, landed gear up
- Late touchdown, runway overrun, wet/slippery runway
- Stalled just before landing, right wing tip scraped runway
- Misjudged speed/altitude (inexperience), overrun on wet runway
- Did not use checklists, hydraulic failure, runway overrun
- Crash approach in IMC - duck under - landed short (CFIT)
- Lost directional control on landing, fatigue noted as factor
- Undershot runway during ILS in IMC - fog CFIT
- CFIT descended below minima during instrument approach in IMC
- Descended into terrain in missed approach, CFIT
- Runway overrun - high elev. airport, incorrect procedures used
- Landed long - overshot - hit localizer - fence into pkg. lot
- Crashed short of rwy. - marg. wx. at pvt. landing strip CFIT
- Switched off warning horn en-route and forgot to lower gear
- Hit mountain during initial VOR approach - night -VMC (CFIT)
- Mid-air with Extra acrobatic aircraft - in VFR daylight
- Did not correctly activate brake system, struck building
- Wing distorted during descent due tape blocking tank vent
- Pilot misjudged flare in ground fog, hard landing
- Descent below minima, FAA orders not communicated, CFIT
- Descent below NDB approach altitude on app. in night VMC (CFIT)
- Acft. taxied onto runway in fog, was hit by air carrier on TO
- Over-rotation, loss of directional control on takeoff
- Hard landing, incorrect elevator trim and failure to go around
- No de-icing, aircraft struck trees in initial climb after takeoff
- Landed long - runway overrun
- Lost control in steep turn for landing
- Lost control during asymmetric approach

1.4 Crew factors not involved

- Veered off side of runway landing - hit snow bank
- Acft. hit unattended truck on rwy. ldg. at WA
- Experienced aft fuselage fire fed by hydraulic. leak
- Nose gear collapsed on landing
- Right main landing gear collapsed landing
- Struck deer landing, punctured fuel tank

- Locked elevator during takeoff, unknown reason, RTO and overrun
- Contamination in anti-skid brake system, veered off runway
- Nose wheel steering failed, inadequate documentation.
- Severe windshear, lack of weather information
- Struck seagulls on takeoff - both engines damaged
- Blown tire damaged hydraulic system, gear up landing
- Worn brakes failed and A/C overran the runway during landing
- Aircraft landed with left main gear retracted
- Loss of control due to maintenance error
- Fire in oxygen system during taxi for departure
- Aircraft struck two deer on landing - fire followed
- Maintenance error, left main collapsed on landing
- Partial failure anti-skid system, ran off runway side on landing
- Right main gear collapsed due manufacturing defect
- Struck bird during cruise flight
- Partial failure of anti-skid system, ran off side of runway

2 TURBOPROP

2.1 Knowledge based

- Takeoff aborted aircraft nosed over after hitting a snow bank
- Aircraft damaged during taxi on ice/snow covered taxiway
- Loss of control - pitot head icing and loss of ASI in IMC
- Control lost while orbiting in marginal wx. awaiting to land
- Lost control - spiral dive during climb in IMC.T storms in area
- Lost control during RTO, aircraft ran off runway side
- Aircraft entered spin in IMC - pilot distracted by icing
- Hydroplaned after deliberate no flap landing on wet runway
- Maintenance problem, failed to follow emergency procedures.
- No pre-flight, fuel leakage, lost control during VFR circuit
- Did not de-ice wings, stalled on takeoff in snow storm
- Non instrument rated pilot lost control in marginal weather
- Inadequate weather briefing resulting in icing and forced landing
- Inadequate management of fuel system resulting in forced landing
- Unrated pilot lost control in IMC (helicopter rating only)
- During taxi high wind gusts tipped aircraft over
- Inadequate planning, fuel exhaustion and forced landing
- Late RTO due erroneous identification of hazard
- Landing gear collapsed, inadequate checklist and inexperience
- Used banned pesticide, later became unconscious in air, ditched
- Mid air with G-III on approach to Van Nuys - CA - in VMC
- Lost control, generator and A/H failure, no standby horizon rqd.
- Lost control, inadequate airspeed when on one engine
- Lost control after AC electric power loss

- Loss of control, inability to feather propeller, inexperience
- Loss of control, inexperienced pilot advised against flight

2.2 Rule based

- Wing struck runway during ILS in marginal IMC
- Flew into severe icing, stalled during turn and hit ground
- No de-icing, known severe icing, hit trees in forced landing
- Wing separation in flight in known thunderstorm area
- Stall on finals, poor management of flight, inadequate supervision
- Impacted mountain attempting VFR in IMC (CFIT)
- Wing hit runway during landing student flying training flight
- Aircraft landed half way down the runway and overran
- Aircraft landed 100 yds. short of the runway due fuel exhaustion
- Stall/spin during climb in icing conditions
- Ustabilised approach followed by a hard landing
- Taxied under and a covered T hangar without adequate clearance
- Inadvertent flight into icing, stall and hard landing
- Lost control when flying into known thunderstorm activity
- Hydroplaned off runway landing in heavy rain
- Loss of control - undetected ice on approach
- Stalled during ILS - icing conditions and pilot inexperience
- CFIT - Impacted terrain - VFR in IMC - white out condition
- Decompression, lost control, AC altitude restriction disregarded
- Lost control, hypoxia, unpressurized flight 20,000 ft., no oxygen
- Inadequate compensation for wind, hard landing, L gear collapsed
- A/C broke up after exceeding max design speed in thunderstorm
- Inadequate planning, overweight TO, fuel exhaustion, hit pool hall
- Inexperienced crew lost engine on T/O, did not maintain VMCA
- Hard landing due severe turbulence encounter on landing
- Icing, did not select continuous ignition, double flame-out
- Taxi accident - tail struck a lamp post
- CFIT, unqualified, overconfident pilot, non-IFR equipped aircraft
- Lost control, EFTO, failed to feather propeller
- Landed late, weather below minima, overran runway, gear collapsed
- Lost control during initial climb after takeoff in IMC
- Lost control, spin following engine failure
- Left main gear unsafe - acft. veered off rwy. side during landing

2.3 Skill based

- Lost control - lost autopilot and gyro in IMC
- Struck wires during duck under approach at night in IMC
- CFIT- hit terrain during ILS in IMC 200 ft. overcast l mi. vis.
- Inadvertent stall on landing, wrong flap set,
- Hard landing, bounced, prop hit rwy, veered off side

- Lost control during back course ILS,IMC, snow/ice, hit building
- Hard landing gear collapsed, fire followed
- Landing gear collapsed during landing
- Mid air during VFR approach both aircraft landed successfully
- Inadequate pre-flight - engine cowling came off in flight
- Hard landing in crosswind, nose gear collapsed
- Lost control - steep turn onto final approach at night in VMC
- Lost control during initial climb in instrument conditions
- Stalled, attempted go around, aborted, lost directional control
- CFIT - 9 miles from airport
- Lost control, strong winds turbulence low cloud, approach in IMC
- Lost directional control on unsuitable landing area
- CFIT - descended below minima during an NDB approach in IMC
- Mid air collision with CE-172 in VMC
- Tail hit ground during patient loading, tail stand not used
- Lost directional control after landing on snow covered runway
- Stalled on finals in IMC following unstabilised approach
- Collided with terrain during VFR approach in white out
- Inadequate pre-flight, water in fuel, forced landing
- CFIT - unstabilised approach, night VMC
- CFIT, LH instead of specified RH night circuit, hit mountain
- Excessive bank angle and stall during circling - medical problems
- Lined up for T/O on RW edge lights instead of centreline lights
- EFTO - did not select "fuel on" before takeoff
- Right main landing gear collapsed during landing
- Inadequate lookout, mid air collision, emergency landing on beach
- Inadvertent stall during circling approach in poor weather
- On landing hit ice and slid off runway side
- CFIT - hit ground short of runway during an ILS in IMC
- CFIT - hit trees during approach in IMC
- CFIT, hit ground short of runway, disregarded approach minima
- Taxied into other aircraft awaiting TO clearance at night
- CFIT - ILS approach when weather below minima conditions
- Decided not to de-ice, near stall on T/O, attempted re-land on RW
- Lost control during ILS approach, pilot impairment by drug.
- Attempted takeoff with control locks on - hit trees
- Lost control - hit trees during circling app. in marg. wx. night
- Inadvertent gear retraction during landing
- Instructor failed to prevent swerve off runway
- Lost control in simulated IFR training flight
- CFIT - deliberate disregard of minima and MDA on NDB approach
- Inadequate pre-flight, blocked fuel vents, fuel starvation
- Disregarded MDA, lost control during circling approach in IMC
- Gear up landing - pilot failed to extend landing gear

- Pilot retracted gear too early during attempted go-around
- CFIT hit ground beside runway, distraction due to other problems
- Inadequate pre-flight, fuel exhaustion, emergency landing
- Hard landing, inadequate supervision by instructor
- Poor lookout, taxied into aircraft ahead on the taxiway
- Pilot failed to lower gear on landing
- Lost control in IMC during climb after T/O, no instrument rating
- Inadvertent stall after takeoff during sky diving flight
- Tired instructor pilot failed to lower gear
- CFIT after IFR departure - leveled off at wrong altitude
- Failure of captain to prevent hard landing by co-pilot
- Inadequate pre-flight, frost on A/C, failed to climb after T/O
- Elevator trim set wrong, lift-off too early,, stalled after T/O
- CFIT, descended below minima during ASR approach in IMC
- CFIT - attempted VFR in deteriorating weather - hit trees
- Gusts blew aircraft off side of runway during landing
- CFIT - did not follow clearance and ATC gave wrong information
- Check list not used, failed to lower gear before landing
- Mid air with CE-182 (N 91994)
- CFIT, unstabilised approach, inadvertent descent below MDA
- Inadvertent gear up landing
- Damaged when the aircraft taxied into another aircraft
- Fuel exhaustion, inadequate planning and monitoring
- Fuel exhaustion in cruise - overran emergency landing
- Hit wires on takeoff for parachute drop
- CFIT, unstabilised approach, questionable IF competence
- CFIT - attempting to remain VFR in marginal weather
- Failed to follow correct RTO procedure, overran runway
- Hard landing, bounced - nose gear and prop damaged
- CFIT, third approach in IMC, unstabilised approach below minima
- Hard landing in crab - gear - prop. and fuselage damaged
- CFIT on approach, dark night - VMC - IFR clearance cancelled
- Improper fuel selector setting - lost all power
- Inadvertent encounter with ships wake during water landing
- CFIT, circling approach, pilot, operator not following procedures
- Gear collapsed during landing
- Stalled circling after return to airport for unspecified problem
- Lost control, stalled on approach - dealing with electric problem
- Double engine loss on final - crash landed short of runway
- Failed to extend landing gear prior to landing
- Stalled short of runway during unstabilised approach in IMC
- CFIT - descended below approach minima in IMC in fog
- Checklist not followed, lost control during T/O roll
- Unstabilised approach, hit approach lights during ILS in IMC

- Hard landing - failed to check flap extension
- Ran out of fuel on approach - crashed in residential area
- Stalled after takeoff - inadequate de-icing
- Struck other aircraft during night taxi - both acft. subs.
- CFIT - flew VFR into IMC on approach
- Nose gear collapsed during landing (autopilot engaged below DH)
- CFIT - ILS approach in weather below minima
- Landing gear collapsed during landing
- RTO above V1, wings contaminated by ice
- Slid off runway during landing in IMC - freezing fog
- Lost control during return after takeoff for leaking fuel cap

2.4 Crew factors not involved

- Acft. struck by baggage cart and tug while taxiing for takeoff
- Landing gear collapsed landing, aircraft slid off runway side
- Right main landing gear collapsed during landing
- Aircraft water taxied into another aircraft
- Aircraft struck a deer landing left main gear collapsed
- Struck bird on takeoff damaging wing leading edge
- Right main landing gear collapsed on landing
- Engine failure - certification/airworthiness problem
- Collision with unknown aerial vehicle
- Top of rudder broke off in flight - undetermined reason
- Landing gear collapsed landing due mechanical malfunction
- Landing gear failed to lock down and collapsed during landing
- In-flight break up at FL 230 during descent, severe turbulence
- Loss of hydraulic power resulted in runway over-run
- Inadvertent encounter with severe icing, damaged wing and fuselage
- ATC failure, runway incursion and collision
- Acft blown over during taxi by CRJ which was running up engine
- Nose gear failed during landing roll
- Landing gear failed to extend - landed gear up
- Uncontained engine failure during descent
- Wheel separation during taxi - tire pressure too high
- Manufacturing flaw, structural failure of landing gear
- Airport snow removal inadequate, wing hit snow drift on landing
- In-flight elec. failure - lost both engines - gear up landing
- Rt. main gear failed to extend - acft. veered off rwy. ldg.
- Gear collapsed on landing on maintenance test flight
- Inadequate maintenance, left main gear collapsed during landing
- Fatigue fracture, Rt. main ldg. gear collapsed in x-wind/gusts
- Loss of control following a heart attack
- Severe fuel leak in cockpit resulted in forced landing
- Bird impact during cruise flight

- Chaffed wiring - main gear retracted when cabin heat selected
- The mud flap detached and impacted the stabilizer in flt.
- Technical failure, prop blade separation during cruise
- Aircraft landed gear up
- Maintenance error - inadvertent feather both engines after T/O
- Undetermined failure of nose gear to extend
- Power loss after takeoff - emergency landing in field
- Steering malfunction landing - attempted abort - swerved - hit fence
- Nose wheel steering cable failed ldg. - veered off runway
- Lost control during night flight in IMC alone, incapacitation
- Power lost in flight - ditched in ocean
- Loss of control following asymmetric flap extension

end

'pushing the limits'.

- Very resistant to guidance
- Rate of descent estimated as 1700 900 ft/min with 73 degrees bank on base leg at night.
- Prescription medication a factor, did not record on his medical renewal form.
- Should have diverted
- Psychotropic medication is considered disqualifying...did not indicate use on applications for airman medical certificates
- Weather below landing minima
- Ceiling 150 to 200 ft.
- Operated airplane with known deficiencies
- Flight manual states that "both boost pumps must be operable prior to take off
- The pilot's concern about maintenance being completed prior to executing a scheduled flight later in the day,
- Icing problem. no detection for non visible surfaces
- Whiteout conditions in snow
- IFR safety pilot instructor rating had been revoked
- Pilot overconfidence
- Disregard of minima
- Previous flight P2 stated PIC intentionally descended to 300 feet (below minima)

- Did not visually verify the fuel level
- Improper aircraft preflight
- Concealed medical condition, Severe coronary artery disease unreported Disregarded AC altitude restriction
- Helicopter pilot, no fixed wing ratings
- Falsified records, failed instrument rating concealed medical condition (diabetes type II).
- Flew below MDA
- Pilot's overconfidence in his personal ability
- Operator infringement of several FARs
- No GPWS
- 2nd pilot not qualified
- Inexperienced pilot
- Undertook flight despite warnings against
- Descended below minima
- Initiated approach when wx below minima
- Aware that he was landing with an almost direct 10 kt tailwind
- Radar data ...6 ft. above DH the aircraft had a ground speed of 176 knots
- PIC stated to the FAA that he did not achieve a stabilized approach
- Landing the day before was not smooth and he was trying to make a better landing" (runway overrun).
- Chief pilot was P2 and accepted the unstabilized approach
- Owner pilot - no oversight
- Captain: “employment was terminated because of his failure to follow company rules"
- First officer was at minimum proficiency and capability.
- Her biggest problem was basic hand eye coordination She was easily overloaded.
- She would be fine if she were paired with a strong pilot in command.
- “Should be able to compression start it once it gets in the air.”
- Flight Manual required two pilots, but copilot was not qualified.
- Had seen others fly faster to get to the ground more quickly and save money
- Routinely observed airspeeds below 10,000 feet in excess of the 250 knot maximum mandated by FARs
- Taught him to avoid executing a go around so as to avoid exciting the passengers
- ... drowsiness may occur with the use of this drug
- Tetrahydrocannabinol Carboxylic acid (Marihuana) detected in urine
- Hadn't slept for three days
- Was distressed by the FAA harassment
- Deficiencies on the college's part to adequately monitor, document and perform required maintenance
- Jackson Hole Ski resort
- Pressure on the captain to land from the charter customer
- Unclear wording of NOTAM regarding the night time restriction for the VOR DME approach

2 ERRONEOUS VIOLATIONS

- Pitot head icing, no ASI
- Flew wrong circuit direction
- Failure to secure the fuel cap
- Improper decision to not apply de icing fluid to the wings
- Starting to taxi for takeoff with the baggage door open
- Really in a big hurry He had a birthday party to go to
- Icing problem, only 19 hours on type.
- Maintenance requirements and ADs not complied with
- Incorrect clearance
- Out of service instrument approach procedure
- Flew below cleared altitude
- Engine failure after takeoff
- No engine anti icing switched on in icing conditions,
- SB for auto ice detection continuous ignition not implemented (after the accident an AD).
- Did not stay ahead of the airplane.
- Pilot lost consciousness due use of banned pesticide
- Pilot, failed IF simulator training
- 100kt pilot in 300kt aircraft
- He was not near the minimum standards set
- Could not keep the airplane right side up
- Did not complete the recurrent training,
- Upcoming weekend was very important
- Electrical system emergency, single pilot operation, company changed policy to require 2 crew.
- Was 2 NM too wide and hit high terrain.
- FAA Visual manoeuvring area smaller than ICAO.
- Lost control after electrical AC failure
- AFM does not have performance data for a contaminated runway since the FAA has not defined what constitutes
- a "contaminated runway."
- Enroute to land he silenced the landing gear warning horn and forgot to lower the landing gear
- Incorrect publications (AIP Italy Jeppesen)
- Markings (in deformity with standard format and unpublished
- Aerodrome standard did not comply with ICAO Annex 14
- Lights and signs did either not exist or were in dismal order and were hard to recognize
- No functional (airport) Safety Management System
- Instructor disoriented by the vibration
- Student pilot believed the instructor was disoriented and assisted in the recovery

3 MISTAKES/LAPSES

- I should have flared, not landed on front tire.
- Pilot's Nav RX unserviceable (used CDI on right hand panel).

- Inadvertently moved the gear handle, collapsing all three landing gears.
- No company guidance on strong winds
- No xwind limits
- P1 confused "expected clearance to FL220" for initial climb to 2,200 ft instead of 5000 ft..
- No procedures specified for loss of propeller control
- Company de ice procedures inadequate
- Misjudged the flare

end