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Australian Transport Safety Bureau

AVIATION RESEARCH PAPER
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ATSB Aviation Safety Survey – Safety Climate Factors

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CONTENTS

1 Executive Summary

The aim of this study was to investigate the safety climate[1] of Australian aviation as perceived by commercial pilots. To do this, the ATSB sent a survey to 5000 commercial pilots throughout Australia. The survey had two parts: one was a safety climate scale and the other asked about safety experiences during the last year. Demographic information was also sought. This report is limited to the demographic data and the first part of the survey, the safety climate scale.

The report explores the demographic data of age, hours flown, employment basis (full-time, part-time etc) and size of organisation, measured by the number of full-time pilots employed. Charter and aerial work pilots had similar profiles on these characteristics while Regular Public Transport (RPT) pilots showed many differences from the other two groups. The demographic data also sought information on stability characteristics of the company that the pilot had worked for during the past year. This information also yielded interesting comparisons between the three groups – RPT, charter and aerial work.

Safety climate perceptions are also reviewed. The safety climate instrument was developed as a generic measure of safety climate for the transport sector. Use of this measure with an aviation sample revealed four factors of safety climate important to aviation – *management commitment*, *training*, *equipment and maintenance* and *rules and procedures.* Graphs of each factor by flying category (RPT, charter and aerial work) are presented. Most respondents either agreed or strongly agreed that the aspects of safety measured were present in the industry.

Finally, the flying category groups (RPT, charter, aerial work) were tested for statistically significant differences across the four safety climate factors. No differences were found among the groups, indicating that it is likely that there is an industry-wide professional safety climate for pilots as a professional group.

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[1] Safety climate is a subgroup of organisational climate. Culture and climate are terms that are applied to organisations to describe characteristics of how workers in the organisation go about carrying out their duties. Culture can be described as an enduring character of organisations (e.g. personality) while climate relates to perceptions of organisational behaviour at a particular time (e.g. mood).

2 The Australian Transport Safety Bureau Aviation Industry Safety Survey

2.1 General

The ATSB distributed the Aviation Industry Safety Survey in November 2003. Part A was designed to measure safety climate by asking commercial pilots to respond to a series of statements about safety in their work environment. Respondents were also asked several questions about their safety experiences and this formed Part B of the survey. This report focuses on Part A – the safety climate scale, which can be found at Appendix D. The safety experience responses in Part B will be analysed in separate report.

2.2 Aviation Industry Safety Survey

The survey was developed to ask pilots about their perceptions of workplace safety. A list of questions relevant to safety in commercial transport was compiled and assessed by aviation safety experts both internal and external to the ATSB. After reducing the number of items, the survey was tested on a small number of pilots and revised before a final version of the survey was compiled.

The final version of the safety climate measure comprised 30 questions – 5 questions for each of the 6 safety factors: *management commitment, training, equipment and maintenance, rules and procedures, communication,* and *schedules.* Responses were recorded on a five-point scale from (1) strongly disagree to (5) strongly agree. These factors were drawn from previous research on safety climate and discussions with aviation safety experts.

The survey was distributed to 5,000 randomly selected pilots currently registered on the pilot licence register maintained by the Civil Aviation Safety Authority (CASA). The sample consisted of Australian Transport Pilot Licence (ATPL) and Commercial Pilots Licence (CPL) holders with current medical certificates. Names and addresses were supplied by CASA under a confidentiality agreement to a mail distribution service that conducted the survey mailout. At no stage were respondents' names or addresses available to the ATSB. A reminder card was sent to the same addresses ten days later to help increase response rates.

2.3 Respondent Profile

In total, 1,542 responses were received, representing a response rate of 31 per cent. Of these responses 940 (61 per cent) had been employed in aviation in flying roles during the last year and completed Part A and Part B of the survey, 323 (21 per cent) had been flying privately in the last year and completed Part B only. A further 235 (15 per cent) had not been flying in the last year and returned the survey without completing it, as requested. Overall, 44 responses (3 per cent) were not usable because they had been completed by military personnel or were missing necessary information.

2.3.1 Stratification of sample

The mailing list for the survey was constructed using stratified sampling. This meant that surveys were sent to pilots in each jurisdiction (state or territory) as a proportion of the registered pilots in that jurisdiction. Table 1 shows the number of surveys sent out and returns by jurisdiction.

The data show that the returns from each jurisdiction closely match the proportion of registered pilots in that jurisdiction. New South Wales and Victoria were slightly under-represented in the return sample; however, responses from these jurisdictions were still high. This means that the sample studied in this report is representative of the geographical distribution of Australian pilots, and results are not likely to be unduly influenced by responses from any particular jurisdiction.

Table 1: Response rates by jurisdiction

	Stratified Sample		Actual Returns	
	Frequency	Per cent	Frequency	Per cent
NSW	1462	29.3	213	22.7
QLD	988	19.8	184	19.6
WA	591	11.8	117	12.4
NT	119	2.4	23	2.4
VIC	1168	23.4	188	20.0
ACT	91	1.8	19	2.0
TAS	134	2.6	22	2.3
SA	447	8.9	91	9.7
Unknown			83	8.8
Total	5000	100	940	100

2.3.2 *Representation of flying categories*

Table 2 shows responses from each flying category recorded. Most respondents were Regular Public Transport (RPT) pilots, with passenger carrying charter pilots and pilots engaged in training also well represented. To simplify analysis, these categories were aggregated into three categories – i) Regular Public Transport (RPT), ii) charter (charter passenger and charter other) and iii) aerial work (emergency medical services, agriculture, survey, training, and other aerial work). The business category was left out of the analysis due to small numbers and a lack of association with other aggregated groups. Figures for the flying categories are in Table 3. All further analysis was conducted using the groups in Table 3.

Table 2: Responses per flying category

Flying Category	Frequency	Per cent
Regular Public Transport (>10 seats)	367	39.0
Charter Passenger	185	19.7
Charter Other	23	2.4
Aerial - Emergency Medical Services	59	6.3
Aerial - Agricultural	43	4.6
Aerial - Survey	29	3.1
Aerial - Training	157	16.7
Aerial - Other	56	6.0
Business	21	2.2
Total	940	100

Table 3: Responses per aggregated flying category

Flying Category	Frequency	Percent
RPT (>10 seats)	367	39.0
Charter	208	22.2
Aerial Work	336	38.8
Total	940	100

3 Demographics of Australian commercial pilots

3.1.1 Age Distribution by Flying Category

RPT pilot respondents ranged in age from 21 to 66 years (mean 46 years, standard deviation [SD] 10 years). Charter pilot respondents ranged in age from 19 to 78 years (mean 45 years, SD 13 years), and pilots engaged in aerial work respondents were aged from 20 to 77 years (mean 49 years, SD 13 years).

Age distribution by flying category is shown in Figure 1. This figure clearly shows that most pilots, regardless of type of flying category, were aged between 50 and 59 years with numbers declining quickly at 60 to 69 years, most probably due to retirement. Sixty-seven per cent of RPT pilots were aged between 40 and 59 years, compared with 52 per cent in charter and aerial work.

There may be many reasons for pilots under 30 years and over 60 years to be more likely to be employed in charter or aerial work than in RPT operations. Pilots usually start their career in charter operations to build up flying hours before moving on to RPT and then retire, usually before 65 years. Pilots in aerial work may be self-employed and may therefore retire later, at around 70 years. Also, older ex-military pilots may have entered civil flying operations thereby inflating pilot numbers, or people may be becoming pilots later in life when they have time and money to pursue flying.

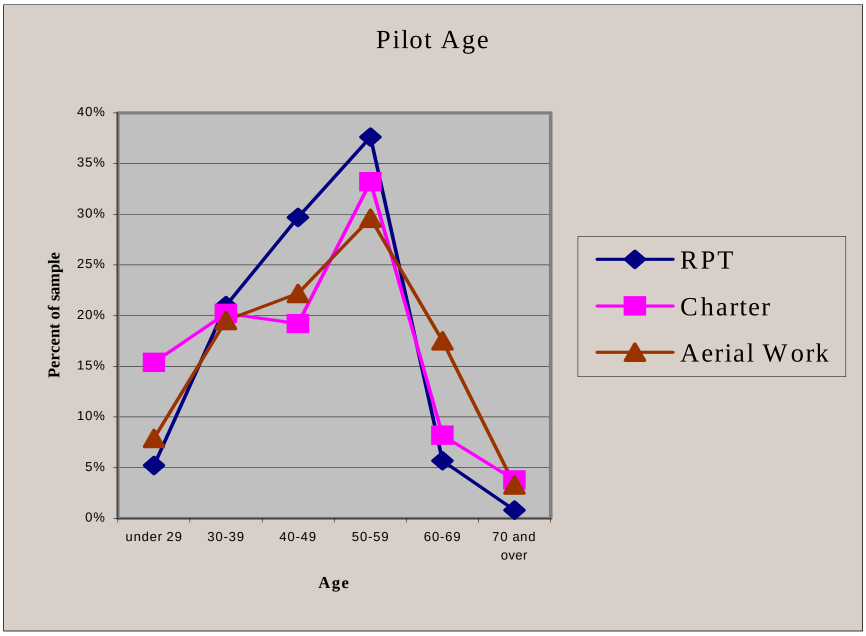

Figure 1: Pilot age distribution by flying category

3.1.2 Hours flown in previous year by flying category

RPT pilots flew an average of 630 hours per year (SD 177 hours). Charter pilots flew an average of 348 hours per year (SD 214 hours) and pilots engaged in aerial work flew an average of 365 hours per year (SD 216 hours). Figure 2 illustrates the similarities between the charter and aerial work categories compared with the RPT category. Pilots in charter and aerial work generally flew less than 550 hours (82 and 78 per cent respectively less than 550 hours) while RPT pilots generally flew more than 550 hours (78 per cent more than 550 hours).

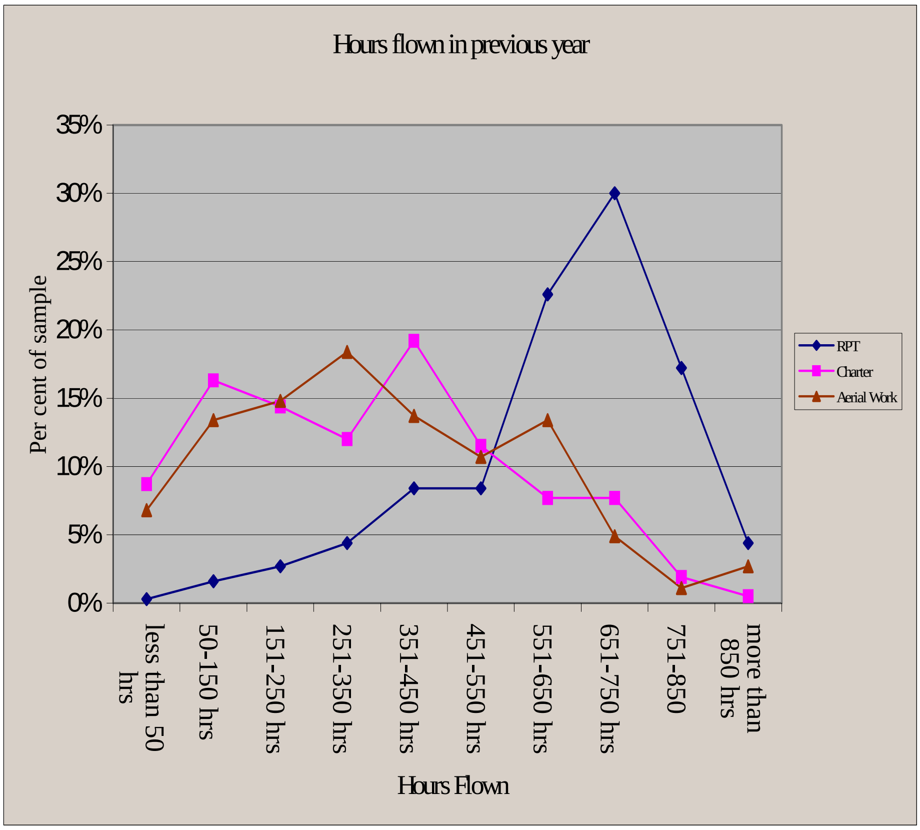

Figure 2: Hours flown in the previous year by flying category

3.1.3 Employment basis by flying category

Nearly all RPT pilots were employed on a full time basis compared with 55 to 60 per cent of charter and aerial work pilots as shown in Figure 3. Around one-third of charter and aerial work pilots worked on a part-time or casual basis (including contract arrangements) and a further 4.4 per cent of aerial work was done on a voluntary or 'payment in kind' basis.

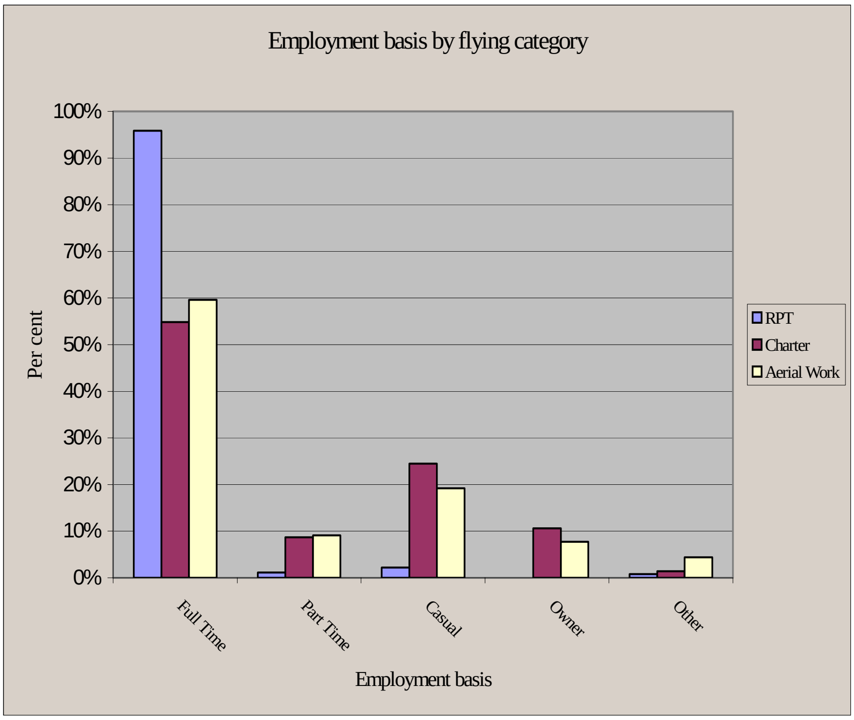

Figure 3: Employment basis by flying category

3.1.4 Number of full-time pilots by flying category

Most charter and aerial work pilots (79 and 70 per cent respectively) worked in organisations with less than ten other pilots. In contrast, 82 per cent of RPT pilots worked in organisations with more than 50 other pilots.

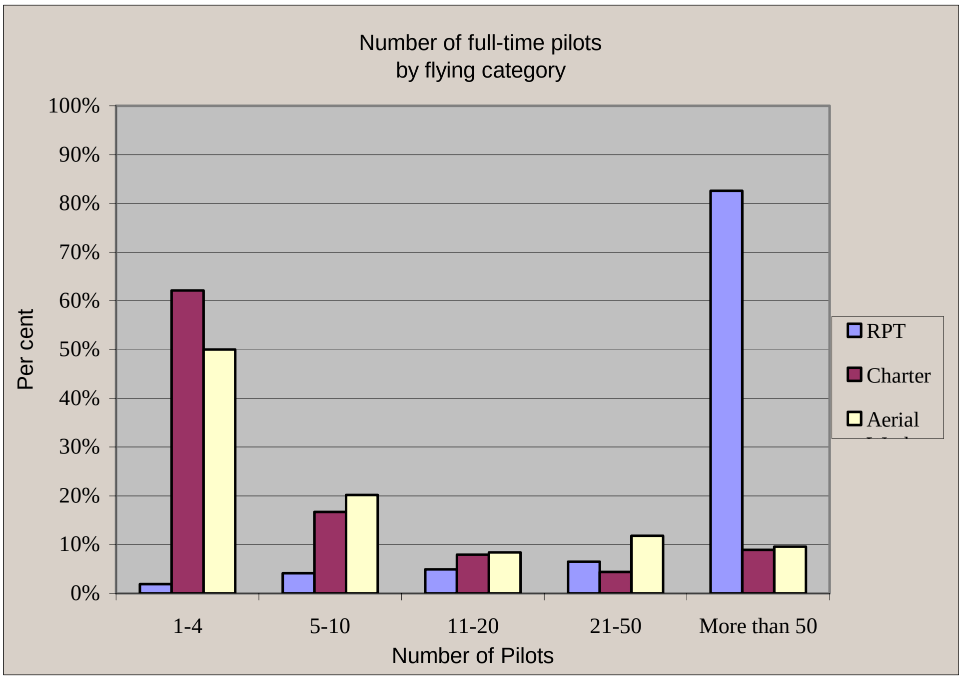

Figure 4: Number of full time pilots by flying category

Charter and aerial work pilots differed from RPT pilots in many aspects. Pilot age, hours flown, the numbers of full-time pilots employed by organisations and employment basis (full-time, part-time etc.) all show charter and aerial work pilots to be distinctly different from RPT pilots.

3.1.5 Company stability by flying category

Five dimensions of company stability were surveyed. These were company operations, type of aircraft operated, management personnel and structure, pilot turnover and financial stability in the last year. Responses are in Table 4.

Within the industry as a whole, around one-third of pilots worked for operators that experienced substantial changes to company operations. This change was largely reported in the RPT category with 55 per cent of RPT pilots reporting substantial changes to company operations in the previous year. This figure was more than double that for charter and aerial work pilots, where around 22 per cent reported significant changes to company operations (see Table 4).

Around 20 per cent of pilots worked for companies that introduced substantial changes to type of aircraft operated. Again, RPT pilots reported the highest incidence of change (64 per cent) while charter and aerial work pilots reported that in 90 per cent of cases there was no change to the type of aircraft operated.

Sixty-six percent of RPT pilots reported substantial changes to management personnel or management structure in the previous year. Again, charter and aerial work pilots experienced far less change at around 30 per cent.

Overall, pilots who worked in RPT in the previous year experienced substantial changes in company operations, type of aircraft flown and management structure, whereas charter and aerial pilots generally experienced less change and more stability of operations in these areas.

Pilot turnover was broadly consistent across the three categories. Overall, 16.7 per cent of respondents reported high pilot turnover within their organisations, indicating that over 80 per cent of pilots were in stable employment. It should be noted that this measure of turnover may be biased by relative perceptions based on the category of flying. For example, charter may experience a turnover that would be considered high in RPT or aerial work, but considered normal for charter operations.

Perceptions of financial soundness were also relatively consistent across the three categories. At an industry level, close to 87 per cent of pilots reported that they believed their company to be financially sound during the previous year. Anecdotally, there are many stories of financially non-viable operations, especially in the charter and aerial work categories. While figures for financially unsound operations in charter and aerial work were higher than those reported for RPT, the figures were still relatively low and appeared to be similar to RPT figures.

Table 4: Company stability profile by flying category

		Flying category			
		RPT	Charter	Aerial Work	Total
There were substantial changes in company operations.					
Yes	Count	200	47	78	325
	%	**54.6**	**22.6**	**21.8**	**34.8**
No	Count	166	161	283	610
	%	**45.4**	**77.4**	**78.4**	**65.2**
Total	Count	366	208	361	935
	%	100	100	100	100
There were substantial changes in the type of aircraft operated.					
Yes	Count	132	21	37	190
	%	**36.0**	**10.2**	**10.3**	**20.4**
No	Count	235	185	325	743
	%	**64.0**	**89.8**	**89.7**	**79.6**
Total	Count	367	206	360	933
	%	100	100	100	100
There were substantial changes in management personnel or structure					
Yes	Count	242	63	104	409
	%	**65.9**	**30.4**	**28.8**	**43.7**
No	Count	125	144	257	526
	%	**34.1**	**69.6**	**71.2**	**56.3**
Total	Count	367	207	361	935
	%	100	100	100	100
There was an unusually high turnover of pilots					
Yes	Count	70	30	56	156
	%	**19.2**	**14.4**	**15.5**	**16.7**
No	Count	294	178	305	777
	%	**80.8**	**85.6**	**84.5**	**83.3**
Total	Count	364	208	361	933
	%	100	100	100	100
Company was perceived as financially sound					
Yes	Count	313	162	290	765
	%	**89.9**	**82.7**	**85.8**	**86.7**
No	Count	35	34	48	117
	%	**10.1**	**17.3**	**14.2**	**13.3**
Total	Count	348	196	338	882
	%	100	100	100	100

Sample size: RPT 367, charter 208, aerial work 336, total 940, excluding missing values.

4 Safety climate – an overview

Workplace safety has been a concern for management and workers for many decades. Technical solutions have provided great gains in reducing incidents and accidents, especially in aviation. However, in many instances, these gains have plateaued and new methods are needed if further improvements are to be made (Cheyne, Tomas, Cox, & Oliver, 1999). Safety climate is an area in which such improvements could be made.

‘Culture’ and ‘climate’ are terms that are applied to organisations to describe characteristics of how workers in the organisation go about carrying out their daily work functions. Organisational culture is often characterised as relatively enduring, with trait-like properties that are not easily changed, while climate is often portrayed as a manifestation of culture with state-like properties that can be used as a temporal measure of culture (Cheyne et al., 1999). Culture can therefore be described as an enduring character of organisations (e.g. personality) while climate relates to perceptions of organisational behaviour at a particular time (e.g. mood).

4.1 Organisational climate and safety climate

Safety climate can be considered as a subset of organisational climate. In an organisational context, climate studies have focused on interpreting individual and organisational characteristics (Denison, 1999). Many organisational climate studies have attempted to define a set of organisational climate dimensions that will assist in describing organisations. Litwin and Stringer (1968) for example, proposed nine dimensions of organisational climate – structure, responsibility, reward, risk, warmth, support, standards, conflict and identity.

The measurement of climate is based on the premise that a group of people within a particular contextual environment may experience normative influences exerted by a particular value system (the value placed on safety in a work context). In this context, people are likely to attribute similar meanings to external cues and behave in a similar way. For example, workers may be influenced to comply with safety rules and procedures because they work in an organisation that values safety and are surrounded by others who comply. When individuals assign similar meanings to aspects of their environment, they are expressing “…temporarily shared social realities which is referred to in today’s terms as collective social realities, organizational cultures and perhaps even organizational climates.” (James, James, & Ashe, 1990, p. 46).

Denison (1999, p. 624) stated that organisational climate “ …portrays organisational environments as being rooted in the organisation’s value system, but tends to present these social environments in relatively static terms, describing them in terms of fixed (and broadly applicable) sets of dimensions. Thus, climate is often considered as relatively temporary, subject to direct control, and largely limited to those aspects of the social environment that are consciously perceived by organisational members.”

Zohar (1980) believed that organisations created a number of different climates and that the term should describe an area of research rather than reflect a specific organisational measure. In this way, safety climate can be viewed as a part of organisational climate and studied in its own right. A more detailed discussion of previous research in safety climate can be found in Appendix B.

4.2 Aviation Industry Safety Climate

Previous research has shown that similar safety climates can exist within professional groups like aircraft maintenance engineers (McDonald, 2000). This means that it is not necessary to restrict the investigation of safety climate to discrete, organisation-bound groups, but that professional groups also exhibit similar safety climates regardless of the organisation they work for (McDonald, 2000). The present research measures safety climate within the Australian aviation industry based on Australian commercial pilots’ perceptions.

5 Safety climate scale results

Part A of the survey contained 30 statements that respondents were asked to consider in terms of their current or most recent employment. The statements were based around six presumed factors of safety climate – *management commitment, training, equipment and maintenance, rules and procedures, communication,* and *schedules.* Each presumed factor was represented by five statements. A factor analysis was conducted on responses to determine the factor structure for this sample. Not all the presumed factors will be represented in the extracted factor structure.

5.1 Factor analysis of safety climate measure

Factor analysis is a generic term given to a class of statistical methods whose primary purpose is to define the underlying structure of a data set. The main aim of this type of analysis is to form coherent sub-groups of questions that are relatively independent from other groups of questions. When factor analysis is performed, the researcher begins by asking questions about several aspects that may be related to the topic of interest. The variables with the strongest relationships or highest inter-correlations are grouped together. The sub-groups of questions are then named based on the general theme of the questions that have been grouped together. By identifying the theme of each group of questions, the researcher identifies the underlying factors of the topic of interest or construct. In this way, much information can be condensed into a few manageable factors to measure a complex construct. For example, several questions on a survey can be reduced to a few factors like *management commitment to safety* or *safety training*. Details of the analysis applied to these data are in Appendix C.

The factors extracted from the factor analysis of the safety climate survey are presented in Table 5. Four factors were extracted, *management commitment, training, equipment and maintenance* and *rules and procedures*. The questions associated with each factors are also in Table 5. Several questions were complex items, which loaded onto more than one factor, and were removed from further analysis.

Table 5: Factor Names and Associated Questions

Label
Factor 1 – Management Commitment
Management regarded safety to be an important part of company operations
Pilots were encouraged to consider that safety was more important than keeping to the schedule
Management were genuinely interested in safety issues
Suggestions for improving safety were encouraged
Pilots were not pressured to fly if they had a safety concern
Management had a good understanding of operational issues that impacted on flight safety
There was no need to work around company safety rules and procedures to get the job done
Safety was considered to enhance rather than limit productivity
Management allocated sufficient resources to safety
Management looked for underlying factors that contributed to safety incidents rather than blame the people involved
Factor 2 – Training
Regular training was provided for a range of emergency situations[2]
Training was received at regular intervals to refresh and update knowledge
Company training was carried out by people with appropriate skills and experience
Company training provided adequate skills and experience to carry out normal operations safely
Training was received when new procedures or equipment were introduced
Factor 3 – Equipment and Maintenance
Aircraft were maintained to a safe standard
Aircraft systems and components were replaced or updated when necessary
Adequate resources were allocated to perform maintenance
Aircraft were appropriately equipped for the type of operations conducted
Factor 4 – Safety Rule and Procedures
Safety rules and procedures were easy for pilots to use during normal operations
Company safety rules and procedures were easy to understand
Company safety rules and procedures were as complete and comprehensive as they needed to be
Company emergency operating procedures gave sufficient guidance on how to deal with emergencies

5.2 Safety climate factors by flying category

Scores for each factor were calculated by averaging the individual responses to each group of questions listed in Table 5. This gave each respondent a score between 1 and 5 on each of the factors that corresponded to the five-point descriptive scale of ‘Strongly Disagree’ to ‘Strongly Agree’.

Characteristics of the sample that may have influenced safety climate perceptions were identified. Clarke (1999) found that perceptions of safety climate differed systematically depending on the position level within the organisation. Cases where respondents had major managerial responsibilities and/or were owner operators were removed from the analysis, leaving a sample of 710 cases. Responses from each flying category on each factor were then examined.

[2] Only some commercial operations have a mandatory programmed training requirement (Reg. 217 operators). The way that these pilots judge this question might be different from the others; however, the influence was deemed minimal.

5.2.1 Statistical differences between flying categories

A three-group multivariate analysis of variance (MANOVA) was conducted to test whether the three groups of flying categories were statistically different across the four factors. See Appendix C for an explanation of MANOVA and its application to these data.

Results for each of the four factors were not statistically significant. This indicated that there were no significant differences between pilots regardless of the type of flying category to which a pilot belonged. In view of the previous discussion of the four safety factors and their similarities, this is to be expected. The result indicates the likely presence of a professional safety climate that is constant across the industry regardless of the type of flying done.

5.2.2 Management commitment factor by flying category

Over 70 per cent of respondents either agreed or strongly agreed that there was *management commitment* to safety, while around eight per cent either disagreed or strongly disagreed.

Response patterns across the three flying categories (RPT, charter aerial work) were similar. However, charter pilots were represented more in the ‘neutral’ and less in the ‘agree’ category than were other groups (see Figure 5). Charter and aerial work respondents seemed to perceive *management commitment* to safety more than RPT pilots did, as shown by higher scores in the ‘strongly agree’ category. This may be due to a higher number of smaller companies in charter and aerial work where closer ties with management are easier to maintain and an understanding of management’s intentions is fostered.

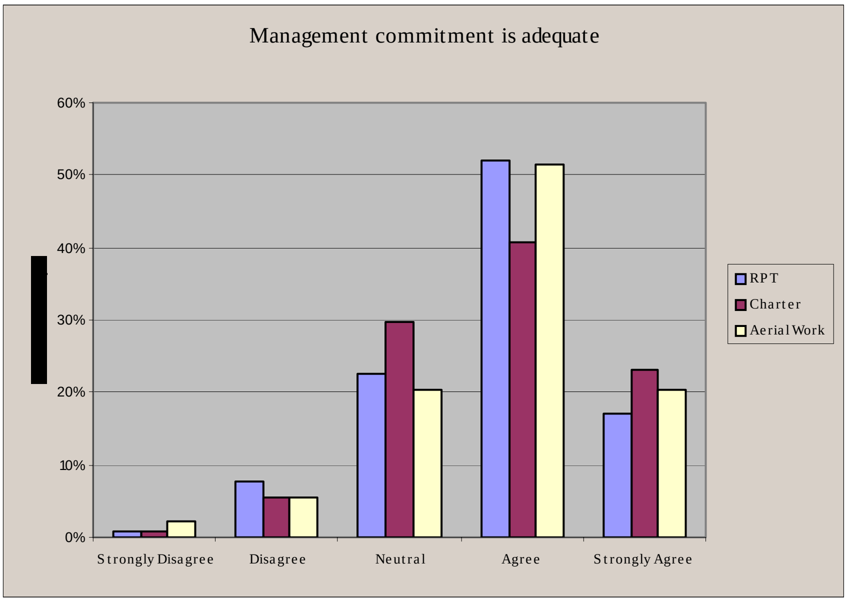

Figure 5: Management commitment factor by flying category

5.2.3 Training factor by flying category

Ongoing pilot training in both emergency and normal operations attracted the lowest agreement rate (67 per cent) among the factors examined. This factor also attracted the highest disagreement rate at nearly ten per cent.

RPT pilots seemed to be the most positive of the groups in regard to training, with 67 per cent of this group ticking either the 'agree' or 'strongly agree' categories. Aerial work pilot responses dropped noticeably in the 'strongly agree' category (see Figure 6). These findings probably reflect the time, money and emphasis placed on training within the various flying categories.

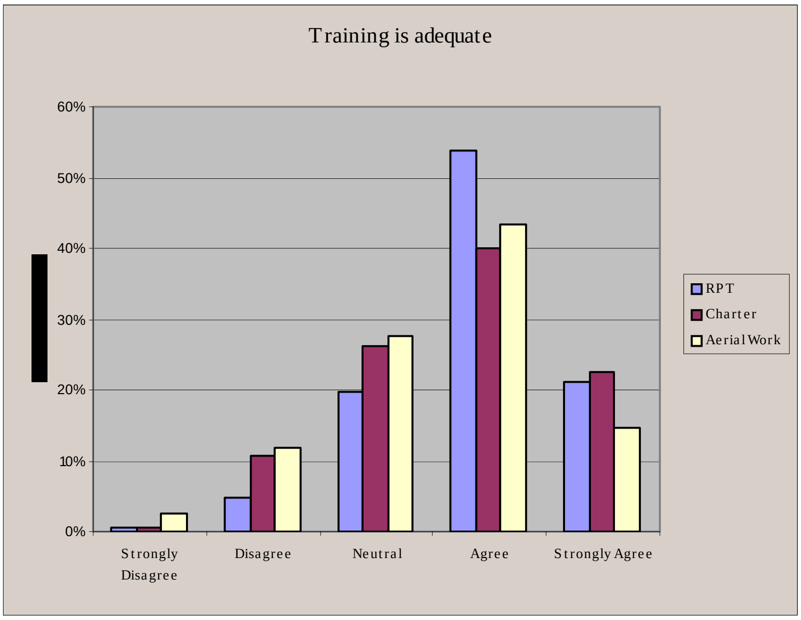

Figure 6: Training factor by flying category

5.2.4 Equipment and maintenance factor by flying category

The adequacy of equipment and maintenance received the highest proportion of 'agree' and 'strongly agree' responses (81 per cent) of all the factors. Only four per cent 'disagreed' or 'strongly disagreed' with these statements. This factor also attracted the highest 'strongly agree' response rate at around 30 per cent compared with between 15 and 20 per cent for the other factors (see Figure 7). It is also interesting to note the similarity of the charter and aerial work responses to the RPT responses, since there is a general belief in the industry that equipment and maintenance are often neglected in charter and aerial work due to the associated costs.

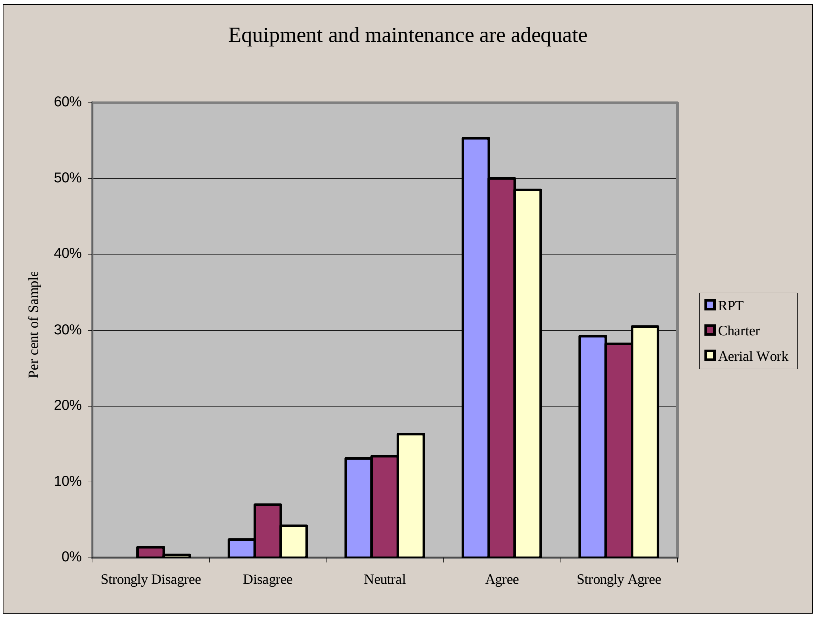

Figure 7: Equipment and maintenance by flying category

5.2.5 Rules and procedures factor by flying category

Nearly 75 per cent of respondents either 'agreed' or 'strongly agreed' that safety rules and procedures were adequate and only three per cent 'disagreed' or 'strongly disagreed'. All three groups presented similar response patterns for the 'agree' and 'neutral' response categories (see Figure 8). Charter and aerial work pilots were more represented in the 'strongly agree' category than were RPT pilots. This may be a reflection of lower expectations in charter operations when compared with RPT rather than lower standards in RPT operations.

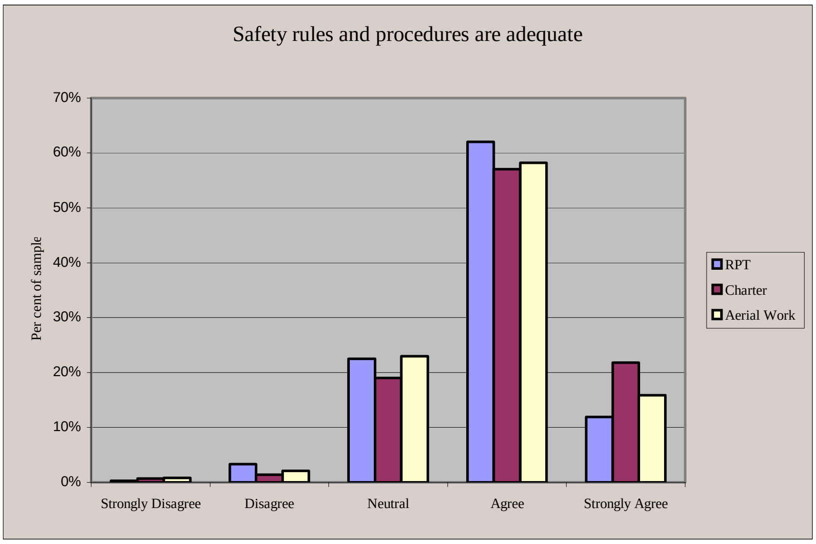

Figure 8: Rules and procedures by flying category

6 Conclusion

This analysis has shown that charter and aerial pilots differ from RPT pilots on demographic characteristics such as age, hours worked, employment basis (full-time, part-time etc.) and size of organisation in which the pilot is employed (measured by number of full-time pilots employed). It is probable that charter is more similar to aerial work than it is to RPT operations. This may prove to be a difficulty for charter operations, as they implement the recent regulations aligning charter operations more with RPT operations[3], especially in the area of safety climate and safety culture[4].

Factor analysis of Part A – the safety climate survey – revealed that *management commitment*, *training*, *equipment and maintenance* and *rules and procedures* are important factors in the construct of safety climate for the aviation sector. The study demonstrated that pilots had positive perceptions of safety climate in relation to the four factors measured. Most ‘agreed’ or ‘strongly agreed’ that the aspects of safety measured were present in the industry, indicating a relatively strong safety climate in aviation.

The finding that the groups did not differ in their perceptions of safety climate indicates that RPT, charter and aerial work pilots all perceived safety in their category of flying in a similar way. In other words, pilots’ perceptions of safety climate are similar regardless of the category of flying in which they are employed. This result indicates a pervasive safety climate for aviation that may be based on membership of a professional group.

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[3] Civil Aviation Safety Regulation – CASR Part 121A & B – Air Transport Operations Large & Small and CASR Part 133 Air Transport and Aerial Work Operations (Rotocraft).

[4] CASR Part 119 – Air Operation Certification – Air Transport, especially AC 119-270(1) on Safety Management Systems.

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Appendix A– Cross-tabulation tables

Table 6: Pilot age by flying category

Age Bracket		Flying Category RPT	Charter	Aerial Work	Total
under 29	Count	19	32	29	80
	%	**5.2**	**15.4**	**7.9**	**8.5**
30-39	Count	77	42	71	190
	%	**21.0**	**20.2**	**19.5**	**20.2**
40-49	Count	109	40	81	230
	%	**29.7**	**19.2**	**22.2**	**24.5**
50-59	Count	138	69	108	315
	%	**37.6**	**33.2**	**29.6**	**33.5**
60-69	Count	21	17	64	102
	%	**5.7**	**8.2**	**17.5**	**10.9**
70 & over	Count	3	8	12	23
	%	**.8**	**3.8**	**3.3**	**2.4**
Total	Count	367	208	365	940
	%	100.0%	100.0%	100.0%	100.0%

Table 7: Hours flown in the previous year by flying category

Hrs flown range		Flying Category RPT	Charter	Aerial Work	Total
less than 50 hrs	Count	1	18	25	44
	%	**.3**	**8.7**	**6.8**	**4.7**
50-150 hrs	Count	6	34	49	89
	%	**1.6**	**16.3**	**13.4**	**9.5**
151-250 hrs	Count	10	30	54	94
	%	**2.7**	**14.4**	**14.8**	**10.0**
251-350 hrs	Count	16	25	67	108
	%	**4.4**	**12.0**	**18.4**	**11.5**
351-450 hrs	Count	31	40	50	121
	%	**8.4**	**19.2**	**13.7**	**12.9**
451-550 hrs	Count	31	24	39	94
	%	**8.4**	**11.5**	**10.7**	**10.0**
551-650 hrs	Count	83	16	49	148
	%	**22.6**	**7.7**	**13.4**	**15.7**
651-750 hrs	Count	110	16	18	144
	%	**30.0**	**7.7**	**4.9**	**15.3**
751-850	Count	63	4	4	71
	%	**17.2**	**1.9**	**1.1**	**7.6**
more than 850 hrs	Count	16	1	10	27
	%	**4.4**	**.5**	**2.7**	**2.9**
Total	Count	367	208	365	940
	%	100.0	100.0	100.0	100.0

Table 8: Employment basis by flying category

Employment Basis		Flying Category RPT	Charter	Aerial Work	Total
Full Time	Count	352	114	217	683
	%	**95.9**	**54.8**	**59.6**	**72.7**
Part Time	Count	4	18	33	55
	%	**1.1**	**8.7**	**9.1**	**5.9**
Casual	Count	8	51	70	129
	%	**2.2**	**24.5**	**19.2**	**13.7**
Owner	Count	0	22	28	50
	%	**.0**	**10.6**	**7.7**	**5.3**
Other	Count	3	3	16	22
	%	**.8**	**1.4**	**4.4**	**2.3**
Total	Count	367	208	364	939
	%	100.0	100.0	100.0	100.0

Table 9:Flying category by number of full-time pilots

Number of Full-Time Pilots		Flying Category RPT	Charter	Aerial Work	Total
1-4	Count	7	126	178	311
	%	**1.9**	**62.1**	**50.0**	**33.6**
5-10	Count	15	34	72	121
	%	**4.1**	**16.7**	**20.2**	**13.1**
11-20	Count	18	16	30	64
	%	**4.9**	**7.9**	**8.4**	**6.9**
21-50	Count	24	9	42	75
	%	**6.5**	**4.4**	**11.8**	**8.1**
More than 50	Count	303	18	34	355
	%	**82.6**	**8.9**	**9.6**	**38.3**
Total	Count	367	203	356	926
	%	100.0	100.0	100.0	100.0

Table 10: Management commitment by flying category

Average Management Commitment Scores		Flying Category RPT	Charter	Aerial Work	Total
Strongly Disagree	Count	3	1	5	9
	%	**.9**	**.7**	**2.1**	**1.3**
Disagree	Count	25	8	13	46
	%	**7.6**	**5.6**	**5.4**	**6.5**
Neutral	Count	74	42	49	165
	%	**22.5**	**29.6**	**20.5**	**23.2**
Agree	Count	171	58	123	352
	%	**52.0**	**40.8**	**51.5**	**49.6**
Strongly Agree	Count	56	33	49	138
	%	**17.0**	**23.2**	**20.5**	**19.4**
Total	Count	329	142	239	710
	%	100.0	100.0	100.0	100.0

Table 11: Training factor by flying category

Average Training Scores		Flying Cat RPT	Charter	Aerial Work	Total
Strongly Disagree	Count	2	1	6	9
	%	**.6**	**.7**	**2.5**	**1.3**
Disagree	Count	16	15	28	59
	%	**4.9**	**10.6**	**11.7**	**8.3**
Neutral	Count	65	37	66	168
	%	**19.8**	**26.1**	**27.6**	**23.7**
Agree	Count	177	57	104	338
	%	**53.8**	**40.1**	**43.5**	**47.6**
Strongly Agree	Count	69	32	35	136
	%	**21.0**	**22.5**	**14.6**	**19.2**
Total	Count	329	142	239	710
	%	100.0	100.0	100.0	100.0

Table 12: Equipment and maintenance by flying category

Average Equipment and Maintenance Score		Flying Category RPT	Charter	Aerial Work	Total
Strongly Disagree	Count	0	2	1	3
	%	**.0**	**1.4**	**.4**	**.4**
Disagree	Count	8	10	10	28
	%	**2.4**	**7.0**	**4.2**	**3.9**
Neutral	Count	43	19	39	101
	%	**13.1**	**13.4**	**16.3**	**14.2**
Agree	Count	182	71	116	369
	%	**55.3**	**50.0**	**48.5**	**52.0**
Strongly Agree	Count	96	40	73	209
	%	**29.2**	**28.2**	**30.5**	**29.4**
Total	Count	329	142	239	710
	%	100.0	100.0	100.0	100.0

Table 13: Rules and procedures by flying category

Average Rules & Procedures Scores		Flying Category RPT	Charter	Aerial Work	Total
Strongly Disagree	Count	1	1	2	4
	%	**.3**	**.7**	**.8**	**.6**
Disagree	Count	11	2	5	18
	%	**3.3**	**1.4**	**2.1**	**2.5**
Neutral	Count	74	27	55	156
	%	**22.5**	**19.0**	**23.0**	**22.0**
Agree	Count	204	81	139	424
	%	**62.0**	**57.0**	**58.2**	**59.7**
Strongly Agree	Count	39	31	38	108
	%	**11.9**	**21.8**	**15.9**	**15.2**
Total	Count	329	142	239	710
	%	100.0	100.0	100.0	100.0

Appendix B– Safety climate research

Safety climate studies

Zohar (1980) is credited with developing the first quantitative measure of safety climate on Israeli manufacturing workers. He identified eight factors (see Table 14) that were later refined by Brown and Holmes (1986) to three, using a sample of manufacturing workers from the United States. It was postulated that national cultural differences were responsible for the differences in factor structure.

Dedobbeleer and Beland (1991) used a sample of construction workers, also from the United States, to test Brown and Holmes' (1986) revised structure. They found support for only two factors, and suggested that different statistical procedures may support a third factor.

Although safety climate factor structures have been identified within organisations, there is increasing evidence that a consistent safety climate factor solution may not transfer to other organisations. Coyle, Sleeman, and Adams (1995) delivered the same survey to two comparable organisations, and extracted a 7-factor solution for one and a 3-factor solution for the other (see Table 14). They concluded that "… the universal stability of safety climate factors is highly doubtful" (p. 253).

Brown and Holmes (1986) explored the possibility of differences between groups of workers who had experienced accidents and those who had not. Their results identified a stable factor structure across both groups and then confirmed differences in their climate scores. Clarke (1999) found significant differences in safety perceptions for three levels of British Rail workers – drivers, supervisors and management. Similarly, Mearns, Flin, Gordon, and Fleming (1998) found evidence of safety climate subgroups that differed as a function of seniority, occupation, age, shift worked and prior accident involvement, and suggested that the interaction of these subgroups partly determines the prevailing safety climate. Niskanen (1994) compared perceptions of worker and supervisor/management levels in road construction across five districts. This research extracted the same factor structure for related groups; however, the groups differed in the importance they placed on the factors, indicating different safety sub-climates.

Zohar (2000) measured the aggregated perception scores of 53 workgroups within one organisation. The resulting group-level construct indicated that groups do form a homogeneous perception of safety practices and that these perceptions vary between groups. Other studies have shown that differences exist between organisations, between sections within organisations (Coyle et al., 1995; Glendon & Litherland, 2001) and between levels within the sections themselves (Niskanen, 1994). These studies show that organisational subgroup differences often occur, drawing into question the belief that an organisation possesses a single safety climate (Hale, 2000).

Table 14: Factors extracted from ten safety climate studies

Study	Sector(s), Country & Sample Size.	Questionnaire Items	Factors Extracted
Zohar (1980)	Manufacturing (Israel) n = 400	40 items developed from literature review	▪ Safety training ▪ Management attitudes ▪ Promotion ▪ Risk in workplace ▪ Required work pace ▪ Status of safety officer ▪ Social status ▪ Status of safety committee
Brown & Holmes (1986)	Manufacturing and Produce (USA) n = 425	Zohar's 40-item questionnaire	▪ Management concern ▪ Management activity ▪ Risk perception
Dedobbeleer & Beland (1991)	Construction (USA) n = 384	Brown & Holmes revision of Zohar's 40 items	▪ Management commitment ▪ Worker involvement
Niskanen (1994)	Road Construction (Finland) n = 1890 workers; 562 supervisors	Generic 10 items plus 12 additional items for workers and 11 for supervisors. Based on literature review	▪ Changes in job demands ▪ Attitudes to safety in organisation ▪ Value of work ▪ Safety as part of productive work
Coyle, Sleeman, & Adams (1995)	Office, Nursing and Social Workers (Australia) n = 320	Interviews and reiterative process to rank important issues	Application 1 ▪ Maintenance and management issues ▪ Company policy ▪ Accountability ▪ Training and management attitudes ▪ Work environment ▪ Policy/ procedures ▪ Personal authority Application 2 ▪ Work environment ▪ Personal authority ▪ Training and enforcement of policy.
Diaz & Cabrera (1997)	Airport ground handling staff (Spain) n = 166	40 climate plus 29 attitude items from literature review and brainstorming	▪ Safety policy ▪ Productivity/safety ▪ Group attitudes ▪ Prevention strategies ▪ Safety level

Mearns, Flin, Gordon, & Fleming (1997)	Offshore Oil Workers (UK) n = 722	52 items from literature review and focus groups	▪ Speaking up ▪ Violations ▪ Supervisors ▪ Rules/regulations ▪ Site management ▪ Work pressure ▪ Work clarity ▪ Communication ▪ Risk ▪ Safety measures
Williamson, Feyer, Cairns, & Biancotti (1997)	Manufacturing (Australia) n = 660	27 items from a review of previous questionnaires	▪ Personal motivation for safe behaviour ▪ Positive safety practice ▪ Risk justification ▪ Fatalism ▪ Optimism
Clarke (1999)	Rail drivers, supervisors, senior management (UK) n = 312	25 railway factors derived from accident report analysis and discussion with management.	▪ Unsafe conditions ▪ Managerial decisions ▪ Working conditions ▪ Local management ▪ Line functions
Zohar (2000)	Manufacturing Workers (Israel) n = 534	23 items generated from themes gathered in interviews	▪ Supervisory expectation ▪ Supervisory action
Glendon & Litherland (2001)	Road Construction and Road Maintenance Workers (Australia) n = 192	40 items adapted from Safety Climate Questionnaire Glendon, Stanton, & Harrison (1994)	▪ Communication and support ▪ Adequacy of procedures ▪ Work pressure ▪ Personal Protective ▪ Equipment ▪ Relationships ▪ Safety Rules

The research has typically demonstrated that safety climates vary within and between organisations. In general, there are differences in the factors extracted, the importance placed on factors when the same factors are held constant, and differences in climate scores of groups within the organisation. These results suggest that a universal factor structure or enduring theory of safety culture or climate may be elusive. However, this does not diminish the usefulness of exploring dimensions of safety climate in various organisations and at various levels of aggregation.

Differences in factor structure may be due to the level at which the measurement is made. Research to date has focused mainly on inter- and intra-organisational strategies, using either groups within an organisation, or groups across organisations. Measurement at this level may incorporate many idiosyncrasies that do not transfer to other samples. Idiosyncrasies may be inherent in variables such as management style, geographical location, level of supervision and professional cultures. For example, Cheyne, Tomas, Cox, and Oliver (1999) sampled from manufacturing, dairy and transport workers to find support for their hypothesis that models of employee attitudes to safety differ depending on the sector sampled.

It may be possible to reduce the effects of these idiosyncrasies by measuring safety climate at an industry level using factors that apply to all organisations in that sector. Ultimately this could lead to a structure that is stable for the sector and a better means for comparison between individual organisational performance and industry averages.

Safety climate and safety performance

Links between safety climate perceptions and safety performance are implied even if they are not always stated explicitly (Zohar, 2000). A common theme in past research on safety climate has been to validate the safety climate measure against various safety performance measures. Common measures used for safety performance are accident or incident rates, self-reported measures of performance or observations of safety behaviours.

Some studies have demonstrated a relationship between climate surveys and other safety measures. Varonen and Mattila (2000) showed that perceptions of safety climate correlated with levels of safety in the work environment and with the safety practices of the organisation. This study found that organisations with below average accident rates had better safety climate scores. Zohar (2000) also associated safety climate with group-level accident rates. However, while some researchers have found a relationship (Brown & Holmes, 1986; Cheyne et al., 2002; Dedobbeleer & Beland, 1991; Diaz & Cabrera, 1997), others have not (Glendon & Litherland, 2001; Tomas, Melia, & Oliver, 1992). Measurement in a broader context may offer insights into the true relationship between safety climate and safety performance.

Glendon and Litherland (2001) believe that surveys can measure aspects of safety climate that are qualitatively different from other measures. Thus, other measures commonly used to assess safety, such as behavioural observations, safety audits and accident data, may be assumed to be complementary rather than overlapping measures of safety. This would suggest that while safety perceptions may have some relationship with other measures that can be statistically shown, such relationships are not straightforward.

Griffin and Neal (2000) suggested that safety performance should be distinguished from safety climate: that the former is a product of behaviour while the latter is the product of safety perceptions. They successfully demonstrated a direct positive relationship between safety performance, measured as safety compliance and safety participation behaviours, and a higher order safety climate factor consisting of perceptions of management values, safety inspections, personnel training and safety communications.

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Appendix C – Statistical analysis

Factor Analysis

Exploratory factor analysis is used to examine underlying patterns of relationships for a large number of variables (e.g. questionnaire responses) and to determine whether the information can be condensed or summarised into a small set of components or factors. Three steps are involved in interpreting of the factors and selecting final factor solutions. First, the initial unrotated factor matrix is computed to assist in obtaining a preliminary indication of the number of factors to extract. The factor matrix contains factor loadings for each variable on each factor. Factor loadings are the correlation of variable and the factor. Loadings indicate the degree of correspondence between the variable and the factor, with higher loadings making the variable representative of the factor. The unrotated solution may not provide a meaningful pattern of variable loadings. The second step in factor interpretation is factor rotation. In most cases rotation of the factors improves the interpretation by reducing the ambiguities that are often found in unrotated solutions.

The term rotation refers to turning the reference axes of the factors about the origin until some other position has been reached. Unrotated solutions tend to produce a first 'general' factor with almost every variable loading significantly and accounting for the largest amount of variance. The second and subsequent factors are then based on the residual variance. The ultimate effect of rotating the factor matrix is to redistribute the variance from earlier factors to later ones to achieve a simpler, theoretically more meaningful factor pattern. The simplest case of rotation is an orthogonal rotation, in which the axes remain at 90 degrees. It is also possible to rotate the axes and not retain the 90 degree angle between the reference axes. When not constrained to being orthogonal, the rotational procedure is called an oblique rotation. Oblique rotations allow correlated factors instead of maintaining independence between the rotated factors. They are used when it is likely that the factors will be related to one another. Statistical software packages offer different approaches to oblique rotations. In this case the statistical package used was SPSS and an OBLIMIN rotation was applied.

The third step of factor analysis is to assess the need to respecify the factor model considering a) deleting variables from the analysis, b) the desire to employ a different rotational method, c) the need to extract a different number of factors, d) the desire to change from one extraction method to another. Respecification is an iterative process accomplished by returning to the extraction stage, extracting factors and reinterpreting.

When a satisfactory factor solution has been derived, the researcher attempts to assign some meaning to each factor. Naming the factor is primarily a subjective exercise. Each factor can then be thought of as a measurement scale for that particular dimension or trait. An assessment of the consistency or reliability of the scale is calculated using Cronbach's alpha. The generally agreed upon limits for Cronbach's alpha are .70 and .95.

A factor analysis was performed on the results gathered from Part A of the survey, containing 30 statements that respondents were asked to consider in terms of their current or most recent employment. The statements were based around six presumed factors of safety climate. These were *management commitment*, *rules and procedures*, *work shifts and schedule*, *equipment and maintenance*, *communication* and *training* and each presumed factor was represented by five statements. The analysis was conducted on responses to these items to determine the factor structure.

The reasonably homogenous sub-group of RPT pilots (with pilots from operations of less than four pilots and/or in management positions removed; N= 215) was used. There were no cases with more than ten per cent missing data and other missing values were replaced with appropriate mean values. The case-to-variable ratio was 7:1, above the recommended ratio of 5:1 (Hair, Anderson, Tatham, & Black, 1995). Skew and kurtosis were reviewed and assessed to be acceptable and the items met with all other aspects of normality. A principal components factor analysis was performed and, as the factors were likely to be related, a direct OBLIMIN rotation was applied.

The analysis revealed seven complex items that loaded onto more than one factor. These items (1,2,3,6,10,12 & 19) were removed from further analysis. A subsequent analysis yielded a four-factor solution, accounting for 64 per cent percent of the explained variance. The factors were named *management commitment, training, equipment and maintenance,* and *rules and procedures*. Reliability coefficients for the factors (Cronbach's alpha) ranged from 76 to .94.

Table 15 displays the factors and each variable's factor loading, their percentage of explained variance and reliability alpha.

Table 15: Direct OBLIMIN rotation factor loadings for the four factor solution

Label	
Factor 1 – Management Commitment *45.9% Variance; α =.94*	Loading
Management regarded safety to be an important part of operations	.832
Pilots were encouraged to consider that safety was more important than keeping to the schedule	.807
Management were genuinely interested in safety	.789
Suggestions for improving safety were encouraged	.758
Pilots were not pressured to fly if they had a safety concern	.757
Management had a good understanding of operational issues that impacted on flight safety	.755
There was no need to work around company safety rules and procedures to get the job done	.722
Safety was considered to enhance rather than limit productivity	.703
Management allocated sufficient resources to safety	.690
Management looked for underlying factors that contributed to safety incidents rather than blame the people involved	.633
Factor 2 – Training *7.1% Variance; α = .84*	
Regular training was provided for a range of emergency situations	.813
Training was received at regular intervals to refresh and update knowledge	.690
Company training was carried out by people with appropriate skills and experience	.647
Company training provided adequate skills and experience to carry out normal operations safely	.543
Training was received when new procedures or equipment were introduced	.465
Factor 3 – Equipment and Maintenance *6.1 % variance α = .76*	
Aircraft maintained to safety standard	.742
Equipment updated and replaced when necessary	.735
Adequate resources to perform maintenance	.733
Aircraft were appropriately equipped for the type of operations conducted	.647
Factor 4 – Safety Rule and Procedures *4.8 % Variance α = .78*	
Safety rules and procedures were easy for pilots to use during normal operations	.851
Company safety rules and procedures were easy to understand	.814
Company safety rules and procedures were as complete and comprehensive as they needed to be	.483
Company emergency operating procedures gave sufficient guidance on how to deal with emergencies	.412

MANOVA

A three-group multivariate analysis of variance (MANOVA) was conducted to test whether the means of the three flying categories were statistically different across the four factors. MANOVA is an extension of the univariate techniques used to assess differences between means. In the univariate case, a single dependent measure is tested for equality across groups. In the multivariate case, a linear combination of variables, a *variate*, is assessed for equality. The MANOVA variate optimally combines the multiple dependent measures into a single value that maximises the differences across groups. In this analysis the MANOVA combined the factors of management commitment, training, rules and procedures and maintenance to make a single variate. The groups of RPT, charter and aerial work were then tested for significant differences on this variate.

As MANOVA is sensitive to differences in cell sizes, the sample for analysis was adjusted to maximise the power of the analysis. The smallest cell size was 63 cases in the charter category. A random 63 cases were taken from each of the other two flying categories and the analysis was conducted on a total of 189 cases.

Prior to performing the analysis, the statistical assumptions necessary to ensure valid MANOVA results were investigated. All factors displayed negative skew and minor kurtosis. In order to address this problem these variable were subjected to a $\log_{10}$ transformation. This reduced the skew to a tolerable level for all variables and the analysis was performed on these data.

Further checks revealed that Levene's test of equality of error variances was non-significant for all variables. However, it was noted that, the *equipment and maintenance* variable approached significance. A significant value would mean that the dispersion of variance across the groups was not even and would result in inaccurate MANOVA calculations, inflating the chance of finding a significant result when in fact there was none (a type 1 error). As the MANOVA results indicated no significant results it was decided to interpret the results as they appeared. The results were *training* [$F(2,187)=0.165$, $P>.05$], *equipment and maintenance* [$F(2,187)=1.502$, $P>.05$], *rules and procedures* [$F(2,187)=1.526$, $P>.05$] and *management commitment* [$F(2,187)=0.190$, $P>.05$].

Further reading in Statistics

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Appendix D – Questionnaire Part A

Please indicate by ticking the box next to the statement that best describes the flying you have done most in the last 12 months and begin at the appropriate part.

□employed in aviation in a flying role in the last 12 months ⟶ go to Part A
—on page 2 and complete the whole of the survey

OR

□only flown privately in the last 12 months ⟶ go to Part B
—on page 4 and complete the rest of the survey

OR

□not flown either privately or commercially in the last 12 months
Please return the survey uncompleted

If you have never worked in aviation or have not worked in aviation in the last 12 months, please tick the last box and return the survey without completing it. This will help us to assess the effectiveness of this survey delivery method. You may still enter the prize draw by completing the entry form and returning it with your survey.

PART A

Please respond to the following statements in terms of your role as a company pilot as they apply to the company you worked most for in the last 12 months.
Circle the appropriate number depending on whether you strongly disagree, disagree, are neutral, agree.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. Pilots were kept informed about safety issues that directly affected them	1	2	3	4	5
2. Pilots were able to openly discuss safety problems with supervisors or managers	1	2	3	4	5
3. Reported technical faults that impacted on safety were rectified	1	2	3	4	5
4. Regular training was provided for a range of emergency situations	1	2	3	4	5
5. Safety rules and procedures were easy for pilots to use during normal operations	1	2	3	4	5
6. Pilots were given sufficient feedback regarding safety incidents involving company aircraft	1	2	3	4	5
7. Pilots were encouraged to consider safety more important than keeping to schedule	1	2	3	4	5
8. Suggestions for improving safety were encouraged	1	2	3	4	5
9. Company training provided adequate skills and experience to carry out normal duties safely	1	2	3	4	5
10. Company work demands on pilots were realistic	1	2	3	4	5
11. Training was received at regular intervals to refresh and update knowledge	1	2	3	4	5
12. Pilots were consulted about safety issues	1	2	3	4	5
13. Aircraft systems and components were replaced or updated when necessary	1	2	3	4	5
14. Company safety rules and procedures were easy to understand	1	2	3	4	5
15. Aircraft were appropriately equipped for the type of operations conducted	1	2	3	4	5

16. Management regarded safety to be an important part of company operations	1	2	3	4	5
17. There was no need to work around company safety rules and procedures to get the job done	1	2	3	4	5
18. Management looked for underlying factors that contributed to safety incidents rather than blame the people involved	1	2	3	4	5
19. Pilots work shifts were too long	1	2	3	4	5
20. Company training was carried out by people with appropriate skills and experience	1	2	3	4	5
21. Management were genuinely interested in safety issues	1	2	3	4	5
22. Company safety rules and procedures were as complete and comprehensive as they needed to be	1	2	3	4	5
23. Adequate resources were allocated to perform maintenance	1	2	3	4	5
24. Company emergency operating procedures gave sufficient guidance on how to deal with emergencies	1	2	3	4	5
25. Management allocated sufficient resources to safety	1	2	3	4	5
26. Pilots were not pressured to fly if they had a safety concern	1	2	3	4	5
27. Safety was considered to enhance rather than limit productivity	1	2	3	4	5
28. Management had a good understanding of operational issues that impacted on flight safety	1	2	3	4	5
29. Aircraft were maintained to a safe standard	1	2	3	4	5
30. Training was received when new procedures or equipment were introduced	1	2	3	4	5

The following questions are about your behaviour as a pilot when you were at work in the last 12 months.

Indicate by circling the appropriate number how often you:

	Never	Rarely	Sometimes	Often	Always
31. encouraged other pilots to work safely	1	2	3	4	5
32. used the appropriate checklists	1	2	3	4	5
33. reported all technical faults and mechanical defects you were aware of	1	2	3	4	5
34. complied with safety rules and procedures	1	2	3	4	5
35. made all required radio calls	1	2	3	4	5
36. reported all incidents and near misses you were involved in	1	2	3	4	5

	Very Unsafe	Unsafe	Neutral	Safe	Very Safe
37. How safe do you think flying operations were in the company you worked for most in the last 12 months	1	2	3	4	5

	Very Much Deteriorated	Deteriorated	Unchanged	Improved	Very Much Improved
38. How has the overall level of flight operations safety changed in the company you worked for most in the last 12 months	1	2	3	4	5