Cost of Civil Aviation Accidents and Incidents

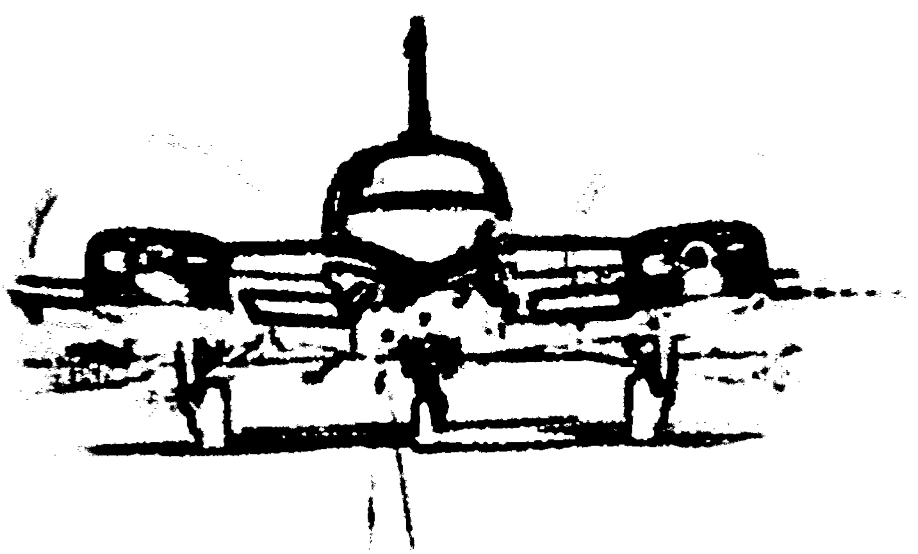
Report

This report is one in a series expected to be published from research being undertaken into the costs of transport accidents by the Bureau of Transport Economics (BTE). The work reported on here relates to the economic costs of aviation accidents and incidents resulting from the operation of Australian aircraft in Australia for 1996.

bureau of transport economics

Report 98

cost of CIVIL AVIATION ACCIDENTS AND INCIDENTS



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FOREWORD

A mature and caring society demands that we do all we can to reduce human harm and enhance our quality of life. In addition, cost minimisation strategies are increasingly being focused on by businesses and institutions to ensure they maintain their viability in an increasingly complex, borderless market-based economy.

Outside the more usual focus on transaction costs, there is now an increasing recognition by many that the economic and social costs resulting from accidents are something we need to know more about if we are to have effective strategies in place to address both societal requirements and institutional efficiency.

This report is one in a series expected to be published from research being undertaken into the costs of transport accidents by the Bureau of Transport Economics. The work reported on here relates to the economic costs of aviation accidents and incidents resulting from the operation of Australian aircraft in Australia for 1996.

The report should assist governments, institutions and households to focus on initiatives they can each employ to mitigate losses through aviation accidents.

The principal author of the report was Johnson Amoako, assisted by Erica Stott and Sharife Rahmani. Contributions made by Steve Garlick, Joe Motha and David Cosgrove are acknowledged. Tim Carlton of the Australian Bureau of Statistics provided valuable comments on the methodology.

The assistance of the numerous organisations, particularly the Bureau of Air Safety Investigation, the Australian Institute of Health and Welfare, the Transport Accident Commission (Victoria) and the Australian Maritime Safety Authority, that provided data for this study is gratefully acknowledged.

Emma Ferguson
Acting Research Manager

Bureau of Transport Economics
Canberra
October 1998

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ABSTRACT

This study refines and expands the methodology and scope of the Bureau of Transport and Communications Economics (BTCE) 1992 study on the community cost of air transport accidents occurring in Australia, *Social Cost of Transport Accidents*. The present study uses the human capital approach to estimate the cost of aviation accidents and incidents in Australia in 1996.

Several refinements have been made to the analysis. The previous study, BTCE Report 79 (1992), calculated productivity losses using a 7 per cent annual discount rate. In the current report the BTE uses a 4 per cent annual discount rate, as research has shown this to be a more appropriate rate. Although previous reports have included a component for pain and suffering, the BTE has widened the application of this intangible element to include the loss of quality of life. This broader application has been applied to fatal and non-fatal costs.

Several accident cost categories have been separately estimated and combined to yield a total cost for aviation accidents. These cost categories include lost earnings, forgone household and community contributions, loss of quality of life, property damage, insurance administration, employer workplace costs, premature funeral costs, rehabilitation expenses, and medical, accident investigation, search and rescue, and legal costs.

Australian life expectancy tables were used to estimate the probable remaining length of life had the fatality not occurred at that particular age in an aviation accident. These probabilities, together with other statistical data, were used to estimate the market and non-market output lost due to disability and premature death of accident victims. A spreadsheet model has been developed to simplify future updates of aviation accident/incident costs.

Aviation accidents in 1996 are conservatively estimated to have cost Australian society $112 million. Of this, productivity losses accounted for about 59 per cent, followed by property damage accounting for around 19 per cent.

SUMMARY

In 1996 aviation accidents cost Australia $112 million. More than half of this cost was attributable to fatal accidents. There were 247 recorded aircraft accidents in 1996, 29 of which resulted in fatalities, 22 in serious injuries and 196 of which involved minor or nil injuries. Each accident cost society on average $450 000.

Table S.1 shows the number of aircraft accidents and the total number of accident victims in 1996, compared with previous years investigated by the Bureau of Transport and Communications Economics (BTCE). In 1996 there were 51 fatalities, 35 serious injuries, and 86 minor injuries. The nil injury category shows the number of people involved in an accident who did not suffer an injury.

Household and workplace productivity losses due to premature death from aviation accidents amounted to $65 million. Allowing for all related costs, each fatality cost society on average $1.5 million. Each serious injury was estimated to have cost society $545 000, and each minor injury $205 000.

TABLE S.1 COMPARISON OF ACCIDENTS AND CASUALTIES

			People with injuries classed as		
Year	*Accidents*	*Fatalities*	*Serious*	*Minor*	*Nil*
1988	328	70	44	55	461
1993	320	67	57	64	438
1996	247	51	35	86	854

Source BTE and the Bureau of Air Safety Investigation.

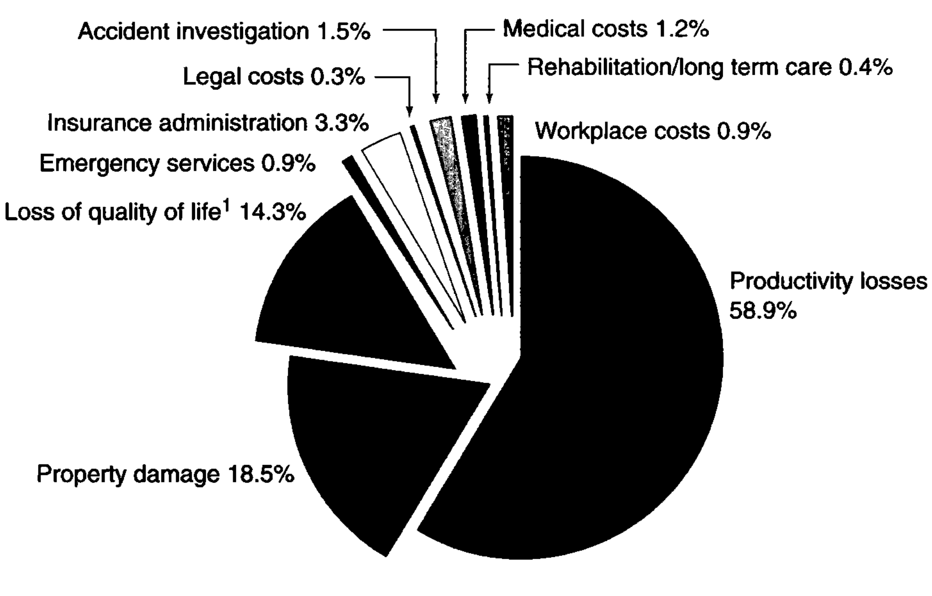
The contribution to these costs by different aviation industry sectors has been analysed. This shows that business / private aviation accounted for the greatest losses, amounting to $41 million. Charter and sports aviation also had substantial losses. These were $26 million and $18 million, respectively.

Significant findings

- Productivity losses in the workplace due to premature death were $29.1 million. This was 26 per cent of the total cost.
- Losses in household production as a result of death amounted to $28.4 million, or 25 per cent of total cost. This represents the loss of productive work that would have been done in the home over an expected lifetime.
- Workplace productivity losses due to injury amounted to $4.0 million, which is 3 per cent of the total cost.
- Losses in household production as a result of injury amounted to $3.8 million, which is 3 per cent of the total cost.
- Property damage amounted to $20.9 million, which is 19 per cent of total cost. This was estimated using insurance claim data.
- Some $16 million represented loss of quality of life and pain and suffering, which accounted for 14 per cent of the total cost.
- Short-term and long-term medical costs amounted to $1.3 million. This was calculated from average hospital and medical costs for serious and minor injuries.
- Rehabilitation and long-term care costs were conservatively estimated to be $446 000. This is likely to be an underestimation of the actual cost, due to incomplete data.
- Insurance administration costs amounted to $3.7 million, which represented 3 per cent of the total cost of aircraft accidents.
- Legal costs were estimated to be $326 000.
- Emergency services and accident investigation amounted to $2.6 million. This contributed 2 per cent towards the total economic cost.
- Workplace costs, associated with the disruption in the workplace caused when someone is killed or injured, amounted to $994 000.

Figure S.1 summarises these cost components.

FIGURE S.1 COMPONENT COSTS OF AVIATION ACCIDENTS



1 The loss of quality of life component on the pie chart includes a cost of $64 000 for premature funeral costs.

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CHAPTER 1 INTRODUCTION

BACKGROUND

This report is the first in a proposed series covering the socio-economic costs of transport accidents in Australia. This analysis covers aviation accidents that occurred in Australia during 1996. Other reports in the series will cover road, rail and maritime transport. The cost data presented in this study should assist the formulation of policies or programs to mitigate aviation accident losses.

Transport accidents / incidents affect the individual and the community in a number of ways. For example, the community pays Medicare expenses, and members of the public subscribing to private health cover will pay higher health insurance premiums. Medical resources are diverted away from other needs. For the individual, the cost may be out-of-pocket medical expenses such as the gap between pharmaceutical subsidies and the actual cost of drugs and between actual and scheduled medical costs. All these are avoidable in the absence of an accident.

There are also significant costs associated with reduced productivity through a person's dying prematurely or suffering disability as a result of an accident. Those dependent on the victim suffer the immediate economic hardship from forgone income, but the community and, by extension, the economy are also adversely affected. Part of the community may give up work or household production time through its efforts to support the victim's dependants. The victims' productive contribution to the community will also be lost. The victims' workplaces will suffer temporary falls in productivity while they adjust to their new circumstances. The expected government tax receipts may fall and greater demands be placed on health and welfare expenditure. These events result in losses to the nation.

ACCIDENT DEFINITION

For the purpose of this analysis the International Civil Aviation Organisation (ICAO) definition of an aviation accident has been used. An accident is defined as

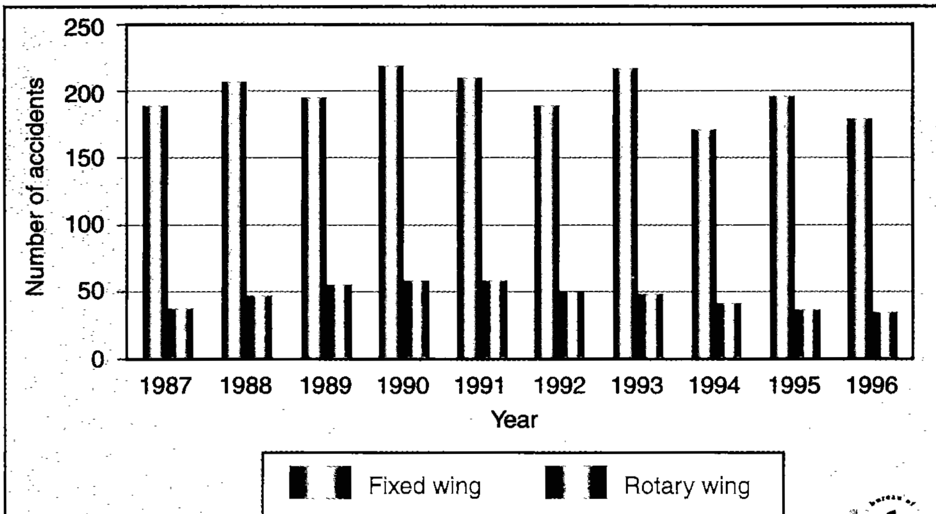
> "...an occurrence associated with the operation of an aircraft that takes place between the time any person boards the aircraft with the intention of flight until such time as all such persons have disembarked, in which a person is fatally or seriously injured and/or the aircraft sustains serious damage or structural failure." (ICAO 1994 Annex 13)

An accident may involve one or more aircraft and persons with varying degrees of injury; the accident is classified according to the most serious injury sustained. The statistics in Table S.1 point to the fact that the majority of people involved in aircraft accidents suffered no injuries or only minor injuries. The definition requires that, to be considered as being sustained in an aviation accident, these minor injuries must be in combination with serious or structural damage to the aircraft or where other people on board suffer death or serious injuries. Some on-board occurrences are not classified as aviation accidents – slight turbulence resulting in only minor injuries, injuries due to 'natural causes' such as falls on board, or injuries that are inflicted by another person. For definitional purposes an aircraft is any device for transporting passengers or goods in the air. This includes aircraft of any type, balloons, dirigibles, gliders, hang gliders, and parachutes. Military aircraft are excluded from our analysis.

An aviation incident does not result in serious injury to people or damage to aircraft, but such events are indicative of failings in either control systems or flight-crews and so are of concern from a safety standpoint. Aviation incidents include violations of controlled airspace, runway incursions, and loss of separation distance. When an aircraft enters controlled airspace without an airways clearance it poses a potential threat to the Air Traffic Control system and the incident is classified as a violation of controlled airspace. Similarly if a vehicle, aircraft or person enters the runway flight strip without permission it is classified as a runway incursion incident. Loss of separation distance is, in layman's terms, a 'near miss' between aircraft in controlled airspace. The costs associated with the investigation of these incidents have been included in our analysis, as this type of investigation reflects a preventive measure, which has a bearing on future accidents. Although there may be associated delays and therefore costs, information was not available to allow us to fully model the cost of delay/disruption from such incidents. It must therefore be recognised that incident costs are underestimated in this report.

Figure 1.1 shows the fluctuations in the number of accidents involving Australian fixed wing and rotary wing aircraft over the decade to December 1996. The number of fixed wing aircraft accidents varied between a low of 171 accidents in 1994 and a high of 219 in 1990 (BASI 1996). When a trendline is drawn through these figures a downward trend in the number of fixed wing accidents becomes apparent, and is more pronounced in the last five years of the period under examination. This downward trend is maintained when changes in flying hours are taken into consideration. Accident statistics involving rotary wing aircraft over the same period show a decline in the later years. Again on a flying hours basis the decline in accident rate is evident. Although fatalities from aviation accidents are relatively low in comparison with those from other forms of transport (indeed there were no aviation fatalities from regular passenger services) they nevertheless represent a major burden to the Australian community.

FIGURE 1.1 CIVIL AIRCRAFT ACCIDENTS 1987–1996



Source Derived from BASI 1996.

CHAPTER 2 METHODOLOGY

Empirical work in this area has focused on two main methods: 'willingness-to-pay' and 'human capital'. The willingness-to-pay method relies on valuing life by determining what individuals actually pay, or would be willing to pay, to reduce their probability of death. According to this approach, the concept encompasses two components: the value an individual places on safety and health and the cost saved by the rest of society by preventing an injury or death (NHTSA 1990). The values are generally estimated by what economists refer to as 'revealed preference' and 'stated preference'. Revealed preference is observed market behaviour: for example, voluntary purchase of safety devices, higher wages for high-risk jobs, or trade-offs between time, money, comfort, and safety. Stated preference values are measured through surveys about individuals' willingness to pay for increases in health and safety. For a detailed discussion of this method, see BTCE (1996).

The 'human capital' method used by the BTCE in previous studies has been adopted for this analysis. Accordingly, readers can compare the estimates with previous BTCE work and with results from a number of similar studies conducted in Australia and overseas (Peat, Marwick and Associates 1981; Brownbill 1984; Andreassen 1992). Notwithstanding the sound economic theory behind the willingness-to-pay concept, the human capital method still remains the preferred approach of many practitioners. Both approaches have limitations (BTCE 1996). The BTE has made some further refinements to the BTCE's method, as detailed below.

The BTCE (1992) defined the human capital method as an ex-post accounting approach, which focuses on the victim's potential output capacity. In this case the individuals are seen as producers and consumers of a stream of outputs throughout their lifetime. Individual victims are considered part of total community impact; hence, the value of their decreased production and decreased consumption is included in total cost. The values are measured by extrapolating workplace and household production to the expected life span of the individual, and discounting the values to present time. To these costs are added the direct costs expended in accident-related activities (hospital, legal, insurance etc.). Also included are values for non-economic losses, which we have used as a proxy for loss of quality of life.

The basic framework for the estimation process used in this study consists of evaluating costs relating to the loss, or partial loss to society. Included in these losses are lost productivity, medical costs, legal and court costs, emergency services costs (search and rescue), insurance administration costs, property damage, workplace losses, investigation costs, and premature funeral costs. For definitions of costs see appendix I. These are costs that could be avoided if the death or injury did not occur. In this report the impact of variations in consumption has been partially modelled through the use of gross earnings. However, the gross earnings used exclude non-earned income (such as income from shares or rental property) as this income and resultant consumption will continue, albeit for a different individual, despite the fatality.

The term 'avoidable cost' is used to denote the costs that could be avoided if a course of action were not followed and an alternative course of action were followed instead. Although it is difficult to maintain that all accidents could be avoided whilst we live in such a chaotic world, we still have the ability to make different choices. To some degree, this notion of avoidable or opportunity cost is subjective, depending on the set of alternatives the decision maker chooses to consider (Hariton 1984).

THE COSTING FRAMEWORK

The estimates of the socio-economic cost of aviation accidents/incidents that occurred in Australia in 1996 have largely been derived from civil aviation data held by BASI.

Table 2.1 sets out details of the accidents that were reported to BASI in 1996. Of particular importance, due to the method being used, is information on the age of fatality victims. This information was not routinely collected by BASI. However, age information was obtained from the coroners' records. Where the age was not specified, descriptions of the victims (such as a 'young man', 'middle aged') were used to estimate age. BASI has now put in place a system whereby the age of fatality victims in future accidents will be collected.

TABLE 2.1 SUMMARY OF CIVIL AVIATION ACCIDENTS BY STATISTICAL GROUP 1996

	Agriculture	*Business*	*Charter*	*Flying training*	*Gliding*	*High capacity RPT*	*Low capacity RPT*	*Sports aviation*	*Private*	*Other aerial work*	*Total*
Injuries											
Crew											
Fatalities	4	1	4	0	0	0	0	7	8	4	28
Serious injuries	1	0	2	1	1	1	0	4	4	2	16
Minor injuries	4	0	5	1	2	8	0	0	5	3	28
Nil injuries	24	6	27	42	17	23	6	11	62	26	244
Passenger											
Fatalities	0	1	9	0	0	0	0	1	11	1	23
Serious injuries	0	0	5	0	0	3	0	3	7	1	19
Minor injuries	0	0	19	0	0	29	0	1	9	0	58
Nil injuries	2	3	62	0	2	444	14	3	64	16	610
Total											
Fatalities	4	2	13	0	0	0	0	8	19	5	51
Serious injuries	1	0	7	1	1	4	0	7	11	3	35
Minor injuries	4	0	24	1	2	37	0	1	14	3	86
Nil injuries	26	9	89	42	19	467	20	14	126	42	854
Aircraft damage level											
Destroyed	8	1	7	0	1	0	0	6	12	6	41
Substantial	25	6	28	26	15	0	2	14	64	21	201
Nil	0	0	0	0	0	2	0	2	0	1	5
Total persons involved	35	11	133	44	22	508	20	30	170	53	1 026
Total accidents	33	7	35	26	16	2	2	22	76	28	247

RPT Regular passenger transport

Note For definitions of statistical groupings see appendix I.

Source BASI database.

In 1996, 247 civil aviation accidents, 4 of which involved regular passenger transport (RPT) with no fatality, were reported to BASI. There were 247 aircraft and 1026 persons involved. Some 41 aircraft were destroyed, 201 sustained substantial damage, and 5 had no damage. There were 51 fatalities, 35 people suffered serious injuries, and 86 suffered minor injuries. Some 854 people, although involved in an accident, suffered no injury. For definitions of accidents and injuries, see appendix I. There were 3633 incidents reported to BASI in 1996.

DERIVATION OF COSTS

The derivation of the costs is presented in three categories—fatality-related, non-fatality, and common costs.

Fatality-related costs include:

- Productivity losses in the workplace due to premature death
- Losses in household production
- Premature funeral costs
- Medical costs prior to death

Non-fatality-related costs include:

- Productivity losses in the workplace due to temporary injury and permanent disability
- Losses in household production due to temporary injury and permanent disability
- Short-term and long-term medical costs
- Rehabilitation and long-term care costs

Common costs associated with both fatal and non-fatal accidents include:

- Loss of quality of life
- Property damage
- Insurance administration costs
- Legal costs
- Emergency services costs
- Accident/incident investigation costs
- Airport closure/delay costs
- Workplace costs

CHAPTER 3 FATALITY COSTS

FATALITY PRODUCTIVITY LOSSES IN THE WORKPLACE

A significant accident cost factor is the loss of future production of those who die prematurely through accidents. The assumption is that, had the victims not died as a result of an aircraft accident, they would have worked productively in the workplace until their retirement. The future production is represented by the net present value of future earnings and directly related on-costs, such as superannuation, leave loadings and fringe benefits.

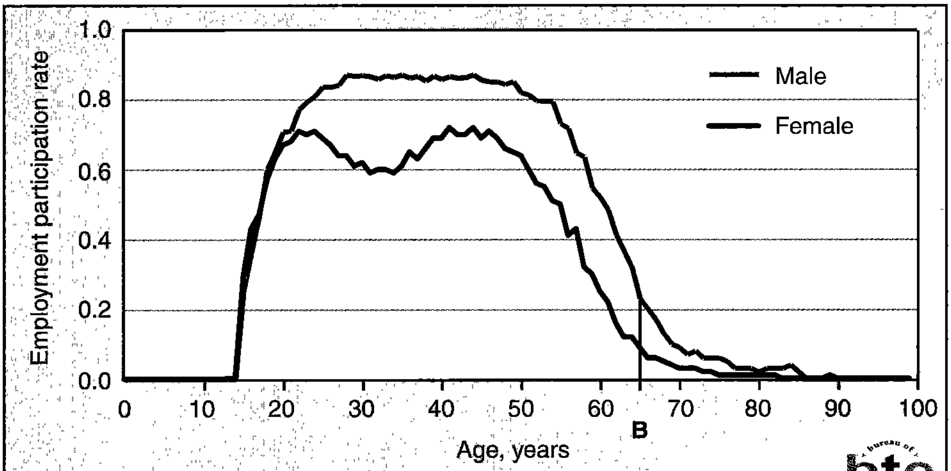
Studies on the cost of transport accidents in Australia (Atkins 1981; Brownbill 1984) have calculated productivity losses of accident victims by estimating the present value of their assumed future total income, taking account of their age and gender. This involved discounting the income stream to a present value from a predetermined age 65 with an adjustment for future productivity gains. Two key assumptions were that all persons not in the labour force value their leisure at prevailing market wage rates, and that all persons age 65+ do not participate in the workforce. Other authors have used different age cut-offs in defining the working life period or the potential productive years. Usually the ages between 15 and 70 years are referred to as potentially productive years of life (Gardner and Sanborn 1990). Productivity is assumed to commence at age 15. Another approach is the use of years of accumulated ability lost. This method weights the number of deaths by the ages at which they occur, on the assumption that the potential contributions of the victim are greater with greater age and experience (Hahn 1995).

The BTCE (1992) introduced some refinements by using the working life table model. The working life tables describe labour force participation and movements into and out of the labour force at each age as well as expectations of years of working and retirement life. These tables were based on Anderson and Ross (1987). The working life tables used 1981 Australian mortality profiles and rates of labour force participation, to yield age- and gender-specific expectations of working life and retired life of persons in the labour force. For details and assumptions of working life tables methodology, refer to Anderson and Ross (1987) and BTCE (1992).

The 1981 Australian working life tables are dated. A reconstruction would require extensive data collection, and be based on a number of hypotheses and assumptions. However, the same results can be achieved by a simpler method, using mortality rates and employment rates, which we describe in the next section.

A working life cut-off age such as 65 or 70 is not used, because this would assume that there is no working life after the arbitrarily determined cut-off age. Australian 1996 age-specific employment rates (ABS 1996c), the number of employed persons as a proportion of the civilian population, indicate the real life situation is that working life continues beyond age 80. For example, people running their own business such as a farm may well continue to work beyond age 65. Thus using an arbitrary working life cut-off age, such as age 65 (point B on figure 3.1), would underestimate productivity losses by excluding the obvious productivity achieved in the years between 65 and the age where the level of employment naturally reaches zero. The approach adopted in this study assumes a potential working life profile as illustrated in figure 3.1.

FIGURE 3.1 1996 AUSTRALIAN WORKING LIFE PROFILES



Source: Derived from ABS 1996c.

At this point some comment should be made on the impact of data limitations on the estimates of productivity losses. The ABS (1996b) estimates of mortality do not go beyond age 99 which means that for the small proportion of the population who live beyond this age no workplace or household productivity losses can be calculated for their last few years of life. However, this is not the major limitation as the use of the mortality figures is itself restricted by the availability of other data. The employment rate reaches zero at age 86 for males and at age 83 for females, so lack of mortality data beyond 99 is only an issue in the calculation of household productivity (ABS 1996c). Of more importance is the fact that the ABS estimates of earnings assume earnings to be constant past 65 years of age (ABS 1996d). Although this is the best assumption considering the lack of real data, it does mean that productivity loss calculations beyond age 65 will not accurately reflect the real life situation. One final assumption made is that any fatality in the age bracket (0–14) is assigned to age 15, so no workplace (or household productivity) values are assigned until the victims are assumed to have reached the legal working age of 15.

APPROACH TO WORKPLACE PRODUCTIVITY LOSSES COMPUTATION

The basic framework for the estimation process relies on the Australian life expectancy tables published by the Australian Bureau of Statistics (ABS 1996b). We make use of column l_x in the Australian life tables (number of persons surviving from a birth cohort of 100 000). As described by the ABS, life tables depict the mortality experience of a hypothetical cohort of newborn babies throughout their entire lifetime. Our estimation process is based on the assumption that this cohort is subject to the age-specific mortality rates of the reference period.

We illustrate this approach by way of an example. Suppose 6 men had died as a result of an aircraft accident all at the age of 44 in 1996. The victims' situation is hypothetically reversed and a question posed: what are the chances that all 6 at age 44 would have survived to age 45, 46, 47, ..., 99? As the 6 progressively survive to the next age their chance of surviving or dying changes to reflect the specific age they have reached. Clearly some ages carry a greater risk of death than others. After estimating the survival rates (at ages 45, 46, ..., 99) of our 6 hypothetical men we then apply the Australian employment rate (at each year of age and by gender) to derive the proportion of the survivors that would be in the workforce. The employment rate used was based on each year of age and disaggregated by gender (ABS 1996c) (see appendix IV). This represents an enhancement in the data set, since the BTCE (1992) relied on age group data. The mean annual average earnings (at each year of age and by gender) is then applied to each surviving person in the workforce. The computation is repeated for each year there is a survivor. Finally the estimated losses are discounted to present time. Table 3.1 shows the spreadsheet computation. It is important to note that the column 'future potential annual earnings' has not been discounted to net present value. This means that, if any of the six men in the sample group were to have survived to, say, the year 2025 (age 73), and still be working, their expected earnings in that year would be $43 110 in 2025 dollars. In 1996 terms (using a 4 per cent annual discount rate) this amount is only $13 823. This scenario analysis for the six fatalities produces real workplace productivity losses of $4 958 000 (a sub-set of the overall analysis).

For the complete analysis this computation is repeated for each fatality that occurs. The computation formula used for each year is thus:

$$P_x = A_x V_x (l_{x+1}/l_x)$$

with

$$V_x = W_x E_x$$

where

P_x is productivity losses for the year the victims would have been age x.[1]

A_x is the total number, at age x, of people who have died in aviation accidents who would statistically otherwise have been alive at age x.

l_x is the number of people who statistically survive to age x in a birth cohort of 100 000 (ABS 1996b).

V_x is employment rate (E_x) at age x multiplied by average earnings (W_x) at age x.

The result, P_x, for each year of statistical survival is discounted to present time; in this instance the base time is 1996. That is,

$$PV = \sum_{x=i}^{\infty} \frac{P_x}{(1 + Rate)^{x-i}}$$

1. This productivity loss makes use of the mortality rate ($lx+1/lx$). The mortality rate can more accurately be calculated as $\left(\frac{lx+1}{lx} + \frac{lx}{lx-1}\right)/2$. However, as there are only very minor changes in the mortality rate in adjacent years the simpler computation was used.

TABLE 3.1 FATALITY WORKPLACE PRODUCTIVITY LOSSES FOR MALES AT AGE 44

Age	Probability of surviving out of 100 000	Fatality	Likely to survive	Future potential annual earnings ($)	Employment rate	Value of productivity lost ($)
44	95 281	6	6.0	51 431	0.874	134 574[a]
45	95 071	0	6.0	48 055	0.859	246 617
46	94 845	0	6.0	53 373	0.854	271 668
47	94 600	0	6.0	52 843	0.845	268 277
48	94 334	0	6.0	62 470	0.846	313 298
49	94 044	0	5.9	54 111	0.855	273 419
50	93 726	0	5.9	57 698	0.822	279 347
51	93 378	0	5.9	57 951	0.815	277 145
52	92 996	0	5.9	68 386	0.798	318 921
53	92 576	0	5.8	64 827	0.797	300 582
54	92 113	0	5.8	52 405	0.796	241 463
55	91 601	0	5.8	51 500	0.732	217 003
56	91 035	0	5.7	51 368	0.718	210 996
57	90 407	0	5.7	54 004	0.648	198 815
58	89 710	0	5.7	61 991	0.636	222 267
59	88 937	0	5.6	50 285	0.547	153 730
60	88 079	0	5.6	57 219	0.520	164 690
61	87 129	0	5.5	89 424[b]	0.484	236 979
62	86 077	0	5.4	67 381	0.413	150 531
63	84 917	0	5.4	63 391	0.366	123 808
64	83 639	0	5.3	47 449	0.318	79 306
65	82 238	0	5.2	36 794	0.233	43 735
66	80 704	0	5.1	37 530	0.197	38 067
67	79 034	0	5.0	38 281	0.173	32 321
68	77 222	0	4.9	39 046	0.133	24 633
69	75 264	0	4.7	39 827	0.100	18 837
70	73 160	0	4.6	40 624	0.092	16 809
71	70 907	0	4.5	41 436	0.071	12 925
73	65 971	0	4.2	43 110	0.061	10 723

Continued on next page

TABLE 3.1 FATALITY WORKPLACE PRODUCTIVITY LOSSES FOR MALES AT AGE 44 (continued)

Age	Probability of surviving out of 100 000	Fatality	Likely to survive	Future potential annual earnings ($)	Employment rate	Value of productivity lost ($)
74	63 296	0	4.0	43 972	0.056	10 494
75	60 484	0	3.8	44 852	0.060	10 229
76	57 532	0	3.6	45 749	0.051	8 270
77	54 436	0	3.4	46 664	0.027	4 789
78	51 195	0	3.2	47 597	0.027	4 594
79	47 821	0	3.0	48 549	0.032	4 377
80	44 332	0	2.8	49 520	0.023	2 759
81	40 752	0	2.6	50 511	0.026	3 881
82	37 118	0	2.3	51 521	0.024	3 605
83	33 467	0	2.1	52 551	0.029	3 316
84	29 847	0	1.9	53 602	0.040	4 022
85	26 303	0	1.7	54 674	0.022	1 807

a. In this first year productivity losses are set at half the calculated amount for the assumed even spread of fatalities throughout the year.

b. This estimate contains an error from the original unpublished data.

Notes
1. Potential future annual earnings are not discounted to present value; e.g. the annual earnings for age 73 is the expected earnings in the year 2025 (in 2025 dollars) for a person aged 44 in 1996.
2. Due to rounding of figures in this table calculations from the figures presented here will not yield the productivity values in the right-hand column.

Source BTE estimates using ABS 1994, 1996a, 1996c, 1996d.

where *PV* is the present value of productivity losses over the relevant period, *rate* is the annual discount rate and *i* is age at death from an aviation accident.

The lost productivity in the base year in which the deaths occur, P_x, is halved to reflect the fact that deaths can occur at random throughout the year. This avoids over- or under-estimation. That is, some people will have earned nearly a full year's salary before their death, while others may have only just entered that earning year. Obviously in all the following years of potential life the full value of annual earnings is forgone. P_x is computed for each year of age, and is summed after discounting. Permanent disabilities victims who by the nature of their injuries will never enter the workforce were treated in the same way in terms of estimating potential productivity losses — these results, however, are presented in Chapter 4.

To demonstrate the sensitivity of the present values, the annual discount rates 4, 7 and 8 per cent have been used. Four per cent is the rate generally used (NHTSA, 1990); however, BTCE (1992) used 7 per cent annual discount rate. Eight per cent is the rate suggested by the Commonwealth Department of Finance (1992) for evaluating government infrastructure projects, which reflects the marginal real rate of return on capital investment. However, the cost streams under consideration represent consumption rather than capital investments so that the appropriate measure is the social rate of time preference, and this may be measured by the real, after-tax rate of return on widely available savings instruments or investment opportunities eg. Treasury bills. The choice of annual discount rate is discussed by Miller in NHTSA (1994). The differences generated by a selection of annual discount rates can be seen in table 3.2.

The earnings from potential work of accident victims are based on mean weekly earnings by each year of statistical survival and disaggregated by gender for 1996 (ABS 1996c). The mean earnings represent the market replacement wage for future potential labour. In BTCE (1992) the market replacement wage for future labour was based on the median wage for each age group as this was assumed to best describe opportunity cost. Using mean earnings at each year of age better reflects the full spectrum of earnings for each age. The weekly earnings are annualised using a 52.18 week year, as periods of unpaid leave have already been included in the measure of AWE (see appendix III). This is then factored by 25.4 per cent to take into account labour on-costs (leave loading, payroll tax, superannuation etc.) which are borne by the employer but which do not appear as a component as earnings. Finally, a 2 per cent annual growth

TABLE 3.2 PRODUCTIVITY LOSSES DUE TO FATALITIES CAUSED BY CIVIL AVIATION ACCIDENTS–WORKPLACE

$'000

Annual discount rate	*8%*	*7%*	*4%*
Males	15 818	17 530	25 009
Females	2 626	2 908	4 115
Total	18 444	20 439	29 124

rate is applied to the earnings stream to take account of real increases in productivity over time.

The value of potential future workplace production losses as a result of fatalities in 1996 civil aviation accidents, using the above method (annual discount rate of 4 per cent), amounted to $29.1 million.

Thus at a 4 per cent annual discount rate, losses per fatality amounted to about $571 000 in potential workplace productivity.

LOSSES IN HOUSEHOLD AND COMMUNITY PRODUCTION

When a person dies prematurely, the value of productive activities in the home and elsewhere outside the formal work environment is lost. These losses are associated both with the employed and unemployed. Although the activities are unpaid they do have a value. In this study, the market replacement method has been used to determine this value. This involves estimating the average hours of work outside the formal workplace and applying a wage rate—that is, the expected or assumed cost of labour to perform the same function. The level of earnings per hour for those in the formal workforce has been assumed to be equivalent to the labour cost to perform the household functions.

The ABS estimates males in work will, on average, devote 14.5 hours per week to household and other productive activities, compared with 22.1 hours per week for males not in paid employment (ABS 1990, 1996d). The female rate is 28.4 hours per week if in employment, and 38.2 hours per week when not employed. These values are annualised using 52.18 weeks, on the assumption that household work is carried out every week of the year.

To estimate household productivity losses for employed people, a similar computational method to that described above for estimating workplace productivity losses is used. Age- and gender-specific earnings and employment rates are used and applied to the number of hours spent in household duties. This calculation is repeated for the remaining proportion of the fatalities, who are deemed not employed.

The value of potential future household productivity losses as a result of 1996 civil aviation accidents, using the above method and a 4 per cent annual discount rate, amounted to $28.4 million (table 3.3).

TABLE 3.3 PRODUCTIVITY LOSSES DUE TO FATALITIES CAUSED BY CIVIL AVIATION ACCIDENTS–HOUSEHOLD

$'000

Annual discount rate	*8%*	*7%*	*4%*
Males	9 151	10 393	16 457
Females	6 031	6 963	11 892
Total	15 181	17 355	28 350

Total workplace and household productivity losses associated with fatalities in 1996 civil aviation accidents amounted to approximately $57 million at 4 per cent annual discount rate. Losses per fatality amounted to about $1.1 million in potential productivity.

PREMATURE FUNERAL COSTS

When a fatality occurs as a result of a transport accident, there is an unexpected cost of a funeral imposed on the bereaved family. The unforeseen nature of this cost is particularly relevant as funerals are not generally saved for until the later years of life. The inclusion of the cost of premature funerals relies on the assumption that the real cost of a funeral will decline over time.

The development of the values involves three distinct steps: firstly, determining a current funeral cost; secondly, calculating what the cost would be of a funeral in the future when the individual would otherwise have died; and finally, discounting the future cost to 1996 dollars.

An average funeral cost was derived, which included all aspects of the funeral including service and administration fees. This was obtained by averaging sample prices from all states and territories in Australia. The average market price of a funeral was determined to be $3 000.

In order to evaluate how much a funeral would have cost in the future, an annual growth rate of 2 per cent was applied to the base cost of $3 000. This was annualised for the number of additional years that an individual was expected to live (ABS 1996b). Different calculations were undertaken for males and females due to the differing life expectancies. Once a future value was determined, this was then discounted to 1996 dollars using a 4 per cent annual discount rate. The difference between the cost of a funeral in 1996 and the cost of the funeral at the end of the expected lifespan of each victim was then calculated. Premature funeral costs associated with 1996 civil aviation accidents amounted to $64 000.

MEDICAL COSTS PRIOR TO DEATH

The ICAO (1994) definition of a fatality is any resultant death within 30 days of the date of the accident. Some eventual fatalities incur medical costs prior to death. However, Australian Institute of Health and Welfare (AIHW 1996) statistics for 1995–96 on all aviation-related accidents indicate that only 3 people died in hospital acute care. The medical cost where there was a fatal outcome was $11 000. Using the AIHW figure of three confirmed hospitalisations that ended in death, medical treatment costs for accidents with a fatal outcome are estimated at $33 000. This figure would be a lower bound of such costs, as there may be instances where medical treatment was given at the accident scene but death occurred without reaching hospital. No information was available on the level of survival of the immediate accident amongst eventual fatalities. Such treatment would be of a much lower cost than treatment received in hospital.

FATALITY COSTS SUMMARY

Table 3.4 summarises losses/costs associated with fatality victims. Additionally, fatality costs include a proportion of the common costs associated with all aviation accidents. Figure 3.2 shows the total costs for fatalities.

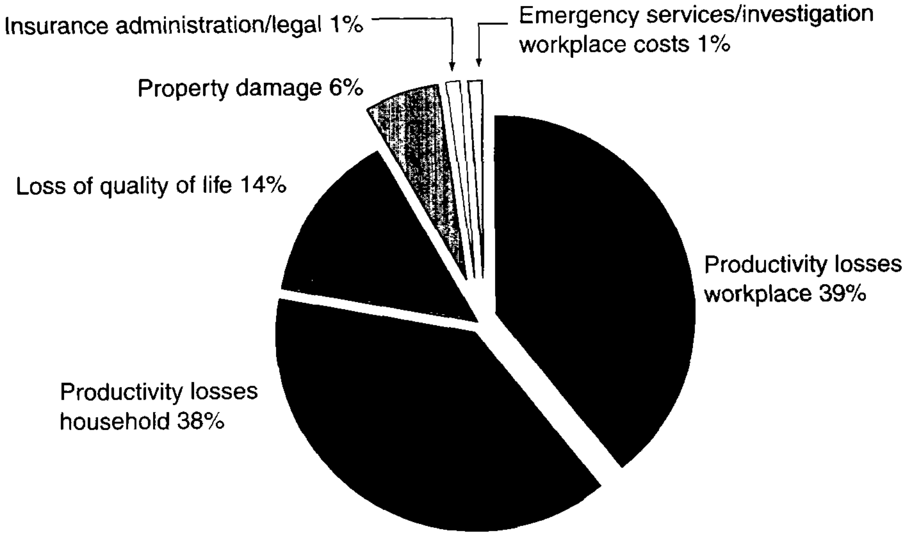
TABLE 3.4 SUMMARY OF FATALITY COSTS

($'000)

Category	*Cost/losses*
Productivity losses—workplace	29 124
Productivity losses—household	28 350
Medical costs prior to death	33
Premature funeral cost	64
Apportionment of common costs*	16 809
Total	74 380

* A full discussion of common costs is contained in chapter 5.

FIGURE 3.2 COMPONENT COSTS OF FATALITIES



Total cost of fatalities is $74.4 million

Note Includes a percentage of costs that are common to fatal and non-fatal accidents.

CHAPTER 4 NON-FATAL INJURIES

PRODUCTIVITY LOSSES IN THE WORKPLACE

Serious and minor injuries can cause both short-term or long-term productivity losses in the workplace. These occur while victims are in hospital or recuperating. The assumption is that victims will return to the workforce when they fully recover from the injuries. However, it is difficult to estimate accurately the number of days victims are absent from work. The approach adopted here is to estimate the potential number of days absent from work by using hospital bed days, and to assume that those returning to normal employment will take additional home rest days and time in rehabilitation programs to recover fully. For some this could be several years, and for others several months. For those who suffer permanent disability, such as quadriplegia, and are unlikely to return to the workforce, it has been assumed their productivity losses are permanent. In such instances the productivity losses have been estimated using the same method as that outlined in Chapter 3 for fatality victims.

AIHW (1996) unpublished data indicate that those injured in aviation accidents (classification E840-E844) spent on average six days in hospital acute care in 1996. This figure is an underestimate of the time spent in hospital for various injuries as some aviation accident patients have a number of separate visits to one or more hospitals, and / or are transferred between hospitals or within hospitals, with each period being recorded as a 'separation'[1] . This lowers the average bed days for an individual

1. 'Separation' is the term used by AIHW to describe the formal process by which a hospital records the completion of treatment and/or care for an admitted patient. Separation data are recorded and classified by diagnosis-related groups which represent a class of patients with similar clinical conditions requiring similar hospital services. This is done using the *International Classification of Diseases*, 9th revision, *Clinical Modification (ICD-9-CM)* (National Coding Centre 1995).

victim. The figure is also distorted by the inclusion of time spent in hospital by accident victims who die in hospital and people injured in aviation accidents in previous years when readmitted for further treatment. In fact, while there were 121 recorded injured aviation accident survivors in 1996 there were 391 recorded hospital visits by aviation accident victims. Using this information, in combination with estimates of time in rehabilitation programs and general recuperation it was assumed that work day losses would be an average of six months for the seriously injured. The BTCE (1992) estimated a total of 59 bed-days in hospital per seriously injured person. The determination of work day losses for those with minor injuries was made on the basis of an average length of stay in hospital of only one day with a subsequent day for recuperation. Thus a minor injury is allocated two lost work days. The BTE is refining its estimates of potential work days lost.

The task of estimating productivity losses due to aviation accidents is made more difficult as the data for serious and minor injuries do not contain information on age and gender of victims. Such information would help to assign employment rates and potential level of earnings lost. It would also make it possible to use quality-adjusted life years (QALYs) to estimate associated losses.

The estimated days out of effective circulation in the community were applied to potential earnings lost (average for males and females over all ages) and the employment participation rate (average for males and females over all ages). Using this approach, and assuming an average 6-month period of work lost, the estimated workplace productivity losses amounted to $223 724 for temporary injuries and $3 513 000 for permanent disability (discounted at 4 per cent and using the average age of fatalities of 37 for the five permanently disabled).

HOUSEHOLD AND COMMUNITY PRODUCTIVITY LOSSES

Those who are severely injured are usually temporarily unable to make a contribution to household or community work. These losses are estimated in the same way as workplace productivity losses discussed above. In all calculations, ABS (1996c) employment rates have been used to determine the proportions likely to have been employed and unemployed, as this impacts on the number of hours in any given week available for household and community work. The estimated total household productivity losses amounted to $442 109 for minor and severely injured victims and $3 422 000 for those permanently disabled with quadriplegia.

Overall, total productivity losses associated with permanent, severe and minor injuries amounted to $7 601 000. The productivity loss of each person suffering permanent disability amounted to $1.4 million.

SHORT-TERM AND LONG-TERM HOSPITAL AND MEDICAL COSTS

Medical costs include hospital care and paramedical treatment, but exclude the cost of any treatment given during transportation to the hospital.

Information relating to hospital and medical costs was obtained from the Transport Accident Commission of Victoria (TAC 1996). This body provides 'a comprehensive no-fault compensation scheme for Victorians who are injured or die as a result of a transport accident'. TAC provided information on 1996 accident claimants for fatal, serious and minor injuries. Although we appreciate that TAC does not compensate victims of aviation accidents, as the cost data for hospital and medical treatment are available by severity and type of injury, the relevant costs can be estimated for the specific injuries suffered by aviation accident victims. Diagnostic group details of aviation accident victims' injuries were obtained from unpublished AIHW data and used in combination with data from TAC to determine medical costs.

Specific costs for short-term hospital and medical costs include: assessment, hospital treatment, theatre fees, dental treatment, medical and hospital rehabilitation and any other medical-related costs. In estimating total medical costs we have determined a unit cost for serious and minor injuries and applied this to the number of people injured in these categories. (The TAC excess payment - $407 for 1996 - is included in the unit costs for short-term medical expenses.)

Short-term medical costs for serious injuries

Serious injuries had a unit cost of $16 900 for medical, hospital and paramedical expenses. This unit cost encompasses a wide range of medical processes of relevance to the aircraft accident victims and was developed by applying TAC costs to the AIHW diagnostic group data from aviation accident victims. Aviation accident injuries show certain similarities, with the serious injuries suffered being predominantly spinal damage, limb fractures and burns. Interestingly accident survivors did not present with serious head injuries and this is certainly a factor in the relatively low per unit medical costs for the seriously injured.

The total cost for seriously injured survivors is estimated as $592 000.

Short-term medical costs for minor injuries

The definition of minor injuries used by BASI is 'an injury that is not fatal or serious' (see Appendix I), but the definition of serious injuries is fairly comprehensive. In practice, hospitals classify minor injuries as those that require 48 hours or less hospital treatment and these include: sprains, broken noses, fractured fingers and toes, first degree burns, whiplash, minor head injuries and lacerations. A unit cost of $6 800 was calculated for minor injuries. Although such injuries would have required less than 48 hours in hospital, many of the victims would have required follow-up outpatient treatment.

The total cost for all minor injuries is estimated as $586 000.

Short-term medical costs for nil injury

Although it is assumed that non-injured victims did not seek medical attention, it is likely that some of those involved in an accident would have had a routine examination and perhaps treatment for shock or post-traumatic stress disorder.

Unfortunately we are unable to estimate any costs for nil injury victims as no data are available on those who may have sought medical help or reassurance. However, since there were 854 nil injury cases in 1996 aviation accidents, this could be a substantial hidden cost.

Long-term medical costs

Some victims of aviation accidents will require further medical treatment in ensuing years. For cases where injuries are multiple and of various levels of urgency in terms of treatment it is clear that the patient will require ongoing attention and is likely to incur future medical costs. However, several research programs have found that relatively simple injuries can cause ongoing medical problems. For example Murray, Pitcher and Galasko (1992) found that average costs for fractures and whiplash injuries actually increased in the second year after the accident.

Nygren and Cassidy (1997) also found that only 42 per cent of victims of whiplash injury had recovered after 2 years.

Data covering long-term medical costs for permanent spinal injury were obtained for a three-year period from 1995 to 1997. This yielded a unit cost of $6 900. The unit cost was applied to the number of permanent spinal injury victims. This resulted in an additional cost for long-term medical treatment of $102 800. It is, however, likely that intermittent medical treatment will occur for more than 3 years beyond the initial phase of treatment.

There are a number of factors that could improve the accuracy of estimation of the above long-term medical costs that we hope to incorporate into future research. People of different ages take different times to heal so being able to link the age of the injured person with the actual injury received would allow a more accurate stream of long-term medical costs to be developed. Additionally the use of the Abbreviated Injury Scale to classify the severity of injury would enable a more accurate assessment of recovery time and hence costs. Having these two pieces of information would let disability-adjusted life years by body region be used in considering the stream of long-term medical costs.

The total cost of short-term and long-term medical and hospital treatment is conservatively estimated to be $1 281 000.

REHABILITATION AND LONG-TERM CARE

This category was defined to be the cost of retraining required to return the victim to the workforce or, if this is not possible, the cost of long-term care and attention required by the victim.

Payments made for rehabilitation include vocational equipment, and vocational education training courses. Long-term care costs include personal care, property and vehicle modifications, computer equipment and special accommodation.

Costs for rehabilitation and long-term care were calculated for all serious injuries. These were separated into permanent injury and other serious injury costs. The permanent injury costs were considered to be applicable to five victims who had suffered severe spinal injuries leading to quadriplegia.

Permanent injuries

The unit cost for rehabilitation and long-term care for permanent injuries was $60 000 for 1996 accident victims as of April 1998. It is difficult to know the exact period this covers, as patients with severe injuries normally spend a considerable time in hospital before the next phase in their treatment. This unit cost is also likely to be higher than the average cost in ensuing years, due to the inclusion of housing modification costs.

Long-term care costs will continue for the patient's whole life. Medical science is helping to save accident victims who may have died a few years ago, and advances in methods of rehabilitation and care also mean that the range of treatment is growing. Ideally, estimates for permanent injuries are better done with disability-adjusted life years. However, due to the fact that we did not have any information on the age of the permanently injured victims, or the victim's response to treatment, we were unable to estimate expenditure beyond the initial period of care. The BTE is continuing work to allow such estimates.

The total cost for permanent injury victims for their initial period of rehabilitation and care is estimated as $300 000.

Other serious injuries

A unit cost of $4 500 for rehabilitation and long-term care was obtained for the range of serious injuries received by aviation accident victims. The total cost for serious injury accident victims is $146 000.

Most minor injuries will not require rehabilitation and long-term care. Additional costs found in the TAC statistics for this category were taken to mean further medical costs after release from hospital, such as costs for outpatient treatment. These costs have been included in the short-term medical costs.

The total cost for rehabilitation and long-term care across all levels of injury is estimated as $446 000.

NON-FATAL INJURIES COST

Table 4.1 summarises non-fatality injury cost. Figure 4.1 shows the component costs for non-fatality injuries.

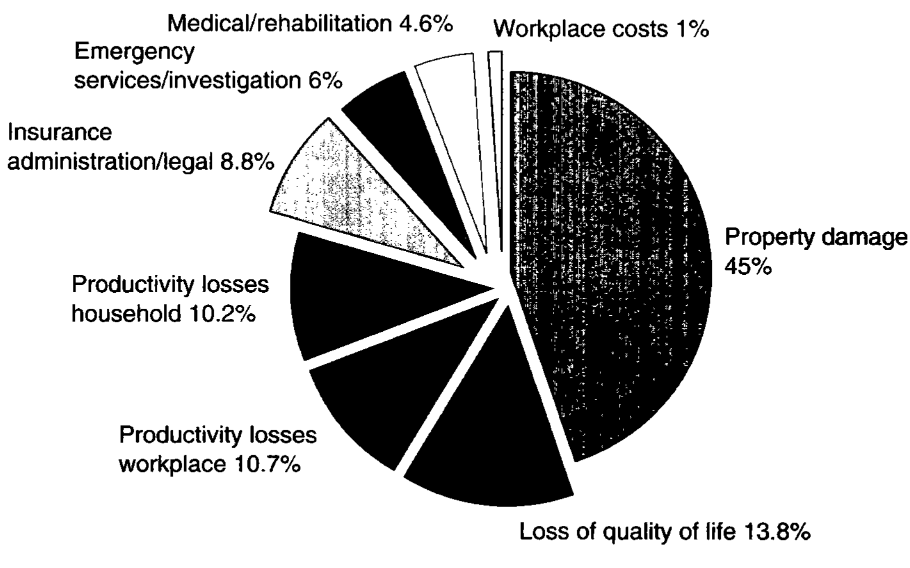
TABLE 4.1 SUMMARY OF NON-FATALITY INJURY COSTS

($'000)

Category	*Cost/losses*
Productivity losses—workplace	3 737
Productivity losses—household	3 864
Medical	1 281
Rehabilitation	446
Apportionment of common costs*	27 834
Total	37 162

* A full discussion of common costs is contained in chapter 5.

FIGURE 4.1 COMPONENT COSTS OF NON-FATALITY INJURIES



Total cost of non-fatal injuries is $37.2 million

Note Includes a percentage of costs that are common to fatal and non-fatal accidents.

CHAPTER 5 COMMON COSTS

LOSS OF QUALITY OF LIFE

The loss of quality of life covers the pain and suffering of those injured in an accident and loss of quality of life for fatalities and those left with a disability. The extension of the human capital method through the inclusion of such an intangible cost element brings it closer to the willingness to pay method without losing its strong real world accounting basis. The social belief that life is more than just a stream of income also necessitates that some attempt to value quality of life is made.

Pain and suffering are relatively easily recognisable, but understanding what quality of life encompasses is more difficult. For those who are left with a disability following an aviation accident the lost quality of life comprises all the things they were able to do prior to the accident but are now unable to do. For a quadriplegic it may be the loss of the ability to run with their children, the lost freedom of driving, or the changes necessary to future plans. Loss of quality of life for fatalities is simultaneously both easy and difficult to conceptualise. Easy because quality of life can be seen as a scale, with a healthy person at one end, which covers a range of progressively more debilitating injuries, and which has death as the logical point marking the other end of the scale. Difficult to understand because a dead person does not feel what is lost. This report does place a value on the loss of this intangible component of life by fatalities, as numerous willingness-to-pay studies have demonstrated that people will pay at a level well above the value of lost production to avoid dying.

Quality of life is also a difficult concept to quantify. Economists have developed many different ways of measuring loss of quality of life. Such measurements include Quality-Adjusted Life Years (QALYs), Disability-Adjusted Life Years (DALYs), jury verdicts and willingness-to-pay. Work is also being carried out on cross-validating estimates using different approaches. For example Miller et al (1998) describes work which has been done on cross-validating jury verdict estimates and QALY estimates. One of the simplest estimations for loss of quality of life according to Miller et al (1998) is to subtract productivity loss estimates with some adjustments for transfer payments and tax from a willingness-to-pay estimate. This he contends will give a value for the loss of quality of life (including pain and suffering).

In this report, a time series of non-economic court awards[2], which list different levels of impairment, has been used as the basis for this estimate. This assumes that such awards accurately reflect the true losses experienced by the victims and can convert such experiences into adequate monetary compensation. This is very much an intangible concept, but the method detailed below is an attempt to estimate such values. The difficulties inherent in such a technique have been recognised. The major issues in using court awards are their notorious variability and inconsistency. Court awards are used in France and Belgium as a component in valuing lives lost or damaged in transportation accidents. In the absence of a willingness-to-pay estimate specific to Australia, and indeed specific to aviation accidents, and also without age data from which QALYs or DALYs can be ascertained, the use of non-economic court awards is the best guide to the value of the quality of life forgone. Non-economic court awards also have one advantage in that they are 'real' costs being borne by the insurance industry.

Values for the loss of quality of life in the BTE study were calculated from data compiled by Britts (1973–1996). A series of non-economic award payments and impairment percentages were used to formulate average awards for the two injury classifications that were deemed to have a pain and suffering or loss of quality of life component. The perceived problems of variability and inconsistency were primarily addressed though the use of averages which were developed using data from a six year period. Variability in awards over this period was not great and indicated Britts (1973–1996) may be correct in his belief that judges are drawing on their own experience of comparable cases in setting awards. For fatalities, an average of the non-economic awards allocated to 100 per cent impairment cases was applied. This is done to place a lower bound value of the intangible component of life which fatalities have lost. It is conceivably a lower bound as it equates death with permanent incapacity.

2. A non-economic court award covers the pain and suffering as a result of any change in the litigant's state.

Awards for minor injuries were assumed to be those where the impairment percentage was 15 per cent or less. Serious injury losses were calculated using an average of the remaining non-economic awards covering the full range of impairment above 15 per cent. This resulted in estimated mean awards of $8 450 and $127 000 per minor and serious injury respectively. Fatality awards averaged $214 000. This approach resulted in an estimated total cost of $16 100 000 for loss of quality of life experienced as a result of 1996 civil aviation accidents.

We consider, however, that our estimate for the loss of quality of life is a lower bound, especially as it does not include the pain and suffering of friends and relatives. It is acknowledged that economists using willingness-to-pay methods have calculated much higher figures. The different theoretical basis of these two approaches means that, although ostensibly trying to provide a value of life, they are doing so by measuring different proxies and as such cannot be expected to provide identical results. Work is currently being undertaken by the BTE to obtain more accurate figures for pain and suffering and lost quality of life in the future.

PROPERTY LOSS AND DAMAGE

Property damage is probably one of the most apparent cost components related to transport accidents. Damage has a direct economic and social link in that such accidents may lead to an aircraft's needing replacement or repairs, which take time and money. There is also the possibility that other property on the ground where the accident occurs could be damaged. However, there was no indication that any of the accidents in 1996 led to on ground property damage.

Information relating to property damage was obtained in confidence from several different sources. These provided the necessary disaggregated data to allow us to estimate approximate repair/replacement costs for aircraft damage across different classes of aircraft. The data obtained from our other sources indicate that BASI's database may reflect some level of under-reporting in connection with property damage-only accidents. However, one has to be cautious about imputing such interpretation as such data sources could include information relating to on ground damage, for example, vandalism and storm damage.

The levels of injuries do not always correlate with the level of damage sustained - there can be very high property costs associated with an accident, but nil injuries. This means that when part of the property loss value is allocated to injury levels this cannot be done with pinpoint accuracy. As a result total minor and serious injury costs may contain some minor misestimation. However it is possible to more accurately allocate property costs to fatal accidents.

The total cost of property damage due to aircraft accidents is estimated as $20 854 000 for 1996.

INSURANCE ADMINISTRATION COSTS

Aviation accidents and their consequent claims result in both a monetary payout to the recipient, and administrative costs to the insurance industry. These underwriting expenses include commissions, brokerages, and other statutory charges. Such costs, which are usually passed on to the public in the form of increased premiums, are experienced every time a claim is submitted.

The Insurance and Superannuation Commission Statistics (ISC 1997) provide data relating to the total direct aviation-related insurance expenses as well as the total underwriting expenses for the year ending 1996. From these data it was possible to proportion underwriting expenses to direct expenses for the aviation industry. This yielded the figure of 17.9 per cent. Data available for previous BTCE reports did not specifically differentiate costs for the aviation industry. This percentage was applied to the estimated property damage and loss payments, to derive an insurance administration cost for 1996 aviation accidents of $3 733 000.

LEGAL COSTS

Legal costs are incurred whenever a lawyer charges a client as a result of a consultation or action concerning an aviation accident. This may encompass legal representation at coronial inquiries, responding to questions regarding legal rights surrounding insurance, or even contesting a settlement related to an aviation accident. The sheer number of lawyers who could potentially provide aviation accident-related services in a consultation and the private status of such inquiries means that there is no centralised body with a vested interest in tracking such costs. Without any knowledge of the scale of such legal contact, realistic estimation of the related costs is not possible.

When the legal costs are incurred in dealing with insurance companies there are some data on which to base an estimation of legal costs. Insurance companies know both their own legal costs and also the costs of the claimant where these have been borne by the insurance company. This is a difficult figure to estimate for any given year as litigation arising from an accident may take years to settle. However, according to figures published by the ISC (1997), indirect claims settlement costs for the aviation industry in 1996 amounted to $326 000. Although only providing part of the total legal costs for aviation accidents, the ISC is the only source of such information and is widely referenced as the source of legal cost estimates. Individuals involved in contesting a claim will also incur personal costs in terms of lost time and out-of-pocket expenses. Such costs have not been included in the estimation.

SEARCH AND RESCUE (EMERGENCY SERVICES) COSTS

In order to calculate emergency services costs, aviation accidents were examined by the type of aircraft involved, the level of damage sustained and the highest level of personal injury recorded. In this way it was possible to identify the number of times Australian Maritime Safety Authority (AMSA) resources were utilised. All Australian emergency search and rescue operations are now integrated into AMSA operations.

It was estimated that AMSA would have been involved in an aircraft recovery and rescue operation in 203 of the 247 aviation accidents in 1996. (The exceptions were considered to be where the accident involved agricultural aviation aircraft and in certain sport aviation accidents and high capacity transport aviation accidents, where no injuries were sustained.) An average cost was obtained from AMSA for aircraft search and rescue operations based on its activities between July 1997 and February 1998. Due to the recent reorganisation of agencies involved in search and rescue operations it was not possible to obtain earlier data. These sample cost data were considered to be representative of the types of search and rescue operations carried out in 1996 and, due to negligible cost inflation, could be applied to 1996 accidents.

It was also assumed that a helicopter would be needed to transport victims of agricultural aviation accidents where there was a serious injury or fatality. For the five instances of this happening we assumed that a helicopter would be needed for approximately one hour to transport the people involved.

It is recognised that the military can also become involved in search and rescue operations where aircraft have crashed. However, our data do not suggest that it became involved with the cases we have analysed.

The total cost due to search and rescue operations for 1996 accidents amounted to $988 000.

ACCIDENTS AND INCIDENTS INVESTIGATION

In examining the costs of accident investigation we only addressed BASI's costs. However it must be recognised that airline companies also carry out their own investigations into aircraft accidents and that by taking only BASI's costs, we are underestimating the total cost of accident/incident investigation.

BASI's principal role is to improve standards and promote the safety of commercial air transport, with particular reference to fare-paying passengers. In assessing accident investigation costs we have examined BASI's expenditure for the financial year of 1996. Although the report covers the calendar year of 1996 it is unlikely that there will be any major difference between the costs incurred by BASI for the calendar year and the financial year unless any major aircraft accidents occurred during that time. BASI staff costs arising from the proportion of time spent in accident investigation have not been fully costed. However, BASI's costs incurred in attending coronial proceedings are included and this forms a significant resource requirement (other administrative expenses of such proceedings have not been costed).

The Civil Aviation Safety Authority is required by the Civil Aviation Act 1988 to cooperate with the Bureau of Air Safety Investigation in relation to the investigation of aircraft accidents. However, CASA's staff and operating costs have not been included in the investigation cost total. Although it plays an important role in maintaining air safety, CASA's functions are regulatory in nature and involvement in accident investigation forms part of a process to monitor the effectiveness of the regulatory environment. Its costs are attributable to maintaining safety rather than being a direct function of accidents and incidents, as is the case with the reported BASI costs.

We have included categories of expenditure that are considered to be directly related to the investigation of aircraft accidents in Australia. Some adjustments to the figures have been made to exclude the cost of air accident investigations outside Australian territory. The resource cost of accident/incident investigation amounted to $1 648 000.

WORKPLACE COST (LOSSES TO NON-VICTIMS)

Losses to non-victims from an aviation accident include costs to employers of the victims, that is, productivity down-time, overtime pay, pay for temporary staff and the cost of recruitment and training. The NHTSA (1994) estimates that employer losses equate to 3 months wages where a fatality is involved, 2 days where minor injury is involved and 4 months in a severe injury case. These estimates have been applied in this analysis. The greater productivity loss resulting from a severe injury (4 months) rather than a fatality (3 months) reflects the case that a significant proportion of those severely injured do return to work, but often experience a substantial period of reduced productivity before their former levels are regained. In some cases this reduced productivity may be a permanent outcome of their injury. Using an average 38-hour week, an hourly rate, and employment rate, the workplace costs amounted to $994 000.

AIRPORT CLOSURE/ DELAY COST

In most cases aircraft accidents occur near or around airports (on approach to landing or take-off). These tend to disrupt air traffic flow. In such instances there are delays to passengers arriving or intending to depart, as well as aircraft diversions to other airports. Aircraft incidents are also likely to incur costs due to delays and disruption as personnel try to remedy a situation and discover the cause of the occurrence. The cost is expected to be substantial. While there were data on the actual incidence of such occurrences, there is little information available on the impact on aviation services. To accurately determine this cost details of the location, time of day, and length of incident would need to be superimposed on information concerning losses to airports, aircraft operators and passengers. Modelling this cost was beyond the capacity of this study, but future transport accident cost studies in this series will place more emphasis on this 'disruption/delay' cost component.

COMMON COST SUMMARY

Table 5.1 summarises common costs associated with fatalities and non-fatal injuries.

TABLE 5.1 SUMMARY OF COMMON COSTS

($'000)

Category	*Cost/losses*
Loss of quality of life	16 100
Property damage	20 854
Insurance administration	3 733
Legal	326
Emergency services	988
Investigation	1 648
Workplace—non-victim	994
Airport closure/delay	na
Total	44 643

CHAPTER 6 TOTAL COSTS

The table below shows a summary of the total costs. It can be seen that productivity losses have by far the largest impact followed by property losses and loss of quality of life. Substantial costs are also incurred by the insurance industry, accident investigation agencies and emergency services. The medical costs are likely to be underestimated as there was insufficient information available regarding the long-term costs of care and medical treatment. Legal costs are also underestimated as these are clearly discernable only for the insurance industry. Airport closure / delay costs were not estimated due to insufficient information, although we believe that such costs could be substantial. The estimated cost to society of $112 million must therefore be regarded as a conservative figure.

TABLE 6.1 SUMMARY OF TOTAL ESTIMATED COSTS

($'000)

Category	*cost/losses*
Productivity losses	65 075
Property damage	20 854
Loss of quality of life	16 100
Insurance administration	3 733
Legal costs	326
Emergency services	988
Accident investigation	1 648
Medical costs	1 314
Rehabilitation/long term care	446
Workplace costs—non-victim	994
Premature funeral costs	64
Total	111 542

Source BTE.

INDUSTRY SEGMENT COSTS

The total estimated accident and incident occurrence cost to society for 1996 has been distributed to each industry sector. This is shown in table 6.2 and figure 6.1. As indicated, private/business aviation imposed the highest costs, followed by charter aviation services. We point out that these costs are raw accident costs and do not reflect the relative safety (which would incorporate a weight such as hours flown) of particular segments of the aviation industry.

Figure 6.1 presents information which agencies such as CASA may find helpful in terms of targeting resources. These statistics may help operators to focus on some areas of their management decisions with a view to addressing issues that will help reduce future accidents and incidents in Australia.

TABLE 6.2 ACCIDENT AND INCIDENT OCCURRENCE COSTS DISTRIBUTED BY INDUSTRY SECTOR

($'000)

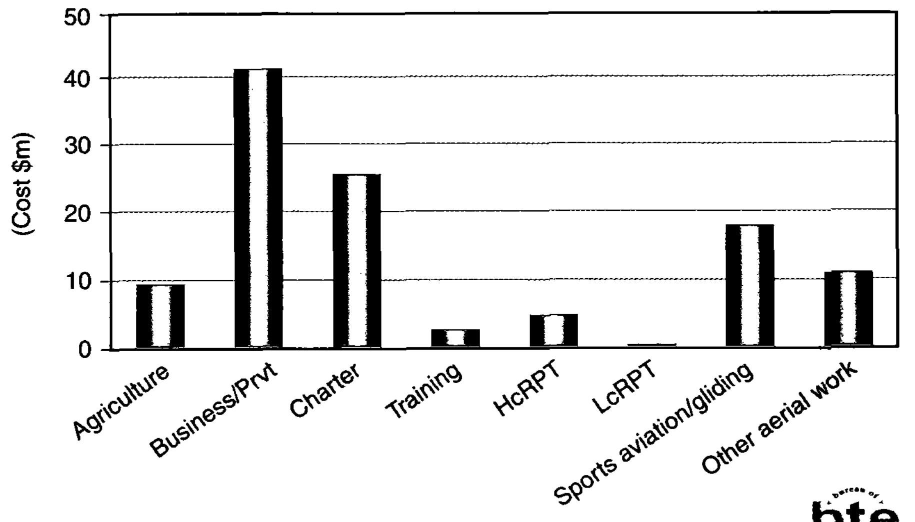
Sector	*Fatal*	*Non fatal*	*Damage*	*Total*	*Cost/accident*
Agriculture	5 358	750	3 055	9 163	278
Business/private	28 131	6 097	7 059	41 287	497
Charter	17 414	4 961	3 110	25 486	728
Training	0	535	1 854	2 389	92
HcRPT	0	4 503	0	4 503	2 252
LcRPT	0	0	143	143	71
Sports aviation/gliding	10 717	3 920	3 181	17 850	469
Other aerial work	6 699	1 604	2 452	10 774	385

HcRPT High capacity regular passenger transport

LcRPT Low capacity regular passenger transport

Source BTE.

FIGURE 6.1 ACCIDENT AND INCIDENT COSTS BY INDUSTRY



Source BTE.

CHAPTER 7 CONCLUSION

The valuation of human life is a field of study that has been plagued with conceptual and practical difficulties. There are those who argue that it is impossible to measure human life in terms of dollars and cents, and others who argue that a notional economic value can be imputed. There is also the issue among practitioners as to what method should be used to impute values to human life. For this study we have adopted the rationale that to enhance society's awareness of the considerable cost of accidents and to design and implement efficient and effective harm minimisation strategies requires good base-line information on the nature and extent of accident costs.

In this study we have used a refined human capital approach to measure the impact of accidents on human life. In doing so we believe we have made contributions to the method by way of conceptual simplification. For example, most practitioners in Australia have estimated productivity losses by first estimating or using working life tables. The construction of the working life table is data-intensive and incorporates many assumptions. The detail of data reflects the many expected uses of these tables. The method of construction is available in Anderson and Ross (1987) but includes assumptions such as the age up until which accessions to the labour force occur and the age after which secessions can occur. These tables also become dated very quickly. We have not constructed working life tables and have avoided the fixed working life concept. This has been done using an abridged form of the working life table, which includes only the information necessary to this study. Our method is simple and involves fewer assumptions than the full working life model. Age- and gender-specific data on mortality rates and employment rates are all that is required to construct our table.

In assessing and estimating the cost of aviation accidents in Australia we have endeavoured to alert the relevant agencies and society to the scale of 1996 civil aviation accident costs and the burden borne by the community. The costs presented are all estimates and have varied in difficulty of estimation. These estimates rely on assumptions and/or the use of proxies. Further research and improved data collection methods can improve the accuracy of such estimates.

There is also the issue of which cost components to include in the basket to demonstrate the magnitude of the burden. To some extent this depends on the objectives of the costing exercises and the method of evaluation. As argued by Mooney (1977), if the costing objective is to allow for the valuation of a safety project to save lives, then the valuation of the 'lives' should be made gross of consumption. This is based on the premise that the individuals concerned will be alive, will be members of society and consequently their future consumption can be taken as benefits to future society. If, on the other hand, the objective is to measure the effect on the surviving population of lives lost, then the net of consumption measure is appropriate.

The report also highlights to the aviation industry the scale of some of the less immediately apparent costs of accidents, the impacts of which may otherwise be underestimated or even overlooked. Quantifying such costs – including the size of productivity losses and the costs due to pain and suffering and loss of quality of life - allows these to be fully considered when assessing the benefits of air safety improvements. Traditionally, industry strives to control and manage the direct production and marketing costs of operation. However, as demonstrated by the costs estimated in this report, there are externalities and these can affect the competitiveness of a whole industry or nation if left unchecked. For the aviation industry this is particularly important. Demand for aviation travel is dependent on cost and, on another front, customer perceptions of safety. By itemising the different cost components, this report helps industry and other relevant agencies to focus on the areas that particularly affect them.

As noted at various points throughout the text, there is always some level of uncertainty in any estimating procedure and, as a result, our estimated total cost of $112 million should be regarded as a lower bound figure.

APPENDIX I DEFINITIONS

DEFINITIONS OF COSTS

Airport closure/ delay costs Any costs incurred due to disruption to other flights or aircraft activity as a result of an air accident.

Emergency services The cost of AMSA services to locate, rescue and recover people involved in aviation accidents. This cost covers helicopter and small plane search and rescue operations.

Insurance administration costs The underwriting expenses of claims made as a result of aviation accidents.

Legal costs Legal costs incurred in aviation accident-related claims.

Loss of quality of life This includes costs of pain and suffering endured by all injury victims together with the loss of quality of life as a result of impairment or loss of life.

Losses in household and community production The costs associated with lost productivity due to unpaid work in the home and elsewhere in the community. Such losses are calculated for both the employed and the unemployed. The market replacement method has been used.

Losses in workplace production The costs associated with lost productivity in the workplace. Such losses are calculated for the employed using age-specific annual average earnings and on-costs as a measure of the value of labour.

Medical costs The costs of all medical treatment of victims other than that given during ambulance treatment. This also includes hospital care and paramedical treatment.

Medical costs prior to death Any medical costs incurred where the patient died within 30 days as a result of the accident.

Premature funeral costs The present discounted value of paying for a funeral in the present instead of at the end of the victim's expected life span.

Property loss and damage Loss and damage to aviation vehicles and property on the ground as a result of an air accident.

Rehabilitation and long-term care The cost of retraining required to return the victim to the workforce, and, when not possible, the cost of long-term care and attention required by the victim.

Workplace cost The cost borne by the workplace due to staff death or injury in an aviation accident. This includes additional recruitment, training and overtime costs, as well as loss of production by other staff members.

ACCIDENT CLASSIFICATIONS

Precise definitions of accident severity, in terms of the severity of injuries suffered by victims of aviation accidents, were crucial to the accurate completion of this project. The definitions below were developed by the Bureau of Air Safety Investigation and the Department of Transport and Regional Services to capture the concept of transport accidents as completely as possible.

Fatal Any accident that results in death within 30 days of the date of the accident.

Serious Any accident other than fatal resulting in an injury that:

- requires hospitalisation for more than 48 hours commencing within 7 days from the date the injury was received; or
- results in a fracture of any bones (except simple fractures of fingers, toes or nose); or
- involves lacerations which cause severe haemorrhage, nerve, muscle or tendon damage; or
- involves injury to any internal organ; or
- involves second- or third-degree burns affecting more than 5 per cent of the body surface.

Minor Any accident that leads to an injury which is not fatal or serious.

Nil Any accident that does not result in injury.

In this report hospitalisation period has been used to classify serious and minor injuries, with serious injuries requiring more than 48 hours hospitalisation. In addition the term **permanent injury** has been used in this report to describe an injury such as paraplegia and quadriplegia that results in the victim's being unable to rejoin the workforce. This is a component of the serious injury classification.

TYPES OF OPERATION

The following definitions, developed by the Bureau of Air Safety Investigation, have been used.

Agriculture Pest and disease control, fertilising, crop seeding, poison baiting and similar operations excluding aerial spotting of livestock.

Charter Activity other than commuter, aerial agriculture, other aerial work or flying training that involves the carriage of passengers or cargo for hire or reward. Includes balloons.

Flying training Activity under the supervision of an appropriately licensed flight instructor for practical instruction for: (1) the issue or renewal of a license or rating; or (2) aircraft type endorsement and conversion training. This category also includes navigation exercises conducted as part of a course of applied flying training.

General aviation All flying by civil aircraft other than RPT operations, gliding and sports aviation.

Gliding Flying by registered gliders.

High capacity regular public transport (HcRPT) Scheduled operations involving aircraft certified as having a maximum seating capacity exceeding 38 seats or for freight aircraft a maximum payload exceeding 4 200 kilograms.

Low capacity regular public transport (LcRPT) Scheduled operations involving aircraft certified as having a maximum seating capacity of 38 seats or less or for freight aircraft a maximum payload of 4 200 kilograms or less.

Other aerial work Mustering, cloud seeding, fire fighting, parachute dropping, survey work, towing, aerial spotting, search and rescue or similar operations.

Private/business Activity for purposes other than those above or for transportation of a business or leisure nature. Includes transportation of the owner and employees.

Sports aviation Includes flying ultralights and gyroplanes, hang gliding, and parachuting.

APPENDIX II AUSTRALIAN MALE AND FEMALE LIFE TABLES 1994–1996

TABLE II.1 AUSTRALIAN MALE LIFE TABLES 1994–1996

Age	*lx*	*qx*	*Lx*	*e"x*	*Age*	*lx*	*qx*	*Lx*	*e"x*
0	100 000	0.00627	99 456	75.22	50	93 726	0.00371	93 555	28.18
1	99 373	0.00054	99 344	74.70	51	93 378	0.00409	93 190	27.29
2	99 319	0.00041	99 297	73.74	52	92 996	0.00452	92 790	26.40
3	99 279	0.00031	99 262	72.77	53	92 576	0.00500	92 348	25.52
4	99 248	0.00024	99 235	71.79	54	92 113	0.00555	91 862	24.64
5	99 224	0.00020	99 214	70.81	55	91 601	0.00618	91 323	23.78
6	99 204	0.00017	99 195	69.82	56	91 035	0.00690	90 727	22.92
7	99 187	0.00017	99 179	68.83	57	90 407	0.00771	90 065	22.08
8	99 170	0.00016	99 162	67.84	58	89 710	0.00862	89 330	21.24
9	99 154	0.00016	99 146	66.85	59	88 937	0.00964	88 516	20.42
10	99 139	0.00016	99 131	65.86	60	88 079	0.01079	87 612	19.62
11	99 123	0.00016	99 115	64.88	61	87 129	0.01207	86 612	18.83
12	99 107	0.00017	99 099	63.89	62	86 077	0.01348	85 507	18.05
13	99 090	0.00021	99 080	62.90	63	84 917	0.01504	84 288	17.29
14	99 070	0.00028	99 056	61.91	64	83 639	0.01676	82 949	16.55
15	99 042	0.00040	99 023	60.93	65	82 238	0.01864	81 482	15.82
16	99 002	0.00057	98 975	59.95	66	80 704	0.02070	79 881	15.11
17	98 945	0.00077	98 909	58.98	67	79 034	0.02293	78 140	14.42
18	98 869	0.00096	98 823	58.03	68	77 222	0.02535	76 255	13.75
19	98 774	0.00110	98 721	57.08	69	75 264	0.02797	74 224	13.09
20	98 666	0.00118	98 608	56.15	70	73 160	0.03078	72 046	12.45
21	98 550	0.00123	98 489	55.21	71	70 907	0.03381	69 720	11.83

Continued on next page

TABLE II.1 AUSTRALIAN MALE LIFE TABLES 1994–1996 (continued)

Age	*lx*	*qx*	*Lx*	*e"x*	*Age*	*lx*	*qx*	*Lx*	*e"x*
22	98 429	0.00124	98 367	54.28	72	68 510	0.03706	67 252	11.23
23	98 306	0.00124	98 245	53.35	73	65 971	0.04055	64 644	10.64
24	98 184	0.00124	98 123	52.41	74	63 296	0.04442	61 901	10.07
25	98 062	0.00123	98 002	51.48	75	60 484	0.04880	59 020	9.51
26	97 941	0.00124	97 881	50.54	76	57 532	0.05383	55 996	8.98
27	97 820	0.00126	97 758	49.60	77	54 436	0.05953	52 827	8.46
28	97 696	0.00129	97 633	48.66	78	51 195	0.06591	49 519	7.96
29	97 570	0.00132	97 506	47.73	79	47 821	0.07297	46 085	7.49
30	97 441	0.00135	97 376	46.79	80	44 332	0.08073	42 548	7.04
31	97 310	0.00137	97 243	45.85	81	40 752	0.08919	38 938	6.61
32	97 176	0.00140	97 109	44.91	82	37 118	0.09834	35 292	6.21
33	97 041	0.00142	96 972	43.98	83	33 467	0.10819	31 653	5.83
34	96 902	0.00145	96 832	43.04	84	29 847	0.11872	28 066	5.48
35	96 762	0.00148	96 690	42.10	85	26 303	0.12994	24 582	5.15
36	96 618	0.00152	96 545	41.16	86	22 885	0.14183	21 246	4.85
37	96 471	0.00156	96 396	40.22	87	19 639	0.15438	18 104	4.57
38	96 320	0.00161	96 243	39.29	88	16 608	0.16757	15 194	4.31
39	96 165	0.00167	96 086	38.35	89	13 825	0.18130	12 547	4.08
40	96 005	0.00174	95 922	37.41	90	11 318	0.19511	10 189	3.87
41	95 838	0.00183	94 724	36.48	91	9 110	0.20849	8 135	3.69
42	95 663	0.00193	95 571	35.54	92	7 211	0.22097	6 389	3.54
43	95 478	0.00206	95 381	34.61	93	5 617	0.23212	4 942	3.40
44	95 281	0.00221	95 177	33.68	94	4 313	0.24150	3 772	3.29
45	95 071	0.00238	94 959	32.75	95	3 272	0.24844	2 848	3.18
46	94 845	0.00258	94 724	31.83	96	2 459	0.25721	2 129	3.07
47	94 600	0.00281	94 469	30.91	97	1 826	0.26570	1 573	2.97
48	94 334	0.00308	94 191	30.00	98	1 341	0.27433	1 149	2.87
49	94 044	0.00338	93 887	29.09	99	973	0.28309	829	2.78

lx Number of persons at exact age x
qx Proportion dying between exact age x and exact age x + 1
Lx Number of persons surviving at age x last birthday
e"x Complete expectation of life at exact age x

Source ABS 1996b.

TABLE II.2 AUSTRALIAN FEMALE LIFE TABLES 1994–1996

Age	lx	qx	Lx	e"x	Age	lx	qx	Lx	e"x
0	100 000	0.00503	99 565	81.05	50	96 674	0.00234	96 563	32.80
1	99 497	0.00052	99 469	80.46	51	96 448	0.00258	96 325	31.88
2	99 446	0.00029	99 429	79.50	52	96 199	0.00285	96 064	30.96
3	99 417	0.00022	99 406	78.52	53	95 925	0.00313	95 777	30.05
4	99 395	0.00018	99 386	77.54	54	95 624	0.00344	95 462	29.14
5	99 378	0.00015	99 730	76.55	55	95 295	0.00378	95 118	28.24
6	99 363	0.00013	99 356	75.57	56	94 935	0.00415	94 741	27.34
7	99 350	0.00013	99 344	74.58	57	94 541	0.00454	94 329	26.45
8	99 338	0.00013	99 331	73.58	58	94 112	0.00496	93 882	25.57
9	99 325	0.00013	99 319	72.59	59	93 645	0.00543	93 394	24.70
10	99 312	0.00013	99 306	71.60	60	93 136	0.00594	92 863	23.83
11	99 299	0.00014	99 292	70.61	61	92 583	0.00652	92 285	22.97
12	99 286	0.00015	99 278	69.62	62	91 979	0.00717	91 654	22.12
13	99 271	0.00016	99 263	68.63	63	91 319	0.00791	90 964	21.27
14	99 255	0.00018	99 246	67.64	64	90 597	0.00874	90 208	20.44
15	99 237	0.00021	99 227	66.66	65	89 806	0.00967	89 378	19.61
16	99 216	0.00026	99 204	65.67	66	88 937	0.01072	88 468	18.80
17	99 191	0.00033	99 175	64.69	67	87 984	0.01190	87 469	18.00
18	99 157	0.00039	99 138	63.71	68	86 937	0.01321	86 372	17.21
19	99 119	0.00039	99 099	62.73	69	85 789	0.01467	85 169	16.43
20	99 080	0.00039	99 060	61.76	70	84 530	0.01629	83 852	15.67
21	99 041	0.00038	99 022	60.78	71	83 154	0.01807	82 413	14.92
22	99 004	0.00038	98 985	59.80	72	81 651	0.02005	80 844	14.19
23	98 996	0.00038	98 948	58.83	73	80 014	0.02226	79 136	13.47
24	98 929	0.00039	98 910	57.85	74	78 233	0.02477	77 278	12.76
25	98 891	0.00039	98 872	56.87	75	76 295	0.02765	75 255	12.07
26	98 852	0.00040	98 832	55.89	76	74 185	0.03095	73 053	11.40
27	98 813	0.00041	98 792	54.91	77	71 889	0.03474	70 658	10.75
28	98 772	0.00042	98 751	53.94	78	69 392	0.03906	68 055	10.12
29	98 730	0.00044	98 709	52.96	79	66 681	0.04398	65 234	9.51
30	98 686	0.00047	98 664	51.98	80	63 749	0.04955	62 188	8.92
31	98 640	0.00050	98 616	51.01	81	60 590	0.05581	58 918	8.36
32	98 591	0.00053	98 566	50.03	82	57 209	0.06282	55 429	7.83

Continued on next page

TABLE II.2 AUSTRALIAN FEMALE LIFE TABLES 1994–1996 (continued)

Age	*lx*	*qx*	*Lx*	*e"x*	*Age*	*lx*	*qx*	*Lx*	*e"x*
33	98 539	0.00056	98 512	49.06	83	53 615	0.07062	51 737	7.32
34	98 484	0.00060	98 455	48.09	84	49 829	0.07922	47 867	6.84
35	98 425	0.00064	98 394	47.11	85	45 881	0.08866	43 855	6.38
36	98 363	0.00068	98 330	46.14	86	41 813	0.09895	39 748	5.95
37	98 296	0.00073	98 261	45.17	87	37 676	0.11009	35 600	5.55
38	98 225	0.00078	98 187	44.21	88	33 528	0.12209	31 474	5.18
39	98 148	0.00084	98 107	43.24	89	29 435	0.13496	27 436	4.83
40	98 065	0.00091	98 021	42.28	90	25 462	0.14870	23 551	4.50
41	97 975	0.00099	97 928	41.32	91	21 676	0.16328	19 883	4.20
42	97 878	0.00108	97 826	40.36	92	18 137	0.17871	16 489	3.92
43	97 772	0.00119	97 715	39.40	93	14 895	0.19496	13 414	3.67
44	97 656	0.00130	97 593	38.45	94	11 991	0.21200	10 690	3.44
45	97 529	0.00143	97 460	37.49	95	9 449	0.22982	8 333	3.24
46	97 389	0.00158	97 313	36.55	96	7 278	0.24752	6 346	3.06
47	97 235	0.00174	97 152	35.60	97	5 476	0.26108	4 732	2.90
48	97 066	0.00192	96 974	34.67	98	4 047	0.27466	3 467	2.76
49	96 879	0.00212	96 778	33.73	99	2 935	0.28863	2 492	2.63

lx Number of persons at exact age x
qx Proportion dying between exact age x and exact age x + 1
Lx Number of persons surviving at age x last birthday
e"x Complete expectation of life at exact age x

Source ABS 1996b.

APPENDIX III PRODUCTIVITY HOURS AND EARNINGS 1996

TABLE III.1 1996 PRODUCTIVITY HOURS AND EARNINGS

MALE

	Employed						Unemployed		
				Estimated earnings				Estimated earnings	
Age	*Workplace earnings ($/hour)*	*Employed hours worked per week*	*Household hours worked per week*	*Employed work ($/week)*	*Household activity ($/week)*	*Annualised ($/year)*	*Household hours worked per week*	*Household activity ($/week)*	*Annualised ($/year)*
15	2.01	40.60	14.50	81.51	29.11	5 772	22.05	44.27	2 310
16	2.93	40.60	14.50	119.13	42.55	8 436	22.05	64.70	3 376
17	5.31	40.60	14.50	215.69	77 03	15 274	22.05	117.14	6 112
18	6.73	40.60	14.50	273.37	97.63	19 359	22.05	148.47	7 747
19	9.20	40.60	14.50	373.69	133.46	26 463	22.05	202.95	10 590
20	9.85	40.60	14.50	400.03	142.87	28 328	22.05	217.26	11 336
21	12.32	40.60	14.50	500.35	178.70	35 432	22.05	271.74	14 179
22	13.84	40.60	14.50	561.79	200.64	39 784	22.05	305.11	15 921
23	16.06	40.60	14.50	652.08	232.89	46 178	22.05	354.15	18 479
24	16.34	40.60	14.50	663.37	236.92	46 977	22.05	360.28	18 799
25	17.23	40.60	14.50	699.73	249.90	49 552	22.05	380.03	19 830
26	17.64	40.60	14.50	716.03	255.73	50 706	22.05	388.88	20 292
27	18.81	40.60	14.50	763.69	272.75	54 081	22.05	414.76	21 642
28	18.87	40.60	14.50	766.19	273.64	54 259	22.05	416.12	21 713
29	20.54	40.60	14.50	833.91	297.83	59 054	22.05	452.90	23 632
30	23.60	40.60	14.50	958.06	342.16	67 845	22.05	520.32	27 150
31	20.20	40.60	14.50	820.12	292.90	58 077	22.05	445.41	23 241

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TABLE III.1 1996 PRODUCTIVITY HOURS AND EARNINGS (continued)

MALE

	Employed						Unemployed		
				Estimated earnings				Estimated earnings	
Age	*Workplace earnings ($/hour)*	*Employed hours worked per week*	*Household hours worked per week*	*Employed work ($/week)*	*Household activity ($/week)*	*Annualised ($/year)*	*Household hours worked per week*	*Household activity ($/week)*	*Annualised ($/year)*
32	20.08	40.60	14.50	815.10	291.11	57 722	22.05	442.68	23 099
33	21.25	40.60	14.50	862.75	308.13	61 096	22.05	468.56	24 450
34	21.90	40.60	14.50	889.09	317.53	62 961	22.05	482.87	25 196
35	24.09	40.60	14.50	978.12	349.33	69 266	22.05	531.22	27 719
36	20.63	40.60	14.50	837.67	299.17	59 320	22.05	454.94	23 739
37	21.62	40.60	14.50	877.80	313.50	62 162	22.05	476.74	24 876
38	22.24	40.60	14.50	902.88	322.46	63 938	22.05	490.36	25 587
39	23.47	40.60	14.50	953.04	340.37	67 490	22.05	517.60	27 008
40	25.14	40.60	14.50	1 020.76	364.56	72 286	22.05	554.38	28 927
41	25.11	40.60	14.50	1 019.50	364.11	72 197	22.05	553.70	28 892
42	26.44	40.60	14.50	1 073.42	383.37	76 015	22.05	582.98	30 420
43	27.30	40.60	14.50	1 108.54	395.91	78 502	22.05	602.05	31 415
44	24.28	40.60	14.50	985.64	352.02	69 799	22.05	535.31	27 932
45	22.24	40.60	14.50	902.88	322.46	63 938	22.05	490.36	25 587
46	24.22	40.60	14.50	983.14	351.12	69 621	22.05	533.94	27 861
47	23.50	40.60	14.50	954.29	340.82	67 579	22.05	518.28	27 044
48	27.24	40.60	14.50	1 106.03	395.01	78 324	22.05	600.69	31 344

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TABLE III.1 1996 PRODUCTIVITY HOURS AND EARNINGS (continued)

MALE

	Employed						Unemployed		
				Estimated earnings				Estimated earnings	
Age	*Workplace earnings ($/hour)*	*Employed hours worked per week*	*Household hours worked per week*	*Employed work ($/week)*	*Household activity ($/week)*	*Annualised ($/year)*	*Household hours worked per week*	*Household activity ($/week)*	*Annualised ($/year)*
49	23.13	40.60	14.50	939.25	335.45	66 513	22.05	510.11	26 617
50	24.18	40.60	14.50	981.88	350.67	69 533	22.05	533.26	27 826
51	23.81	40.60	14.50	966.83	345.30	68 467	22.05	525.09	27 399
52	27.55	40.60	14.50	1 118.57	399.49	79 212	22.05	607.50	31 699
53	25.61	40.60	14.50	1 039.57	371.27	73 618	22.05	564.59	29 460
54	20.29	40.60	14.50	823.88	294.24	58 344	22.05	447.45	23 348
55	19.55	40.60	14.50	793.78	283.49	56 212	22.05	431.11	22 495
56	19.12	40.60	14.50	776.23	277.22	54 969	22.05	421.57	21 998
57	19.71	40.60	14.50	800.05	285.73	56 656	22.05	434.51	22 673
58	22.18	40.60	14.50	900.37	321.56	63 760	22.05	489.00	25 516
59	17.64	40.60	14.50	716.03	255.73	50 706	22.05	388.88	20 292
60	19.67	40.60	14.50	798.80	285.29	56 567	22.05	433.83	22 637
61	30.15	40.60	14.50	1 223.90	437.11	86 672	22.05	664.71	34 684
62	22.27	40.60	14.50	904.13	322.91	64 027	22.05	491.04	25 622
63	20.54	40.60	14.50	833.91	297.83	59 054	22.05	452.90	23 632
64	15.07	40.60	14.50	611.95	218.55	43 336	22.05	332.35	17 342
65+	11.46	40.60	14.50	465.23	166.16	32 946	22.05	252.67	13 184

Continued on next page

TABLE III.1 1996 PRODUCTIVITY HOURS AND EARNINGS (continued)

FEMALE

	Employed						Unemployed		
				Estimated earnings				Estimated earnings	
Age	*Workplace earnings ($/hour)*	*Employed hours worked per week*	*Household hours worked per week*	*Employed work ($/week)*	*Household activity ($/week)*	*Annualised ($/year)*	*Household hours worked per week*	*Household activity ($/week)*	*Annualised ($/year)*
15	3.27	28.80	28.40	94.05	92.74	9 747	38.23	124.84	6 514
16	3.92	28.80	28.40	112.86	111.29	11 696	38.23	149.81	7 817
17	5.09	28.80	28.40	146.72	144.68	15 205	38.23	194.76	10 162
18	8.49	28.80	28.40	244.53	241.13	25 342	38.23	324.60	16 937
19	11.19	28.80	28.40	322.28	317.80	33 399	38.23	427.80	22 323
20	12.37	28.80	28.40	356.14	351.19	36 908	38.23	472.75	24 668
21	16.37	28.80	28.40	471.50	464.96	48 864	38.23	625.89	32 659
22	17.90	28.80	28.40	515.39	508.24	53 413	38.23	684.15	35 699
23	18.81	28.80	28.40	541.73	534.20	56 142	38.23	719.11	37 523
24	20.90	28.80	28.40	601.92	593.56	62 380	38.23	799.01	41 692
25	19.33	28.80	28.40	556.78	549.04	57 702	38.23	739.08	38 565
26	21.34	28.80	28.40	614.46	605.93	63 680	38.23	815.65	42 561
27	20.07	28.80	28.40	578.09	570.06	59 911	38.23	767.38	40 042
28	23.77	28.80	28.40	684.68	675.17	70 957	38.23	908.87	47 425
29	22.69	28.80	28.40	653.33	644.26	67 708	38.23	867.26	45 253
30	19.68	28.80	28.40	566.81	558.94	58 741	38.23	752.40	39 260
31	21.42	28.80	28.40	616.97	608.40	63 940	38.23	818.98	42 734

Continued on next page

TABLE III.1 1996 PRODUCTIVITY HOURS AND EARNINGS (continued)

FEMALE

	Employed						*Unemployed*		
				Estimated earnings				*Estimated earnings*	
Age	*Workplace earnings ($/hour)*	*Employed hours worked per week*	*Household hours worked per week*	*Employed work ($/week)*	*Household activity ($/week)*	*Annualised ($/year)*	*Household hours worked per week*	*Household activity ($/week)*	*Annualised ($/year)*
32	20.46	28.80	28.40	589.38	581.19	61 081	38.23	782.36	40 824
33	19.94	28.80	28.40	574.33	566.36	59 521	38.23	762.39	39 781
34	22.77	28.80	28.40	655.84	646.73	67 968	38.23	870.58	45 427
35	21.47	28.80	28.40	618.22	6109.64	64 070	38.23	820.65	42 821
36	18.24	28.80	28.40	525.43	518.13	54 453	38.23	697.47	36 394
37	22.64	28.80	28.40	652.08	643.02	67 578	38.23	865.59	45 167
38	25.30	28.80	28.40	728.57	718.45	75 506	38.23	967.13	50 465
39	21.07	28.80	28.40	606.94	598.51	62 900	38.23	805.67	42 040
40	18.46	28.80	28.40	531.70	524.31	55 102	38.23	705.79	36 828
41	18.90	28.80	28.40	544.24	536.68	56 402	38.23	722.44	37 697
42	18.20	28.80	28.40	524.17	516.89	54 323	38.23	695.80	36 307
43	20.29	28.80	28.40	584.36	576.25	60 561	38.23	775.70	40 476
44	20.03	28.80	28.40	576.84	568.83	59 781	38.23	765.72	39 955
45	21.77	28.80	28.40	627.00	618.29	64 979	38.23	832.30	43 429
46	23.08	28.80	28.40	664.62	655.39	68 878	38.23	882.24	46 035
47	19.11	28.80	28.40	550.51	542.86	57 052	38.23	730.76	38 131
48	22.86	28.80	28.40	658.35	649.21	68 228	38.23	873.91	45 601

Continued on next page

TABLE III.1 1996 PRODUCTIVITY HOURS AND EARNINGS (continued)

FEMALE

	Employed						Unemployed		
				Estimated earnings				Estimated earnings	
Age	*Workplace earnings ($/hour)*	*Employed hours worked per week*	*Household hours worked per week*	*Employed work ($/week)*	*Household activity ($/week)*	*Annualised ($/year)*	*Household hours worked per week*	*Household activity ($/week)*	*Annualised ($/year)*
49	20.20	28.80	28.40	581.86	573.77	60 301	38.23	772.37	40 302
50	21.47	28.80	28.40	618.22	609.64	64 070	38.23	820.65	42 821
51	21.90	28.80	28.40	630.76	622.00	65 369	38.23	837.29	43 690
52	20.90	28.80	28.40	601.92	593.56	62 380	38.23	799.01	41 692
53	20.86	28.80	28.40	600.67	592.32	62 250	38.23	797.34	41 605
54	18.51	28.80	28.40	532.95	525.55	55 232	38.23	707.45	36 915
55	16.76	28.80	28.40	482.79	476.08	50 034	38.23	640.87	33 441
56	17.29	28.80	28.40	497.84	490.92	51 594	38.23	660.85	34 483
57	13.98	28.80	28.40	402.53	396.94	41 717	38.23	534.34	27 882
58	14.59	28.80	28.40	420.09	414.26	43 536	38.23	557.64	29 098
59	20.38	28.80	28.40	586.87	578.72	60 821	38.23	779.03	40 650
60	19.42	28.80	28.40	559.28	551.52	57 962	38.23	742.41	38 739
61	29.65	28.80	28.40	853.97	842.11	88 502	38.23	1133.59	59 151
62	14.11	28.80	28.40	406.30	400.65	42 107	38.23	539.33	28 142
63	24.91	28.80	28.40	717.29	707.33	74 336	38.23	952.15	49 683
64	11.58	28.80	28.40	333.56	328.93	34 569	38.23	442.78	23 104
65+	17.98	28.80	28.40	517.90	510.71	53 673	38.23	687.48	35 873

Source BTE estimates and ABS 1996d unpublished data.

APPENDIX IV LABOUR FORCE PARTICIPATION RATE 1996

TABLE IV.1 LABOUR FORCE PARTICIPATION RATE 1996

Age	*Female*	*Male*	*Age*	*Female*	*Male*
15	0.29	0.25	51	0.60	0.82
16	0.43	0.36	52	0.56	0.80
17	0.47	0.47	53	0.55	0.80
18	0.57	0.60	54	0.51	0.80
19	0.63	0.65	55	0.50	0.73
20	0.67	0.71	56	0.41	0.72
21	0.68	0.71	57	0.43	0.65
22	0.71	0.77	58	0.32	0.64
23	0.70	0.80	59	0.30	0.55
24	0.71	0.81	60	0.25	0.52
25	0.69	0.84	61	0.22	0.48
26	0.67	0.84	62	0.16	0.41
27	0.64	0.84	63	0.12	0.37
28	0.64	0.87	64	0.12	0.32
29	0.61	0.87	65	0.09	0.23
30	0.62	0.87	66	0.06	0.20
31	0.59	0.87	67	0.06	0.17
32	0.60	0.86	68	0.05	0.13
33	0.60	0.87	69	0.04	0.10
34	0.59	0.87	70	0.03	0.09
35	0.61	0.87	71	0.03	0.07
36	0.65	0.87	72	0.03	0.08
37	0.63	0.87	73	0.02	0.06
38	0.66	0.86	74	0.02	0.06
39	0.69	0.87	75	0.01	0.06
40	0.69	0.86	76	0.01	0.05

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TABLE IV.1 LABOUR FORCE PARTICIPATION RATE 1996 (continued)

Age	*Female*	*Male*	*Age*	*Female*	*Male*
41	0.72	0.87	77	0.01	0.03
42	0.70	0.87	78	0.01	0.03
43	0.70	0.87	79	0.01	0.03
44	0.72	0.87	80	0.01	0.02
45	0.69	0.86	81	0.01	0.03
46	0.71	0.85	82	0.01	0.03
47	0.69	0.85	83	0.00	0.03
48	0.66	0.85	84	0.00	0.04
49	0.65	0.86	85	0.00	0.02
50	0.64	0.82	86+	0.00	0.00

Source ABS 1996d unpublished data.

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ABBREVIATIONS

ABS	Australian Bureau of Statistics
AIHW	Australian Institute of Health and Welfare
AMSA	Australian Maritime Safety Authority
BASI	Bureau of Air Safety Investigation
BTCE	Bureau of Transport and Communications Economics
BTE	Bureau of Transport Economics
CASA	Civil Aviation Safety Authority
DALYs	disability-adjusted life years
HcRPT	high capacity regular passenger transport
ICAO	International Civil Aviation Organisation
ISC	Insurance and Superannuation Commission
LcRPT	low capacity regular passenger transport
NHTSA	National Highway Traffic Safety Administration (USA)
QALYs	quality adjusted life years
RPT	regular passenger transport
TAC	Transport Accident Commission (Victoria)