Occupational Health and Safety Priorities for the Australian Coal Industry

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March 2000

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Research Funded by:
Australian Coal Association Research Program (ACARP)

Executive Summary

The University of Ballarat, funded by the Australian Coal Association Research Program (ACARP), has analysed workers' compensation claims relating to the black coal mining industry in Queensland and New South Wales (ACARP Project No. C8025). This project followed an ACARP project some years earlier that examined the same issues (Mitchell & Larsson 19994).

Data from Queensland (2287 claims from 1 July 1997 to 25 March 1999) and New South Wales (13850 claims from 1 January 1996 to 31 December 1998) were analysed. Four-hundred and six (406) abstracts of research published since 1993 were also analysed. The priorities emerging from the compensation claims data were compared with the topics addressed over recent years of research in coal mining.

The analysis of compensation data showed that soft-tissue injuries that are usually thought of as being related to manual handling (strain, sprain, etc) make up a large proportion of the compensation costs in both underground (44% in Queensland and 59% in NSW) and open cut mines (41% in Queensland and 74% in NSW). Traumatic injuries (fracture, bruise, laceration, etc) are also significant with the costs of these injuries contributing to between 10 and 30 percent of the total in both mine types and both states.

The costly injury types in underground mining are: overexertion (29%); slips, trips and falls (22%); and being struck by objects (20%). In open cut mining the costly injury types include: overexertion (18%); slips, trips and falls (22%); vehicle vibration (21%); and vehicle accidents (16%).

In open cut mining, injury causation mostly involves mobile plant (52%) including: dump trucks (21%); dozers (11%); and front-end loaders (5%). Floor surfaces and steps and stairs (11% combined) are also commonly involved in open cut injuries. Underground accidents are more diverse with accidents involving a wide range of mobile/semi-mobile plant and the work environment itself. Powered plant is often associated with underground accidents (17%) and includes: conveyors (4%); transporters (3%); roof-bolters (3%); chocks (2%); and loaders (2%). The work environment itself is often involved, including: floor surfaces (18%), the rib, roof and face (11%); and coal, rocks, etc in general (6%). Other plant is also important such as the trailing cable (3%) and ventilation equipment (2%).

In terms of research, activity World-wide over the 1990's seems to have kept pace with the 1980's with 700-800 research reports being published in both decades (see Mitchell & Larsson 1994). The topics of international literature seem to be consistent between this study period (post 1993) and the pre 1994 literature examined by Mitchell and Larsson (1994). Research about dust and respiratory issues was common pre 1994 (30%) and remains common (27%)

post 1993. In Australia this topic was common pre 1994 (25%) but has recently been less significant (3% post 1993).

To summarize recent research efforts, two-thirds (66%) of research internationally has addressed the topics of: dust and respiratory issues (27%); fire (15%); ground, wall or roof support (14%); or ventilation or air quality (10%). In contrast recent Australian research has addressed somewhat different topics. In Australia, two-thirds of recent Australian research (ACARP projects) has been concerned with the topics of: ground, wall or roof-support (25%); explosions (15%); machinery (10%); fire (7%); and management systems (7%). In both Australian and international efforts there is an absence of research about manual handling issues.

In order to ensure that occupational health and safety are addressed in a way that will reduce compensation costs, research projects must be encouraged in areas where these costs are incurred. Given that manual handling is so costly in compensation terms, encouragement of research about how to control this problem should be encouraged. However, more generally, this report recommends that an *OHS Impact Statement* be required of all research projects in coal mining. This requirement should cover all research, including those not specifically targeting workplace safety, so as to maximize opportunities to draw safety benefits from all projects. A simple one-page checklist model is proposed to assist applicants with the identification of the areas of occupational health and safety that their project could influence. This will assist funding agencies in the assessment of the degree to which proposed research will address priority issues. It is recognized in this report that compensation costs are not the only parameter to consider when determining the merit of safety research and considerations outside the scope of the checklist presented will also be needed.

The following organisations and people are acknowledged for their support:
Australian Coal Association Research Program (ACARP);
WorkCover Queensland (provision of data);
Joint Coal Board NSW (provision of data); and
Ian Firth, Rio Tinto (industry monitor).

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1 Introduction

Over the last decade the mining industry in Australia has improved its OHS performance significantly (Minerals Council of Australia 1999). Coal mining has been part of this general improvement. For instance, between 1993-94 and 1997-98, the lost-time injury frequency rate (LTIFR) in NSW underground coal mining dropped from 88 to 65 injuries per million hours (JCB 1998). In open cut mining the reduction has not been so pronounced, with the figures being 33 in 1993-94 and 31 in 1997-98 (JCB 1998). In Queensland, the rate of lost-time injuries has also reduced over this period with the rate in underground mining falling from 73 to 39 and in open cut mining dropping from 25 to 7.8 (DME 1998).

Funded by ACARP Mitchell and Larrson (1994) undertook a study of coal mining compensation claims (NSW and Queensland) and a study of research literature about occupational health and safety in coal mining (World-wide). They concluded that there was something of a mis-match between the problems addressed by research literature and the problems that cause injuries. Among the findings were issues such as::

- research literature was dominated by analytical and informative research and too little attention was given to investigative/preventative research;
- research was dominated by studies concerned with underground activities and there was too few research projects about above-ground work at underground coal mines and about open-cut mining; and
- there were no research reports addressing manual handling problems despite this issue accounting for a large proportion of compensation costs.

It is thus worthwhile at this time to re-examine compensation data to determine priorities that are likely to result in a continuing fall in claims and compensation costs. Therefore the central aims of the study were to:

- identify priority OHS issues to be addressed that will achieve greatest return on strategic investment for the industry; and
- review relevancy of existing OHS research topics for the Australian Black Coal Industry and where necessary, recommend new and emerging issues for research investment.

This research consisted of an analysis of New South Wales and Queensland compensation data and an analysis of literature concerning research projects in Australia and abroad.

2 Methods

2.1 Methods: compensation analysis

Workers' compensation injury and disease claims data for the black coal mining sector were obtained for analysis:

- Queensland, 2287 claims from 1 July 1997 to 25 March 1999, courtesy of WorkCover Queensland; and
- New South Wales, 13850 claims from 1 January 1996 to 31 December 1998[1], courtesy of the Joint Coal Board (JCB).

The analysis focussed on NSW and Queensland because these two states produce 96% of saleable Australian coal (Figure 1 & Table 1; JCB & DME 1999).

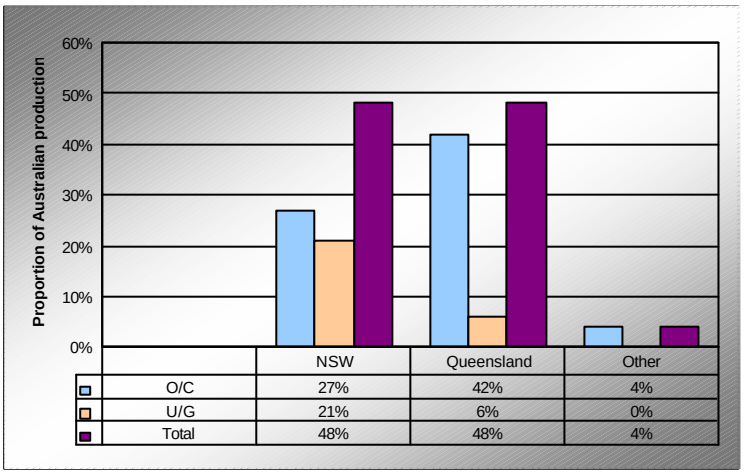


Figure 1 Coal production in Australia, 1998 (JCB & DME 1999)

Table 1 Coal production in Australia, 1998 (JCB & DME 1999)

	NSW	**Queensland**	**Other**	**Total**
O/C Saleable Coal, Mt	58.7 (27%)	91.6 (42%)	8.7 (4%)	159 (72%)
U/G Saleable Coal, Mt	46.5 (21%)	13.6 (6%)	0.3 (0%)	60 (28%)
Total Saleable Coal, Mt	105 (48%)	105 (48%)	9.0 (4%)	219 (100%)

[1] There was no data supplied beyond an "entry date" of 31 December 1998. Based on inspection of the data, there is often about a month between the injury and the entry date therefore some injuries late in 1998 (especially December) are likely to be missing.

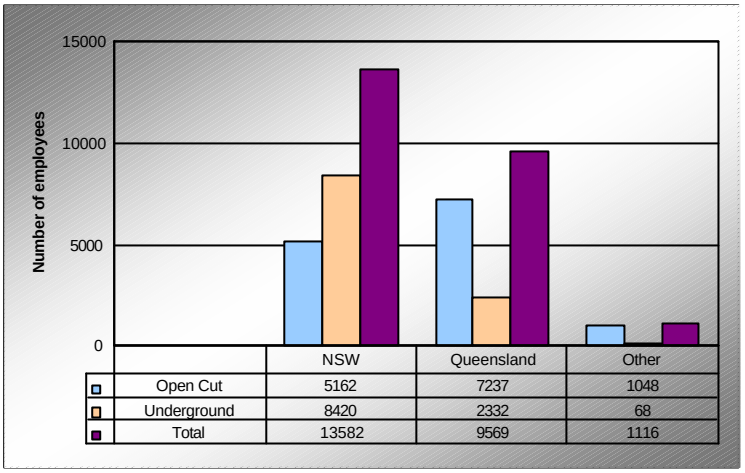


Figure 2 Coal employment in Australian, 1996-1998 [2] (JCB & DME 1999)

Table 2 Coal employment in Australia (JCB & DME 1999)

Mine type	State	Year			Average	Study Period	Average over study period
		1996	1997	1998			
Underground	NSW	8999	8955	7306	8420	Jan 96 - Dec 98	8420
	Queensland	2374	2369	2314	2352	Jul 97- Mar 99	2332 [2]
	Other	67	65	71	68		
Open Cut	NSW	5135	5370	4980	5162	Jan 96 - Dec 98	5162
	Queensland	8469	8161	6775	7802	Jul 97- Mar 99	7237 [2]
	Other	1125	1051	969	1048		

The period of analysis in the case of the Queensland data was chosen because, prior to 1 July 1997, the coding of the data did not enable black coal mining to be differentiated from other types of mining.

The data fields available are shown in Appendix A (Table 25). All major fields were reasonably complete with the exception of occupation in the Queensland data. The occupation field was generally incomplete for dates prior to 1 January 1998 and generally complete since. Confidential fields, such as the claimant's name, were blank.

Some of the Queensland data fields were text (e.g. “occupation”, “nature of injury” and “part of body”). These were converted from text to codes as per the NSW Joint Coal Board system.

Some of the claims may be ongoing, especially as some of the claims are recent, however these claims are not identified. A comparison of the date of ceasing work[3] and the number of

[2] Queensland: average for study period July 1997 to March 1999 calculated based on weighted average of 33% 1997 employment figures and 66% 1998 employment figures (1999 not available).

[3] There is no "date of ceasing work" in the Queensland data hence the "injury date" was used.

days lost shows that ten of the Queensland claims and 33 of the NSW claims appear to be ongoing. The ongoing claims are well distributed over the analysis period[4]. There could be other claims that are ongoing, for instance where the person returned to work for a period of time. This said, it appears as though there are a reasonably small number of ongoing claims in each data set. Costs are thus slightly underestimated, although the difference this would make would seem to be relatively small. The underestimation makes no difference in terms of comparing mine-types or other variables, as we could expect these open claims to be about equally dispersed across the variables. In addition, some no-lost-time claims could be ongoing, however these tend to be of small significance in terms of cost.

Very often, a lost-time injury frequency rate (LTIFR) is used as an indicator of the level of injuries. Because of the focus on determining priorities that will achieve financial returns, the analysis here mainly uses claims cost rather than the number of claims. Further, the analysis here is based on all claims rather than only lost-time claims.

All cost components (compensation, hospital, lump sums, medical, other, rehabilitation) in the Queensland data are significantly correlated (at the 0.01 level) with the total claim cost (Pearson correlation coefficient = 0.56 to 0.85). New South Wales data includes no breakdown of total payments into components (i.e. no data about medical payments, compensation, etc). Compensation payments are the main cost, constituting 54% of the total cost. Lump sum payments and medical costs were also prominent at 20% and 13% respectively. Similarly, the number of days lost per claim and the claim cost were significantly correlated (at the 0.01 level) both in the Queensland data (0.82) in the NSW data (0.67). Because the cost components are correlated with the total cost, and the number of days lost is correlated, "total claim cost" was used as the dependent variable analysis.

[4] NSW: 14 in 1998, 9 in 1997, and 7 in 1996; Queensland: 4 in the first 3 months of 1999, 9 in 1998, and one in the second 6 months of 1997

2.2 Methods: analysis of research abstracts

The sources of information listed in Table 3 were used. Sources of information shown in Table 4 were consulted but literature from these sources was not used for the reasons outlined. Reports were selected for analysis if they satisfied the criterion: *did the content of the report indicate a relationship to occupational health and safety matters in the mining industry?* Literature was analyzed using the model outlined by Mitchell and Larsson (1994) and shown in Table 5.

Table 3 Sources of research literature

Sources	**Comment**
NIOSHTIC, HSELINE and CISDOC Databases	Two hundred and sixty-four (264) abstracts were included. The research was published in the following journals: *Occupational and Environmental Medicine, Journal of Occupational and Environmental Medicine, Mining Engineering, Mine Engineer, Mining Technology, Science of the Total Environment, Occupational Medicine: State of the Art Review, Journal of Environmental Science and Health, Applied Occupational and Environmental Hygiene, Journal of Health and Safety.*
Dissertations Abstracts International	Nine (9) PhD theses were included and combined in the report with the data from the NIOSHTIC, HSELINE and CISDOC databases.
ACARP (including ERDDC) Projects (1993-1999)	Forty-eight (48) ACARP projects were included that satisfied the inclusion criterion and where an abstract was available. Thirteen (13) NERDDC reports were included (the National Energy Research, Development and Demonstration Council (NERDDC) was the predecessor body to ACARP).
ACARP research in progress (1999-2001 completion dates)	Forty (40) ACARP quarterly reports of research in progress were included.
NIOSH Office for Mine Safety & Health Research www.cdc.gov/niosh/pit/welcome.htm	Sixteen (16) projects were included. The projects included research from 1994-1997 and included research by the US Bureau of Mines.
South African Chamber of Mines, Coal Research & Development http://196.26.82.197/coaldb98.ns http://196.26.82.197/coaldb99.ns)	Twenty-nine (29) projects over 1998 and 1999 were included.

Table 4 Sources of research literature consulted but not used

Source	Comment
Australian Mineral Industries Research Association Ltd (AMIRA) www.amira.com.au	A small number of current AMIRA research projects may have relevance for the coal industry (e.g. *Rock support and reinforcement practice*; *Blasting & reinforcement technology*; *Shotcrete, mesh & bolts – what, where, when and how?*; *Autonomous underground mining vehicles*) however these are not directly related to the coal industry and were not included.
CSIRO mineral exploration and mining research pages. www.its.csiro.au	Eight research projects were identified as relevant to this study. With the exception of one project (*Virtual mine safety – apply virtual reality techniques to mine applications for safety, health and mines rescue*), these projects were counted in the ACARP and AMIRA projects lists.
Coal Association of Canada www.coal.ca	The Coal Association of Canada did not have a record of research projects. The proceedings of the 1997 *42nd Canadian Conference on Coal,* were available but were not purchased.
United States Department of Energy www.fe.doe.gov	None of the 17 University project awards for 1999 were coal related. Over one thousand (1230) items resulted from using the website search string "coal mining research". A review of the top 100 of these items showed them to be concerned mainly with policy and pollution control. There were no citations related to occupational health and safety and coal mining.
RILO Database (Reyerson International Labour Occupational Safety and Health Index, Ryerson Library Ontario, Canada).	The RILO abstracts were too brief to analyze and included few reports of original research.
UK "Coal Abstracts on CD-ROM", including 100,000 entries.	This database was not purchased. A copy in Australia was located (HRL Industries, in Mulgrave, Victoria). The license is held in conjunction with the Institution of Engineers Australia. The librarian at HRL Industries was not willing to conduct a search for this project.

Table 5 Literature variables and categories (from Mitchell & Larsson 1994)

Variable	Categories
(a) Subject	1. Worker health and safety 2. Disaster control 3. General
(b) Focus	1. Analytical 2. Information 3. Investigation 4. Prevention
(c) Activity	1. Underground 2. Surface Excavations 3. Services & Processing 4. General
(d) Topic	1. Dust and Respiratory 2. Accident Analysis 3. Ground, wall or roof support 4. Fire 5. Explosions 6. Machinery, incl. vehicles 7. Diesel fumes 8. Ventilation or air quality 9. Management Systems 10. Manual Handling 11. Miscellaneous Hazards 12. Electrical 13. Noise 14. Other
(e) Country	1. Africa (excluding South Africa) 2. Australia 3. Canada 4. China 5. CIS or Russia 6. France 7. Germany, Baltic 8. India 9. Italy 10. Japan 11. South Africa 12. South America 13. United Kingdom 14. United States of America 15. Not stated 16. Other
(f) Year	

3 Results

3.1 Compensation analysis

3.1.1 Overview

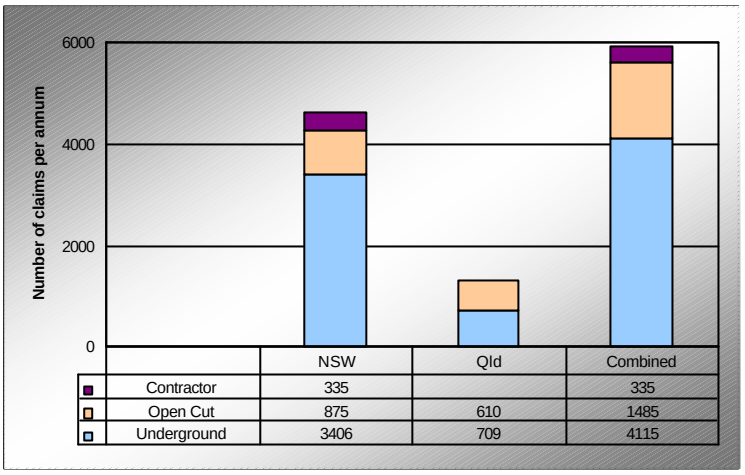
Table 6 lists the number of claims and claims cost by state and by mine type (Queensland data does not separately list contractors) in the data set analyzed. The mine type "contractor" refers to contract mining companies. These data are also presented on a per annum basis (NSW data includes three years and Queensland data includes 633 days or 1.73 years).

Table 6 Number and cost of claims by mine type and state

Mine type	State	Total data set			Per annum	
		No. claims	Mean cost	Total cost	No. claims	Cost
Underground	NSW	10218	$4,283	$43,764,963	3406	$14,588,321
	Queensland	1229	$1,645	$2,021,641	709	$1,165,717
	Total	11447	$4,000	$45,786,604	4115	$15,754,038
Open Cut	NSW	2626	$6,252	$16,416,800	875	$5,472,267
	Queensland	1058	$2,479	$2,622,663	610	$1,512,278
	Total	3684	$5,168	$19,039,463	1485	$6,984,545
Contractor	NSW	1006	$7,109	$7,151,604	335	$2,383,868
Total	NSW	13850	$4,862	$67,333,367	4617	$22,444,455
	Queensland	2287	$2,031	$4,644,304	1319	$2,677,995
	Total	16137	$4,460	$71,977,671	5935	$25,122,450

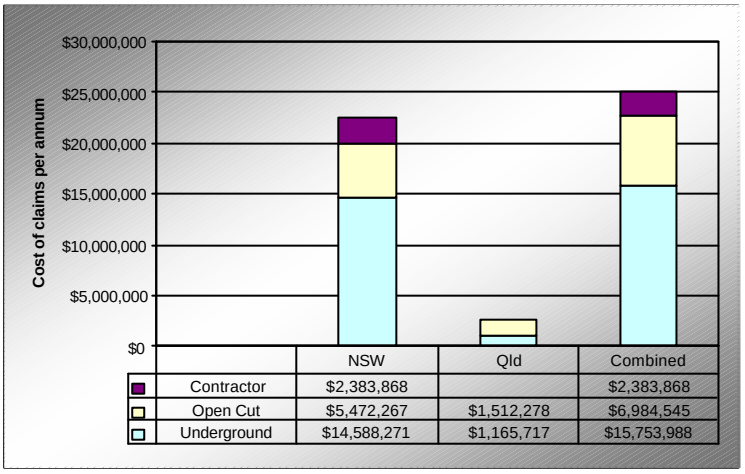
The number of claims per annum is illustrated in Figure 3. Two things are apparent. Firstly, the majority of claims are made on NSW operations (77%) and secondly the majority of claims are made on underground operations (69%). These two facts are likely to be related given the higher proportion of mine workers employed in underground mines in NSW (Figure 2 & Table 2; JCB & DME 1999).

Figure 4 and Figure 5 respectively show the cost of claims and days per annum by state (NSW & Queensland) and by mine type (underground, open cut & contractors). Like the number of claims, the claims cost and days lost are dominated by claims on NSW mines, especially underground mines.



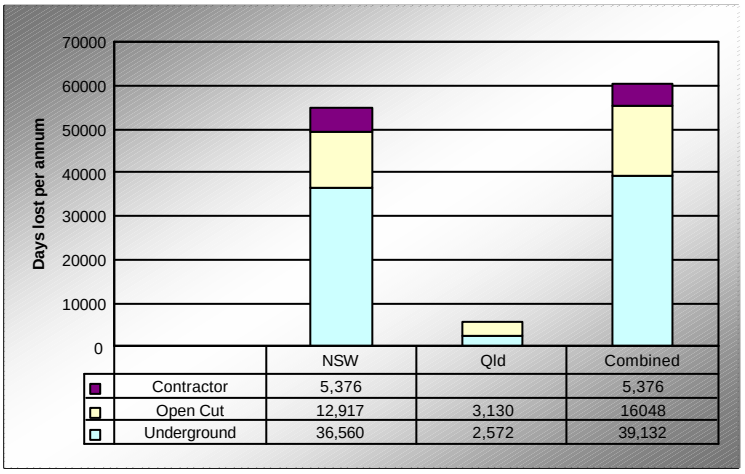
	NSW	Qld	Combined
Contractor	335		335
Open Cut	875	610	1485
Underground	3406	709	4115

Figure 3 Number of claims per annum: by state and mine type



	NSW	Qld	Combined
Contractor	$2,383,868		$2,383,868
Open Cut	$5,472,267	$1,512,278	$6,984,545
Underground	$14,588,271	$1,165,717	$15,753,988

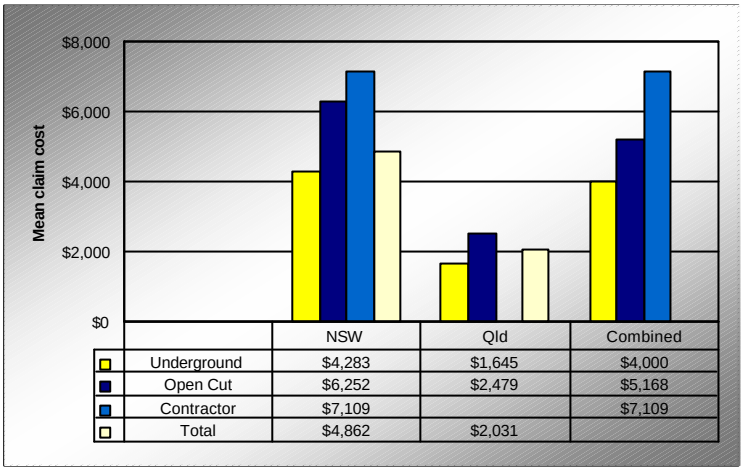
Figure 4 Cost of claims per annum: by state and mine type



	NSW	Qld	Combined
Contractor	5,376		5,376
Open Cut	12,917	3,130	16048
Underground	36,560	2,572	39,132

Figure 5 Days lost per annum: by state and mine type

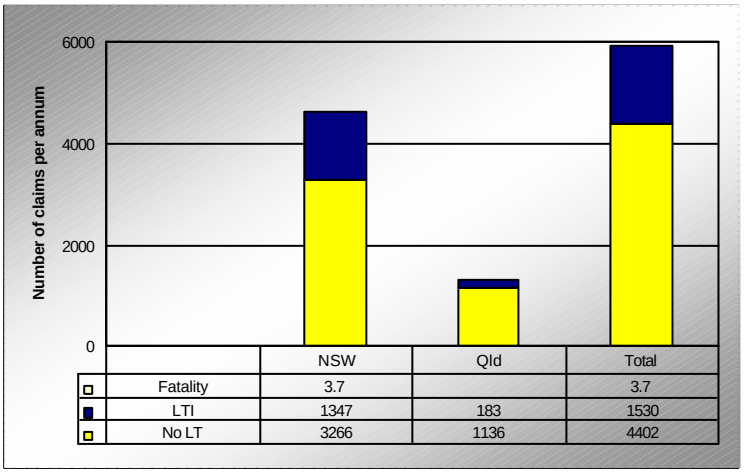
Figure 6 illustrates the mean claim cost by state and mine type. On average, claims in NSW are more costly than in Queensland in both underground mining (NSW 160% greater than Queensland) and open cut mining (NSW 150% greater than Queensland). It is also apparent that the mean cost in open cut mining is greater than in underground mining both in Queensland (open cut 51% greater than underground) and NSW (open cut 46% greater than underground). In NSW, contractor claims also seem to be greater than underground (66%).



	NSW	Qld	Combined
Underground	$4,283	$1,645	$4,000
Open Cut	$6,252	$2,479	$5,168
Contractor	$7,109		$7,109
Total	$4,862	$2,031	

Figure 6 Mean claim cost: by state and mine type

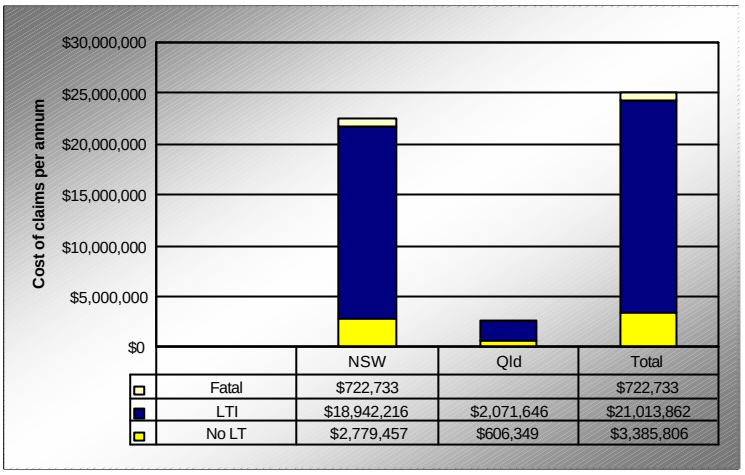
Figure 7 illustrates the number of claims per annum by state and by outcome (fatality, lost time, no lost time). Lost-time claims were 26% of the total (1530 of 5935) however this proportion was noticeably different between states. In NSW, 29% (3266 of 4617) of claims involve lost time, whereas in Queensland the figure is 14% (183 of 1319) and this is reflected in the lower mean claim cost in Queensland. The remainder of the claims were no lost time claims, with the exception of about 4 fatalities per annum in NSW (11 in the three-year sample in NSW).



	NSW	Qld	Total
Fatality	3.7		3.7
LTI	1347	183	1530
No LT	3266	1136	4402

Figure 7 Number of claims per annum: lost time v no lost time

In terms of total cost, it is apparent from Figure 8 that lost-time claims dominate. While only consisting of 26% of claims per annum, lost-time claims made up 84% of the total cost per annum ($21,013,862 of $25,122,450). These proportions are similar between the states (84% in NSW and 77% in Queensland).



	NSW	Qld	Total
Fatal	$722,733		$722,733
LTI	$18,942,216	$2,071,646	$21,013,862
No LT	$2,779,457	$606,349	$3,385,806

Figure 8 Cost of claims per annum: lost time v no lost time

3.1.2 Claims data on a per-employee basis

Table 2 outlines the number of employees in underground and open cut mines in Queensland and NSW over the study period. These figures were used as a basis for the calculation of claims cost, days lost, etc, on a per-employee basis.

Figure 9 illustrates the number of claims per employee per annum by state and mine type. It is apparent that on average, the number of claims per employee per annum is much greater in underground mining compared to open cut mining in NSW (2.4 times greater) and Queensland (3.6 times greater). Somewhat less outstanding, but nevertheless apparent, is the difference between the states, with the number of claims per employee per annum in NSW being greater than in Queensland in underground (1.3 times greater) and open cut mining (2 times greater).

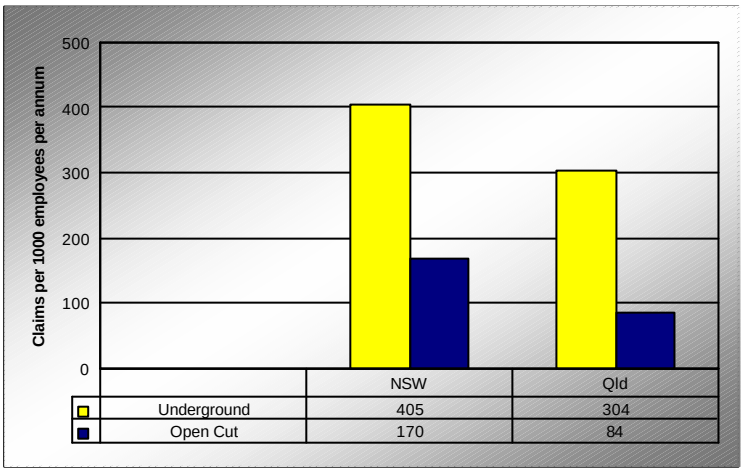


Figure 9 Number of claims per 1000 employees per annum (claims incidence): by state and mine type

Figure 10 illustrates the days lost per employee per annum by state and mine type. It is apparent that on average, the time lost due to injury per employee in NSW is greater than that in Queensland - in both underground (4 times greater) and open cut mining (8 times greater). It is also apparent that the number of days lost per employee per annum is greater in underground mining than in open cut mining in Queensland (2.8 times greater) and NSW (1.4 times greater).

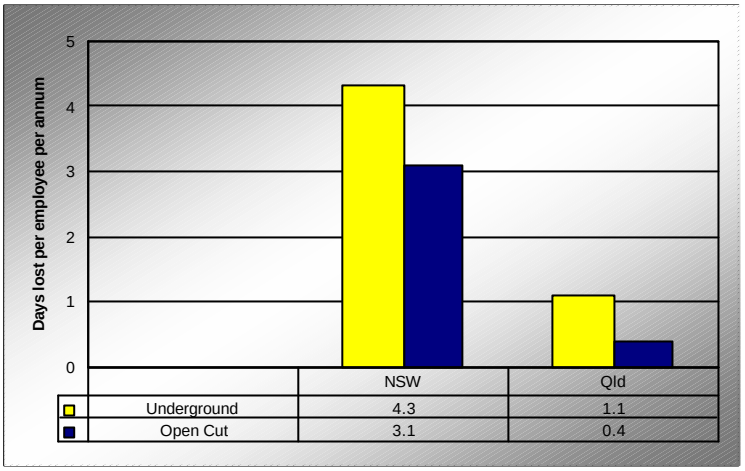


Figure 10 Days lost per employee per annum: by state and mine type

Figure 11 illustrates the cost per employee per annum by state and mine type. It is apparent that the costs are much greater in NSW compared to Queensland in underground (250% greater) and open cut mining (410% greater). It is also apparent that the cost per employee per annum is greater in underground mining than in open cut mining in Queensland (140% greater) and in NSW (63% greater).

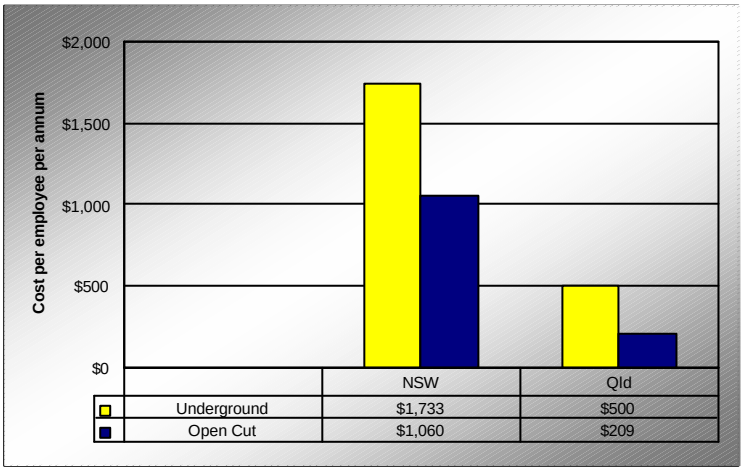


Figure 11 Cost per employee per annum: by state and mine type

3.1.3 Trends over time

Figure 12 shows the number of claims per month over the study period. A downward trend over time is most apparent in Queensland and evident (but less so) in NSW. There is no apparent trend among contractors in NSW. Because of changes in employment over time, these data would be best considered on a per employee basis (or other bases such as production) and this is considered further below.

Figure 13 and Figure 14 respectively show the mean number of days lost per claim and the mean claim cost on a month by month bases. These are highly correlated as previously noted. A downward trend in these figures, that represent claim severity, is less apparent than the trend with regard to the number of claims, but the mean claim severity seems to be reducing over time, especially in Queensland and among contractors in NSW.

Figure 15 and Figure 16 respectively show the cost per employee and number of days lost per 1000 employees per month over the study period. Again, these show a trend downward. For instance in underground mining in NSW, the cost per employee per month at the beginning of 1996 was about $200 (or about $2400 per annum) whereas two years later the figure was closer to $100 per month (or $1200 per annum).

Some caution should be attached to data near the end of the study period as claims may either have not been made (for instance injuries or diseases that become apparent later). Also, as noted earlier, there is often about a month between the injury and the entry of the data. This means that many late 1998 injuries in the NSW data may not be included (thus mainly affecting the last point in the chart, the "NSW UG/OC/Cont November 1998" moving average).

A summary of the per employee data is shown in Table 7. In most cases these figures have improved over time. Hence the average figures shown here generally overstate the current situation.

Table 7 Summary annual data per employee

Mine type	**State**	Claims per 1000 employees per annum	Days lost per employee per annum	Claims cost per employee per annum
Underground	NSW	405	4.3	$1,733
	Queensland	84	0.4	$209
Open Cut	NSW	170	3.1	$1,060
	Queensland	304	1.1	$500

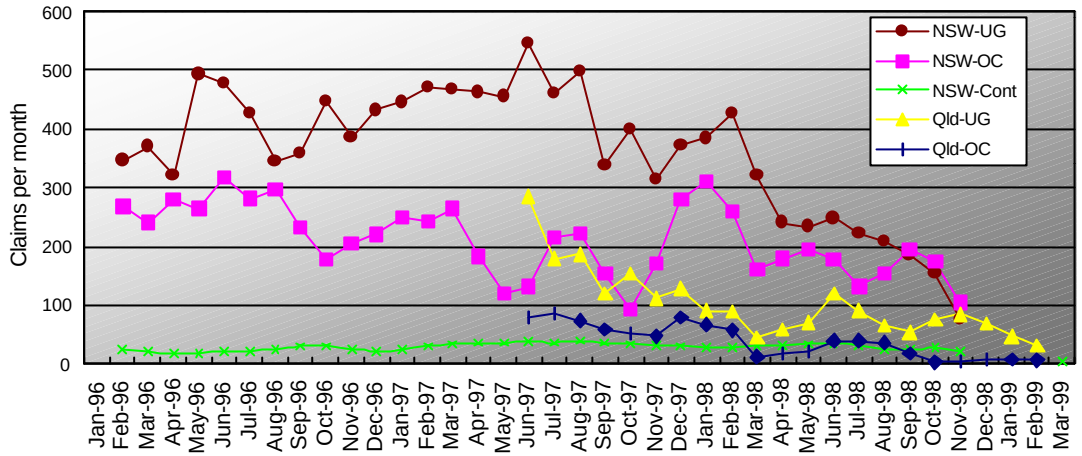


Figure 12 Number of claims per month (three month moving average)

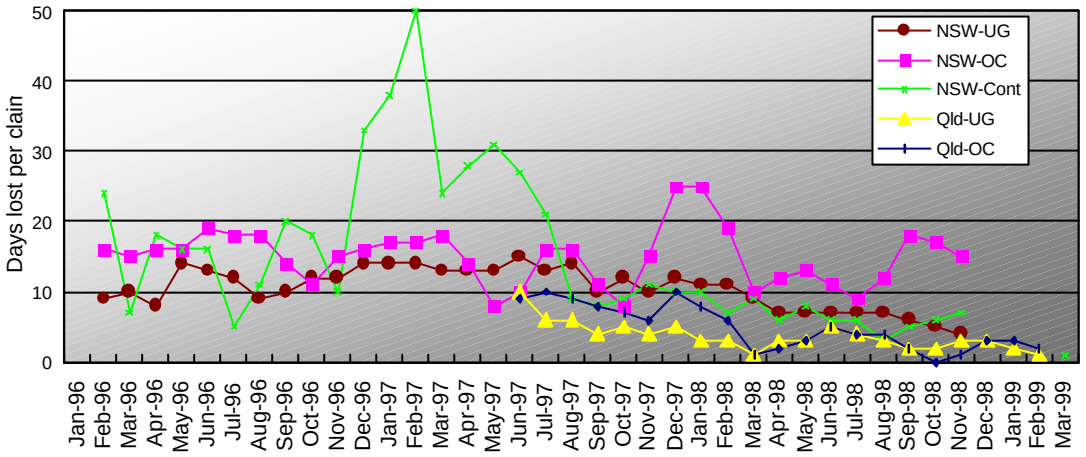


Figure 13 Mean number of days lost per claim: by month (three month moving average)

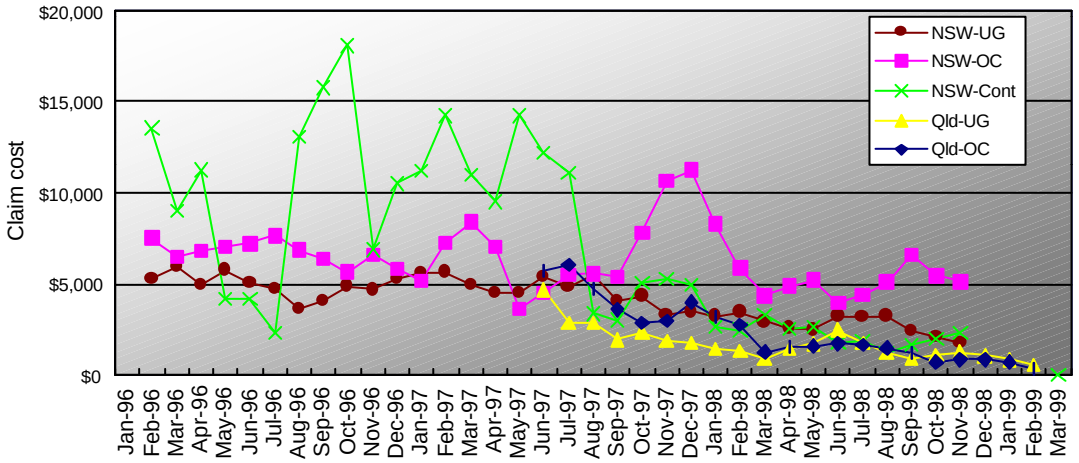


Figure 14 Mean claim cost: by month (three month moving average)

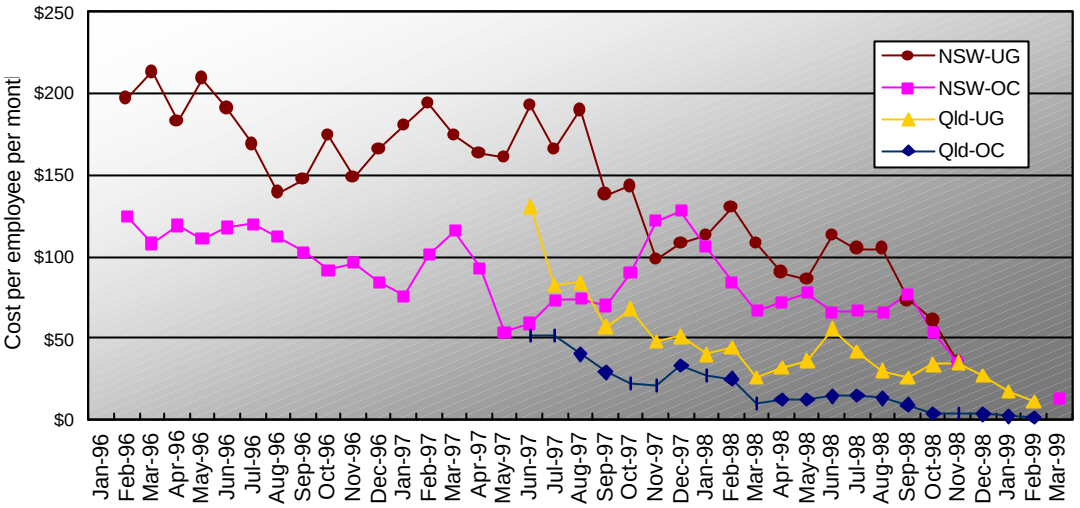


Figure 15 Cost per employee per month (three month moving average)

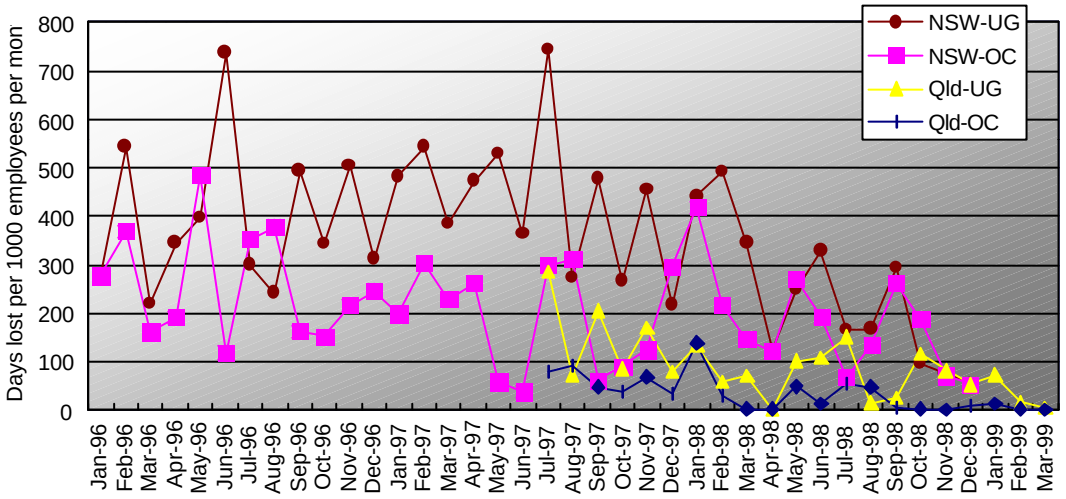


Figure 16 Days lost per 1000 employees per month (three month moving average)

3.1.4 Analysis of serious injuries

Figure 17 plots the cumulative proportion of cost against the cumulative proportion of claims with the claims ordered from most costly to least costly. It can be seen that the most costly 15 % of claims contribute about 90% of the cost.

As can be seen from Table 8 the most costly 15% of claims yields about 90% of the cost in each state/mine-type group. These 15% of claims were selected for further analysis. The purpose of this was to concentrate on relatively costly injuries and to simplify data analysis. The sample size is reasonably large, as the top 15% consist of 2,421 claims. These costly claims are hereafter referred to as serious injuries.

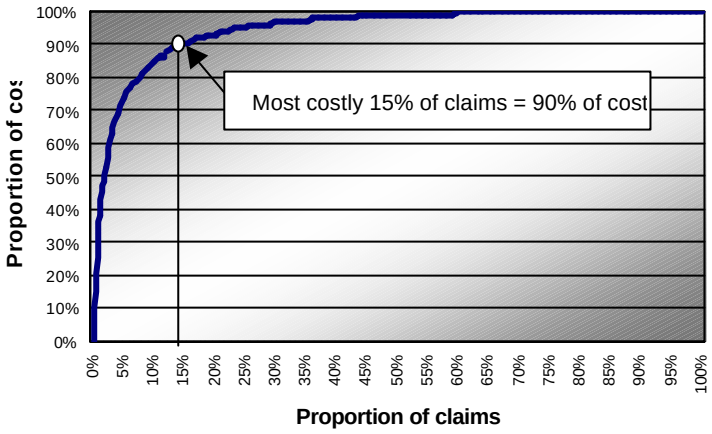


Figure 17 Cost versus claims: ordered by most costly claim to least costly

Table 8 Reduced data set (most costly 15% of claims in each state/mine-type group)

Mine type	State	No. claims	Mean cost	Cost	Proportion of total cost
Underground	NSW	1533	$25,523	$39,126,324	89%
	Queensland	184	$10,126	$1,863,256	92%
	Total	1717	$23,873	$40,989,580	90%
Open Cut	NSW	394	$37,737	$14,868,243	91%
	Queensland	159	$14,703	$2,337,849	89%
	Total	553	$31,114	$17,206,092	90%
Contractor	NSW	151	$44,028	$6,648,214	93%
Total	NSW	2078	$29,183	$60,642,780	90%
	Queensland	343	$12,248	$4,201,106	90%
	Total	2421	$26,784	$64,843,886	90%

3.1.5 Occupation

Table 9 outlines the number and cost of serious injuries by occupation. Specific occupations were included if they contributed at least 0.5% of the total for that state/mine-type group. These can be grouped into three categories:

1. production/processing (57-76%);
2. maintenance/trades (2-17%); and
3. others (3-12%).

Specifically we can see that the occupations of concern are:

- for underground mining:
  - *machineman* and *underground miner* (47% in NSW and 66% in Queensland); and
  - *deputy* (8% in NSW and 7% in Queensland)
- for open cut mining:
  - *plant operator unspecified* (49% in NSW and 14% in Queensland); and
  - *open cut miner* (9% in NSW and 33% in Queensland);
- for underground and open cut mining
  - *fitters* of various specialization.

Note: contractor employees are often specified only as "contractors".

Table 9 Number and cost of serious injuries: by occupation

Occupation	Code	NSW			Queensland	
		Underground	Open cut	Contractor	Underground	Open cut
Production/processing		**60%**	**71%**	**76%**	**72%**	**56%**
MACHINEMAN	7201231	34%	1%	1%	0%	0%
MINER U/G	7201239	13%	1%	2%	66%	1%
MECH UNIT MAN	7201232	6%	0%	1%	0%	0%
LOADERMAN	7201233	5%	0%	0%	0%	0%
WASHERY OPERATOR	7399111	1%	6%	2%	0%	2%
PLANT OPERATOR UNSPEC	7201214	0%	49%	6%	3%	14%
CONTRACTOR	7317114	0%	1%	65%	0%	0%
MINER O/C	7201219	0%	9%	0%	0%	33%
MINER TECHNICIAN U/G	7201238	0%	0%	0%	1%	0%
SHOVEL DRIVER	7201213	0%	1%	0%	0%	0%
TRUCK DRIVER	7105131	0%	1%	0%	0%	0%
DRILLER	7317111	0%	0%	0%	0%	1%
CRANE DRIVER	7311110	0%	0%	0%	0%	3%
SHOTFIRER	4909110	0%	1%	0%	0%	0%
DRAGLINE OPERATOR	7201212	0%	0%	0%	0%	1%
MINER TECHNICIAN O/C	7201216	0%	0%	0%	0%	1%
TRAINEE MINER	7201913	0%	0%	0%	1%	0%
Maintenance/trades		**17%**	**16%**	**2%**	**7%**	**16%**
FITTER	4103111	8%	9%	2%	5%	3%
ELECTRICIAN	4309112	4%	3%	0%	1%	0%
ELECT FITTER	4303111	2%	0%	0%	0%	0%
ENG FITTER	4103113	1%	0%	0%	0%	1%
MECH FITTER	4103115	1%	1%	0%	0%	0%
FITTER/WELDER	4103112	0%	1%	0%	0%	1%
BOILERMAKER	4205111	0%	0%	0%	0%	6%
LABOURER	8415111	0%	0%	0%	1%	0%
PLANT FITTER	4103114	0%	1%	0%	0%	0%
SERVICEMAN	7201912	0%	0%	0%	0%	1%
RIGGER	8405130	0%	0%	0%	0%	1%
TYRE FITTER	8923110	0%	0%	0%	0%	2%
TRADES ASSISTANT NEC	8101991	0%	0%	0%	0%	2%
Others		**10%**	**3%**	**12%**	**10%**	**9%**
DEPUTY	3299993	8%	0%	0%	7%	0%
UNDERMANAGER	3299991	1%	0%	0%	0%	0%
FOREMAN/SUPERVISOR	3299996	1%	0%	0%	2%	8%
CLERK	5999990	0%	0%	1%	0%	0%
DEPUTY MINE MANAGER	1305112	0%	0%	2%	0%	0%
FIRST AID OFFICER	8999991	0%	0%	0%	1%	0%
MAINT ENGINEER	2219996	0%	2%	6%	0%	0%
LABORATORY TECHNICIAN	3103110	0%	0%	0%	0%	1%
SEAMAN	8925011	0%	0%	3%	0%	0%
Total		**86%**	**89%**	**90%**	**88%**	**81%**
Total Cost		**$43,764,963**	**$16,416,800**	**$7,151,604**	**$2,021,641**	**$2,622,663**

3.1.6 Types of serious injuries

Table 10 outlines the number and cost of serious injuries by the nature of injury. Specific injury types were included if they contributed at least 0.5% of the total for that state/mine-type group. These can be grouped into three categories:

1. "manual handling" type injuries (strain, pain, jarring, sprain, torn muscle/ligament);
2. "traumatic injuries" (fracture, bruise, multiple injuries, laceration, crushing, amputation); and
3. deafness.

In underground and open cut mining in NSW and Queensland, serious injuries in these three categories constitute 80% or more of the total claims cost.

Table 10 Number and cost of serious injuries: by nature of injury

	NSW			Queensland	
	Underground	Open cut	Contractor	Underground	Open cut
Manual Handling Style Injuries	**59%**	**74%**	**50%**	**44%**	**41%**
STRAIN	27%	24%	22%	44%	41%
PAIN	19%	18%	12%		
JARRING	7%	27%	13%		
SPRAIN	4%	3%	2%		
TORN MUSCLE/LIGAMENT	2%	1%	1%		
Traumatic Injuries	**23%**	**11%**	**17%**	**29%**	**21%**
FRACTURE	10%	4%	9%	13%	10%
BRUISE	5%	4%	4%	4%	0.4%
MULTIPLE INJURIES	3%	1%	3%	3%	10%
LACERATION	2%	1%	1%	5%	0.1%
CRUSHING	2%		0.5%	4%	0.5%
AMPUTATION	1%		14%	3%	6%
Deafness	**1%**	**2%**	**1%**	**4%**	**14%**
Total	**83%**	**87%**	**83%**	**80%**	**82%**
Total Cost	**$43,764,963**	**$16,416,800**	**$7,151,604**	**$2,021,641**	**$2,622,663**

3.1.7 Body location of serious injuries

Table 11 outlines the number and cost of serious injuries by the body location. Specific injury types were included if they contributed at least 0.5% of the total for that state/mine-type group. These can be usefully grouped into seven categories:

1. back injuries (lower back & back unspecified);
2. lower limb injuries (knee, ankle, foot, lower limb multiple, lower leg);
3. neck (neck muscles/bones, neck and trunk);
4. multiple (trunk & limbs, multiple unspecified, multiple);
5. shoulder;
6. fingers; and
7. ear.

In underground and open cut mining in NSW and Queensland, serious injuries in these seven categories constitute 70-80% of the total claims cost. Injuries to these parts of the body are priority issues for both states and mine types with the exception that finger injuries currently appear to be of no consequence to the open cut industry in Queensland.

Table 11 Cost of serious injuries: by body location

		NSW			Queensland	
		Underground	Open cut	Contractor	Underground	Open cut
Back		**26%**	**28%**	**29%**	**19%**	**22%**
	LOWER BACK	25%	28%	26%	15%	15%
	BACK UNSPEC	1%	0.5%	3%	5%	7%
Lower limbs		**22%**	**15%**	**11%**	**33%**	**17%**
	KNEE	12%	10%	8%	14%	5%
	ANKLE	3%	3%	2%	7%	4%
	FOOT	3%	0.2%	1%	10%	1%
	LOWER LIMB MULTIPLE	3%	1%			
	LOWER LEG	2%	0.2%		2%	8%
Neck		**7%**	**24%**	**9%**		
	NECK MUSCLES/BONES	4%	15%	2%		
	NECK AND TRUNK	2%	9%	7%		
Multiple		**8%**	**5%**	**4%**	**3%**	**10%**
	TRUNK AND LIMBS	4%	3%	0.4%		
	MULTIPLE UNSPEC	3%	1%	3%		
	MULTIPLE	2%	1%	0.1%	3%	10%
Shoulder		**6%**	**7%**	**17%**	**3%**	**4%**
Fingers		**3%**	**0.2%**	**2%**	**6%**	**2%**
Ear		**1%**	**2%**	**1%**	**5%**	**14%**
Total		**73%**	**81%**	**74%**	**70%**	**69%**
Total Cost		**$43,764,963**	**$16,416,800**	**$7,151,604**	**$2,021,641**	**$2,622,663**

3.1.8 Time of accident

Figure 18 outlines the number and cost of serious injuries by the time of accident. There appear to be variations over the day. Variations in exposure (i.e. greater staffing levels and activity at certain times of the day) is likely to be an important underlying reason for variations in accidents by time of day and other factors such as shift changes may also be important.

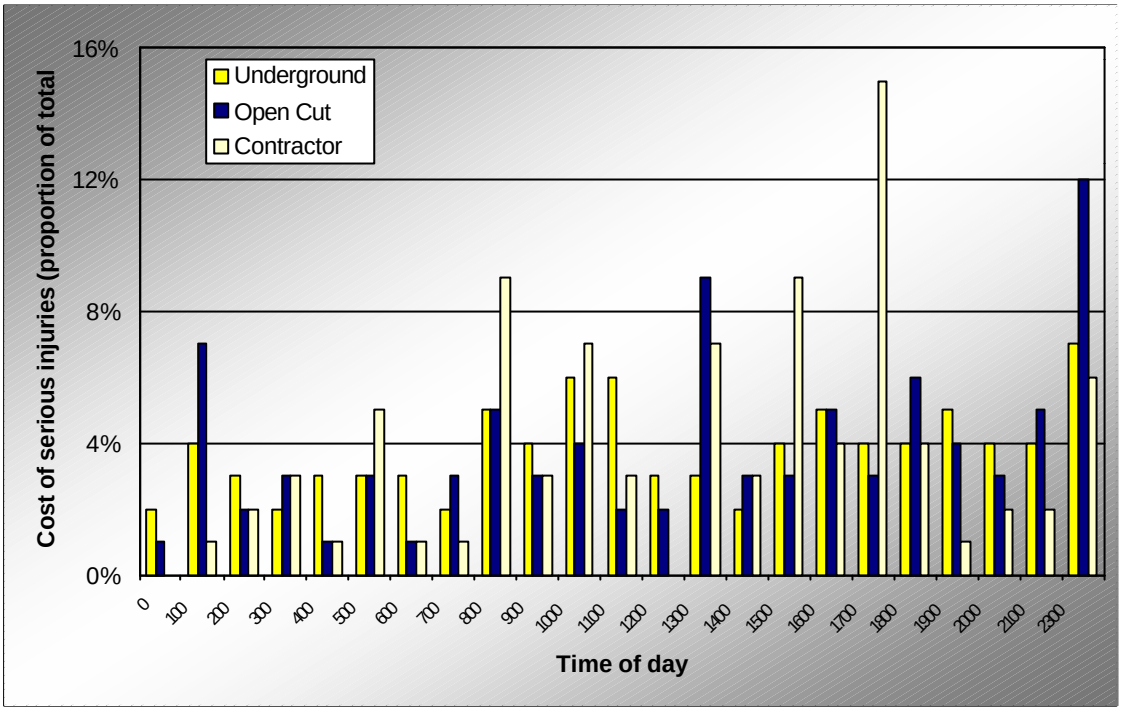


Figure 18 Cost of serious injuries (proportion of total): by time of accident

3.1.9 Accident types leading to serious injuries

Table 12 outlines the number and cost of serious injuries by the accident type. This data field was only available in the NSW data. Specific accident types were included if they contributed at least 0.5% of the total for that mine-type group. These can be usefully grouped into eight categories:

1. overexertion (overexertion lifting/carrying, overexertion pushing/pulling & overexertion);
2. slips, trips and falls (slip, fall, trip, fall from height);
3. hit by objects (slide/fall of rock/coal, hit by falling object & hit by moving object);
4. trapping (trapped between moving objects, trapping in/by machinery);
5. bumping into stationery object;
6. vehicle vibration;
7. vehicle accident; and
8. long term exposure to sounds.

Table 12 Cost of serious injuries (proportion of total cost): by accident type (NSW only)

	Underground	Open cut	Contractor
Overexertion	**29%**	**18%**	**19%**
OVEREXERTION LIFTING/CARRYING	17%	5%	5%
OVEREXERTION PUSHING/PULLING	7%	6%	8%
OVEREXERTION	5%	8%	5%
Slips, trips and falls	**22%**	**22%**	**15%**
SLIP	9%	9%	9%
FALL	5%	6%	2%
TRIP	5%	3%	2%
FALL FROM HEIGHT	3%	4%	2%
Hit by objects	**20%**	**5%**	**18%**
SLIDE/FALL OF ROCK/COAL	11%		6%
HIT BY FALLING OBJECT	6%	0.2%	2%
HIT BY MOVING OBJECT	3%	5%	10%
Trapping	**4%**	**1%**	**18%**
TRAPPED BETWEEN MOVING OBJECTS	3%	0.1%	0.5%
TRAPPED IN/BY MACHINERY	1%	1%	17%[5]
Bumping into stationary object	**3%**	**2%**	**4%**
Vehicle vibration	**3%**	**21%**	**10%**
Vehicle accident	**2%**	**16%**	**1%**
Long term exposure to sounds	**1%**	**2%**	**1%**
Total	**86%**	**87%**	**87%**
Total Cost	**$43,764,963**	**$16,416,800**	**$7,151,604**

[5] One claim of $971,857 contributed 13.6%.

3.1.10 Agency of serious injuries

Table 13 outlines the number and cost of serious injuries by the agency of injury. This data field was only available in the NSW data. Specific accident types were included if they contributed at least 0.5% of the total for that mine type group. These can be usefully grouped into thirteen categories:

1. underground machinery;
2. rib roof and face;
3. floor surfaces;
4. props, bolts and other objects;
5. other machinery & equipment;
6. coal, rocks & metal;
7. ventilation equipment;
8. U/G Water;
9. conveyor;
10. electric trailing cable;
11. internal conditions;
12. step/stairway; and
13. agency not apparent.

Table 13 Cost of serious injuries: by agency of injury (NSW only)

	Underground	Open cut	Contractor
Underground machinery	**13%**		**10%**
UNDERGROUND TRANSPORTER	3%		3%
ROOFBOLTER	3%		3%
SELF ADVANCING CHOCK/SHIELD	2%		
UNDERGROUND LOADER	2%		1%
SHUTTLE CAR	1%		
LONGWALL FACE CONVEYOR (AFC)	1%		
CONTINUOUS MINER	1%		3%
Rib, roof & face	**11%**		**3%**
U/G RIB/SIDE	6%		
U/G ROOF	4%		3%
U/G FACE	1%		0.2%
Floor surfaces	**18%**	**8%**	**4%**
U/G UNEVEN FLOOR	6%		3%
U/G WET/SLIPPERY FLOOR	5%		
U/G FLOOR NEC	1%		0.4%
U/G FLOOR HAZARDOUS OBJECTS	3%		
SLIPPERY FLOOR	1%	1%	0.3%
SLIPPERY GROUND	0.4%	3%	
UNEVEN GROUND	0.2%	4%	0.1%
Props, bolts & other objects	**6%**	**1%**	**7%**
TIMBER PROP/BAR	2%		
ROOF BOLT	2%		2%
ROD/PIPE	1%	0.1%	0.5%
PRESSURISED PIPING	1%	1%	
CHAIN	0.1%	0.0%	2%
DRUM/CRATE	1%	0.4%	2%
Other machinery & equipment	**6%**	**52%**	**22%**
MACHINE/EQUIPMENT PART	3%	1%	1%
STACKER/RECLAIMER	1%		
EQUIPMENT NEC	1%	1%	0.2%
CAR	1%	2%	
TRAFFIC/GROUND SURFACE	0.3%	2%	2%
DUMP TRUCK	0.1%	21%	12%
VAN/UTILITY	0.1%	2%	0.3%
DOZER	0.05%	11%	5%
FRONT END LOADER	0.04%	5%	0.2%
MOTOR CYCLE	0.03%	2%	
GRADER	0.02%	2%	1%
POWER SHOVEL		3%	
WATER CART/TANKER		2%	
Coal, rocks & metal	**6%**	**1%**	**4%**
COAL/ROCK	3%	0.1%	1%
FERROUS/NON FERROUS METAL	3%	1%	3%
Ventilation equipment	**2%**		**0.1%**
U/G Water	**1%**		**3%**
Conveyor	**4%**	**0.2%**	**14%**
Electric trailing cable	**3%**	**2%**	
Internal conditions	**1%**	**2%**	**1%**
Step/stairway	**0%**	**3%**	**7%**
Agency not apparent	**3%**	**4%**	**5%**
Total	**73%**	**75%**	**80%**
Total Cost	**$43,764,963**	**$16,416,800**	**$7,151,604**

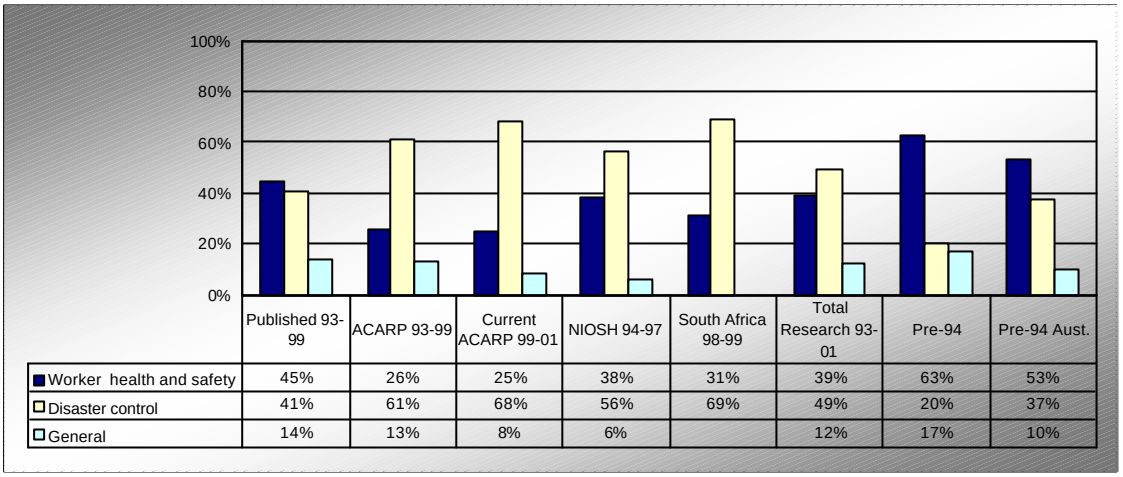
3.2 Analysis of research abstracts

3.2.1 Subject of research

The data according to the subject of the research is shown in Table 14 and Figure 19. The main point to note is that there seems to have been a shift away from research about worker health and safety (63% pre-1994 down to 39% 1993-99) toward research about disaster control (20% pre-1994 to 49% 1993-99) when comparing the pre-1994 data (Mitchell & Larsson 1994) with the current study. The bias toward research into disaster control seems strongest in Australia (e.g. 61% of ACARP research 1993-99) and South Africa (69% 1998-99) but is also apparent in the USA (56% of NIOSH research).

Table 14 Subject of research

	Worker health and safety	**Disaster control**	**General**	**Total**
NIOSHTIC, HSELINE, CISDOC & Dissertations Abstracts (1993-1999)	124 45%	111 41%	38 14%	273
ACARP (1993-1999) (Includes NERDDC 1993-1994)	1 26%	37 61%	8 13%	61
Current ACARP (for completion 1999-2001)	10 25%	27 68%	3 8%	40
NIOSH Office of Mine Safety & Health Research (ex. US Bureau of Mines) (1994-1997)	6 38%	9 56%	1 6%	16
South Africa Chamber of Mines, Coal Research & Development (1998-1999)	9 31%	20 69%		29
Total Research (1993-2001)	165 39%	204 49%	50 12%	419
Pre-1994 Research (from Mitchell & Larsson 1994)	997 63%	319 20%	267 17%	1583
Pre-1994 Australian Research (from Mitchell & Larsson 1994)	36 53%	25 37%	7 10%	68



	Published 93-99	ACARP 93-99	Current ACARP 99-01	NIOSH 94-97	South Africa 98-99	Total Research 93-01	Pre-94	Pre-94 Aust.
Worker health and safety	45%	26%	25%	38%	31%	39%	63%	53%
Disaster control	41%	61%	68%	56%	69%	49%	20%	37%
General	14%	13%	8%	6%		12%	17%	10%

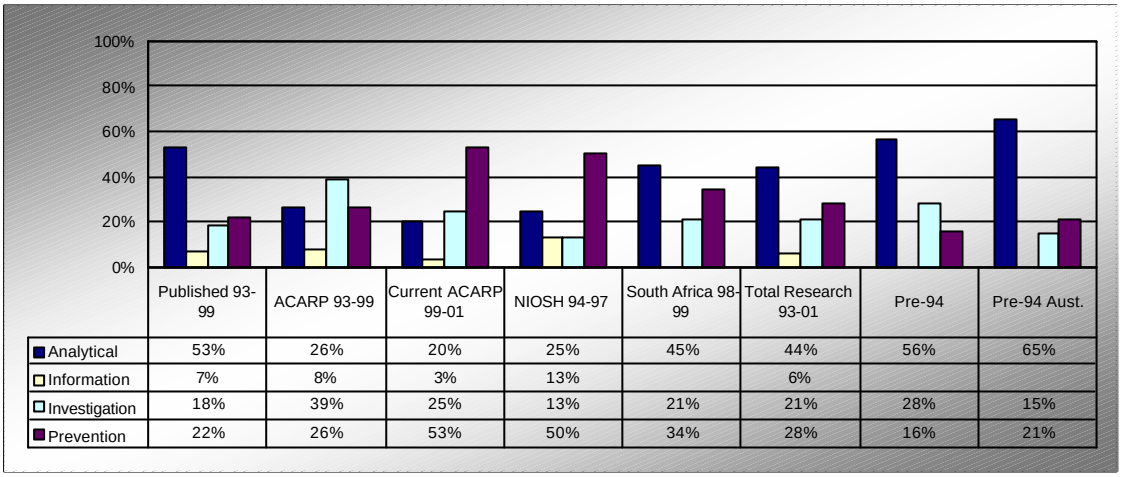
Figure 19 Subject of research

3.2.2 Focus of research

The data grouped by focus of the research is shown in Table 15 and Figure 20. It can be seen that analytical projects dominated research prior to 1994 (Mitchell & Larsson 1994) constituting 56% of research worldwide and an even greater proportion in Australia (65%). The remainder of research concentrated on prevention and investigation. The emphasis in recent times seems to have shifted away from analysis and toward other types of research, especially prevention (from 16% internationally pre-1994 to 28% in this study). This is especially evident in the ACARP projects in progress (53% 1999-2001), recent NIOSH projects (50% 1994-97) and recent South African projects (34% 1998-99).

Table 15 Focus of research

	Analytical	**Information**	**Investigation**	**Prevention**	**Total**
NIOSHTIC, HSELINE, CISDOC & Dissertations	145	19	48	61	273
Abstracts (1993-1999)	53%	7%	18%	22%	
ACARP (1993-1999)	16	5	24	16	61
(Includes NERDDC 1993-1994)	26%	8%	39%	26%	
Current ACARP (for completion 1999-2001)	8	1	10	21	40
	20%	3%	25%	53%	
NIOSH Office of Mine Safety & Health Research (ex. US	4	2	2	8	16
Bureau of Mines) (1994-1997)	25%	13%	13%	50%	
South Africa Chamber of Mines, Coal Research &	13		6	10	29
Development (1998-1999)	45%		21%	34%	
Total Research (1993-2001)	186	27	90	116	419
	44%	6%	21%	28%	
Pre-1994 Research	890		441	252	1583
(from Mitchell & Larsson 1994)	56%		28%	16%	
Pre-1994 Australian Research	44		10	14	68
(from Mitchell & Larsson 1994)	65%		15%	21%	

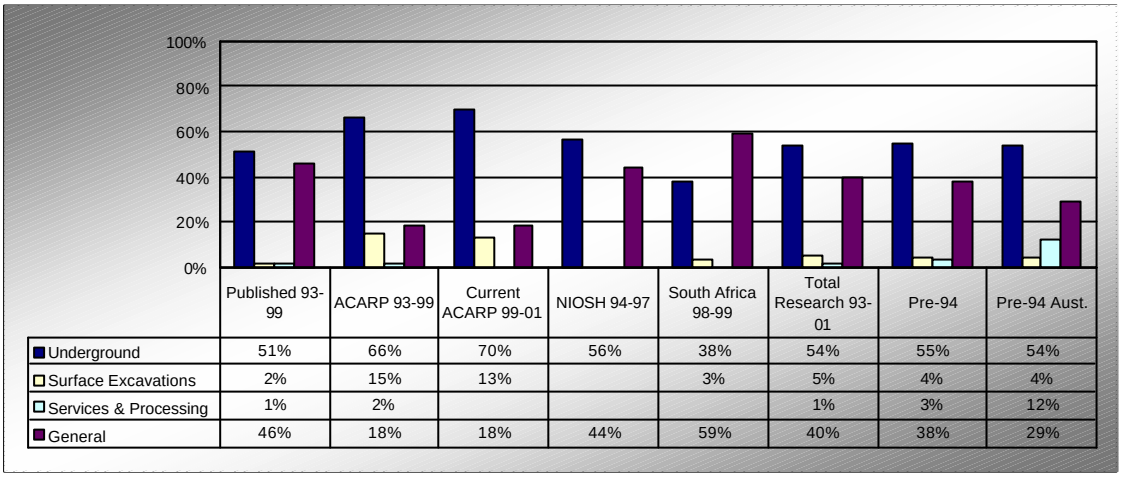


	Published 93-99	ACARP 93-99	Current ACARP 99-01	NIOSH 94-97	South Africa 98-99	Total Research 93-01	Pre-94	Pre-94 Aust.
Analytical	53%	26%	20%	25%	45%	44%	56%	65%
Information	7%	8%	3%	13%		6%		
Investigation	18%	39%	25%	13%	21%	21%	28%	15%
Prevention	22%	26%	53%	50%	34%	28%	16%	21%

Figure 20 Focus of research

3.2.3 Activity of research

The data according to the activity of the research is shown in Table 16 and Figure 21. Research about underground operations dominates the published reports. This was true based on the pre-1994 study (Mitchell & Larsson 1994) and continues to be true based on the analysis of more recent reports. The trend is very strong in recent and ongoing ACARP research (66% 1993-99; 70% 1999-2001). There is much less research about open cut mining, although research of a general nature remains reasonably prominent outside of Australia.



	Published 93-99	ACARP 93-99	Current ACARP 99-01	NIOSH 94-97	South Africa 98-99	Total Research 93-01	Pre-94	Pre-94 Aust.
Underground	51%	66%	70%	56%	38%	54%	55%	54%
Surface Excavations	2%	15%	13%		3%	5%	4%	4%
Services & Processing	1%	2%				1%	3%	12%
General	46%	18%	18%	44%	59%	40%	38%	29%

Figure 21 Activity of research

Table 16 Activity of research

	Underground	Surface Excavations	Services & Processing	General	Total
NIOSHTIC, HSELINE, CISDOC & Dissertations	140	5	3	125	273
Abstracts (1993-1999)	51%	2%	1%	46%	
ACARP (1993-1999)	40	9	1	11	61
(Includes NERDDC 1993-1994)	66%	15%	2%	18%	
Current ACARP (for completion 1999-2001)	28	5		7	40
	70%	13%		18%	
NIOSH Office of Mine Safety & Health Research (ex. US	9			7	16
Bureau of Mines) (1994-1997)	56%			44%	
South Africa Chamber of Mines, Coal Research &	11	1		17	29
Development (1998-1999)	38%	3%		59%	
Total Research (1993-2001)	228	20	4	167	419
	54%	5%	1%	40%	
Pre-1994 Research	866	66	48	603	1583
(from Mitchell & Larsson 1994)	55%	4%	3%	38%	
Pre-1994 Australian Research	37	3	8	20	68
(from Mitchell & Larsson 1994)	54%	4%	12%	29%	

3.2.4 Topic of research

The data according to the topic of the research is shown in Table 17. These data are too complex to be usefully presented as a chart. The topics that have been most commonly the subject of recent research in Australia (62% of research) include:

1. ground, wall or roof support (25%);
2. explosions (15%);
3. machinery (10%);
4. fire (7%); and
5. management systems (7%).

Internationally, the most common recent research projects (66% of research) have been about:

1. dust and respiratory issues (27%);
2. fire (15%);
3. ground, wall or roof support (14%); and
4. ventilation or air quality (10%).

The major differences between Australian and international literature (mainly American) has been the lesser focus on dust and respiratory issues and ventilation or air quality. This is a change from the previous study period where these issues were given greater prominence in Australian research (about the same as internationally). The growth in Australian research has been in the areas of ground, wall and roof support (9% to 25%) and machinery (1% to 10%).

In terms of matching research effort with priorities drawn from the data (see Table 12) it could be argued that a reduced emphasis is warranted on disease-related hazards such as *dust and respiratory*, *diesel fumes* and *ventilation or air quality*. While these issues do not arise as priorities from the analysis of compensation, it is important to note there are a number of reasons why occupational diseases may not appear in compensation data. For instance, unlike traumatic injury, the connection between the exposure at work and the disease may not be apparent and hence a claim may not be submitted. Therefore, despite their non-priority nature as a result of the compensation analysis, it would be a mistake to deter research in these areas.

The compensation data show that research about *ground, wall and roof support* is warranted as, for instance in underground mining in NSW, serious injuries involving slides/falls account for 11% of the compensation cost.

The level of research into machinery hazards is also warranted, as serious injuries caused by trapping, vehicle vibration and vehicle accidents account for reasonable proportions of the cost (9% underground and 29% in open cut). Machinery can also be implicated in other accidents (such as falls, hit by moving objects, etc).

Fire and explosion are issues that are not important as far as compensation costs are concerned. However, the potential for catastrophic incidents is of course ever-present in the industry. The costs of catastrophes include production and reputation losses as well as a high potential for fatal injuries. Therefore the prevention of fire, explosion and other high potential incidents will remain a priority despite being unimportant in terms of compensation costs.

Research that is not evident includes the important areas of manual handling and slips, trips and falls. Overexertion and slips trips and falls constitute about 40-50% of injuries and yet receive virtually no attention in research. This is true today and has been for many years and is also an area of research lacking internationally as well as in Australia.

Table 17 Topic of research

	Dust and Respiratory	Accident Analysis	Ground, wall or roof support	Fire	Explosions	Machinery, incl. vehicles	Diesel fumes	Ventilation or air quality	Management Systems	Manual Handling	Miscellaneous Hazards	Electrical	Noise	Other	Total
NIOSHTIC, HSELINE, CISDOC & Dissertations Abstracts (1993-1999)	75 27%	12 4%	37 14%	41 15%	9 3%	7 3%	11 4%	27 10%	12 4%		11 4%	5 2%	3 1%	23 8%	273
ACARP (1993-1999) (Includes NERDDC 1993-1994)	2 3%	1 2%	15 25%	4 7%	9 15%	6 10%	2 3%	3 5%	4 7%		8 13%	3 5%	1 2%	3 5%	61
Current ACARP (for completion 1999-2001)	1 3%		5 13%	4 10%	3 8%	5 13%	2 5%	1 3%	2 5%		11 28%	1 3%		5 13%	40
NIOSH Office of Mine Safety & Health Research (ex. US Bureau of Mines) (1994-1997)	4 25%		2 13%	4 25%	1 6%	4 25%			1 6%						16
South Africa Chamber of Mines, Coal Research & Development (1998-1999)	4 14%		7 24%	3 10%	3 10%	3 10%		3 10%	3 10%		1 3%			2 7%	29
Total Research (1993-2001)	86 21%	13 3%	66 16%	56 13%	25 6%	25 6%	15 4%	34 8%	22 5%		31 7%	9 2%	4 1%	33 8%	419
Pre-1994 Research (from Mitchell & Larsson 1994)	478 30%	267 17%	126 8%	80 5%	80 5%	74 5%	65 4%	63 4%	54 3%	50 3%	42 3%	39 2%	37 2%	128 8%	1583
Pre-1994 Australian Research (from Mitchell & Larsson 1994)	17 25%	7 10%	6 9%	7 10%	11 16%	1 1%	2 3%	4 6%	2 3%				6 9%	5 7%	68

3.2.5 Year and country of research

The data according to the year of the research is shown in Table 18. These data are also too complex to be usefully presented as a chart. There has been a reasonable body of research conducted over the 1990's with activity matching that of the previous decade (759 research abstracts between 1990-1999 compared with 790 abstracts over 1980-1989).

Table 19 shows the country of research. International literature is dominated by research originating in the United States, as has been the case in the past.

Table 18 Year of research

	Pre 1960	1960 -1969	1970-1979	1980-1989	1990-1993	1993	1994	1995	1996	1997	1998	1999	2000	2001	Not dated	Total
NIOSHTIC, HSELINE, CISDOC & Dissertations Abstracts (1993-1999)						37 14%	26 10%	53 19%	43 16%	104 38%	10 4%					273
ACARP (1993-1999) (Includes NERDDC 1993-1994)						11 18%	5 8%	4 7%	10 16%	16 26%	12 20%	3 5%				61
Current ACARP (for completion 1999-2001)												26 65%	11 28 %	3 8%		40
NIOSH Office of Mine Safety & Health Research (ex. US Bureau of Mines) (1994-1997)							1 6%	7 44%	2 13%	6 38%						16
South Africa Chamber of Mines, Coal Research & Development (1998-1999)											17 59%	12 41%				29
Total Research (1993-2001)						48 11%	32 8%	64 15%	55 13%	126 30%	39 9%	41 10%	11 3%	3 1%		419
Pre-1994 Research (from Mitchell & Larsson 1994)	23 1%	20 1%	393 25%	790 50%	340 21%										17 1%	1583

Table 19 Country

	Africa	Australia (excluding Sth. Africa)	Canada	China	CIS or Russia	France	Germany,	Baltic India	Italy	Japan	South Africa	South	America United	Kingdom United States	of America Not stated	Other	Total
NIOSHTIC, HSELINE, CISDOC & Dissertations Abstracts (1993-1999)		8	1	3	2	4	20	35		5	6	1	21	6	8	23	273
		3%	0%	1%	1%	1%	7%	13%		2%	2%	0%	8%	50%	3%	8%	
ACARP (1993-1999) (Includes NERDDC 1993-1994)		61															61
		100%															
Current ACARP (for completion 1999-2001)		40															40
		100%															
NIOSH Office of Mine Safety & Health Research (ex. US Bureau of Mines) (1994-1997)														16			16
														100%			
South Africa Chamber of Mines, Coal Research & Development (1998-1999)											29						29
											100 %						
Total Research (1993-2001)		109	1	3	2	4	20	35		5	35	1	21	152	8	23	419
		26%	0%	1%	0%	1%	5%	8%		1%	8%	0%	5%	36%	2%	5%	
Pre-1994 Research (from Mitchell & Larsson 1994)	7	68	37	23	69	31	162	7	1	13	18	3	152	949	43	0	1583
	0%	4%	2%	1%	4%	2%	10%	0%	0%	1%	1%	0%	10%	60%	3%	0%	
Pre-1994 Australian Research (from Mitchell & Larsson 1994)		68															68
		100%															

4 Discussion

4.1 Priorities

The bulk of compensation costs occur because of manual handling-type injuries, in particular strains and sprains of the back. Traumatic injuries are also significant and often involve interaction with plant. These issues are discussed more closely as follows.

4.1.1 Types of injuries

In terms of the types of injuries, it can be seen that they fall into three categories: "manual handling" style soft-tissue injuries (strain; pain; jarring; sprain; and torn muscle/ligament); "traumatic" injuries (fracture; bruise; multiple injuries; laceration; crushing; and amputation; and "deafness" (Table 20). Furthermore the order of these priorities is the same in all state/mine-type groups. Soft-tissue injuries dominate, constituting between 41% (Queensland open cut mining) to 74% (NSW open cut mining) of the cost of serious injuries. Traumatic injuries are important also, representing between 11% (NSW open cut) to 29% (Queensland underground) of the cost of serious injuries. Deafness, is third in importance comprising between 1% (NSW underground) and 14% (Queensland open cut) of serious injuries.

Table 20 Priorities by nature of injury: (data as per Table 10)

NSW			**Queensland**	
Underground	**Open cut**	**Contractor**	**Underground**	**Open cut**
1. Soft Tissue Injuries 59%	1. Soft Tissue Injuries 74%	1. Soft Tissue Injuries 50%	1. Soft Tissue Injuries 44%	1. Soft Tissue Injuries 41%
2. Traumatic Injuries 23%	2. Traumatic Injuries 11%	2. Traumatic Injuries 17%	2. Traumatic Injuries 29%	2. Traumatic Injuries 21%
3. Deafness 1%	3. Deafness 2%	3. Deafness 1%	3. Deafness 4%	3. Deafness 14%
Total 83%	Total 87%	Total 83%	Total 80%	Total 82%

4.1.2 Body location

The body location data reveals between six or seven priority areas (back; lower limbs; shoulder; neck; multiple injuries; fingers; and the ear). The order of these priorities varies between the state/mine-type groups (see Table 21). Although there are differences, serious injuries to the back are the first priority in four of the five groups ranging from 19% (Queensland open cut) and 29% (NSW open cut and contractors) of the total cost. Serious injuries to the lower limbs are probably the second most important priority across the groups ranging from 11% (NSW contractors) to 33% (Queensland underground).

Table 21 Priorities by body location: (data as per Table 11)

NSW			Queensland	
Underground	**Open cut**	**Contractor**	**Underground**	**Open cut**
1. Back 26%	1. Back 28%	1. Back 29%	1. Lower limbs 33%	1. Back 22%
2. Lower limbs 22%	2. Neck 24%	2. Shoulder 17%	2. Back 19%	2. Lower limbs 17%
3. Multiple 8%	3. Lower limbs 15%	3. Lower limbs 11%	3. Fingers 6%	3. Ear 14%
4. Neck 7%	4. Shoulder 7%	4. Neck 9%	4. Ear 5%	4. Multiple 10%
5. Shoulder 6%	5. Multiple 5%	5. Multiple 4%	5. Multiple 3%	5. Shoulder 4%
6. Fingers 3%	6. Ear 2%	6. Fingers 2%	6. Shoulder 3%	6. Fingers 2%
7. Ear 1%		7. Ear 1%		
Total 73%	Total 81%	Total 74%	Total 70%	Total 69%

4.1.3 Types of accidents

The type of accident data was only available for NSW. There are eight priorities as shown in Table 22. In two cases the priorities are similar. For instance, overexertion (between 18 and 29% of the total cost) and slips, trips and falls (15 to 22% of total cost) are important in all three groups. Aside from these common problems, there are some problems that differ among the mine type groups:

- *hit by objects* is more important in underground mining (20% of cost) and among contractors (18%) than it is in open cut mining (5%);
- *trapping* is more important in the contractor industry (18% of cost) compared to underground (4%) or especially open cut mining (1%);
- *vehicle vibration* is more important in open cut mining (21% of cost) than in underground mining (10%) or especially among contractors (3%); and
- *vehicle accidents* are more important in open cut mining (16% of cost) than in underground mining (2%) or among contractors (1%).

Table 22 Priorities by accident type (NSW only): (data as per Table 12)

Underground	**Open Cut**	**Contractor**
1. Overexertion 29%	1. Slips, trips and falls 22%	1. Overexertion 19%
2. Slips, trips and falls 22%	2. Vehicle vibration 21%	2. Hit by objects 18%
3. Hit by objects 20%	3. Overexertion 18%	3. Trapping 18%
4. Trapping 4%	4. Vehicle accident 16%	4. Slips, trips and falls 15%
5. Bumping into stationary object 3%	5. Hit by objects 5%	5. Vehicle vibration 10%
6. Vehicle vibration 3%	6. Bumping into stationary object 2%	6. Bumping into stationary object 4%
7. Vehicle accident 2%	7. Exposure to long term sounds 2%	7. Vehicle accident 1%
8. Exposure to long term sounds 1%	8. Trapping 1%	8. Exposure to long term sounds 1%
Total 86%	Total 87%	Total 87%

4.1.4 Agency of injury

This type of accident data was only available for NSW. There are between eight and twelve priorities as shown in Table 23. Because of the variation in equipment between open cut and underground mining, the priority order is very different between the mine type groups.

- *other machinery and equipment* (a broad category) dominates the injury cost (52%) in open cut mining and is also important among contractors (22%) but is much lower in underground mining (6%);
- *floor surfaces* are more important underground (18%) than in open cut mining (8%) or among contractors (4%);
- *underground machinery* features prominently in underground mining (13%) and among contractors (10%) (and of course are of no significance in open cut mining);
- *conveyors* are important agencies of injuries among contractors (14%) but of less important in underground mining (4%) and of no significance in open cut mining.

Table 23 Priorities by agency of injury (NSW only): (data as per Table 12)

Underground	**Open Cut**	**Contractor**
1. Floor surfaces 18%	1. Other machinery & equipment 52%	1. Other machinery & equipment 22%
2. Underground machinery 13%	2. Floor surfaces 8%	2. Conveyor 14%
3. Rib, roof & face 11%	3. Agency not apparent 4%	3. Underground machinery 10%
4. Props, bolts & other objects 6%	4. Step/stairway 3%	4. Props, bolts & other objects 7%
5. Other machinery & equipment 6%	5. Electric trailing cable 2%	5. Step/stairway 7%
6. Coal, rocks & metal 6%	6. Internal conditions 2%	6. Agency not apparent 5%
7. Conveyor 4%	7. Props, bolts & other objects 1%	7. Floor surfaces 4%
8. Electric trailing cable 3%	8. Coal, rocks & metal 1%	8. Coal, rocks & metal 4%
9. Agency not apparent 3%		9. Rib, roof & face 3%
10. Ventilation equipment 2%		10. U/G Water 3%
11. U/G Water 1%		11. Internal conditions 1%
12. Internal conditions 1%		
Total 73%	Total 75%	Total 80%

4.2 Targeting the priorities through research: *Occupational Health and Safety (OHS) Impact Statement*

If compensation costs are to be addressed, it is recommended that research be conducted in the priority areas identified here. This could be achieved through funding agencies requiring applicants to provide an *Occupational Health and Safety (OHS) Impact Statement* with regard to their application. A checklist such as that shown in Table 24 could be used to identify the health and safety impacts of potential projects in terms of the likely effect on compensation costs. In terms of the selection of projects, the OHS Impact Statement would be of most relevance where the project is specifically concerned with safety, however the requirement to provide the statement for all projects would encourage health and safety to be addressed in conjunction with other issues.

Two potential limitations of this model should be noted. Firstly, disease-related concerns (except deafness) are not represented in the model because they are not evident in the compensation data. This may reflect a failure of the compensation system to capture these diseases rather than an absence of diseases. Secondly, catastrophic events (with the exception of falls/slides) are not a feature of the compensation data and are therefore not noted in this model. Catastrophic events do not feature in this analysis, and are not likely to feature in any compensation analysis of this type, nevertheless there are obvious and compelling reasons for a proportion of research to further knowledge about the prevention of these events.

Table 24 Checklist for research OHS Impact Statement

	Underground mining	**4**	**Open cut mining**	**4**
Nature of injury priorities	1. Soft tissue injuries	1	1. Soft tissue injuries	1
	2. Traumatic injuries	1	2. Traumatic injuries	1
	3. Deafness	1	3. Deafness	1
Accident type priorities	1. Overexertion	1	1. Slips, trips and falls	1
	2. Slips, trips and falls	1	2. Vehicle vibration	1
	3. Hit by objects	1	3. Overexertion	1
	4. Trapping	1	4. Vehicle accident	1
	5. Bumping into stationary object	1	5. Hit by objects	1
	6. Vehicle vibration	1	6. Bumping into stationary object	1
	7. Vehicle accident	1	7. Exposure to long term sounds	1
	8. Exposure to long term sounds	1	8. Trapping	1
Body location priorities	1. Back	1	1. Back	1
	2. Lower limbs	1	2. Neck	1
	3. Multiple	1	3. Lower limbs	1
	4. Neck	1	4. Shoulder	1
	5. Shoulder	1	5. Multiple	1
	6. Fingers	1	6. Ear	1
	7. Ear	1		
Agency of injury priorities	1. Floor surfaces	1	1. Other machinery & equipment	1
	2. Underground machinery	1	2. Floor surfaces	1
	3. Rib, roof & face	1	3. Step/stairway	1
	4. Props, bolts & other objects	1	4. Electric trailing cable	1
	5. Other machinery & equipment	1	5. Internal conditions	1
	6. Coal, rocks & metal	1	6. Props, bolts & other objects	1
	7. Conveyor	1	7. Coal, rocks & metal	1
	8. Electric trailing cable	1		
	9. Ventilation equipment	1		
	10. U/G Water	1		
	11. Internal conditions	1		

4.3 Examples of the use of data for the identification of specific projects

The NSW data provides a range of variables, with fields such as agency of injury, etc. Combined with the text field ("description" of accident) the data are quite rich and provide possibilities for the identification of specific research projects. This project is concerned with the identification of research priorities rather than individual projects as such, however to provide examples of how the data can be interrogated to discover more information about particular issues, the following *examples* are provided in Appendix B:

- Neck injuries caused by heavy vehicle accidents (open cut)
- Vibration injuries (open cut)
- Trapping injuries (underground)
- Trailing cable injuries (underground)
- Rock falls (underground)

4.4 Improvement of data collection

Further data fields, such as the involvement of plant could be useful if an alternative data collection system was proposed for Queensland. The Department of Mines and Energy (DME Queensland) database is an existing source of some additional information about injuries in Queensland. However there has been historically no link between a WorkCover claim and a DME investigation. As of 1 July 1999 reports of accidents to DME will apparently include provision for the listing of a WorkCover claim number and hence in the future it may be possible to make such links to use the information from both bodies in a complementary fashion. In a previous project there has been an attempt to merge the data sets (Mitchell & Larsson 1994) with mixed results due to data inconsistency. Mitchell and Larsson (1994, vol. 2, p. 26) commented that a better system of co-ordination of data between the workers' compensation authority (now WorkCover Queensland) and the Department of Mines and Energy. Recently the DME have instituted an approach (correspondence with M. Wiggins, DME) whereby accident/incident reports have an optional field whereby employers can include the WorkCover claim number thereby providing a link between the two data sets. In NSW, the JCB data system includes provision for the collection of more extensive data including information about the involvement of plant, etc and these should be utilised.

A model of in-depth investigation could be developed, or an existing model utilised, to undertake selected investigations into clusters of injury types in order to develop ideas for prevention. This could be in the form of discrete research activities into injury clusters with the aim of developing preventative plans. Examples of the projects that could be undertaken (the examples are far from exhaustive) are shown in Appendix B.

An industry-co-operative approach could be developed to formally share internal accident investigation information in the form of a database. Industry-standard models of investigation could be agreed, to provide consistency of approach and to guide investigators toward describing the hazard source and identifying the failures in hazard control.

5 Conclusions

The analysis of research literature shows that the focus in Australia is somewhat different from elsewhere in the World. For instance, there has historically been a strong universal focus on respiratory diseases, ventilation, etc. While this has been maintained outside Australia, it has recently been given less attention within Australia. Both in Australia and elsewhere there is a lack of attention paid to manual handling or slips, trips and falls noticeable in the present and the previous studies.

Comparison of the research literature and the compensation data reveals some opportunities to conduct research in areas that will reduce claims and associated costs. While infrequent high-consequence events are of obvious importance, high-frequency low-consequence events amount to a significant ongoing burden to the industry.

In order to reduce compensation costs, co-ordinated research efforts are needed to prevent injuries caused by manual handling, slips, trips and falls, etc. In addition, further attention needs to be given to the hazards of interaction with machinery. Machinery hazards are the subject of a certain amount of research but the area probably warrants more research attention and there would also be a good degree of overlap between this topic and that of manual handling and slips, trips and falls.

6 Recommendations

1. Research should be conducted in the areas noted above in section 4.1 and outlined in Table 20 to Table 23.
2. In particular, research is needed in the high-cost areas of manual handling, slips trips and falls, and interaction with plant.
3. An *OHS Impact Statement* (using tools such as the checklist shown in Table 24) should be required to be submitted with funding applications to serve to guide both the applicants and the funding agencies toward projects that address high compensation cost issues.
4. Individual companies and/or industry bodies should give attention to the areas noted above in section 4.1 and outlined in Table 20 to Table 23. Solutions developed should be shared throughout the industry.
5. Industry bodies should establish systems of sharing solutions or work in conjunction with the Solutions Project of the National Occupational Health and Safety Commission that will enable solutions to be available on the internet.
6. The Department of Mines, Queensland and WorkCover Queensland should collect and manage data in such a way as to facilitate analysis of merged data.

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Appendix A: Data fields

Table 25 Data fields

NSW Fields		Queensland Fields
Report no	Size of fall/slump	IB-Code (mine type)
Claim no	Type of fall/slump	Injury Date
Entry Date	Remedial action	Occupation
Incident Involving	Payee name	Occupation Code
Mine code	Policy no	Nature of Injury
Working at	Mine name	Action at time of Injury
Surname & Initials	First name	.Workplace
Occupation code	Second name	Total Statutory Payments
Time began work	Birth date	Comp-Pay
Date of accident	Sex	Hosp-Pay
Time of accident	Payroll no	Lumpsum-Pay
Duty status	Department	Medical-Pay
Date reported	Award code	Other-Pay
Time reported	Pay classification	Rehab-Pay
Ceased work	Work experience in industry	Work Days Lost
Date ceased work	Work experience below ground	
Time ceased work	Work experience with company	
Nature of injury	Work experience at mine	
Part of body	Shift type	
Protective equipment	Shift basis	
Job task	Shift overtime	
Frequency	Hours worked day 1	
Activity code	Hours worked day 2	
Type of accident	Hours worked day 3	
Agency of accident	Hours worked day 4	
Agency of injury	Hours worked day 5	
Accident Description	Hours worked day 6	
Equipment type (1)	Hours worked day 7	
Make/model (1)	Absent after	
Company no (1)	Where after	
Equipment type (2)	Ambulance	
Make/model (2)	Recurrence	
Company no (2)	Others	
Place code	Hours lost to date	
Exact location	Hours lost current year	
Environment 1	Amount paid to date	
Environment 2	Amount paid in current year	
Environment 3		

Appendix B: Examples of potential research projects

B.1 Introduction

The range of possibilities for detailed analysis is numerous. Detailed examination could be made in a number of areas to seek out specific research projects. A small number have been chosen as examples and these are presented as follows:

- Neck injuries caused by heavy vehicle accidents (open cut)
- Vibration injuries (open cut)
- Trapping injuries (underground)
- Trailing cable injuries (underground)
- Rock falls (underground)

B.2 Neck injuries caused by heavy vehicle accidents (open cut)

Serious injuries in open cut mining involving vehicle accidents constitute 16% (n=31) of the total cost for that group.

Analysis shows that the following contributed about half of the cost of these vehicle accidents (see Table 26):

- *jarring* injuries;
- *neck muscles/bones* injuries; and
- injuries involving *dozers* (3) and *dump trucks* (11).

Analysis of a reduced data set only including open cut mining, vehicle accidents, jarring, neck muscles bones, and dozers/dump trucks leaves six claims costing a total of $998,000 or 6% of the total cost claims in NSW open cut mining over the period studied. The accident descriptions of these six claims are shown in Table 27. Three of the claims (one a relatively small cost) occurred when a truck was struck by a loader while being loaded, two involved heavy vehicles colliding with earth structures, and one involved a tire blowout and subsequent sudden vehicle movement.

Research could thus be conducted to investigate means of prevention of occurrences like these. This would include determination of methods to prevent contact between vehicles (such as the prevention of the contact of loading buckets with trucks) and investigation of cabin technology in order to minimize the effects of collisions when they occur.

Table 26 Vehicle accidents in open cut mining: by type, body location and agency of injury (NSW only)

Injury type	N	Mean	Sum	
FRACTURE	5	$96,055	$480,277	3%
SPINAL FRACTURE	2	$36,169	$72,337	0%
SPRAIN	1	$30,029	$30,029	0%
STRAIN	5	$45,728	$228,638	1%
JARRING	11	$115,268	$1,267,951	8%
PAIN	1	$65,764	$65,764	0%
LACERATION	2	$27,981	$55,961	0%
BRUISE	3	$51,181	$153,542	1%
MULTIPLE INJURIES	1	$237,150	$237,150	1%
Total	31		$2,591,649	16%

Body location of injury	N	Mean	Sum	
FACE NEC	1	$49,917	$49,917	0%
NECK MUSCLES/BONES	9	$143,783	$1,294,048	8%
UPPER BACK	1	$12,614	$12,614	0%
LOWER BACK	5	$52,189	$260,945	2%
PELVIC BONES	1	$197,121	$197,121	1%
UPPER LIMB MULTIPLE	1	$6,045	$6,045	0%
ANKLE	2	$57,379	$114,758	1%
FOOT	1	$8,324	$8,324	0%
LOWER LIMB MULTIPLE	1	$116,898	$116,898	1%
LOWER LIMB UNSPEC	1	$35,192	$35,192	0%
NECK AND TRUNK	3	$22,941	$68,823	0%
TRUNK AND LIMBS	3	$35,150	$105,449	1%
MULTIPLE	1	$84,366	$84,366	1%
MULTIPLE UNSPEC	1	$237,150	$237,150	1%
Total	31		$2,591,649	16%

Agency of injury	N	Mean	Sum	
POWER SHOVEL	1	$6,307	$6,307	0%
DOZER	3	$186,554	$559,662	3%
BUCKET WHEEL EXCAVATOR	1	$6,045	$6,045	0%
FRONT END LOADER	1	$65,764	$65,764	0%
DUMP TRUCK	11	$68,952	$758,471	5%
WATER CART/TANKER	1	$117,935	$117,935	1%
BUS	1	$84,366	$84,366	1%
CAR	5	$72,731	$363,653	2%
VAN/UTILITY	2	$133,589	$267,179	2%
MOTOR CYCLE	4	$89,082	$356,328	2%
UNEVEN GROUND	1	$5,940	$5,940	0%
Total	31		$2,591,649	16%

Table 27 Vehicle accidents in open cut mining: six cases of jarring of the neck while operating heavy equipment (NSW only)

Description	Cost
WHILE HE WAS BACKING UP TO LOW WALL COAL EDGE DOZER CONTINUED OVER EDGE WITH RIPPER STRIKING BENCH CAUSING SEVERE WHIPLASH TO HIS NECK & BACK	$497,131
WHILE BEING LOADED WITH OVERBURDEN BY 992 LOADER WHEN LOADER HIT THE TRUCK CAUSING NECK WHIPLASH	$185,333
WHILE CARTING SHOVEL O/B TO DUMP UPON ENTERING RAMP AN OVERSPEED SITUATION OCCURRED CAUSING THE VEHICLE TO STRUCK A WINDROW INJURING HIS NECK-SEVERE WHIPLASH	$100,765
WHILE SITTING IN CABIN OF 240T TRUCK BEING LOADED BY 400 SHOVEL WHEN BUCKET OF SHOVEL HIT BACK OF TRAY HITTING HIS HEAD ON THE STEERING WHEEL CAUSING NECK JARRING	$99,162
WHILE HE WAS OPERATING LOADER L1800 LOADING CAT 783 TRUCKS WHEN R/H TYRE BLEW CAUSING MACHINE TO COLLAPSE ONTO TRUCK JARRING HIS NECK	$92,647
WHILE HE WAS DRIVING TRUCK 448 BEING LOADED BY 708 LOADER THE BUCKET STRUCK THE TRUCK JARRING HIS NECK & BACK	$12,659

B.3 Vibration injuries (open cut)

Serious injuries caused by vehicle vibration cost 21% of the total cost in open cut mining in NSW. Table 29 shows the breakdown of these injuries by the type, part of body and agency of injury. The key factor here is probably the type of equipment. It can be seen that 32 vibration injuries associated with dump trucks cost 9% of the total cost of injuries in open cut mining (or about half the cost of all vibration injuries). The circumstances of these 32 injuries are outlined in Table 28. It can be seen that most of the injuries involve rough roads, potholes, etc. The seat "bottoming out" is mentioned a number of times. A smaller set of injuries involves situations where movement of the truck body causes vibration.

The issues here logically center on removal of uneven sections of roadway, or probably more practically the enhancement of vehicle cabin systems to account for vehicle vibration (see recent ACARP project about vibration assessment; Ismail 1998).

Table 28 Dump truck-related vibration injuries (open cut mining in NSW only)

Description	Cost
WHILE DRIVING 410 TRUCK AFTER TIPPING LOAD THE OPERATOR MOVED FORWARD TO LOWER BODY WHEN THE BODY CAME DOWN BY ITSELF ABOUT 1MTR JERKING THE TRUCK JARRING HIS NECK & LOWER BACK	$431,224
WHILE OPERATING WISEDA DUMP TRUCK HE STRUCK UNEVEN SURFACE IN ROADWAY STRAINING HIS LOWER BACK - LUMBAR LESION	$115,057
WHILE OPERATING HAUL TRUCK CONTINUAL TRAVEL OVER ROUGH ROAD HE STRAINED HIS NECK	$98,145
WHILE DRIVING A CAT 793 TRUCK FROM A 4100 FACE SHOVEL TO THE DUMP OVER A ROUGH HAUL ROAD HE FELT PAIN TO HIS LOWER BACK	$66,361
WHILE DRIVING TRUCK OVER A PERIOD OF WEEK & HALF CAUSED LOWER BACK PAIN	$65,868
WHILE DRIVING 388 TRUCK HIT A POTHOLE IN ROAD CAUSING SEAT TO BOTTOM OUT STRAINING HIS LOWER BACK - SCIATICA	$64,319
WHILE ENTERING VEHICLE DURING SHIFT AS A PASSENGER TRAINING NEW OPERATOR IN REAR DUMP TRUCK THE DRIVERS FOOT SLIPPED OFF THE CLUTCH JARRING HIS NECK	$60,928
WHILE DRIVING TRUCK FROM COAL LOADER TO HOPPER HIT ROUGH PATCH OF HAUL ROAD AT THE BOTTOM OF RAMP 15 JARRING HIS LOWER BACK	$56,454
WHILE RETURNING FROM DUMP TO SHOVEL WHEN HE DROVE THROUGH A LARGE POOL OF WATER REAR OF TRUCK BOUNCED CAUSING THE SEAT IN TRUCK TO BOTTOM OUT JARRING HIS LOWER BACK	$54,350
WHILE DRIVING DUMP TRUCK 506 HE HIT A POT HOLE ON THE HAUL ROAD JARRING HIS LOWER BACK	$48,334
WHILE HE WAS DRIVING EUCLID TRUCK TO WASHERY HOPPER HE DROVE INTO SOFT SPOT COVERED BY LOOSE MATERIAL INJURING HIS LOWER BACK	$43,158
WHILE OPERATING DUMP TRUCK WHEN TIPPING A LOAD THE BODY RECOILED 6'-8' JARRING HIS NECK & UPPER BACK	$42,369
WHILE HE WAS DRIVING THE DRESSER REAR DUMP TRUCK OFF THE DUMP USING A TEMPORARY RAMP THE TRUCK HIT A BUMP CAUSING THE VEHICLE TO VIBRATE JARRING HIS NECK	$41,876
WHILE HE WAS DRIVING 447 TRUCK ACROSS ROUGH WET COAL FLOOR OVER A HOLE COVERED IN MUD HE JARRED HIS LOWER BACK	$39,695
WHILE HE WAS OPERATING DUMP TRUCK DUMPING THE LOAD WHEN THE BODY CAME DOWN ABOUT 1 METRE JARRING HIS LOWER BACK	$38,965
WHILE TRAVELLING BACK TO SHOVEL THE LEFT SIDE OF TRUCK WENT IN A HOLE ON HAUL ROAD CAUSING TRUCK TO DIP & SPRING BACK THE SEAT BOTTOMED OUT JARRING HIS LOWER BACK	$36,570
WHILE DRIVING TRUCK ON HAUL ROAD WITH HUMPS & HOLLOWS ON ROADS CAUSED SEAT TO BOTTOM OUT INJURING HIS UPPER & MIDDLE BACK	$35,666
WHILE HE WAS TIPPING A LOAD OFF MT4000 U/RIG 7 DUMP TRUCK WHEN THE HOIST HOSE BLEW OUT THE TRUCK BODY CAME BACK DOWN JARRING HIS NECK LOWER BACK & L/THIGH	$29,949
WHILE OPERATING CAT 789 APPROACHING 202 SHOVEL HE DROVE OVER WINDROWS LEFT BY GRADER THE TRUCK BOTTOMED OUT SPRAINING HIS NECK	$22,758
STRATFORD O/C - WHILE HE WAS OPERATING TRUCK OVER ROUGH ROADS HE STRAINED HIS LOWER BACK	$16,120
WHILE OPERATING U/RIG 7 AT ROCKY SHOVEL DOING A THREE POINT TURN ON THE DUMP HE FELT PAIN IN HIS L/SHOULDER	$13,323
WHILE OPERATING TRUCK 104 HAULING TO CHITTER DUMP THE ACCESS WAS VERY ROUGH CAUSING THE VEHICLE TO VIBRATE JARRING HIS LOWER BACK	$13,253
WHILE DRIVING HIS LOADED TRUCK FROM THE SHOVEL HE HIT A HOLE IN THE ROAD & THE SEAT BOTTOMED JARRIED HIS LOWER BACK	$11,994
WHILE DRIVING THE CAT 785 HAUL TRUCK IT HIT A HOLE IN THE ROAD & THE SEAT BOTTOMED OUT STRAINING HIS LOWER BACK	$10,755
WHILE DRIVING TO 201 SHOVEL HE DROVE ON UNEVEN ROAD CAUSING STRAIN TO LOWER BACK	$10,630
WHILE DRIVING TRUCK OVER ROUGH ROADS CAUSED VIBRATION JARRING HIS NECK & BACK	$9,896
WHILE DRIVING A TRUCK HE DROVE INTO A POTHOLE IN THE ROAD STRAINING HIS NECK	$9,320
STRATFORD O/C - WHILE DRIVING LOADED TRUCK UP RAMP E4 WITH A LARGE ROCK IN THE BACK THE TRUCK REARED UP IN THE AIR SPILLING LOAD & THEN CAME BACK STRAINING HIS NECK	$9,134
WHILE DRIVING THE DUMP TRUCK IN PIT ROAD HE HIT A LARGE POT HOLE JARRING HIS NECK L/SHOULDER & L/ARM	$8,933
WHILE HE WAS DRIVING TRUCK IN SOUTH PIT OVER VERY ROUGH ROADS THE SEAT BOTTOMED OUT JARRING HIS LOWER BACK	$8,002
STRATFORD O/C - WHILE DRIVING 789 TRUCK OVER BAD ROAD CONDITIONS THE DRIVERS SEAT BOTTOMED OUT ON NUMEROUS OCCASIONS JARRING HIS LOWER BACK	$6,003
WHILE DRIVING TRUCK DOWN RAMP FROM THE DUMP IN WET SLIPPERY CONDITIONS WHEN HE COULD NOT SLOW TRUCK SUFFICIENTLY TO PREVENT HITTING LARGE BUMPS AT THE BOTTOM OF THE RAMP HE JARRED HIS LOWER BACK	$5,793

Table 29 Vibration injuries in open cut mining: by type, body location and agency of injury (NSW only)

Type of injury		Valid N	Mean	Sum	
	JARRING	38	$54,281	$2,062,662	13%
	PAIN	13	$61,788	$803,249	5%
	STRAIN	15	$33,766	$506,487	3%
	SPRAIN	2	$34,075	$68,150	0%
	SLIPPED DISC	1	$8,029	$8,029	0%
	BRUISE	1	$7,876	$7,876	0%
	Total	70		$3,456,454	21%
Part of body					
	LOWER BACK	42	$44,846	$1,883,521	11%
	NECK AND TRUNK	6	$129,745	$778,470	5%
	NECK MUSCLES/BONES	14	$45,006	$630,087	4%
	TRUNK AND LIMBS	3	$22,378	$67,134	0%
	BACK OTHER/MULTIPLE	1	$35,666	$35,666	0%
	BACK UNSPEC	1	$26,135	$26,135	0%
	TRUNK MULTIPLE	1	$14,240	$14,240	0%
	SHOULDER	1	$13,323	$13,323	0%
	THIGH	1	$7,876	$7,876	0%
	Total	70		$3,456,454	21%
Agency of injury					
	DUMP TRUCK	32	$47,663	$1,525,203	9%
	DOZER	11	$79,009	$869,094	5%
	FRONT END LOADER	4	$61,558	$246,231	1%
	POWER SHOVEL	3	$79,220	$237,660	1%
	GRADER	5	$42,936	$214,679	1%
	SERVICE TRUCK/TANKER	3	$36,890	$110,669	1%
	WATER CART/TANKER	4	$27,528	$110,110	1%
	VAN/UTILITY	3	$28,435	$85,305	1%
	UNEVEN GROUND	2	$12,273	$24,546	0%
	MANHAUL	2	$9,347	$18,693	0%
	CAR	1	$14,264	$14,264	0%
	Total	70		$3,456,454	21%

B.4 Trapping injuries (underground)

Entrapment of workers that led to serious injuries accounted for 4% and 17% of the claims costs in underground mines and among contractors respectively. Analysis of the data (Table 30) shows that one claim of $971,857 dominates with four others above $100,000 (including one fatal entrapment injury) representing much of the remaining cost.

The accident descriptions of the most costly 20 of these claims are shown in Table 31. Some issues that feature in more than one description are conveyors, the inadvertent operation of equipment (implicated in the fatality); longwall chocks, and trapping/entanglement points in equipment. Projects could thus be conducted in these areas. For example; projects aimed at improving the identification and control of trapping and entanglement points and the ergonomics/user-interface aspects of the design of remote controls of underground mining equipment would be useful especially if the manufacturers were brought into the process at an early stage.

Table 30 Entrapment accidents at underground mines and among contractors: by type, body location and agency of injury (NSW only)

Injury type	Valid N	Mean	Sum	
AMPUTATION	8	$143,444	$1,147,556	2.3%
CRUSHING	16	$47,346	$757,540	1.5%
FRACTURE	24	$20,042	$481,006	0.9%
MULTIPLE INJURIES	1	$235,350	$235,350	0.5%
LACERATION	15	$12,574	$188,615	0.4%
STRAIN	1	$60,448	$60,448	0.1%
BRUISE	3	$18,115	$54,345	0.1%
DISLOCATION	2	$14,294	$28,588	0.1%
CONTUSION	1	$7,832	$7,832	0.0%
TORN MUSCLE/LIGAMENT	1	$6,786	$6,786	0.0%
CUT	1	$6,452	$6,452	0.0%
Total	73		$2,974,518	5.8%
Location of Injury				
SHOULDER	1	$971,857	$971,857	1.9%
FINGERS	36	$23,392	$842,128	1.7%
HAND	6	$41,397	$248,384	0.5%
MULTIPLE UNSPEC	1	$235,350	$235,350	0.5%
THUMB	7	$20,628	$144,399	0.3%
LOWER LEG	4	$31,991	$127,965	0.3%
FOOT	7	$18,062	$126,435	0.2%
UPPER ARM	1	$69,599	$69,599	0.1%
FOREARM	2	$30,326	$60,651	0.1%
TRUNK AND LIMBS	1	$60,448	$60,448	0.1%
ABDOMEN OTHER/MULTIPLE	1	$45,469	$45,469	0.1%
Others	6	$6,972	$41,834	0.1%
RIBS	1	$11,894	$11,894	0.0%
KNEE	1	$10,441	$10,441	0.0%
LOWER LIMB MULTIPLE	1	$6,539	$6,539	0.0%
WRIST	1	$4,589	$4,589	0.0%
HAND/FINGERS OTHER/MULTIPLE	1	$4,377	$4,377	0.0%
ANKLE	1	$3,994	$3,994	0.0%
Total	73		$2,974,518	5.8%
Agency of injury				
CONVEYOR	5	$224,666	$1,123,328	2.2%
ROOFBOLTER	4	$85,300	$341,202	0.7%
CONTINUOUS MINER	3	$103,179	$309,538	0.6%
SELF ADVANCING CHOCK/SHIELD	6	$47,949	$287,695	0.6%
FERROUS/NON FERROUS METAL	12	$13,959	$167,511	0.3%
DRILLING/BORING EQUIPMENT	3	$39,427	$118,280	0.2%
VENTILATION EQUIPMENT	3	$33,475	$100,424	0.2%
ELECTRIC TRAILING CABLE	2	$39,337	$78,674	0.2%
LONGWALL FACE CONVEYOR (AFC)	2	$35,462	$70,924	0.1%
UNDERGROUND TRANSPORTER	1	$62,221	$62,221	0.1%
UNDERGROUND LOADER	5	$9,113	$45,564	0.1%
U/G ROOF	3	$10,563	$31,688	0.1%
U/G RIB/SIDE	3	$9,910	$29,730	0.1%
LONGWALL EQUIPMENT	3	$8,891	$26,672	0.1%
ROOF BOLT	1	$24,512	$24,512	0.0%
ROOFBOLTER MINER MOUNTED	1	$23,206	$23,206	0.0%
SHUTTLE CAR	2	$10,494	$20,989	0.0%
MACHINE/EQUIPMENT PART	3	$6,849	$20,547	0.0%
BLOCK AND TACKLE	1	$19,077	$19,077	0.0%
SHAFT MANCAGE/SKIP	1	$18,898	$18,898	0.0%
COMPRESSOR/PUMP	1	$12,782	$12,782	0.0%
COAL/ROCK	2	$6,191	$12,383	0.0%
SAFETY/RESCUE EQUIPMENT	1	$6,786	$6,786	0.0%
PLANING MACHINE	1	$5,051	$5,051	0.0%
SCRAPER	1	$4,784	$4,784	0.0%
CHAIN	1	$4,711	$4,711	0.0%
HOIST/WINCH (POWERED)	1	$3,922	$3,922	0.0%
NAIL/SCREW	1	$3,419	$3,419	0.0%
Total	73		$2,974,518	5.8%

Table 31 Entrapments (twenty most costly) at underground mines and among contractors (NSW only)

AFTER COMPLETING REPAIRS HE WAS INSPECTING THE OPERATION OF THE CRUSHER FEED BELT WHEN HE MADE CONTACT WITH THE BELT & WAS TRAPPED BY LEFT ARM IN THE SPACE BETWEEN THE HEAD ROLLER & PLUMMER BLOCK CAUSING AMPUTATION TO L/ARM	$	971,857
WHILE ASSISTING BOLTER OPERATOR INSTALLING CABLE BOLT INTO HOLE ATTEMPTING TO PLACE BOLT INTO DOLLY HE MISSED DOLLY & BOLT SLIPPED OUT OF HOLE CRUSHING HIS R/MIDDLE FINGER BETWEEN BOLT & ROOFBOLTER	$	318,058
IT IS ALLEGED HE WAS WORKING ALONE CARRYING OUT SERVICE U/G ON C/MINER PICKS REMOTE CONTROL ACTIVATED CRUSHING HIM CAUSING FATAL INJURIES	$	235,350
WHILE STANDING ON NO 15 CHOCK OPERATING THE TILT CYLINDER TO CLEAN RUBBLE OFF ROOF HIS FINGERS JAMMED BETWEEN THE LEG EXTENSION THE SECOND STAGE OF T/G LEG CYLINDER CAUSING CRUSH INJURY L/INDEX & MIDDLE FINGERS	$	122,223
WHILE DRILLING FOR STAND PIPE TAKING REEMER OUT OF GRIPPERS ON DRILL HIS L/HAND JAMMED BETWEEN GRIPPER & REEMER CAUSING CRUSH INJURY TO L/INDEX & MIDDLE FINGERS	$	108,741
WHILE REPAIRING BROKEN BELT HE WAS LIFTING THE STEEL ROPE ON THE BELT CARRIAGE PULLEY WHEN THE CARRIAGE MOVED INBYE PULLING HIS L/HAND INTO THE SHEATH & ROPE SEVERING 3 FINGERS 1ST & 2ND JOINTS	$	88,671
WHILE ATTEMPTING TO TAKE CH4 READING WITH D6 IN MAIN SUCTION COMPARTMENT OF ABM20 HIS R/UPPER ARM WAS SUCKED IN & DRAGGED THROUGH SLIDING DOOR & JAMMED BETWEEN INTERNALS OF MACHINE CAUSING CRUSH INJURY	$	69,599
WHILE HE WAS TENDING C/MINER CABLE S/CAR PICKED UP THE CABLE AS IT LEFT THE FACE JAMMING HIS R/LOWER LEG BETWEEN CABLE &REAR OF S/CAR CAUSING FRACTURED R/TIBIA	$	66,814
WHILE INSTALLING CHOCK 119 THE RELAY BAR WAS LIFTED BY THE MULE TO ALLOW THE CHAIN TO BE RELEASED WHEN THE RELAY BAR FELL OFF THE PONTOON JAMMING HIS R/THUMB BETWEEN HOOK & RELAY BAR CAUSING CRUSH INJURY	$	63,480
WHILE FIXING FLOAT LEVEL ON MPV THE LID COVER FELL JAMMING HIS L/FINGERS CAUSING CRUSH FRACTURE L/RING & LITTLE FINGERS	$	62,221
WHILE ERECTING VENT TUBES IN PREPARATION FOR C/MINER RELOCATION AS HE CONNECTED NEXT TUBE IT SUCKED HIM ONTO THE TUBE AROUND THE CHEST AREA STRAINING HIS BACK & R/KNEE	$	60,448
WHILE HE WAS WALKING PAST THE BELT HIS SLEEVE GOT CAUGHT & PULLED HIS L/FOREARM ALONG THE BELT CAUSING MULTIPLE FRACTURES TO L/FOREARM	$	52,820
WHILE INSPECTING FACE INADVERTENTLY PLACED HIS R/FOOT UNDER RELAY BAR WHEN NO 4 CHOCK WAS ADVANCING HIS R/FOOT WAS CRUSHED BY THE RELAY BAR	$	52,695
WHILE HE WAS STANDING ON THE FACE PLATE OF CHOCK WHEN IT STARTED TO MOVE HE ATTEMPTED TO CLIMB ONTO THE CHOCK PLATFORM & BECAME WEDGED BETWEEN THE CHOCK & AFC CAUSING BRUISING TO HIS PELVIS	$	45,469
WHILE HE WAS ABOUT TO CLEAN DRILL STEEL WITHDRAWING IT FROM BOLT HOLE HE ACCIDENTALLY ENGAGED THE TILT JACK LEVER PINNING HIS L/MIDDLE FINGER INSIDE GUIDE & DRILL STEEL CAUSING LACERATION	$	41,271
WHILE CHANGING A PIN ON A RAM ON THE LONGWALL THE CHOCK MOVED FORWARD JAMMING HIS L/THUMB CAUSING LACERATION	$	37,056
WHILE MOVING BOOTEND ASSISTING IN GUIDING THE WAGNER DRIVER LIFTING THE REAR END OF THE BOOT THE BOOT SLID OFF THE PLATE OF WAGNER TRAPPING L/LOWER LEG BETWEEN BOOT & VENT TUBE CAUSING FRACTURE	$	35,900
WHILE ROOFBOLTING PUTTING UP ROOF BOLTS DRILL JAMMED ON TOP OF RIG & BENT CATCHING HIS R/HAND BETWEEN DRILL & RIG CAUSING AMPUTATION TO HIS R/LITTLE FINGER	$	29,783
WHILE HE WAS OPERATING SHEARER CUTTING T/G FLOOR WHEN THE HYDRAULIC CHOCK ADVANCED PINNING HIS R/FOOT AGAINST AFC CAUSING FRACTURE	$	25,455
WHILE RIB BOLTING AT 13 CT RIB BOLT GOT CAUGHT IN HOLE HE TRIED TO REDIRECT BOLT AS CO-WORKER TRIED SPINNING THE BOLT IN CATCHING HIS R/HAND ON THE BOLT CAUSING DISLOCATION TO HIS R/MIDDLE FINGER	$	24,512

B.5 Trailing cable injuries (underground)

Electric trailing cables were involved in 57 claims that totaled 3% of the cost underground in NSW. The common features are (Table 32):

- most of the injuries are strain (35) or pain (8) and these contribute most of the cost (2.6% of the 3.3% total);
- injuries to the back are common (21 injuries and 1.9% of cost) with the remaining injuries occurring to many other parts of the body;
- cable handling is the most common task (33) constituting 1.4% of cost; and
- overexertion is the common type of accident (46 claims and 2.7% of cost).

Most of the 33 cable handling injuries (the descriptions are shown in Table 32) are very similar and often involve lifting cables into and from roof hangers/rollers. Solutions are needed for this common problem and this could be the subject of a research project.

Table 32 Electric trailing cable injuries underground: by type of injury, body location, task and type of accident

Type of injury

STRAIN	35	$25,097	$878,401	2.0%
PAIN	8	$34,749	$277,990	0.6%
FRACTURE	3	$41,002	$123,007	0.3%
LACERATION	2	$46,351	$92,702	0.2%
TORN MUSCLE/LIGAMENT	1	$25,953	$25,953	0.1%
SPRAIN	4	$5,759	$23,036	0.1%
BRUISE	2	$5,529	$11,059	0.0%
CONTUSION	1	$5,608	$5,608	0.0%
CONCUSSION	1	$4,859	$4,859	0.0%
Total	57		$1,442,614	3.3%

Part of body

LOWER BACK	21	$38,848	$815,816	1.9%
SHOULDER	6	$21,380	$128,279	0.3%
LOWER LEG	2	$46,383	$92,767	0.2%
HAND	1	$80,842	$80,842	0.2%
KNEE	5	$14,599	$72,997	0.2%
WRIST	2	$23,562	$47,124	0.1%
ELBOW	2	$18,649	$37,297	0.1%
GROIN	4	$8,565	$34,261	0.1%
FOREARM	1	$31,612	$31,612	0.1%
HEAD MULTIPLE	1	$24,582	$24,582	0.1%
NECK AND TRUNK	4	$5,124	$20,497	0.0%
ABDOMINAL MUSCLES	1	$16,325	$16,325	0.0%
FINGERS	1	$11,860	$11,860	0.0%
NECK MUSCLES/BONES	1	$5,809	$5,809	0.0%
ABDOMEN OTHER/MULTIPLE	1	$5,608	$5,608	0.0%
BRAIN	1	$4,859	$4,859	0.0%
UPPER AND LOWER LIMBS	1	$4,189	$4,189	0.0%
LOWER LIMB UNSPEC	1	$4,141	$4,141	0.0%
UPPER LIMB MULTIPLE	1	$3,749	$3,749	0.0%
Total	57		$1,442,614	3.3%

Task

CABLE HANDLING	33	$19,068	$629,237	1.4%
OPERATING CONTINUOUS MINER	2	$159,993	$319,987	0.7%
INSPECTIONS	6	$35,986	$215,915	0.5%
HANDLING SUPPLIES/MATERIALS	6	$27,915	$167,488	0.4%
ELECTRICAL WORK NEC	1	$31,612	$31,612	0.1%
ROOFBOLTING-DRILLING	1	$24,582	$24,582	0.1%
HANDLING ITEMS	3	$6,609	$19,827	0.0%
EQUIPMENT REPAIR/MAINTENANCE	1	$11,860	$11,860	0.0%
OPERATING SHUTTLE CAR	1	$7,927	$7,927	0.0%
SERVICING PLANT/EQUIPMENT	1	$6,394	$6,394	0.0%
ROOFBOLTING-INSERTING BOLT	1	$4,141	$4,141	0.0%
OPERATING SELF-ADVANCING CHOCK	1	$3,644	$3,644	0.0%
Total	57		$1,442,614	3.3%

Type of accident

OVEREXERTION LIFTING/CARRYING	32	$31,250	$1,000,003	2.3%
OVEREXERTION PUSHING/PULLING	14	$11,181	$156,534	0.4%
HIT BY MOVING OBJECT	5	$29,073	$145,365	0.3%
TRAPPED BETWEEN MOVING OBJECTS	2	$39,337	$78,674	0.2%
FALL	2	$25,786	$51,572	0.1%
TRIP	1	$5,608	$5,608	0.0%
HIT BY FALLING OBJECT	1	$4,859	$4,859	0.0%
Total	57		$1,442,614	3.3%

Table 33 Injuries related to handling electric trailing cable underground (NSW only)

Description	Cost
WHILE HE WAS LIFTING C/MINER CABLE ONTO A HANGER HE STRAINED HIS LOWER BACK	$117,395
WHILE HE WAS WITH A GROUP OF MEN RECLAIMING A TRS CABLE WHICH WAS TIED TO THE ROOF HE FELT PAIN IN HIS R/SHOULDER	$81,476
WHILE HE WAS TENDING C/MINER CABLE S/CAR PICKED UP THE CABLE AS IT LEFT THE FACE JAMMING HIS R/LOWER LEG BETWEEN CABLE &REAR OF S/CAR CAUSING FRACTURED R/TIBIA	$66,814
WHILE HE WAS LIFTING THE C/MINER CABLE FOR ANOTHER MAN TO TIE UP HE STRAINED HIS LOWER BACK	$61,038
WHILE ATTEMPTING TO SHUNT S/CAR IN 3 C/T THE CAR TOOK DIFFERENT ROUTE THAN HE EXPECTED & TRAILING CABLE PINNED HIM TO RIB HE FELL & TWISTED HIS R/KNEE	$44,702
WHILE PULLING C/MINER CABLE BY HAND TO CHANGE IT LOOP OF CABLE GOT CAUGHT STRAINING HIS LOWER BACK & L/KNEE	$25,979
WHILE HE WAS ASSISTING TO CHANGE A U/S S/CAR CABLE WHEN PULLING CABLE TO THE ANCHOR POINT HE FELT A SHARP PAIN FROM THE L/ANKLE TO BACK OF HIS CALF MUSCLE CAUSING L/SOLEUS MUSCLE TEAR	$25,953
AFTER LIFTING C/MINER CABLE HE STRAINED HIS L/ELBOW	$23,678
WHILE LIFTING C/MINER CABLE INTO CABLE ROLLER CABLE SLIPPED OUT OF ROLLER BRINGING FULL WEIGHT OF CABLE DOWN ONTO HIS R/SHOULDER - ROTATOR CUFF STRAIN	$17,755
WHILE HE WAS LIFTING C/M CABLE HE STRAINED HIS STOMACH - VENTRAL HERNIA	$16,325
WHILE HE WAS LIFTING A C/M CABLE UP ONTO ROLLERS HANGING OFF THE ROOF HE STRAINED HIS R/WRIST - FLEXOR TENDONITIS	$15,564
WOLLEMI-WHILE LIFTING C/M CABLE ONTO A ROLLER HE SPRAINED HIS LOWER BACK	$11,185
WHILE LIFTING CONTINUOUS C/MINER CABLE INTO BRACKETS ON ROOF SUPPORTS HE STRAINED HIS GROIN - INGUINAL HERNIA	$9,557
WHILE HE WAS PULLING C/MINER CABLE BACKWARDS HE SLIPPED ON THE FLOOR PULLING A MUSCLE IN HIS GROIN - STRAIN	$8,968
WHILE ASSISTING IN CHANGING OUT A U/S S/CAR CABLE WHEN HE WAS PULLING THE CABLE HE STRAINED HIS R/GROIN - INGUINAL HERNIA	$8,923
WHILE HE WAS PULLING C/MINER CABLE HE STRAINED HIS L/KNEE	$8,260
WHILE HE WAS PULLING THE C/MINER CABLE OFF THE ROAD HE STRAINED HIS LOWER BACK - L/SCIATICA	$8,024
WHILE HE WAS ASSISTING OTHERS TO PULL EXCESS CABLE OFF S/CAR HE STRAINED HIS R/SHOULDER	$7,218
WHILE PULLING CABLE OFF S/CAR CABLE REEL HE STRAINED HIS NECK & LEFT SHOULDER	$7,089
WHILE PULLING ALPINE CABLE BY HAND THROUGH STOPPING SITE HE TWISTED HIS R/KNEE - INFLAMMATION	$6,772
WHEN LIFTING HOSES & C/MINER CABLE ONTO ROLLER HANGERS HE FELT PAIN IN HIS BACK & NECK	$5,855
WHILE HE WAS LIFTING C/MINER CABLE OUT OF CABLE ROLLER HE STRAINED HIS NECK & SHOULDER	$5,809
WHILE UNTANGLING BLS CABLE HE PULLED THE BLS CABLE OVER C/M CABLE TRIPPING OVER C/MINER CABLE HITTING HIS RIGHT KNEE HARD INTO FLOOR CAUSING CONTUSION TO R/PELVIS	$5,608
WHILE LIFTING & HANGING C/MINER CABLE ON TIES NAILED TO THE RIB ASSISTED BY ANOTHER MAN HE FELT PAIN IN HIS LOWER BACK	$5,141
WHILE DISCUSSING CUTTING SEQUENCE WITH CREW LEADER C/MINER CUTTING CHANGED DIRECTION SLIGHTLY CREATING WEIGHT ON CABLE ROLLER WEIGHT CAUSED CABLE TO FALL STRIKING HIS HEAD SHOULDER CLOSED HEAD INJURY & NECK PAIN	$4,859
WHILE PULLING C/MINER CABLE HE STRAINED HIS LEFT SHOULDER & LOWER NECK	$4,036
WHILE HE WAS PULLING A C/MINER CABLE IN THE MUD HE STRAINED HIS LOWER BACK	$3,931
WHILE HE WAS LIFTING C/MINER CABLE HE FELT A SHARP PAIN IN HIS LOWER BACK	$3,695
WHILE ATTEMPTING TO LIFT THE C/MINER CABLE UP TO POSITION IT IN A RECENTLY LOCATED CABLE ROLLER HE STRAINED HIS LOWER BACK	$3,680
WHILE PULLING & STACKING C/MINER CABLE IN THE RIB HE SPRAINED HIS LOWER BACK	$3,613
WHILE HANGING C/M CABLE ACROSS THE ROAD HE STRAINED HIS R/SHOULDER & NECK	$3,517
WHILE PULLING SLACK C/MINER CABLE INTO THE RIB LINE IN SPLIT SEQUENCE 1 SO THE MINER WOULD NOT DAMAGE IT HE STRAINED HIS LEFT SHOULDER	$3,428
AFTER HANDLING C/MINER CABLE HE STRAINED HIS LOWER BACK & HIP	$3,391

B.6 Rock falls (underground)

Serious injuries resulting from slides/falls of rock or coal constituted 11% of the underground claims cost. As shown in Table 34, the most costly types of injury are fractures (29 claims and 5.1% of cost), multiple injuries (3 claims and 1.7% of cost), and bruises (14 claims and 1.4% of cost). The injuries affect many parts of the body, however a small number of costly injuries to the ankle (2 claims and 1.4% of cost), lower limb multiple (5 claims and 1.5% of cost) and multiple unspecified (3 claims and 1.7% of cost) make up a reasonable proportion of the total cost due to this type of accident. In terms of the job task, there are a great variety of jobs that were being undertaken when these types of accidents occurred. The most common job task was roof bolting.

The descriptions of the 20 roof bolting-related accidents are shown in Table 35. Each description presents a similar scenario, involving a fall of coal while bolting. Investigations are needed about bolting equipment and procedures to determine best practice in the area. In conjunction with this, on site investigations are needed including problem solving efforts that involve experienced miners and equipment manufacturers.

Table 34 Slide/fall of rock/coal injuries underground: by type of injury, body location, and job task

Type of injury

FRACTURE	29	$77,677	$2,252,625	5.1%
MULTIPLE INJURIES	3	$243,562	$730,687	1.7%
BRUISE	14	$44,058	$616,808	1.4%
LACERATION	11	$22,259	$244,847	0.6%
EXPOSURE	1	$232,263	$232,263	0.5%
SPINAL FRACTURE	3	$64,495	$193,484	0.4%
PAIN	6	$31,524	$189,144	0.4%
CUT	1	$120,381	$120,381	0.3%
AMPUTATION	1	$115,901	$115,901	0.3%
ABRASION	6	$17,111	$102,667	0.2%
CONTUSION	3	$33,192	$99,575	0.2%
STRAIN	4	$24,804	$99,214	0.2%
SPRAIN	2	$9,629	$19,259	0.0%
PUNCTURE WOUND	1	$5,301	$5,301	0.0%
CRUSHING	1	$4,422	$4,422	0.0%
Total	86		$5,026,578	11%

Body location

MULTIPLE UNSPEC	3	$243,562	$730,687	1.7%
LOWER LIMB MULTIPLE	5	$131,546	$657,729	1.5%
ANKLE	2	$295,972	$591,945	1.4%
LOWER LEG	7	$47,796	$334,570	0.8%
TRUNK AND LIMBS	5	$53,251	$266,256	0.6%
RIBS	4	$59,075	$236,301	0.5%
RESPIRATORY SYSTEM	1	$232,263	$232,263	0.5%
NECK MUSCLES/BONES	6	$31,970	$191,820	0.4%
KNEE	4	$46,039	$184,158	0.4%
UPPER LEG	1	$172,818	$172,818	0.4%
FOOT	7	$23,416	$163,913	0.4%
MULTIPLE	2	$75,010	$150,020	0.3%
FINGERS	5	$27,422	$137,112	0.3%
SHOULDER	6	$20,654	$123,923	0.3%
BACK OTHER/MULTIPLE	1	$118,138	$118,138	0.3%
FOREARM	2	$58,714	$117,428	0.3%
TOES	1	$115,901	$115,901	0.3%
LOWER LIMB UNSPEC	2	$57,210	$114,420	0.3%
HEAD MULTIPLE	1	$76,873	$76,873	0.2%
HAND	1	$70,734	$70,734	0.2%
UPPER LIMB MULTIPLE	3	$14,257	$42,770	0.1%
THUMB	2	$14,691	$29,381	0.1%
BACK UNSPEC	1	$28,014	$28,014	0.1%
LOWER BACK	2	$12,521	$25,041	0.1%
HEAD AND OTHER	3	$8,279	$24,838	0.1%
CHEST MUSCLES	1	$19,659	$19,659	0.0%
THIGH	1	$18,505	$18,505	0.0%
FACE NEC	1	$16,479	$16,479	0.0%
CHEST OTHER/MULTIPLE	2	$5,628	$11,257	0.0%
ELBOW	1	$8,938	$8,938	0.0%
UPPER LIMB UNSPEC	1	$5,971	$5,971	0.0%
CHEEK	1	$5,253	$5,253	0.0%
UPPER AND LOWER LIMBS	1	$3,464	$3,464	0.0%
Total	86		$5,026,578	11%

Continued overleaf

Job task

ROOFBOLTING-DRILLING	20	$47,930	$958,602	2.2%
HANDLING ITEMS	1	$527,467	$527,467	1.2%
OPERATING CONTINUOUS MINER	6	$78,095	$468,572	1.1%
VENTILATION WORK NEC	1	$466,462	$466,462	1.1%
INSPECTIONS	8	$56,698	$453,582	1.0%
CABLE HANDLING	6	$54,188	$325,131	0.7%
ROOF/RIB SUPPORT NEC	3	$102,778	$308,334	0.7%
NOT STATED/UNKNOWN	1	$244,362	$244,362	0.6%
OPERATING LONGWALL SHEARER	7	$33,328	$233,295	0.5%
ROOFBOLTING-NEC	3	$50,023	$150,070	0.3%
UNDERGROUND ACTIVITY NEC	3	$49,369	$148,106	0.3%
SERVICING PLANT/EQUIPMENT	4	$31,471	$125,883	0.3%
WALKING/RUNNING	2	$62,057	$124,113	0.3%
OPERATING SHUTTLE CAR	6	$20,604	$123,622	0.3%
BARRING DOWN FACE/ROOF/RIB	1	$106,767	$106,767	0.2%
RIB-BOLTING	2	$51,190	$102,380	0.2%
HANDLING SUPPLIES/MATERIALS	2	$49,486	$98,972	0.2%
TIMBERING	2	$9,706	$19,412	0.0%
OBSERVING OPERATIONS	2	$6,729	$13,458	0.0%
OPERATING SELF-ADVANCING CHOCK	1	$5,955	$5,955	0.0%
OPERATING U/G LOADER	1	$5,842	$5,842	0.0%
ELECTRICAL REPAIR/MAINTENANCE	1	$4,793	$4,793	0.0%
CONVEYOR WORK	1	$4,437	$4,437	0.0%
ERECT STOPPINGS/OVERCASTS ETC	1	$3,497	$3,497	0.0%
PERIODIC JOURNEY	1	$3,464	$3,464	0.0%
Total	86		$5,026,578	11%

Table 35 Injuries due to slide/fall of rock/coal while roofbolting (NSW only)

Description	Cost
WHILE ROOFBOLTING AT THE FACE FROM THE ABM A PIECE OF COAL FELL FROM THE RIB & HIT HIS CHEST BACK & SHOULDERS FRACTURING HIS STERNUM	$203,995
WHILE ROOFBOLTING AT FACE RIB CAME AWAY STRIKING HIM & FORCING HIM INTO SIDE OF C/MINER & ONTO THE FLOOR BRUISING HIS L/HAND - NECK & SHOULDER	$117,095
WHILE HE WAS ROOFBOLTING ON SIDE OF C/MINER A PIECE OF RIB FELL ONTO HIS LEFT FOOT CAUSING AMPUTATED L/4TH TOE & FRACTURED L/3RD - 4TH & 5TH TOES	$115,901
WHILE BOLTING A LARGE PIECE OF STONE FELL AWAY STRIKING HIS LEFT FOOT AS HE STARTED TO MOVE AWAY THE MESH FELL CAUSING SCRATCHES TO HIS LOWER BACK	$93,728
WHILE ROOFBOLTING ON THE SIDE OF ABM 20 C/MINER WHEN THE CORNER OF THE COAL PILLAR FELL STRIKING HIM CAUSING LACERATIONS TO HIS HEAD - L/FOREHEAD - L/EYE & ABRASIONS TO L/CHEEK	$76,873
WHILE HE WAS BOLTING BROKEN ROOF IN G PANEL A LARGE PIECE OF STONE FELL FROM THE ROOF CRUSHING HIS L/HAND & HITTING HIS L/SHOULDER & NECK	$70,734
WHILE ROOFBOLTING HE WAS DRILLING A HOLE INTO THE ROOF WITH A ROOFBOLTER THE ROOF CAME AWAY HITTING HIS R/ANKLE & R/KNEE	$66,628
ROOFBOLTING - WHILE HE WAS DRILLING CENTRE BOLT ON FACE STRAP LEFT SIDE OF FACE FELL AWAY FROM THE ROOF LEVEL HITTING & BRUISING HIS L/LEG	$63,451
WHILE ROOFBOLTING ON R/H SIDE OF C/MINER A PIECE OF RIB FELL OUT JAMMING FINGER ON TRIGGER LACERATING & CRUSHING HIS R/MIDDLE FINGER	$32,410
WHILE PUTTING UP ROOF BOLTS IN STRAP THE RIB FELL KNOCKING HIM OVER THE BOLTER & IT FELL ONTO HIS L/SHOULDER & L/ELBOW - BRUISING	$23,172
WHILE HE WAS AT THE FACE OFFSIDING ROOFBOLTER RIB FELL HITTING HIS R/KNEE CAUSING BRUISING	$16,483
WHILE BOLTING COAL FELL FROM THE RIB HITTING HIS HAND ON THE HANDLE OF THE BOLTER CAUSING PAIN TO HIS LEFT THUMB	$16,450
WHILE HE WAS ROOFBOLTING A SLAB OF COAL SLIPPED FROM THE RIB CRUSHING HIS L/FOOT CAUSING FRACTURE - LACERATION & ABRASION	$15,230
WHILE HE WAS ROOFBOLTING HE WAS HIT ON THE HAND BY A SMALL PIECE OF ROCK & AS HE STEPPED BACK A LARGER PIECE FELL FROM BETWEEN THE STRAPS & HIT HIS LOWER R/LEG CAUSING BRUISING & GRAZING	$10,550
WHILE HE WAS ADVANCING THE ROOFBOLTER TO INSTALL A BOLT WHEN HE LIFTED THE BOLTER A LARGE PACKER FELL FROM THE RIB ONTO THE BOLTER ADDING EXTRA WEIGHT KNOCKING HIM OFF BALANCE STRAINING HIS R/SHOULDER	$9,211
WHILE HE WAS ROOFBOLTING AT THE FACE WHEN FACE COAL FELL OUT FRACTURING HIS L/FOOT 2ND & 3RD METATARSUS & BRUISING HIS L/KNEE	$7,902
WHILE HE WAS ROOFBOLTING SUPPORTING ROOF A PIECE OF STONE FELL OUT OF THE ROOF HITTING HIS FACE LACERATING HIS L/CHEEK	$5,253
WHILE GETTING CHEMICAL ANCHORS A PIECE OF COAL FELL FROM THE ROOF ONTO HIS HEAD CAUSING NECK PAIN	$5,205
WHILE HE WAS ON TOP OF THE C/MINER FINDING THE LASER CENTRE WHEN COAL TOPS FELL ONTO HIS L/FOOT & SHOULDER CAUSING CRUSH INJURY L/FOOT	$4,422
WHILE BOLTING RIG ON THE RIGHT SIDE OF ABM A PIECE OF STONE SLID FROM THE RIB FORCING HIS R/KNEE AGAINST THE MACHINE IT THEN SLID DOWN STRIKING HIS R/ANKLE - BRUISE	$3,908