NOHSC
National Occupational Health & Safety Commission

# Work-related fatalities Associated with design Issues involving machinery and fixed plant in Australia, 1989 to 1992

September 2000


NOHSC
National Occupational Health & Safety Commission

National Occupational Health and Safety Commission

# Work-related fatalities associated with design issues involving machinery and fixed plant in Australia, 1989 to 1992

**Information from**
**the second work-related fatalities study,**
**1989 to 1992**

**September 2000**

National Occupational Health and Safety Commission
Sydney

ISBN 0642 43262 7



**Further information and use of this publication**

Further information from this study regarding fatalities involving design issues of machinery and fixed plant in Australia may be available. Persons with a specific interest in this area and who would like more information are encouraged to approach the authors of this report.

Wide dissemination and use of the information arising from the work-related fatalities studies is encouraged. This publication is copyright. However, it may be reproduced with proper acknowledgment. The suggested citation is: *NOHSC. Work-related fatalities associated with design issues involving machinery and fixed plant in Australia, 1989 to 1992.* NOHSC: Sydney, 2000.

For further information regarding all work-related deaths see: NOHSC. *Work-related traumatic fatalities in Australia, 1989 to 1992*. NOHSC: Sydney, 2000.

## Table of Contents

## Table of Contents

## Table of Contents

## List of Tables

## List of Tables

## List of Tables

## List of Tables

## List of Figures

# Work-related fatalities associated with design issues involving machinery and fixed plant in Australia, 1989 to 1992

**Information from the second work-related fatalities study, 1989 to 1992**

## OVERVIEW

### Background

The use of passive approaches to eliminating or controlling hazards is probably the most effective way of decreasing the risk of injury from workplace exposures. The design of equipment is an important area where passive safety measures can be implemented. Work often requires the use of machinery and various types of plant, and the use of such equipment may pose hazards to the operator or to bystanders to the work. If these hazards are not appropriately controlled, they can contribute to the occurrence of serious incidents. Consideration of incidents involving equipment can provide information on important design problems that could usefully be the target of preventive action.

As part of NOHSC's 'Safe design' project, and using information from the second work-related fatalities study (which covered the year's 1989 to 1992), fatal workplace and bystander incidents involving various types of equipment and machinery were examined, looking particularly for incidents where design issues appeared to be important. This report describes the results of the analysis of incidents that involved machinery and fixed plant. Design issues relevant to other equipment types are likely to be the subject of subsequent reports.

The aim of the report was to examine fatal incidents involving machinery and fixed plant in an attempt to:

- determine the extent to which equipment design issues contribute to the occurrence of work-related injury; and
- identify equipment design issues which may be amenable to change in order to prevent work-related injury.

### Definition of design issues

Design issues in the fatal incidents were defined as any aspect of the design of equipment that contributed to an injury occurring or being more severe than it would otherwise have been.

### Involved agencies

There were 233 deaths in 225 incidents involving machinery and fixed plant. Two hundred and twenty one of these persons were working and 12 were bystanders. A variety of equipment was involved in the incidents, with conveyors and lifting plant (68%) being by far the most commonly involved agency type. This group included forklifts, cranes, lifts, hoists, conveyors and screw augers. Other agency types included cutting, slicing and sawing machinery; crushing, pressing and rolling equipment; heating, cooking and baking equipment; and cooling and refrigeration equipment.

## Mechanisms

The main mechanisms involved in the incidents were ‘being hit by falling objects’; ‘contact with electricity’; ‘falls from a height’; ‘being hit by a moving object’; ‘being trapped by moving machinery’; ‘being trapped between stationery and moving objects’ and ‘rollovers’.

## Contributing factors

There were 686 contributing factors identified in the 225 incidents, with design issues, other equipment-related issues, behavioural factors and organizational factors being the most common.

There was a range of design issues, with the more common being connected with guarding, controls and safety equipment. Many of the incidents occurred when some form of maintenance was being undertaken on the machine.

## Major design issues

Of the 225 incidents, 117 had at least one design factor contributing to the fatal outcome. Design factors related to guarding were the most common single design problem identified. Issues related to the design of controls were the next most common. However, the majority of design factors were more specific. Some of the more common contributing factors included:

- guarding could be removed or rendered inoperative;
- no guarding of area designed around work space or equipment;
- controls in a position which did not allow adequate viewing of machinery;
- positioning of controls allowed inadvertent activation by operator during maintenance or other activities on the equipment;
- equipment not designed to ‘fail safe’;
- equipment able to function with inappropriate attachments;
- blind spots on manoeuvrable equipment;
- equipment able to function when nearing overhead wires (lack of over luffing devices);
- reliance of equipment on one mechanism which, if it failed, had catastrophic consequences; and
- seatbelts not designed into equipment.

### GUARDING

Guarding issues are well illustrated by consideration of the incidents involving cutting, slicing and sawing machinery. There were 18 incidents involving this type of machinery, 13 of which involved guarding problems. Many of the incidents had very similar circumstances. A typical incident is described here.

> *As a piece of timber was being sawn, it kicked back and hit the bench saw operator, producing fatal injuries to his liver. The saw had no riving knife, helmet guard or vee-belt guard. It was not clear whether the guards had ever been fitted, or had been installed and later removed.*

Five other incidents involving bench saws occurred because guards were missing, raised or mal-adjusted. In addition, incidents of inadequate, missing or removed machine guarding involved a range of other cutting, slicing and sawing equipment, such as a garbage shredder, balancing machine, grinder, chipper machine, sanding machine and milling machine. There were also guarding problems with many other types of machinery.

## CONTROLS

A second series of major design issues was with the placement and layout of equipment controls. This occurred in a variety of equipment types.

### *Controls too far from the equipment*

*A machine operator was crushed in a de-hacking machine. He had entered the service area of the production line to clear an obstruction, triggering the automatic safety device, which stopped the machine. As per normal practice, the machine had then been turned on again by an operator who sat at a console, from which he could not see the other operator in the service area.*

This incident arose primarily because the equipment was activated by an operator whilst a second person was within the machinery. The controls were placed away from the machinery, so the first operator couldn't see inside the equipment when the controls were used. This, combined with a lack of safety cut-off devices, lead to fatal incidents involving a printing press, de-hacking machine, log carriage conveyor and ore conveyor.

### *Controls too close to moving parts*

*A machine setter was preparing a power press when he was struck in the head by the setting bar attached to the crank shaft. He had reached over it to operate controls and accidentally stepped on the foot pedal. The guarding had been removed while the machine was being set. There was an interlock available but it was not fitted.*

A second problem with controls was their placement too close to the moving parts of the machinery. This allowed them to be activated unintentionally while the person was exposed to the hazard of the moving parts. This problem led to fatal incidents involving a hay baler, wool press, power press, mutton pelting machine and power strapping machine.

### *Poorly placed safety switches*

*A truss assembler was working on a roll-a-span machine when he either put his hand into it, or slipped onto the rollers and was pulled in over the safety cut out. He could not reach the emergency stop. Extra guarding was installed after the incident.*

The third major problem with controls was having the safety cut-off switch placed so that it was not accessible by someone caught in the machine. This prevented the machinery being stopped if someone was working alone and became caught in the equipment. This problem led to fatal incidents involving a roll-a-span machine, a garbage shredder and a waste conveyor.

## MAINTENANCE

Twenty per cent of all incidents described in this report occurred during some sort of maintenance activity. Maintenance issues are well illustrated by consideration of the incidents involving conveyor belts and escalators. There were 15 incidents involving this type of machinery, nine of which involved maintenance. A typical incident is described here.

*A man died from crush injury syndrome when his arm was caught in a soil screener as he was adjusting it. The screener's belt needed adjusting often, but apparently this could only be done when the machine was running. He dropped the spanner he was using and became caught between the drum and belt when he bent over to retrieve it. The machine had inadequate guarding and the main guard had also been removed.*

Four other incidents involved conveyor belts and escalators, and in three of these the worker's arm became caught in a conveyor belt, just as occurred in the incident described above. In another incident, the worker became caught in rollers. A fuel conveyor, two mining conveyors and a waste conveyor were involved in these incidents. Other types of conveyor belts and escalators involved in fatal incidents that occurred during maintenance activity were a log carriage conveyor, a factory conveyor, an ore conveyor and a soil screening plant.

## Recommendations resulting from incidents involving machinery and fixed plant

Of the 225 fatal incidents, a Coroner, OHS Authority or other agency made recommendations arising from 112 (49.8%). Of these, 53 recommendations were specifically related to the design of equipment. Common recommendations included:

- adoption of an Australian standard for a type of equipment;
- amendments be made to standards for forklift design;
- guarding be designed such that the machinery cannot function if it is not in place;
- guarding be installed as per regulations;
- installation of guarding around moving parts, entire machine or entire work area;
- controls have a captive key system;
- controls be located at a safe distance from moving parts;
- amend regulations to make certain safety equipment mandatory;
- compulsory fitting of seatbelts.
- electrical equipment should be insulated; and
- interlocking distance monitoring devices be installed.

## Problems with identifying design issues

Problems arose when using the coronial files to identify design issues in the fatal incidents. Some of these related to the definition of "design" and the fact that there might be a number of potential design approaches to appropriately control a hazard. This meant that the type of design issue, and the connection to design, was not always clear.

Also, it was costly and time-consuming to identify and access the files, and the files sometimes lacked relevant detail about the equipment or the circumstances. Finally, for some types of events, there were (fortunately) too few to allow patterns of design problems to be easily identified or to be raised as a priority. This is less of a problem in a detailed study such as that reported here, but is particularly important for individual coroners, OHS authorities and manufacturers, many of whom come across such incidents rarely.

## Opportunities to identify design issues

The National Coronial Information System (NCIS), being developed by state and territory coroners, should provide a more complete coverage of work-related fatalities than is currently routinely available, and do so in a more timely manner. This should make it easier to identify design issues on an on-going basis and evaluate the effect of attempts to address the design issues.

Activities such as the 'Safe Design' project help to improve recognition of the ways that poor design can lead to health and safety problems, and how improvements in design can eliminate or control many of the hazards that are currently present in the working environment. They also lead to improved opportunities for collaborative work between the architects, engineers, employers, workers, manufacturers, researchers and governments who can contribute to better health and safety in Australia through consideration of design issues.

## Conclusions

This report has shown that design issues with machinery and fixed plant are an important contributing factor to fatal work-related injury, and that in-depth use of data can provide specific information on the type and extent of particular design issues. This information can be used to support appropriate preventive activities.

# INTRODUCTION

The use of passive approaches to eliminating or controlling hazards are probably the most effective way of decreasing the risk of injury from workplace exposures. The design of equipment is an important area where passive safety measures can be implemented. Issues in equipment design include the physical structure of the equipment (such as the presence and type of guarding), the location and layout of controls, and the materials used, as well as the associated function, both when in normal operating mode and when being maintained or repaired.

Work often requires the use of machinery and various types of plant, and the use of such equipment may pose a hazard to the operator or to bystanders to the work. If these hazards are not appropriately controlled, they can contribute to the occurrence of serious incidents. Consideration of incidents involving equipment can provide information on important design problems that could usefully be the target of preventive action.

There are a variety of information sources that could potentially provide information on work-related incidents involving equipment. These sources include State and Territory Occupational Health and Safety (OHS) authorities, workers' compensation data sets, government agencies covering specific industry sectors, serious incident reporting, government agencies not specific to industry sectors, specific surveys, police services and the coronial system, research projects and the press. Of these, only workers' compensation information is currently readily available on an on-going basis.

Unfortunately, although workers' compensation data sources contain (mainly) coded information on agency and mechanism, there is no information on contributing factors and no direct information on design issues. They are therefore not useful when considering possible contribution of design issues to work-related incidents.

In contrast, coronial files contain a wealth of information on the circumstances surrounding work-related fatal injury. Where equipment has been involved, relevant aspects of the design and function of the equipment is often addressed. Unfortunately, the coronial information is usually difficult to access, as the coronial system and files have been, until very recently, largely paper-based.

The second work-related fatalities study (WRFS 2), which considered all work-related fatalities that occurred in Australia in the four-year period 1989 to 1992, was based on coronial information, and so provided the opportunity for an in-depth analysis of design issues relevant to the work-related deaths.

The work-related fatalities study covered the years 1989 to 1992 inclusive. In that four-year period, 1,787 workers were fatally injured as a result of their work. Of these 1,787, 543 workers ("work-road") were injured in motor vehicle incidents on public roads, and the remaining 1,244 workers ("workplace") were injured elsewhere, usually in some sort of workplace. There were an additional 323 people ("bystanders") who were not working but who were fatally injured as a result of someone else's work.

Equipment was involved in many of the fatal workplace incidents, with common involved agencies being machinery and fixed plant (24%), tractors and mobile plant (9%), powered equipment and tools (8%) and non-powered tools and equipment (17%). Equipment was also involved in some of the bystander deaths.

As part of NOHSC's 'Safe design' project, fatal workplace and bystander incidents involving various types of equipment and machinery were examined, looking particularly for incidents where design issues appeared to be important. This report describes the results of the analysis of incidents that involved machinery and fixed plant. Design issues relevant to other equipment types are likely to be the subject of subsequent reports.

The aim of the report was to examine fatal incidents involving machinery and fixed plant in an attempt to:

- determine the extent to which equipment design issues contribute to the occurrence of work-related injury; and
- identify equipment design issues which may be amenable to change in order to prevent work-related injury.

# METHODS

## Inclusion criteria

Cases were defined as those persons who were fatally injured in incidents where one of the agencies involved included fixed plant and machinery. In keeping with the 'NSW WorkCover Modification to Type of Occurrence' (NOHSC, 1990) coding system, the description of agencies was "machinery and (mainly) fixed plant", as some mobile plant, most notably fork lifts, truck-mounted cranes and tow trucks were also included in this group. However, for ease of understanding, the group is referred to as 'machinery and fixed plant' in the rest of the report. The group also included a number of electrical installation agencies. Of these agencies, this report only includes turbines, generators, electric motors and transformers. Other electrical apparatus, such as high tension electric wires, although in this agency grouping, have been excluded from this report. This is because they are not usually thought of as "plant" or "equipment", and because they tended to have different contributing factors which could best be dealt with separately. (Future reports may examine design issues with that electrical apparatus, as well as other agencies that may have design issues relevant to fatal injuries.)

People who were working at the time of the incident, as well as bystanders to work, were included. The information is primarily presented on the basis of the individual persons who were fatally injured. However, some of the incidents involved multiple deaths. Where the number of incidents is described rather than the number of deaths, this is made clear in the text.

Persons who were working at the time of the incidents, and bystanders to that work, were included in the presented analysis. Appendix 2 describes the inclusion criteria for workers and bystanders to work.

## Definition of design issues

Design issues in the fatal incidents were defined as any aspect of the design of equipment that contributed to an injury occurring or being more severe than it would otherwise have been.

## Contributing factors

Contributing factors were defined as factors that led to the incident occurring or made its outcome more severe than it otherwise would have been. The contributing factors were determined from information available in the case files. They are based on statements from the Coroners, police and OHS inspectors, as well as interpretation of the case information by the study team. Identification of the contributing factors was therefore dependent on a number of elements, including the type and quality of data available, and the training and philosophy of the persons whom contributed information to the files, and of the study team.

Various types of contributing factors could be identified. In the majority of incidents, it was possible to identify several contributing factors. For many incidents, identification of the contributing factors was straightforward. However, in some instances, determination of the contributing factors was difficult to do comprehensively. The contributing factors for each incident were identified through examination of the text descriptions of the incident, with each identified factor being categorised as one of the following:

- equipment/machinery
- organizational
- behavioural
- experience/knowledge

- personal protective equipment
- remote working site
- physiological
- physical
- toxicological
- psychological
- other

Some of these factors also contained a number of distinct sub-factors. In such cases, the total number of contributing factors in the overall category, as well as the individual ones, is reported. Where equipment design was identified as a contributing factor, further examination of those factors in relation to guarding, controls or other equipment design issues was conducted.

The specific design issues that contributed to an event were sometimes quite apparent. However, in some cases, possible design problems could have been overcome by more than one method. For example, if the design issue was 'equipment able to function with excess metal protruding', such a design issue could conceivably be overcome in a number of different ways. This report states what the identified design problem was, but does not attempt to suggest a particular solution.

In some deaths involving machinery and fixed plant, design issues of other equipment, not included in the machinery and fixed plant agency groups, was identified as having contributed to the death. In such cases, the design issues are reported in the section where the machinery and fixed plant is discussed, but the description of the design issue indicates where the problem was identified. For example, in one death involving an air conditioning unit, a worker was electrocuted when his metal ladder pierced an extension cord. In this case, the design of the ladder was inadequate, because its feet were not insulated. This design issue is included in the section on cooling and refrigeration plant and equipment.

### Rates

Where rates are presented, they have been determined using only those workers who had been members of the Employed Civilian Labour Force (ECLF). Rates are expressed as deaths per 100,000 persons per year. Denominator data for calculation of rates were based on the relevant Labour Force Surveys conducted during 1989 to 1992 by the Australian Bureau of Statistics. The ECLF includes nearly all working persons aged 15 years or older, but specifically excludes members of the armed services (ABS, 1993). Ninety-five percent confidence intervals are included where appropriate, calculated assuming a Poisson distribution (Armitage and Berry, 1987).

### Agencies and mechanisms

The agency or agencies that were involved in each death were recorded. Up to three agencies could be identified for a death. All agencies that included machinery and fixed plant, regardless of whether the agency was determined as the first, second or third agency of incident, were identified and the incidents examined. There were occasions where more than one agency within the selected range was identified for a death. Thus, the number of agencies exceeded the number of deaths.

The mechanism involved in the death was also recorded. Up to two mechanisms could be identified for each death. However, as 94% of the deaths had only one mechanism identified,

only the first (primary) mechanism was studied for this report. Thus, the number of mechanisms reported here is the same as the number of deaths.

## Recommendations

Information pertaining to the recommendations made by Coroners, OHS bodies, or other Authorities was obtained from examination of the coronial files. Some files were not detailed and may not have recorded all of the relevant information. Thus, it is possible that there may have been cases where recommendations were made but were not recorded in the database. However, it is likely that nearly all the relevant recommendations were recorded.

# RESULTS

During the four-year period 1989 to 1992, there were 233 work-related deaths (about 5 per month) involving machinery and fixed plant in Australia. Of those, 221 were of persons working at the time of the incident[1], and 12 were of bystanders to work (Table 1). There were eight incidents where more than one person was killed (each having two fatalities), so that the 233 deaths occurred in 225 incidents.

The 221 working persons represented 12.4% of all fatally injured workers in Australia during the four years of the overall study, with a rate of work-related deaths from machinery and fixed plant of 0.70 deaths per 100,000 persons per year.

## Gender and age

The vast majority (94%) of working people who were fatally injured were males. In contrast, one third of the bystanders who were fatally injured were females (Table 1).

The mean age of the fatally injured working persons was 39 years (range nine to 86 years), and for bystanders was 20 years (range five to 64 years).

**Table 1 Gender of working persons and bystanders fatally injured in incidents involving machinery and fixed plant. Number and percent — Australia, 1989 to 1992**

| Duty Context | Number | Percent |
|---|---|---|
| **Working** | | |
| Males | 218 | 93.6 |
| Females | 3 | 3.4 |
| **Total Working** | **221** | **97.0** |
| **Bystanders to Work** | | |
| Males | 8 | 1.3 |
| Females | 4 | 1.7 |
| **Total Bystanders** | **12** | **3.0** |
| **Total Persons** | **233** | **100.0** |

[1] Two hundred and sixteen of the 221 deceased working persons were in the ECLF.

## Jurisdiction

Just over one third of the working persons were fatally injured while working in New South Wales, with Queensland and Victoria having the next highest numbers of deaths. The rate of death was highest in the Northern Territory, although it was based on a relatively small number of deaths. The number of bystanders to work who were fatally injured were more equally distributed across jurisdictions, with the highest number reported in Western Australia (Table 2).

**Table 2 Jurisdiction of working persons and bystanders at the time of fatal injury in incidents involving machinery and fixed plant. Number and percent — Australia, 1989 to 1992**

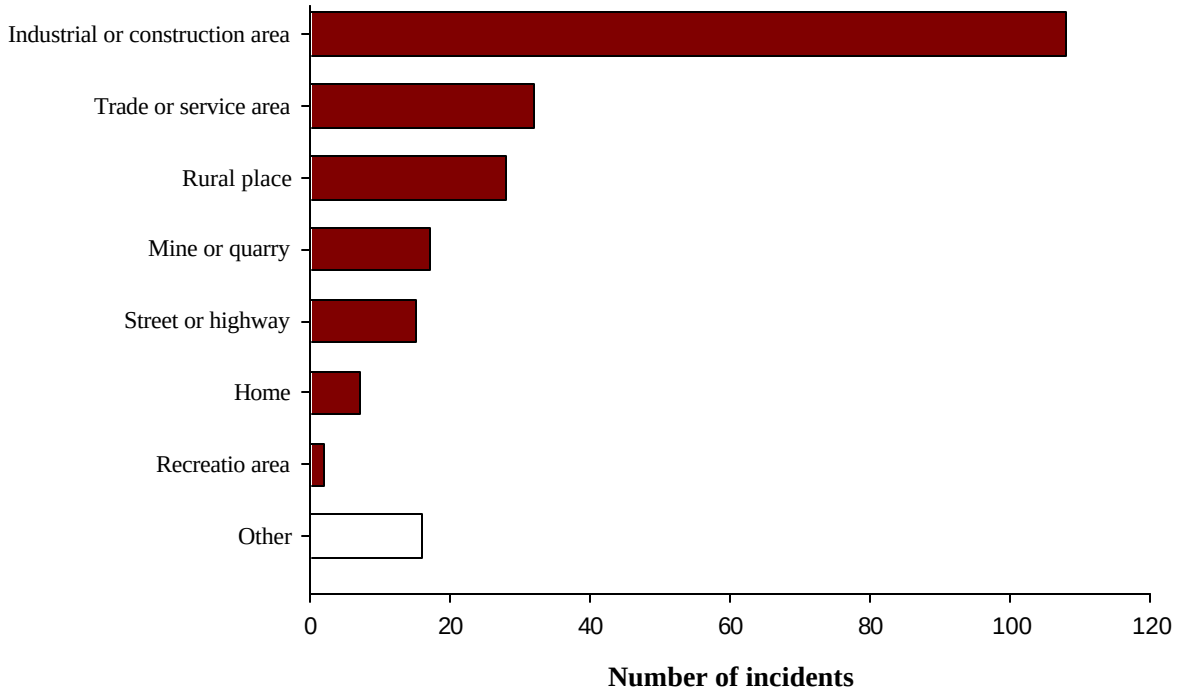
| Jurisdiction | Working | | | Bystanders | | Total | |
|---|---|---|---|---|---|---|---|
| | Number | Percent | Rate[1] (CI) | Number | Percent | Number | Percent |
| NSW | 74 | 34.5 | 0.67 (0.52-0.85) | 1 | 8.3 | 75 | 32.2 |
| QLD | 48 | 21.7 | 0.91 (0.67-1.21) | 3 | 25.0 | 51 | 21.9 |
| VIC | 40 | 18.1 | 0.48 (0.34-0.66) | 2 | 16.7 | 42 | 18.0 |
| WA | 22 | 9.6 | 0.74 (0.46-1.12) | 4 | 33.3 | 26 | 11.2 |
| SA | 21 | 9.5 | 0.82 (0.50-1.25) | 1 | 8.3 | 22 | 9.4 |
| NT | 8 | 3.6 | 2.56 (1.12-5.05) | - | - | 8 | 3.4 |
| TAS | 6 | 2.7 | 0.77 (0.28-1.68) | 1 | 8.3 | 7 | 3.0 |
| ACT | 2 | 0.9 | - | - | - | 2 | 0.9 |
| **Total** | **221** | **100.0** | **0.70 (0.61-0.79)** | **12** | **100.0** | **233** | **100.0** |

1: Deaths per 100,000 employed persons per year with 95% confidence intervals. Rates were not calculated where there were fewer than 4 deaths.

## Place of incident

Of the 225 fatal incidents, approximately half occurred in industrial or construction areas (Figure 1).

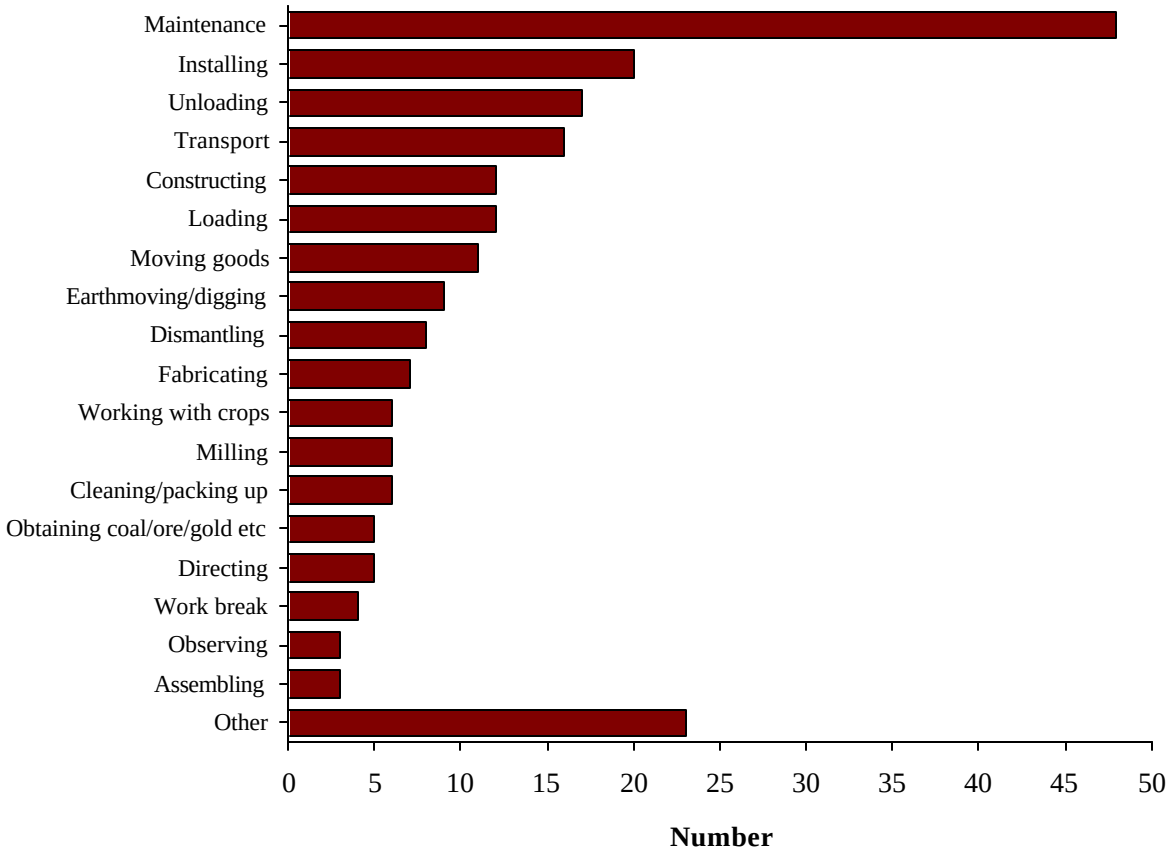
**Figure 1 Place of fatal incident where working persons and bystanders were fatally injured from machinery and fixed plant. Number — Australia, 1989 to 1992**



## Activity at time of incident

The most frequent single activity being conducted by persons fatally injured while working at the time of the incident was maintenance. This was being performed by just over 20% of the working persons. The other common activities at the time of the incident included installing, transport and unloading (Figure 2).

**Figure 2 Activity at time of incident for working persons fatally injured in incidents involving machinery and fixed plant. Number — Australia, 1989 to1992**



## Industry of employer

The most common single industry in which the fatally injured working persons were employed was manufacturing, followed by construction. Together, almost half of the workers were in these two industries (Table 3). However, the highest rate of fatal injury was in the mining industry, followed by the electricity, gas and water industry.

**Table 3 Industry of working persons fatally injured in incidents involving machinery and fixed plant.**
**Number, percent and rate — Australia, 1989 to 1992**

| Industry of employer | Number | Percent | Rate[1] | Confidence Interval |
|---|---|---|---|---|
| Manufacturing | 66 | 29.9 | 1.42 | 1.09 – 1.80 |
| Construction | 38 | 17.2 | 1.69 | 1.20 – 2.33 |
| Transport and storage | 28 | 12.7 | 1.79 | 1.19 – 2.59 |
| Agriculture, forestry fishing and hunting | 24 | 10.9 | 0.68 | 0.43 – 1.02 |
| Wholesale and retail trade | 21 | 9.5 | 0.32 | 0.20 – 0.50 |
| Mining | 18 | 8.1 | 4.70 | 2.79 – 7.42 |
| Electricity, gas and water | 9 | 4.1 | 2.09 | 0.95 – 3.98 |
| Finance, property and business services | 6 | 2.7 | 0.16 | 0.06 – 0.36 |
| Recreation personal and other services | 5 | 2.3 | 0.21 | 0.06 – 0.49 |
| Public administration and defence | 4 | 1.8 | 0.28 | 0.07 – 0.73 |
| Unknown | 2 | 0.9 | - | - |
| **Total** | **221** | **100.0** | **0.70** | **0.61 – 0.79** |

1: Deaths per 100,000 employed persons per year with 95% confidence intervals. Rates were not calculated where there were fewer than 4 deaths.

## Equipment (agency)

Examination of the machinery and fixed plant involved in the incidents indicated that the largest group of agencies was conveyors and lifting plant, which accounted for 68% of the agencies in this group (Table 4).

**Table 4 Agency groups identified for working persons and bystanders fatally injured from machinery and fixed plant. Number and percent — Australia, 1989 to 1992**

| Agency Group | Number | Percent |
|---|---|---|
| **Conveyors and lifting plant** | **161** | **67.6** |
| Forklifts | 50 | 21.0 |
| Cranes | 44 | 18.5 |
| Hoists and lifts | 29 | 12.2 |
| Conveyor belts, escalators and agricultural conveyors | 15 | 6.3 |
| Mechanical power transfer mechanisms | 5 | 2.1 |
| Other lifting plant | 18 | 7.6 |
| **Cutting, slicing and sawing machinery** | **18** | **7.6** |
| **Crushing, pressing and rolling machinery** | **9** | **3.8** |
| **Heating, cooking and baking equipment** | **10** | **4.2** |
| **Cooling and refrigeration plant and equipment** | **9** | **3.8** |
| **Turbines, generators, motors and transformers** | **9** | **3.8** |
| **Other plant and equipment** | **22** | **9.2** |
| **Total** | **238**[1] | **100.0** |

1: More than one agency could be involved in a death. Thus the total number of agencies exceeds the number of deaths.

## Mechanisms involved in deaths

Overall, the most common primary mechanisms involved with each death were ‘being hit by falling objects’, ‘contact with electricity’, ‘falls from a height’, ‘being hit by moving objects’ and ‘being trapped by moving machinery’ (Table 5).

**Table 5 Primary mechanism identified for working persons and bystanders fatally injured from machinery and fixed plant. Number and percent — Australia, 1989 to 1992**

| Mechanism | Number | Percent |
|---|---|---|
| Being hit by falling objects | 42 | 18.0 |
| Contact with electricity | 40 | 17.2 |
| Falls from a height | 38 | 16.3 |
| Being hit by moving object | 37 | 15.9 |
| Being trapped by moving machinery | 29 | 12.4 |
| Being trapped between stationary and moving objects | 13 | 5.6 |
| Rollover | 13 | 5.6 |
| Vehicle accident | 8 | 3.4 |
| Explosion | 5 | 2.1 |
| Contact with hot objects | 3 | 1.3 |
| Single contact with chemical or substance | 3 | 1.3 |
| Hitting stationary objects | 1 | 0.4 |
| Exposure to non-ionising radiation | 1 | 0.4 |
| **Total** | **233** | **100.0** |

## Contributing factors to incidents involving machinery and fixed plant

For the 225 incidents (233 deaths) that involved machinery and fixed plant, there were 686 contributing factors identified. More than one contributing factor could be identified for any incident, and on average about three factors were identified per incident (Table 6). More detail on the contributing factors is provided in the sections on each agency subgroup.

### Table 6 Contributing factors identified in deaths involving machinery and fixed plant. Number and percent — Australia, 1989 to 1992

| Contributing Factor | Number[1] | Percent |
|---|---|---|
| **Equipment** | **211** | **30.8** |
| Controls | 15 | 2.2 |
| Guarding | 53 | 7.7 |
| Other design issues | 70 | 10.2 |
| Other equipment issues | 73 | 10.6 |
| **Behavioural** | **167** | **24.3** |
| **Organisational** | **145** | **21.1** |
| Work procedures | 61 | 8.9 |
| Training | 37 | 5.4 |
| Supervision | 25 | 3.6 |
| Other organisational factors | 22 | 3.2 |
| **Physical environment** | **50** | **7.3** |
| **Experience/ knowledge** | **45** | **6.6** |
| **Personal Protective Equipment** | **28** | **4.1** |
| **Physiological** | **15** | **2.2** |
| **Toxicology** | **7** | **1.0** |
| **Other factors** | **18** | **2.6** |
| **Total** | **686**[2] | **100.0** |

1: The number of contributing factors exceeds the number of incidents as sometimes more than one contributing factor was identified for each incident.

2: The total number of contributing factors is less than that of the grand total from each agency subgroup in the later sections of this report, as there were five deaths where two types of machinery and fixed plant were identified. The contributing factors for these deaths were tabulated under the two relevant agency subgroups, but are only reported once in this table.

## Design issues involving machinery and fixed plant

Of the 225 incidents, 117 had at least one design factor contributing to the fatal outcome. Design factors related to guarding were the most common single design problem identified. Issues related to the design of controls were the next most common. The majority of design factors however, were more specific and have been loosely grouped under the heading of 'other design issues' (Table 6). There was a large variety of design issues which contributed to the incidents, common contributing factors included:

- guarding could be removed or rendered inoperative;
- no guarding of area designed around work space or equipment;
- controls in a position which did not allow adequate viewing of machinery;
- positioning of controls allowed inadvertent activation by operator during maintenance or other activities on the equipment;
- equipment not designed to 'fail safe';
- equipment able to function with inappropriate attachments;
- blind spots on manoeuvrable equipment;
- equipment able to function when nearing overhead wires (lack of over luffing devices);
- reliance of equipment on one mechanism which, if it failed, had catastrophic consequences; and
- seatbelts not designed into equipment.

## Recommendations from incidents involving machinery and fixed plant

Of the 225 fatal incidents, the Coroner, OHS Authority or other agency made recommendations arising from 112 incidents (49.8%). Of these, 89 recommendations were specifically related to the design of equipment. Common recommendations included:

- adoption of an Australian standard for a type of equipment;
- amendments be made to standards for forklift design;
- guarding be designed such that the machinery cannot function if it is not in place;
- guarding be installed as per regulations;
- installation of guarding around moving parts, entire machine or entire work area;
- controls have a captive key system;
- controls be located at a safe distance from moving parts;
- amend regulations to make certain safety equipment mandatory;
- compulsory fitting of seatbelts.
- electrical equipment should be insulated; and
- interlocking distance monitoring devices be installed.

## Agency subgroups

To more closely examine design issues relevant to specific agencies, subsequent sections of this report focus on each agency subgroup. Examination of the specific contributing factors and recommendations, particularly those relevant to design issues are discussed in each section. There were five deaths where two types of machinery and fixed plant was identified. Where this occurred, the incidents are described under both agency subgroups.

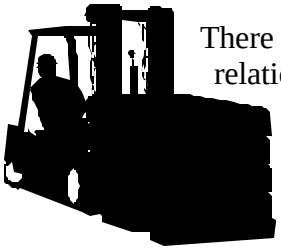
### CONVEYORS AND LIFTING PLANT

There were 161 conveyor and lifting plant agencies identified in the 225 fatal incidents. Of those, the most common agencies were forklifts and cranes (Table 7). Given the large number of deaths within each agency subgroup, they are each discussed separately below.

**Table 7 Agencies identified in deaths involving conveyors and lifting plant. Number and percent — Australia, 1989 to 1992**

| Agency | Number | Percent |
|---|---|---|
| Forklifts | 50 | 31.1 |
| Cranes (including tow trucks) | 44 | 27.3 |
| Power hoists and lifts (including jacks and elevated work platforms) | 29 | 18.0 |
| Conveyor belts, escalators and agricultural conveyors | 15 | 9.3 |
| Mechanical power transfer mechanisms | 5 | 3.1 |
| Other conveyors and lifting plant | 18 | 11.2 |
| **Total** | **161** | **100.0** |

## *Forklifts*



There were 50 deaths (48 workers and two bystanders) that occurred with relation to forklifts. The most common mechanism of death was 'being hit by falling objects' (38%), 'rollover' (22%) and 'fall from a height' (16%) (Table 8).

**Table 8 Mechanism associated with each death involving forklifts. Number and percent — Australia, 1989 to 1992**

| Mechanism | Number |
|---|---|
| Hit by falling object | 19 |
| Rollover | 11 |
| Fall from a height | 8 |
| Hit by moving object | 7 |
| Trapped between stationary and moving object | 3 |
| Vehicle accident | 2 |
| **Total** | **50** |

The most common circumstances included a load falling from a forklift, or being manoeuvred by a forklift, and striking the person (17 deaths), a person working on a platform while the forklift was raised and falling off (seven deaths), and the forklift rolling over (11 deaths).

A forklift driver was loading shipping containers when a container rolled onto the cabin of the forklift and crushed him. He had stacked two containers on the forklift at once, which resulted in one falling back onto the cabin. The operator only had a learner's permit for driving the forklift. Following the incident, it was recommended that the containers only be moved one at a time and that they be stacked no higher than two high.

## Contributing factors to incidents involving forklifts

There were 165 contributing factors identified in the 50 deaths involving forklifts. The most common contributing factors included organisational, behavioural and equipment factors (Table 9).

**Table 9 Contributing factors identified in deaths involving forklifts. Number and percent — Australia, 1989 to 1992**

| Contributing Factor | Number | Percent |
|---|---|---|
| **Organisational** | **43** | **26.1** |
| Procedures | 20 | 12.1 |
| Training | 15 | 9.1 |
| Supervision | 5 | 3.0 |
| Other organisational issues | 3 | 1.8 |
| **Behavioural** | **38** | **23.0** |
| **Equipment** | **35** | **21.2** |
| Lack of safety equipment | 11 | 6.7 |
| Guarding | 3 | 1.8 |
| Other design issues | 5 | 3.0 |
| Other equipment issues | 16 | 9.7 |
| **Physical environment** | **18** | **10.9** |
| **Personal protective equipment** | **12** | **7.3** |
| **Experience/ knowledge** | **11** | **6.7** |
| **Other person** | **5** | **3.0** |
| **Physiological** | **2** | **1.2** |
| **Toxicology** | **1** | **0.6** |
| **Total** | **165**[1] | **100.0** |

1: The number of contributing factors exceeds the number of incidents as sometimes more than one contributing factor was identified for each incident.

## Design issues involving forklifts

There were 18 incidents where design factors contributed to the 50 deaths involving forklifts. In one incident, there were two factors, resulting in 19 design issues identified. The most common issues included an absence of safety railing on pallets, lack of seatbelts designed into the forklift, and the design resulting in blind spots or poor vision from the forklift (Table 10).

**Table 10 Design issues identified as contributing factors in deaths involving forklifts.**
**Number — Australia, 1989 to 1992**

| Design Issue | Number |
|---|---|
| **Lack of safety equipment designed in** | **11** |
| No safety cage or railing on pallet when lifting people | 4 |
| No seatbelt fitted | 3 |
| No reversing beeper, no beeper, lights or mirrors, or beeper malfunctioning | 3 |
| Absence of jib attachment on forklift | 1 |
| **Guarding** | **3** |
| Insufficient or lack of guarding to area where forklift is operating | 2 |
| Insufficient back guarding on forklift | 1 |
| **Other design issues** | **5** |
| Blind spot or inadequate vision from forklift | 3 |
| Stillage design insufficient | 1 |
| Home made forklift inadequately designed | 1 |
| **Total** | **19** |

## Recommendations from incidents involving forklifts

Of the 50 deaths involving forklifts, recommendations were made by the Coroner, OHS agency or other body following investigation of 22. Recommendations related to design and other issues are listed below.

### Recommendations related to design

- Adopt a phasing in program to replace pneumatic tyres with solid tyres for fork lifts.
- The forklift may have suffered from sawdust and moisture between the core and sheath, and it is recommended that the suppliers of these cables be approached to making gaiters standard.
- A canopy be installed on the Tamrock roof bolter.
- All stillages manufactured by the company to be modified to have the equivalent of four fork locations. The rear bottom right hand side steel section be strengthened by adding 44mm x 44mm x 5 mm angle iron and the hoops be fully welded.
- Relevant standards be amended to specify that:
  1. forklifts be painted in a basic high visibility colour and the ends painted in a check or stripe pattern with high visibility contrasting colours.
  2. forklifts be fitted with:

a) a conspicuous amber flashing dome light or lights mounted on the cab's roof that operate automatically whilst the engine is on;
b) conspicuous flashing lights at the approximate eye level of a person standing on the ground to each corner of the vehicle, which operate automatically whilst the engine is on;
c) white lights on the rear of the vehicle which operate automatically whilst the reversing gear is engaged;
d) a reversing alarm of distinctive tone and a high degree of audibility that operates automatically whilst the reversing gear is engaged where such an alarm is likely to be of value having regard to the nature and volume of other noise in the area; and
e) mirrors of a suitable size and placement for the assistance of the driver whilst reversing.

- Inhibitor switches on manual transmission forklifts should be mandatory.
- A seat operated warning device and a safety latch preventing inadvertent release should be installed on the forklift. It is suggested that the Department of Labour notify the manufacturer of the forklift of the facts in this case and of problems associated with the handbrake as it is currently designed.
- Compulsory fitting and wearing of seat safety belts.
- Consideration be given to requiring properly designed and constructed rollover cages to be retrofitted to existing forklifts and made a registration requirement for all new vehicles.
- Reversing beepers should be wired into the motor circuitry so that the machine can not run with a defective beeper, or at least ensure that a defective beeper be fixed before the forklift is allowed to be used.
- All forklifts should be fitted with seat belts and their wearing be made mandatory.
- Introduction of restraining devices such as seat belts in combination with cages on forklifts.
- Correspondence to the Australian Standards Association in regard to the fitting of safety belts and lateral restraints for forklifts.
- All new forklifts sold in the state are required to have a safety belt fitted and an additional lateral seat restraint.

## Other recommendations

- Meetings to take place to make personnel aware of the instability of forklifts.
- The company ensure pedestrian traffic is by way that is not necessary to walk in areas where forklifts are operating.
- Handling and movement of shipping containers one at a time.
- The company provide restraining pins to each of the two "feed in" skids which are to be movable to permit unrestricted entry to the loaded forklift. The pins to be positioned as the forklift releases its load.
- Stacking of containers two high only to prevent double handling.
- More speed limit signs be introduced.
- A maximum speed limit of 15 km/h for forklifts be instituted.
- Use of seat belts when travelling between stores be enforced.
- Maintenance procedures are reviewed and history cards used to record maintenance.

- The training program is reviewed to ensure that employees understand recommendations.
- Management provide a safe work procedure on drilling operation with hand held or hydraulic operated machines.
- Forklifts should never be used as lifts or platforms without an appropriate safety cage.
- Publicity be given to the dangers of raising persons by forklifts, except when proper rails or a cage are fitted.
- No one be permitted to operate a forklift without possessing a permit to learn or a certificate of competency.
- Management given a copy of the 'Forklift truck operator's' handbook, and to ensure that all operators are instructed that all loads on forklifts must be carried as close to the ground as practical.
- The carrying of personnel in the stillage is to cease.
- Management to urgently institute written safety procedures to be effective at all times in the workplace.
- The relevant standards and safety codes and guides be amended to specify that persons in the proximity of operations involving forklifts should be required to wear distinctively patterned, high visibility coloured vests.
- Ensure that manufacturers in the industry are aware of the dangers associated with riding on forklifts and using them as lifting platforms for personnel, and the need for operators to have a certificate of competency.
- Regularly monitor the work practices and procedures relating to safety at the premises and the employer should provide the Department a copy of the consultant’s report on work-place safety.
- Document the recent spate of forklift fatalities as a hand out leaflet for distribution during the blitz.
- The floor area immediately in front of the "feed in" skids to be painted so as to clearly indicate a hazard area by yellow and black zebra type lines.
- The Department should alert forklift operators of the dangers of relying on adjustable handbrakes to secure forklifts.
- The timber industry be alerted to the dangers associated with;

    1. the transport of timber packs fully wrapped in plastic;
    2. loading trucks with persons standing on or near the tray of the truck; and
    3. the need to regularly maintain forklifts.

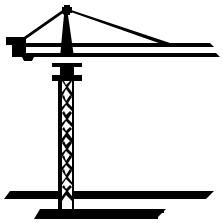
- The timber industry ensure that:

    1. loading procedures be supervised;
    2. pedestrian traffic in loading areas be reduced; and
    3. forklift operators undergo regular retraining courses.

- The company undertake an independent safety audit of its work practices and procedures, specifically regarding training of forklift operators.
- The relevant employer, union, manufacturer, distributor, repairer and hirer groups ensure that their clients/customers are made aware of the dangers associated with unlicensed or incorrect work practices when using forklifts and the information also be distributed via small business organisations.

- Undertake a program at wharf facilities to monitor compliance with the industry's Safety Code of wearing of safety vests or high visibility clothing.
- An education programme be implemented to alert the users of these machines to the appropriate design specifications for their particular application.
- A mandatory certificate course for operators.
- There is no statutory or regulatory provision relating to loading of tanks with forklifts or otherwise and this matter should be addressed.
- Publicity be given for the need of on-going training of forklift drivers.
- Publicity be directed at reminding occupiers of premises of their safety obligations for all persons at the workplace, including visitors.
- Further publicity be given of the duty of employers to promptly notify the OHS department.
- Consideration be given to imposing a duty on occupiers of workplaces to notify the OHS authority when a serious incident occurs.
- The existing regulations regarding the use of machinery only after training and a practical competency test be strengthened by requiring employers to use accredited trainers and/or testers with a rigidly enforced certification and authorisation system.
- OHS officers ensure compliance to the requirements of Australian Standard for all forklift operators.
- The company ensure that all employees required to operate forklifts be trained.
- The company ensure that there is a clear line of responsibility for all training requirements.
- Management at the brickworks have the capacity to adequately train the employees.
- A safety bulletin be sent to all forklift selling agents regarding the hazards of forklift operation.
- The company ensure that all employees who operate an industrial truck be specifically trained.
- The company be made fully aware of the Australian Standard 2359.2- 1985, Industrial Truck Code part 2 Operation, and ensure that all forklift operators are cognisant of the standard and operate within its requirements.
- The company ensure that there is clear line of responsibility and authority known to all employees, and that this leads to a situation whereby adequate instruction and supervision is provided to employees.
- The company be required to comply with "the duty of care of employers" as outlined under Section 19 of the Occupational Health Act 1984.
- The company ensure that employees in remote locations receive general occupational health and safety training as a priority, and are made fully aware of company safety policies and procedures.
- The OHS authority conduct an information and publicity campaign on the hazards, risk and requirements of operating forklifts.
- Consider a training course for the operation of industrial trucks because it is deemed necessary to provide a uniform standard of training.

## *Cranes*



Forty-four deaths (43 workers and one bystander) occurred with relation to cranes. These occurred in 42 incidents, as there were two incidents which each involved two deaths. The most common mechanisms involved 'being hit by falling objects' and 'fall from a height' (Table 11). The most common circumstances involved people working under or adjacent to loads carried by cranes and the load falling and striking the person, and electrocutions resulting from the crane contacting electrical wires (each circumstance resulting in seven deaths).

**Table 11 Mechanism associated with each death involving cranes. Number — Australia, 1989 to 1992**

| Agency | Hit by falling objects | Fall from a height | Contact with electricity | Vehicle accident | Hit by moving objects | Trapped between stationary & moving object | Trapped by moving machinery |
|---|---|---|---|---|---|---|---|
| Cranes | 3 | 3 | 1 | - | 2 | 2 | - |
| Overhead travelling crane | 7 | 1 | - | - | 1 | - | 1 |
| Mobile crane | 1 | - | 2 | 1 | 2 | - | - |
| Tower crane | - | 3 | - | - | - | - | - |
| Truck mounted crane | 1 | - | 4 | 2 | - | 1 | - |
| Tow truck | - | - | - | 3 | - | - | - |
| Other cranes | - | 3 | - | - | - | - | - |
| **Total** | **12** | **10** | **7** | **6** | **5** | **3** | **1** |

A labourer was removing steel pipes from the back of a truck, using a crane attached to the truck, when he was electrocuted. A fellow employee was standing in a hole awaiting the pipes. Having not received them he came up and found the man laying on his back. The crane was approximately five cm from overhead wires and had shown evidence of contact with the electrical source. It was recommended that site managers ensure that crane operators have appropriate certificates, that work sites be properly prepared and over luffing devices be fitted to cranes to disengage the controls if the crane encroaches the safe working distance of the wires.

## Contributing factors to incidents involving cranes

There were 127 contributing factors identified in the 44 deaths involving cranes. Of these, the most common were equipment and behavioural factors (Table 12).

### Table 12 Contributing factors identified in deaths involving cranes. Number and percent — Australia, 1989 to 1992

| Contributing Factor | Number | Percent |
|---|---|---|
| **Equipment** | **34** | **26.8** |
| Guarding | 2 | 1.6 |
| Other design issues | 14 | 11.0 |
| Other equipment issues | 18 | 14.2 |
| **Behavioural** | **32** | **25.2** |
| **Organisational** | **23** | **18.1** |
| Procedures | 12 | 9.5 |
| Training | 5 | 3.9 |
| Supervision | 5 | 3.9 |
| Other organisational | 1 | 0.8 |
| **Physical environment** | **13** | **10.2** |
| **Experience/ knowledge** | **12** | **9.4** |
| **Other persons** | **5** | **3.9** |
| **Personal protective equipment** | **4** | **3.1** |
| **Physiological** | **2** | **1.6** |
| **Toxicology** | **2** | **1.6** |
| **Total** | **127**[1] | **100.0** |

1: The number of contributing factors exceeds the number of incidents as sometimes more than one contributing factor was identified for each incident.

## Design issues involving cranes

Design issues were determined to be contributing factors in 16 of the 42 incidents involving cranes. These are shown in Table 13 and demonstrate that an absence of wire proximity monitoring devices and poor visibility from cranes were the most frequently identified design issues.

**Table 13 Design issues identified as contributing factors in deaths involving cranes.**
**Number — Australia, 1989 to 1992**

| Design Issue | Number |
|---|---|
| **Guarding** | **2** |
| Absence of safety rails on elevated work areas | 2 |
| **Other design issues** | **14** |
| Absence of wire proximity detection system | 5 |
| Poor visibility from crane | 3 |
| Absence of seat belt in tow truck | 1 |
| Lack of automatic door catches | 1 |
| Reliance of crane magnet on one pin | 1 |
| Erection design of crane unsafe | 1 |
| Use of nonstandard sling and hook | 1 |
| Piece of metal protruding on crane, which caught clothing | 1 |
| **Total** | **16** |

## Recommendations from incidents involving cranes

Of the 42 incidents (44 deaths), related to cranes, 14 incidents had associated recommendations from the Coroner, OHS body, or other agency. Recommendations related to design and other issues are listed below.

### Recommendations related to design

- An over luffing device be fitted to cranes to disengage the controls if the operator encroaches the safe working distance of power lines.
- Automatic door catches be installed on all crane drivers' cabin doors.
- Guard railing should be provided on working platforms.
- Guard railing should be provided on the open side of the top walkway.

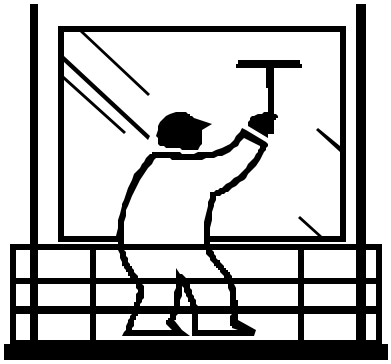
### Other recommendations

- Work site managers should check operators for the appropriate certificate before commencing any work.
- All work sites to be properly prepared before any under road bracing equipment is brought on site.
- Eliminate need for a person to remain in the racking once the clamp has been retained.

- Permanent signs placed at maintenance access ladders stating that the access should only be used for maintenance and emergency purposes.
- Permanent signs placed on the crane driver's cabin doors stating that doors are to remain closed at all times whilst the crane is working.
- All crane drivers are to be re-instructed in appropriate procedures.
- Trestles be in good condition and of uniform dimensions.
- Welding of the frame to the trestles be carried out in a correct or adequate manner.
- Overhead crane and chain slings be left attached as a back-up safety device.
- Plant and equipment needs to be serviced, maintained and inspected regularly.
- Training, instruction and supervision to personnel operating equipment.
- Remind workers of the dangers of working with cranes.
- The appropriate marine surveyor should ensure the regulations as to safety during loading and unloading on ships are followed.
- That the OHS Authority has a responsibility to:
  1. ensure that a plan of crane erection was approved;
  2. ensure duly licensed riggers were employed; and
  3. supervise erection of the crane or to prevent it from proceeding.
- The duty to ensure a plan of erection is approved is imposed upon the crane erector.
- Safety legislation be interpreted correctly so as to give optimal protection to the public. Authorities should avail themselves of good legal advice when in doubt as to the import of particular legislation and such legislation should be carefully drafted so as to eliminate competing interpretations.
- New regulations will require a licensed person to be in charge of crane erection. An onus remains upon the individual undertaking any work that requires a licence not to commence unless he holds a licence.
- It is the main contractor's responsibility to ensure workers on their site are fully qualified for the work they are asked to perform. Contractors must be aware of this before construction commences.
- Contractors must be made aware of their responsibility to notify the Authority of the erection procedure before the erection of a crane.
- Interstate authorities should be notified of the failure of this crane and its causes.
- The state's OHS department should be approached regarding the continued issue of learner's permits without the applicant having to undergo examination.
- The employer provide a proper training syllabus and suitable training officer.
- The crane driver receive proper training and familiarisation with these cranes.
- Examination requirements for all future crane drivers to be a written, oral and practical examination.
- Trucks be straightened up before loading commences.
- The company keep the driveway approach clear of pallets and rubbish bins to allow truck drivers plenty of room to straighten on their approach to the loading bays.

- Forestry Department supervisors ensure warning signs placed on roads or tracks where electrical conductors extend over roads.
- Appropriate emergency authorities have copies of an 'Electrical safety handbook for emergency personnel' and when this book is reprinted it should contain illustrations of 'voltage gradients due to fallen wire', 'step potential' and 'touch potential'.
- Copies of this rider be forwarded to: police, State Emergency Services, Fire Services, Ambulance, Electricity Commission, Department of Forestry, Rural Fires Board and Electricity Supply Association of Australia.
- Access to the carriage wheel area should be improved.
- An alert be issued to the industry encouraging the use of whistles by crane-chasers or others assisting a crane operator as it would assist in achieving safer working conditions where risks do exist, and where a crane operator's experience and self-reliance could be backed up by another person.
- In the industry of specialised coating, with the varied nature of the structures and objects coated, there should be particular supervision of employees while lifting heavy loads, which may involve instructions on their handling.
- Certificated persons should be in charge of piling operations for the lifting and lowering of loads with hoisting appliances.
- Letters sent to piling companies highlighting the circumstances surrounding the accident and the need for safe slinging practice, requirements for certificated personnel, adequate supervision, preventative maintenance checks on plant and equipment, and duty of care by employers with regard to correct training and supervision.
- An article be published in appropriate magazines/newsletters highlighting the circumstances regarding the accident.
- The practice of slinging piles from the hammer be discontinued by way of amendment to legislation or guidance note.
- Consideration be given for the development of a code of practice for piling operations.
- Piling contractors and companies be the subject of a targeted inspection to check on plant and equipment and be advised on safe work procedures.

## *Hoists and lifts*



Twenty nine deaths occurred in 26 incidents where hoists or lifts were one of the agencies involved. Overall, the most common mechanisms involved 'fall from a height', 'contact with electricity', and 'being hit by falling objects' (Table 14). The most common circumstance involved people working in elevated work platforms (EWPs) or cherry pickers and coming into contact with electricity (seven deaths). Additionally, four miners were killed, all in separate incidents, when the winch which was carrying them failed (two deaths) or the seat became disengaged, resulting in them falling down the mine shaft (two deaths).

**Table 14 Mechanism associated with each death involving hoists and lifts. Number — Australia, 1989 to 1992**

| Agency | Fall from a height | Contact with electricity | Hit by falling objects | Hit by moving objects | Contact with hot objects | Other[1] |
|---|---|---|---|---|---|---|
| Men & material hoists | 3 | - | 3 | - | - | 2 |
| Platform hoists | 1 | - | - | - | - | 1 |
| Elevated work platforms | 3 | 7 | - | - | 2 | - |
| Other material handling hoists | 2 | - | - | - | - | - |
| Passenger lifts | 1 | - | - | 1 | - | - |
| Other[2] | 1 | - | 1 | 1 | - | - |
| **Total** | **11** | **7** | **4** | **2** | **2** | **3** |

1: The other mechanisms were an explosion, single contact with a chemical substance and being trapped between stationery and moving objects.
2: The other agencies were a power hoist, a power operated guided work platform and a lift where the specific type was not known.

An opal miner died from crush asphyxia after falling 15 metres down a mine shaft from a hoist and being crushed by debris when planned charges detonated. At the time of the incident, the miner was being winched up the mine shaft after setting the charges. The winch chair had detached from the winch cable because the spring loaded winch safety clip had lateral movement. It was recommended that this type of winching hook be banned from precious stone fields and be replaced by a lockable safety hook.

## Contributing factors to incidents involving hoists and lifts

There were 74 contributing factors identified in the 29 deaths involving hoists and lifts. The most common contributing factors were equipment and organisational factors (Table 15).

### Table 15 Contributing factors identified in deaths involving hoists and lifts. Number and percent — Australia, 1989 to 1992

| Contributing Factor | Number | Percent |
|---|---|---|
| **Equipment** | **27** | **36.5** |
| Other design issues | 17 | 23.0 |
| Other equipment issues | 10 | 13.5 |
| **Organisational** | **20** | **27.0** |
| Procedures | 7 | 9.5 |
| Supervision | 6 | 8.1 |
| Training | 5 | 6.8 |
| Other organisational issues | 2 | 2.7 |
| **Behavioural** | **15** | **20.3** |
| **Physical environment** | **4** | **5.4** |
| **Physiological** | **2** | **2.7** |
| **Experience/ knowledge** | **2** | **2.7** |
| **Other persons** | **2** | **2.7** |
| **Personal protective equipment** | **1** | **1.4** |
| **Other factors** | **1** | **1.4** |
| **Total** | **74**[1] | **100.0** |

1: The number of contributing factors exceeds the number of incidents as sometimes more than one contributing factor was identified for each incident.

## Design issues involving hoists and lifts

The design issues were diverse in the 26 incidents involving hoists and lifts, the most common being that the design of the hoist allowed for items or body parts to extend out of the hoist (Table 16).

**Table 16 Design issues identified as contributing factors in deaths involving hoists and lifts. Number — Australia, 1989 to 1992**

| Design Issue | Number |
|---|---|
| Design of hoist allowed items to catch on side of lift, or allowed body parts out of moving lift or into lift well | 3 |
| Absence of safety hook | 2 |
| Attachment to winch poorly designed or allowed movement | 2 |
| Poor design (failure of 2 bolts caused whole platform to fall, one davit broke other could not hold the platform) | 2 |
| Absence of safety harness | 1 |
| Poor harness attachment site | 1 |
| No fail-safe braking system | 1 |
| Pole top steel work not insulated | 1 |
| Absence of interlocking distance monitoring device | 1 |
| EWP not flame retardant | 1 |
| Inadequate design of tripod | 1 |
| Lift doors operable when lift not on floor | 1 |
| **Total** | **17** |

## Recommendations from incidents involving hoists and lifts

Of the 26 incidents related to hoists or lifts, 17 had associated recommendations from the Coroner, OHS body, or other agency. Recommendations related to design and other issues are listed below.

### Recommendations related to design

- Technology exists to equip crane booms with an interlocking distance monitoring system, either by laser light or an electromagnetic field signal device and should be used.
- Portable live line testers and cables and fittings are suitable for use with EWPs. They should be suitable for use from the EWP while elevated and it should not be necessary to attach a clamp to rail for the negative, as this should be provided by the wheels of the EWP.
- All EWPs used by councils for tree trimming should be fitted with a non-conductive (fibreglass) overhead bar to protect the operator from contacting overhead mains.
- Air driven or other non-flammable drive sources for all tools used in preference to flammable hydraulic oil in EWPs.
- EWPs' fittings and buckets be flame retardant.
- Provide adequate lighting on the EWP to illuminate the immediate work area.
- A secondary system be developed so that the EWP's buckets can be maneuvered if the hydraulic system fails.

- Anchor points for harnesses in EWPs be higher than 200mm off the floor to avoid crouching.
- The feasibility be investigated of fitting an anti-drop device around the bell crank connections.
- The spring loaded winch hook safety clip (with lateral movement which may allow the seat cable to slip) be banned on precious stone fields and be replaced by a lockable screw safety hook.
- Regulations be made to specify standards and requirements for the design, construction, installation, operation, maintenance, inspection, and certification of lifts and goods hoists installed in all buildings to which such regulations do not now apply.
- Employer review the construction and design of transmission circuits to enable personnel to work in a safe manner separate from live conductors.
- Safety latches or safety hooks be made mandatory on all equipment where lifting from a hook takes place.
- The width of the vision panels be permanently reduced or alter the lift to have solid landing doors without vision panels and a power door operator.

## Other recommendations

- Loads (pipes) be properly secured, and the person responsible for the load travel separately from the materials cage.
- Prior to tree trimming within close proximity of overhead electrical wires persons working from EWPs spend a minimum of 4 months ground experience to gain a greater respect for electricity.
- Provide a live to rail tester with a high tension probe suitable for measuring voltage up to 1500DC for each EWP.
- All span wires be tested for absence of high voltage, prior to work.
- All overhead line workers employed by the rail authority to work on 1500 volt overhead wiring should receive and sign receipt for the mains superintendents' circular No. 97 "Mobile elevating work platform use of portable live line testers".
- All existing electrical branch instructions, circulars etc., especially those concerned with 1500 volt equipment, should be updated in line with changes to safe working distances and other issues within six months.
- A full set of all relevant instruction circulars should be held and constantly updated by the electrical standards engineer and be personally issued to all appropriate new employees.
- A refresher course be introduced every six months for all employees in all state electrical authorities working on EWPs within close proximity to overhead mains.
- Recommend to reject the request from local councils to carry out their own tree trimming and obtain an exemption to work within three meters from overhead mains.
- Better education and training for all crane operators.
- Improve supervision to stop bad behaviour becoming acceptable.
- Improve hazard awareness levels.  Risk assessment should be part of job planning.
- Contractors assess the safety training and awareness levels of new recruits.

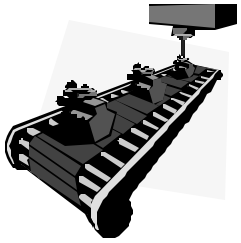
- Contractors provide for additional training for new employees to ascertain and maintain levels of competency.
- Electrical line work should have two observers present who are in radio contact with the EWP.
- Every power pole should have a proven earth on it to which the EWP can attach.
- The EWP and truck be placed nearest to the point where work is to be conducted.
- A national data bank be established to record details of all incidents/de-briefs so as to enhance safety and improve practices.
- An independent report be obtained to establish if the bolt was of the specified grade, fatigued, or partially cracked before the final failure. Determine the force necessary to fail this bolt and if a loud sound would be heard when the bolt failed.
- As it is possible to overload the machine by handling a cut branch after the bucket and operators have been hoisted into the air, consideration be given to reducing the safe working load of this unit to 120kgs.
- The commission's manual and training syllabus be revised to prohibit:
  1. pole top steel not covered in insulating material;
  2. neutral conductor of low voltage not being insulated;
  3. attempting to lower redundant conductor without reducing its length;
  4. a lifting pole and not a wire holding stick used to remove the redundant conductor; and
  5. lowering a redundant conductor while not under direct supervision of another crew member.
- Retraining and refresher courses for those associated with live line work, and spot checks of crews by qualified persons. Identify and correct departures from safe practice.
- Install, wherever practicable, line protection devices to decrease the dangers associated with live line work.
- One member of each live line crew constantly observe operations to ensure their safe co-ordination and execution.
- Work site safety committees examine procedures for the handling of unfamiliar equipment.
- When working in the vicinity of live high voltage apparatus, all high voltage apparatus are to be isolated where practicable. If not practicable, a permit system be implemented whereby all personnel involved are formally informed the apparatus is live.
- Clearly defined and suitable training provided for supervisory staff.
- Employer ensure that all staff comply to safe work procedures and supervisors effectively enforce compliance.
- Employer to review policies and rules to ensure safety of personnel who work on high voltage apparatus.
- When a structure for conveying personnel is being installed in relation to mining activity:
  1. the mine manager to send the department all relevant details and they be closely examined by suitably qualified persons and either approved or rejected;
  2. the structure installed only when approval is obtained;
  3. approval should have specific conditions or reference to relevant legislation;
  4. installation should be supervised by a suitably qualified engineer;

5. the installation used only when it has been formally certified by a suitably qualified engineer and with written notice of this being given to the Department.

These principles should be incorporated into the Mines Regulations Act and Regulations.

- The State Government should review the current legislation relevant to mining and safety on mining sites to make sure that it is unequivocal and covers all appropriate areas.
- Develop a systematic approach to incident prevention within the Department of Labour. The department ensure that the appropriate distance be maintained between an inspector and a former employer to avoid conflict of interest.
- The Department of Labour ensure that:
  1. diaries/notes of meetings are adequately entered and inspectors keep the diary or notes for future reference (court or otherwise);
  2. improvements in filing systems to minimise the risk of files being lost, mislaid or put away without action being taken; and
  3. when a problem arises within a particular industry an appropriate general warning be promptly sent to the particular industry involved (or a more general public warning).
- Amend regulation 528 requiring the provision of safety latches or safety hooks to hoists and inform all suppliers of hoist equipment of this legislation change.
- Workplace inspections enforce the requirements of safety latches or safety hooks.
- A media campaign be instituted advising of the legislative change, supported by an article in ‘Safety Line’ and the production of a Safety Bulletin.

### *Conveyor belts, escalators and agricultural conveyors*



There were 15 deaths that involved conveyor belts, escalators and agricultural conveyors. All deaths were of working persons. The most common circumstances were where workers were cleaning debris from, or conducting maintenance on, the equipment while it was running or was turned on while the work was in progress (nine deaths). In these cases, the person was hit by a moving object, trapped by moving machinery or trapped between a stationary and moving object (Table 17).

**Table 17 Mechanism associated with each death involving conveyor belts, escalators and agricultural conveyors.**
**Number — Australia, 1989 to 1992**

| Agency | Trapped by moving machinery | Fall from a height | Contact with electricity | Hit by falling objects | Trapped between stationary & moving objects | Hit by moving object | Contact with chemical or substance | Rollover |
|---|---|---|---|---|---|---|---|---|
| Conveyor belts and escalators | 4 | - | - | - | - | - | - | 1 |
| Belt conveyors | 2 | - | 1 | - | 1 | 1 | 1 | - |
| Other[1] | - | 2 | 1 | 1 | - | - | - | - |
| **Total** | **6** | **2** | **2** | **1** | **1** | **1** | **1** | **1** |

1: The other agencies were an escalator, 'other conveyor', agricultural conveyor, and a hay bale stacker

A mill operator who worked at a gold mine was using a high pressure hose to remove crushed ore from a feed chute supplied by a conveyor. With one foot on either side of the chute, he slipped and fell into the chute, was knocked unconscious and was overcome by cyanide. Another person was also overcome, but not killed, by the cyanide when attempting a rescue without using breathing apparatus. A third person pulled both persons out after breathing apparatus had been obtained. It was stated that the death would not have occurred if there had been a 'grizzly' over the feed.

## Contributing factors to incidents involving conveyor belts, escalators and agricultural conveyors

For the 15 deaths involving conveyor belts, escalators and agricultural conveyors, there were 53 contributing factors identified. The most commonly identified contributing factors were equipment and behavioural issues (Table 18).

### Table 18 Contributing factors identified in deaths involving conveyor belts, escalators and agricultural conveyors. Number and percent — Australia, 1989 to 1992

| Contributing Factor | Number | Percent |
|---|---|---|
| **Equipment** | **18** | **34.0** |
| Guarding | 11 | 20.8 |
| Controls | 1 | 1.9 |
| Other design issues | 2 | 3.8 |
| Other equipment issues | 4 | 7.5 |
| **Behavioural** | **13** | **24.5** |
| **Organisational** | **10** | **18.9** |
| Procedures | 4 | 7.5 |
| Training | 2 | 3.8 |
| Other organisational issues | 4 | 7.5 |
| **Physical environment** | **4** | **7.5** |
| **Experience/ knowledge** | **4** | **7.5** |
| **Toxicology** | **3** | **5.7** |
| **Personal protective equipment** | **1** | **1.9** |
| **Total** | **53**[1] | **100.0** |

1: The number of contributing factors exceeds the number of incidents as sometimes more than one contributing factor was identified for each incident.

## Design issues involving conveyors, escalators and agricultural conveyors

Design issues were seen as contributing factors in 12 of the 15 incidents involving conveyors, escalators and agricultural conveyors, and comprised 14 of the 53 contributing factors (Table 19).

**Table 19 Design issues identified as contributing factors in deaths involving conveyor belts, escalators and agricultural conveyors. Number — Australia,1989 to 1992**

| Design Issue | Number |
|---|---|
| **Guarding** | **11** |
| Not installed or insufficient | 6 |
| Able to lean over escalator or safety rail | 2 |
| Removed | 1 |
| Lack of safety rail | 1 |
| Safety shroud removed on power plug | 1 |
| **Controls** | **1** |
| Poor location to view work area | 1 |
| **Other** | **2** |
| Blind spot on bulldozer | 1 |
| Overload circuit breaker amperage too high | 1 |
| **Total** | **14** |

## Recommendations from incidents involving conveyor belts, escalators and agricultural conveyors

Of the 15 deaths related to conveyor belts, escalators and agricultural conveyors, six had associated recommendations from the Coroner, OHS body, or other agency. Recommendations related to design and other issues are listed below.

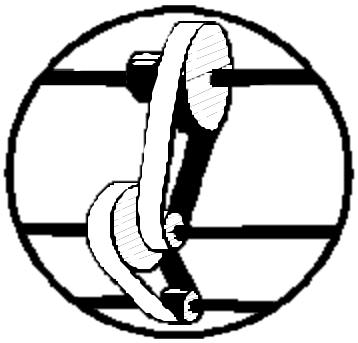
### Recommendations related to design

- Electric motors and belt drives be guarded in accordance with regulations.
- Assess the feasibility of installing a protective barrier to prevent patrons from falling from escalators.
- Install a grizzly in the feed chute below the conveyor head pulley and construct a step beside the chute to give operators better access to material in the chute without danger of falling in.
- An emergency pull switch be placed above and in the center of all conveyor belts in the colliery.

## Other recommendations

- Bridges be placed at regular intervals along all operating conveyor belts.
- The passageway under one of the conveyor belts be improved.
- Workers working alone be equipped with a form of communication and a system requiring them to contact an appointed person at predetermined and regular intervals.
- Workers who work along conveyor belt systems be thoroughly re-trained in all aspects of their duties.
- A programme be identified and put in place for a complete overhaul of the conveyor systems in operation at the colliery.
- Approved scaffolding be used during maintenance and overhaul of the screening plant.
- Australian Standard 1755 needs clarifying. The words "guards shall be provided for all exposed shaft couplings and collars" and "restricted access areas" be made explicit and clarified.
- Employees should be provided with adequate information, instruction, training and supervision to enable them to perform their tasks without exposure to hazards.
- Plant and equipment be maintained to an appropriate standard.
- Employers ensure a safe system of work when cleaning around machinery or conducting maintenance on it.
- Employers should ensure lighting is provided to an appropriate standard.

### *Mechanical power transfer mechanisms*



There were five separate incidents which involved mechanical transfer mechanisms. The most common mechanism involved was 'being hit by moving objects', which occurred in two incidents. Common circumstances included two incidents where a rope or cable 'whip lashed' and hit the worker, and a third where excessive tension in the cable resulted in a tractor rolling over. Four of the five deaths involved the 'cables and belts' agency, and the fifth involved another type of 'mechanical power transfer mechanism' (Table 20).

**Table 20 Mechanisms identified in deaths involving mechanical power transfer mechanisms.**
**Number — Australia, 1989 to 1992**

| Mechanism | Number |
|---|---|
| Hit by moving object | 2 |
| Fall from a height | 1 |
| Trapped by moving machinery | 1 |
| Rollover | 1 |
| **Total** | **5** |

The second officer aboard a ship was fatally injured when a mooring rope that was being winched aboard flew up and struck him, knocking him off the boat and trapping him under the pontoon. The winch control had been set to its fastest retrieval speed, although this was known by the person to be a dangerous practice.

## Contributing factors to incidents involving mechanical power transfer mechanisms

For the five deaths that involved mechanical power transfer mechanisms, there were 17 contributing factors identified. The most common contributing factors were equipment and organisational factors (Table 21).

**Table 21 Contributing factors identified in deaths involving mechanical power transfer mechanisms.**
**Number and percent — Australia, 1989 to 1992**

| Contributing Factor | Number | Percent |
|---|---|---|
| **Equipment** | **8** | **47.0** |
| Controls | 2 | 11.8 |
| Guarding | 2 | 11.8 |
| Other design factors | 1 | 5.9 |
| Other equipment factors | 3 | 17.6 |
| **Organisational** | **5** | **29.4** |
| Procedures | 2 | 11.8 |
| Supervision | 2 | 11.8 |
| Other organisational factors | 1 | 5.9 |
| **Behavioural** | **2** | **11.8** |
| **Experience/ knowledge** | **1** | **5.9** |
| **Personal protective equipment** | **1** | **5.9** |
| **Total** | **17**[1] | **100.0** |

1: The number of contributing factors exceeds the number of incidents as sometimes more than one contributing factor was identified for each incident.

## Design issues involving mechanical power transfer mechanisms

Design issues were identified as contributing factors in four of the five deaths involving mechanical transfer mechanisms (Table 22). For one incident, there were two design issues related to the incident.

**Table 22 Design issues identified as contributing factors to deaths involving mechanical power transfer mechanisms.**
**Number — Australia, 1989 to 1992**

| Design Issue | Number |
|---|---|
| **Guarding** | **3** |
| Absence of equipment or workspace guarding | 2 |
| Absence of ROPS or equivalent on tractor | 1 |
| **Controls** | **2** |
| Controls sticking and unmarked | 1 |
| Poor location | 1 |
| **Total** | **5** |

## Recommendations from incidents involving mechanical power transfer mechanisms

Of the five deaths related to mechanical power transfer mechanisms, four had associated recommendations from the Coroner, OHS body, or other agency. Recommendations related to design and other issues are listed below.

### Recommendations related to design

- Fitting of rollover protection to the tractor.
- Attach cables to the front of tractors so operators can look along the line of the cable.
- Investigate inherent danger in slipping of the Kelly pole attached to mobile augers and the possibility of mandatory installation of clutch mechanisms to the hydraulic systems.
- Positioning of control levers in the control box should direct operators towards the recovery of the rope closest to them.
- Consider design and installation of a protective structure for operators given the danger of rope whipping or recoil.

### Other recommendations

- A person strategically stationed to relay messages from one operator to another.
- Use two-way radio to communicate between operators.
- Each cable should be attached securely and separately to the supporting rope except when cables are used that can support their own mass.
- Support rope will be attached to the electrical cables at the lower end using the current improved method of two half hitch ties.
- Half hitch ties will remain in place as part of permanent support.
- When lowering more than one electrical cable, each cable will be individually clamped to the support rope.
- All future suspended cable installations shall be carried out in accordance with an amended standard job procedure.
- The current installation procedure for crossed eyebolt shall remain unchanged.
- Clarify the rules regarding qualifications of crane operators and in particular mobile augers.
- Consider drafting a code of practice for employers to issue hard hats to employees engaged in any crane operations.
- Operators must be made familiar with the proportional operating capacity of the remote control rope winches.

### *Other lifting plant*

There were 18 deaths (16 workers and two bystanders) that involved other lifting plant. Two incidents involved two deaths each, making the total number of incidents 16. Of those, the most common agency involved was a screw auger (Table 23).

**Table 23 Mechanism associated with each death involving other lifting plant. Number — Australia, 1989 to 1992**

| Agency | Trapped by moving machinery | Hit by moving object | Hit by falling objects | Trapped between stationary & moving objects | Contact with electricity |
|---|---|---|---|---|---|
| Screw auger | 7 | 1 | 2 | 1 | 2 |
| Winches & hooks | 1 | 1 | 1 | - | - |
| Other conveyors & lifting plant | - | 1 | - | 1 | - |
| **Total** | **8** | **3** | **3** | **2** | **2** |

The most common mechanism of the18 deaths involving other lifting plant was being 'trapped by moving machinery'. There were six deaths which involved a person's body or clothing becoming caught in an auger (post hole digger or drill) while it was rotating, and subsequently pulled the person into the machine. There was no machine guarding of any of these augers.

A farm assistant was killed while assisting in testing soil salinity. While shovelling dirt away from the auger, the assistant's jacket became caught in the apparatus and he was pulled into the machine. There was no cage guarding around the auger. It was recommended that a guard be fitted to the machine, a 'dead-man' control be utilized, and a formal training program be implemented.

## Contributing factors to incidents involving other lifting plant

For the 18 deaths (16 incidents) involving other lifting plant, 49 contributing factors were identified. The most common ones were equipment and behavioural factors (Table 24).

**Table 24 Contributing factors identified in deaths involving other lifting plant.**
**Number and percent — Australia, 1989 to 1992**

| Contributing Factor | Number | Percent |
|---|---|---|
| **Equipment** | **17** | **34.7** |
| Guarding | 9 | 18.4 |
| Controls | 2 | 4.1 |
| Other design factors | 4 | 8.2 |
| Other equipment factors | 2 | 4.1 |
| **Behavioural** | **14** | **28.6** |
| **Organisational** | **8** | **16.3** |
| Supervision | 3 | 6.1 |
| Procedures | 3 | 6.1 |
| Other organisational factors | 2 | 4.1 |
| **Physical environment** | **4** | **8.2** |
| **Physiological** | **2** | **4.1** |
| **Experience/ knowledge** | **2** | **4.1** |
| **Toxicology** | **1** | **2.0** |
| **Personal protective equipment** | **1** | **2.0** |
| **Total** | **49**[1] | **100.0** |

1: The number of contributing factors exceeds the number of incidents as sometimes more than one contributing factor was identified for each incident.

## Design issues involving other lifting plant

In 12 of the 18 deaths involving other lifting plant, design issues were identified as contributing factors. The most common issue was an absence of guarding around equipment. For three deaths, there were two design issues related to the incident. (Table 25).

**Table 25 Design issues identified as contributing factors in deaths involving other lifting plant. Number — Australia, 1989 to 1992**

| Design Issue | Number |
|---|---|
| **Guarding** | **9** |
| Absent | 9 |
| **Controls** | **2** |
| Poor location of controls (unable to depress button and drive simultaneously) | 1 |
| Unmarked and sticking controls | 1 |
| **Other design factors** | **4** |
| Auger easily overbalanced | 1 |
| Supporting structure of auger inadequate | 1 |
| Blind spot on vehicle | 1 |
| Auger functional with longer piece of rod than recommended | 1 |
| **Total** | **15** |

## Recommendations from incidents involving other lifting plant

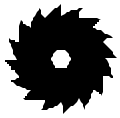
Of the 16 incidents related to other lifting plant, recommendations were made by the Coroner, OHS agency or other body in nine incidents (10 deaths). Recommendations related to design and other issues are listed below.

### Recommendations related to design

- The OHS authority arrange consultation with manufacturers and users of augers, to explore ways of minimising the risks involved in their use.
- Guarding installed in the form of a meshed, hinged gate above the working platform, approx 1500mm high, complete with an interlock system connected to the hydraulic system, to ensure that when the gate is in the open position the rig cannot operate.
- A ‘dead-man’ control be fitted to the operating panel of the auger.
- Controls of all slide mounted rock drills should be located in a manner that facilitates easy shut off of the machines rotation.
- Investigate the danger inherent in the slipping of the Kelly pole attached to mobile augers and the possibility of the mandatory installation of a clutch mechanism to the hydraulic systems.
- Guards be provided around the vee belt and other exposed working parts of the auger.

## Other recommendations

- A copy of the accident file be sent to the Rural Safety and Education Section of the Workcover Authority, so inspectors in rural areas are made aware of the potential dangers of not using manufacturer's specified replacement parts on this type of machinery.
- This type of accident (caught in an auger whilst digging fence posts) be focussed on in forthcoming field days.
- A formal training program be developed and implemented to ensure employees working with boring rigs are aware of the dangers, and also safe systems of work to be carried out at all times.
- Clothing, as well as being close fitting and close fastening, should also be close weaved when worn about rotating machinery.
- Protective clothing should be provided to all operators of quarry drilling equipment by the employer.
- Clarify the rules relating to the qualification of persons to operate cranes, and in particular mobile augers.
- The findings be brought to the attention of the Federal Advisory Committee which was publishing a safety code for container handling, the state OHS authority, the relevant union and the employer organisations.
- The ground approaching the silo door should be flat and level.
- Outer clothing including PPE worn during fishing should be of a type that does not expose the wearer to the risk of loose ends or cords becoming entangled in machinery, nets or ropes.
- Work stations arranged on fishing vessels so employees are not exposed to the hazards of moving machinery and/or equipment.
- Crews of fishing vessels maintain a constant awareness of the whereabouts of all other nearby crew members and to only operate the machinery when others are clear.
- Operators of fishing vessels throughout the state raise health and safety standards and the awareness of all those within the industry to both the potential hazards as well as their respective rights and responsibilities.
- The company provide appropriate information, instruction, training and supervision for the employees so they are not exposed to hazards.
- The company should ensure written instructions and signs are taken into consideration due to the fact that some employees had a poor understanding of written English.
- The company formally provide and enforce a policy on entry of persons other than employees onto the worksite.
- Appropriate sign-posting be provided and displayed.
- Ensure that all future augers be constructed with warnings of the dangers of upending an auger.
- An alert be issued to manufacturers and users of these appliances of the potential dangers involved when using a large auger at or near its maximum height.



There were 18 deaths (16 workers and two bystanders), each occurring in separate incidents, that had cutting, slicing and sawing machinery as one of the agencies. Seven of the 18 deaths involved circular saws (Table 26).

**Table 26 Agencies identified in deaths involving cutting, slicing and sawing machinery. Number and percent — Australia, 1989 to 1992**

| Agency | Number | Percent |
|---|---|---|
| **Circular saws (excludes portable)** | **7** | **38.9** |
| Timber | 6 | 33.3 |
| Other | 1 | 5.6 |
| **Lathes** | **5** | **27.8** |
| Metal | 1 | 5.6 |
| Other | 4 | 22.2 |
| **Planing machines** | **1** | **5.6** |
| **Grinders** | **1** | **5.6** |
| **Other cutting, slicing, sawing machinery**[1] | **4** | **22.2** |
| **Total** | **18** | **100.0** |

1: The other agencies were a garbage shredder, a foam cutting machine, a chipper machine and a breast saw bench.

The most common mechanism of the 18 deaths involving cutting, slicing and sawing machinery was ‘being hit by moving objects’, which occurred in 61% of the cases. The circumstances surrounding these events most often involved a circular saw operator being struck by a piece of material (usually wood) thrust from the saw. Generally, inadequate guarding against kickback, and/or poorly maintained equipment or workspace layout, were contributing factors to such incidents. Just under one quarter of the deaths involved ‘being trapped by moving machinery’, which included, pushing material into a machine and becoming caught in the machine in the process (Table 27).

**Table 27 Mechanism associated with each death involving cutting, slicing and sawing machinery. Number — Australia, 1989 to 1992**

| Agency | Hit by moving object | Trapped by moving machinery | Contact with electricity | Hit by falling object |
|---|---|---|---|---|
| Circular saws (excludes portable) | 7 | - | - | - |
| Lathes | 2 | 1 | 1 | 1 |
| Planting machines | - | 1 | - | - |
| Grinders | 1 | - | - | - |
| Other cutting slicing sawing machinery | 1 | 2 | 1 | - |
| **Total** | **11** | **4** | **2** | **1** |

A bench saw operator was cutting a piece of timber. When the wood was almost through the saw, the off-cut fell downwards. The resting trolley which usually held the off-cuts was out of position. Consequently the piece of wood hit the blade and thrust it back towards the operator, delivering a fatal blow to his chest. At the time of the incident, the hood guard had been raised, rendering it inoperative. The OHS authority recommended that the hood guard of the saw bench be lowered, so that the timber passing through just clears the bottom of the guard.

## Contributing factors to incidents involving cutting, slicing and sawing machinery

For the 18 deaths involving cutting, slicing and sawing machinery, 59 contributing factors were identified. Of those, equipment factors were identified most often, and represented almost half of all contributing factors (Table 28).

**Table 28 Contributing factors identified in deaths involving cutting, slicing and sawing machinery.**
**Number and percent — Australia, 1989 to 1992**

| Contributing Factor | Number[1] | Percent |
|---|---|---|
| **Equipment** | **26** | **44.1** |
| Guarding | 13 | 22.0 |
| Controls | 4 | 6.8 |
| Other design issues | 2 | 3.4 |
| Other equipment | 7 | 11.9 |
| **Behavioural** | **13** | **22.0** |
| **Organisational** | **10** | **16.9** |
| Training | 4 | 6.8 |
| Work procedures | 3 | 5.1 |
| Other organisational issues | 3 | 5.1 |
| **Experience/ knowledge** | **3** | **5.1** |
| **Physiological** | **3** | **5.1** |
| **Physical environment** | **2** | **3.4** |
| **Other person** | **1** | **1.7** |
| **Other factors** | **1** | **1.7** |
| **Total** | **59**[1] | **100.0** |

1: The number of contributing factors exceeds the number of incidents as sometimes more than one contributing factor was identified for each incident.

## Design issues involving cutting, slicing and sawing machinery

For almost all deaths involving cutting, slicing and sawing machinery, at least one design issue (controls, guarding, or other design issues) was identified as a contributing factor. Absent or inadequately designed guarding of the equipment was by far the most frequently recognized design issue contributing to the deaths with cutting, slicing and sawing machinery (Table 29).

**Table 29 Design issues identified as contributing factors in deaths involving cutting, slicing and sawing machinery. Number — Australia, 1989 to 1992**

| Design Issue | Number |
|---|---|
| **Guarding** | **13** |
| Absent or inadequate | 10 |
| Able to be removed or modified | 3 |
| **Controls** | **4** |
| Emergency stop button: poor placement | 1 |
| Emergency stop button: unsafely modified | 1 |
| Automatic stop controls inadequate | 1 |
| Controls able to be adjusted unsafely | 1 |
| **Other design issues** | **2** |
| Able to operate with wrong attachment | 1 |
| Protruding screws from drive shaft | 1 |
| **Total** | **19** |

## Recommendations from incidents involving cutting, slicing and sawing machinery

Eight of the 18 deaths involving cutting, slicing and sawing machinery had recommendations made by the Coroner, OHS body or other agency. Recommendations related to design and other issues are listed below.

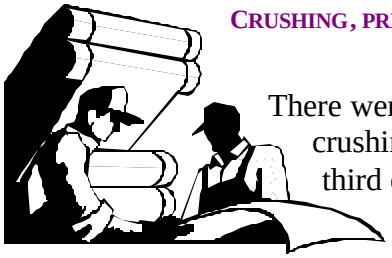
### Recommendations related to design

- Reasons for the machine blocking need to be resolved.
- Controls need to be modified so machine stops if it malfunctions.
- The saw bench's hood guard should be lowered so timber passing through just clears the bottom of the guard.
- Power rollers to be fitted to the machine so as to remove the product.
- Guarding to be fitted along length of the machine on non-discharge side.
- The machine be guarded in accordance with regulations.
- An Alert be prepared to warn balancing machine operators of the dangers, and informing them of the availability of AS3710, Vibration and Shock-balancing Machines-enclosures, and other safety measures.

- Owners of Zayer long-bed Universal milling machines and similar machines be warned:
  1. of the danger of using heavy unbalanced cutter assemblies for facing operations;
  2. to use sufficient grub screws of an appropriate type;
  3. that adequate torque must be applied to all grub screws;
  4. that grub screws be replaced when worn; and
  5. that interlocking mesh guard should be used between the operator and the work piece when using a heavy unbalanced rotating cutter assembly.
- Consider designing grinding wheels with a safety guard which cannot be removed.

## Other recommendations

- A system be developed to ensure that the machinery is used in a safe manner.
- All operators and supervisors need refresher courses in the operation of machinery.
- Shredding should only be carried out in automatic mode.
- Supervision system needs to be established.
- All supervisors need to do an OHS course.
- A ladder must not be kept in the shredding area.
- All safety and control switches to be kept clear at all times.
- Proper training and internal testing procedures be implemented.
- A survey to ascertain the level of compliance with guarding of balancing machines.
- A crown law opinion be sought clarifying the exact status of persons (*friend of company's owner, working without pay without instructions or directions)* at workplaces.
- A safety bulletin be drafted indicating the status and obligations of occupiers towards persons other than employees at workplaces.
- Suitable first aid equipment at every mine site.
- Manufacturers ensure that information on the correct storage of, and dangers of incorrect storage of, grinding wheels are on the labels affixed to the wheels.
- Grinding machines should have information on size or speed of the grinding wheel to be used and warnings on the hazards of using incorrectly sized wheel prominently displayed on them in a fashion that will not suffer from the effects of wear and tear.
- In addition to their speed, grinding wheels should clearly have noted on them the possible effects or dangers of using them on a machine for which they are not designed or at a speed different to that specified.
- Let the general public know of the dangers of using a grinding wheel on a machine for which they are not designed, or at a speed different to that specified, and publish an article in 'Safetyline'.
- Suppliers of saw milling equipment such as saw blades have informative literature to pass on to their clients.
- Recommend against acquiring home made saw benches.
- Saw benches be maintained by trained personnel.



There were nine deaths (eight workers and one bystander) that had crushing, pressing, or rolling machinery as one of the agencies. One third of the cases involved presses (wool or other power presses) (Table 30).

**Table 30 Agencies identified in deaths involving crushing, pressing and rolling machinery.**
**Number and percent — Australia, 1989 to 1992**

| Agency | Number | Percent |
|---|---|---|
| **Presses** | **3** | **33.3** |
| Wool press | 2 | 22.2 |
| Other power press | 1 | 11.1 |
| **Metal crimping punching stamping machinery** | **1** | **11.1** |
| **Garbage compactors** | **1** | **11.1** |
| **Rolling mills** | **1** | **11.1** |
| **Paper paperboard milling machinery** | **1** | **11.1** |
| **Roll-a-span roller machine** | **1** | **11.1** |
| **Pedestrian roller** | **1** | **11.1** |
| **Total** | **9** | **100.0** |

The most common mechanism involved in the nine deaths related to crushing, pressing and rolling machinery was 'being trapped by moving machinery', which accounted for 77.8% of the deaths (Table 31). In seven of the nine deaths, the person entered the compacting section of the machinery, which was then activated by the person, or another person.

**Table 31 Mechanism associated with each death involving crushing, pressing and rolling machinery.**
**Number — Australia, 1989 to 1992**

| Agency | Trapped by moving machinery | Trapped between stationary and moving object | Hit by moving object |
|---|---|---|---|
| Presses | 3 | - | - |
| Metal crimping, punching, stamping machines | - | - | 1 |
| Garbage compactors (excludes mobile) | 1 | - | - |
| Rolling mills | 1 | - | - |
| Paper, paperboard mill machinery | 1 | - | - |
| Roll-a-span machinery | 1 | - | - |
| Pedestrian roller | - | 1 | - |
| **Total** | **7** | **1** | **1** |

A maintenance fitter died from head injuries when he was crushed in a printing press. He had begun the maintenance during the afternoon shift, and continued working into the next shift. The night shift operator did not receive the normal handover, and was unaware of the presence of the fitter. The night shift operator looked in the machine and, as he did not see anyone, started the press. The fitter was crushed by the rollers of the machine. There was no delay start or siren warning regarding the impending start of the machine's cycle.

## Contributing factors to incidents involving crushing, pressing and rolling machinery

For the nine deaths involving crushing, pressing or rolling machinery, 29 contributing factors were identified. Of those, equipment and behavioural factors were identified most frequently (Table 32).

**Table 32 Contributing factors identified in deaths involving crushing, pressing and rolling machinery.**
**Number and percent — Australia, 1989 to 1992**

| Contributing Factor | Number | Percent |
|---|---|---|
| **Equipment** | **12** | **41.4** |
| Guarding | 6 | 20.7 |
| Controls | 4 | 13.8 |
| Other design issues | 1 | 3.4 |
| Other equipment | 1 | 3.4 |
| **Behavioural** | **8** | **27.6** |
| **Organisational** | **4** | **13.8** |
| Training | 2 | 6.9 |
| Procedures | 1 | 3.4 |
| Other organisational issues | 1 | 3.4 |
| **Experience/ knowledge** | **2** | **6.9** |
| **Physiological** | **1** | **3.4** |
| **Personal protective equipment** | **1** | **3.4** |
| **Other persons** | **1** | **3.4** |
| **Total** | **29**[1] | **100.0** |

1: The number of contributing factors exceeds the number of incidents as sometimes more than one contributing factor was identified for each incident.

## Design issues involving crushing, pressing and rolling machinery

In eight of the nine deaths involving crushing, pressing and rolling machinery, at least one equipment design issue was identified as a contributing factor to the death. The most frequently cited design problem was related to equipment guarding (Table 33).

**Table 33 Design issues identified as contributing factors in deaths involving crushing, pressing and rolling machinery. Number — Australia 1989 to 1992**

| Design Issue | Number |
|---|---|
| **Guarding** | **6** |
| Absent | 4 |
| Blindspot present | 1 |
| Removed | 1 |
| **Controls** | **4** |
| Location | 3 |
| Design allowed inadvertent activation | 1 |
| **Other design issues** | **1** |
| Absence of siren warning/delay start | 1 |
| **Total** | **11** |

## Recommendations from incidents involving crushing, pressing and rolling machinery

Six of the nine deaths related to crushing, pressing and rolling machinery had recommendations from a Coroner, OHS body or other agency. Recommendations related to design and other issues are listed below.

### Recommendations related to design

- The company use a captive key and lock out system, operator's isolation switch and siren warning with time delay starting switch on control panel of the printing press.
- Garbage compactors and similar machines to be fitted with a key switch so only authorised personnel may operate them.
- All access door/gates to be electrically interlocked to prevent accidental operation.
- Control panels to be located a safe distance from all moving parts.
- Controls operated by a captive key system and the issue of such keys strictly controlled.
- The wool press be redesigned to only be activated by a solenoid connected to a recessed button with a shroud over it, and the button has to be held in place to complete the cycle.
- Owners of the older version of the Power Tech Lyco wool press modify it to have a safety guard on the side from which the operator would stand.
- Consider adopting an Australian standard for wool presses.
- Consider adopting regulations to ensure appropriate guarding for all new and old wool presses.
- Changes to guarding of the machine.

## Other recommendations

- The compactor/bin should be located where access is only available to authorised persons.
- Media coverage and an extensive publicity campaign to identify hazards on rural properties and industrial safety in rural areas.
- OHS Commission should consider a reassessment of its ability to enforce safety regulations in relation to the rural industry.

There were ten deaths that had heating, cooking and baking equipment as one of the agencies. Half of those deaths involved boilers (Table 34).

**Table 34 Agencies identified in deaths involving heating, cooking and baking equipment.**
**Number and percent — Australia, 1989 to 1992**

| Agency | Number | Percent |
|---|---|---|
| Boilers | 5 | 50.0 |
| Kilns and industrial ovens | 1 | 10.0 |
| Gas ovens | 1 | 10.0 |
| Other heating cooking baking equipment[1] | 3 | 30.0 |
| **Total** | **10** | **100.0** |

1: The three 'other' agencies were a moulding machine, a gas heater and a percolator basket.

Overall, the most common mechanism of the ten deaths involving heating, cooking and baking equipment was 'explosion'. The most common circumstances surrounding these events involved the equipment exploding due to a build up of gas or loss of water. Generally, malfunction of equipment or the equipment being turned off contributed to these incidents. Other common events included two persons falling from a height while working on boilers (Table 35).

**Table 35 Mechanism associated with each death involving heating, cooking and baking equipment.**
**Number — Australia, 1989 to 1992**

| Agency | Explosion | Fall from a height | Hit by moving object | Other |
|---|---|---|---|---|
| Boilers | 1 | 2 | 1 | 1 |
| Kilns and industrial ovens (not food) | 1 | - | - | - |
| Gas ovens | 1 | - | - | - |
| Other | - | - | 1 | 2 |
| **Total** | **3** | **2** | **2** | **3** |

A boiler stoker on board an international passenger liner was monitoring a 'blowdown' when the boiler exploded, causing him to sustain fatal injuries. The alarm on the boiler to indicate low water level had been put in the 'off' position, rendering it inoperative.

## Contributing factors to incidents involving heating, cooking and baking equipment

For the ten deaths involving heating, cooking or baking equipment, 25 contributing factors were identified. Of these, equipment, behavioural, and organisational factors were most commonly identified (Table 36).

**Table 36 Contributing factors identified in deaths involving heating, cooking and baking equipment.**
**Number and percent — Australia, 1989 to 1992**

| Contributing Factor | Number | Percent |
|---|---|---|
| **Equipment** | **6** | **24.0** |
| Guarding | 1 | 4.0 |
| Other design issues | 5 | 20.0 |
| **Behavioural** | **6** | **24.0** |
| **Organisational** | **6** | **24.0** |
| Procedures | 3 | 12.0 |
| Training | 1 | 4.0 |
| Supervision | 1 | 4.0 |
| Other organisational issues | 1 | 4.0 |
| **Physical environment** | **2** | **8.0** |
| **Personal protective equipment** | **2** | **8.0** |
| **Experience/knowledge** | **1** | **4.0** |
| **Physiological** | **1** | **4.0** |
| **Other persons** | **1** | **4.0** |
| **Total** | **25**[1] | **100.0** |

1: The number of contributing factors exceeds the number of incidents as sometimes more than one contributing factor was identified for each incident.

## Design issues involving heating, cooking and baking equipment

In six of the ten deaths involving heating, cooking and baking equipment, equipment design issues were identified as contributing factors (Table 37). The most common issues involved safety equipment that could be turned off, or that did not have warnings when malfunctioning.

**Table 37 Design issues identified as contributing factors in deaths involving heating, cooking and baking equipment. Number — Australia, 1989 to 1992**

| Design Issue | Number |
|---|---|
| **Guarding** | |
| Lack of guarding | 1 |
| **Other design issues** | **5** |
| Design resulted in condensation problems, thus drain cocks left open | 1 |
| Lack of safety hook on hoist holding perculator basket | 1 |
| Alarm could be placed in 'off' position | 1 |
| Malfunction of safety shut-off valve- non fail safe | 1 |
| Neutral wire burnt out and house's earth system not connected to ground | 1 |
| **Total** | **6** |

## Recommendations from incidents involving heating, cooking and baking equipment

Of the ten deaths related to heating, cooking or baking equipment, five had associated recommendations from a Coroner, OHS body or other agency. Recommendations related to design and other issues are listed below.

### Recommendations related to design

- The guard fence be modified to close off the ends and a gate with an electrical interlock installed so the machine would stop if the gate was opened.
- Safety latches or safety hooks be made mandatory on all equipment where lifting from a hook takes place.
- An amendment be made to regulation 528 requiring the provision of safety latches or safety hooks to hoists.
- Thermo electric flame failure valves should be clearly marked with their operating pressures to notify purchaser of their limitations.

### Other recommendations

- Company develop a better method of draining waste from the gas pipes.
- Fail safe systems be developed to prevent the same situation occurring.
- Written procedures be developed.
- More detail be recorded in the daily instruction book, operators sign it after reading, and the instruction and regulator's book be combined.

- Public announcement made to ensure that high pressure gas burner operators have them checked to ensure the safety shut-off valves are appropriate for the pressure flowing through them.
- Inform all suppliers of hoist equipment of the legislation change.
- Where inspections are conducted at workplaces where hoists are located, the requirements of safety latches or safety hooks be enforced.
- A media campaign be instituted advising of the legislative change, supported by an article in Safety Line and the production of a safety bulletin.
- Other homes of about the same vintage also had the neutral wires on the customer mains burnt out. A system for checking all similar houses should be put in place.

## COOLING AND REFRIGERATION PLANT AND EQUIPMENT

There were nine deaths that had cooling and refrigeration plant and equipment as one of the agencies. Seven of the nine deaths involved air conditioning equipment (Table 38).

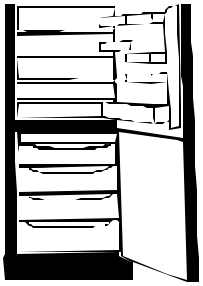


**Table 38 Agencies identified in deaths involving cooling and refrigeration plant and equipment.**
**Number and percent — Australia, 1989 to 1992**

| Agency | Number | Percent |
|---|---|---|
| Air conditioning | 7 | 77.8 |
| Refrigeration equipment (cool room) | 1 | 11.1 |
| Ice machine | 1 | 11.1 |
| **Total** | **9** | **100.0** |

The most common mechanism was 'contact with electricity', which was related to six of the nine deaths (Table 39). The most common circumstances involved attempting repairs on the equipment and contacting electricity, either through live wires in the equipment or due to faulty insulation in electrical wiring.

**Table 39 Mechanism associated with each death involving cooling and refrigeration plant and equipment.**
**Number — Australia, 1989 to 1992**

| Agency | Contact with electricity | Hit by falling objects | Fall from a height |
|---|---|---|---|
| Air conditioning | 5 | 1 | 1 |
| Refrigeration equipment (cool room) | - | 1 | - |
| Other refrigeration plant | 1 | - | - |
| **Total** | **6** | **2** | **1** |

An apprentice air conditioning and refrigeration mechanic was killed while he was attempting to re-gas an air conditioning unit. While the power was supplied to the unit, his bare arm came into contact with two live phases of the terminal block mounted on the internal section of the unit. The Coroner recommended that the terminal block should have appropriate insulation to avoid accidental contact with the live wires.

## Contributing factors to incidents involving cooling and refrigeration plant and equipment

For the nine deaths involving cooling and refrigeration plant and equipment, 24 contributing factors were identified. Equipment and behavioural factors were the most frequently identified contributing factors (Table 40).

**Table 40 Contributing factors identified in deaths involving cooling and refrigeration plant and equipment.**
**Number and percent — Australia, 1989 to 1992**

| Contributing Factor | Number | Percent |
|---|---|---|
| **Equipment** | **7** | **29.2** |
| Guarding | 1 | 4.2 |
| Other design factors | 2 | 8.3 |
| Other equipment factors | 4 | 16.7 |
| **Behavioural** | **7** | **29.2** |
| **Organisational** | **5** | **20.8** |
| Procedures | 1 | 4.2 |
| Training | 1 | 4.2 |
| Supervision | 1 | 4.2 |
| Other organisational factors | 2 | 8.3 |
| **Experience/ knowledge** | **4** | **16.7** |
| **Personal protective equipment** | **1** | **4.2** |
| **Total** | **24**[1] | **100.0** |

1: The number of contributing factors exceeds the number of incidents as sometimes more than one contributing factor was identified for each incident.

## Design issues involving cooling and refrigeration plant and equipment

Design issues were identified as contributing factors in three of nine deaths involving cooling and refrigeration plant and equipment (Table 41).

**Table 41 Design issues identified as contributing factors in deaths involving cooling and refrigeration plant and equipment. Number — Australia, 1989 to 1992**

| Design Issue | Number |
|---|---|
| **Guarding** | **1** |
| Absence over live section of terminal block | 1 |
| **Other Design issues** | **2** |
| Absence of insulation on feet of metal ladder | 1 |
| Only part of switchboard lockable | 1 |
| **Total** | **3** |

## Recommendations from incidents involving cooling and refrigeration plant and equipment

Of the nine deaths related to cooling and refrigeration plant and equipment, six had associated recommendations from a Coroner, OHS body or other agency. Recommendations related to design and other issues are listed below.

### Recommendations related to design

- The terminal block connection be suitably insulated to prevent accidental contact.
- Unlimited access to all of the switchboard could be reconsidered.
- Consideration be given to fitting and retrofitting of residual current devices (RCDs) as well as the use of portable RCDs for handyman use.
- Relay coaches safe access is to be provided to an area on the air conditioning cover panels. Within this safe area are to be facilities to allow the dual pressure control and the overload relays for the compressor motor, condenser fan motors, and air circulating fan motor to be reset.

### Other recommendations

- When disconnecting services in relation to demolition, electricians must remove in its entirety that part of the installation.
- Ensure all employees are instructed on the hazards and safe use of mobile scaffolds and be made aware that all employees must work within the relevant acts and regulations, and that any scaffold over three meters in height should only be erected by a certified scaffolder.
- Regulations on ‘clear working area’ around an electrical switchboard be more vigorously policed.
- A better system of supervision for electrical mechanic apprentices be monitored.
- Isolate electrical apparatus before removing plant and equipment.
- Deny unqualified and/or unauthorised personnel access to electrical and air conditioning wiring panels.
- All electrical control panels should be signed to warn of dangers.
- Plumbers be made aware of the dangers of working with electricity.

There were nine deaths (seven workers and two bystanders) in eight incidents that had turbines, generators, motors and transformers as one of the agencies. Five of the nine deaths involved generators (Table 42).

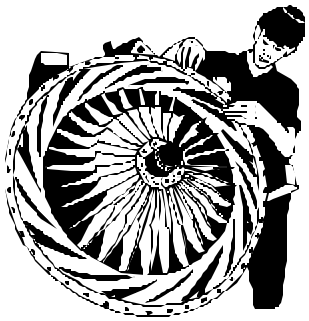


**Table 42 Agencies identified in deaths involving turbines, generators, motors and transformers.**
**Number and percent[1] — Australia, 1989 to 1992**

| Agency | Number | Percent |
|---|---|---|
| Generator | 5 | 55.6 |
| Transformer | 3 | 33.3 |
| Portable alternator | 1 | 11.1 |
| **Total** | **9** | **100.0** |

The most common mechanism was 'contact with electricity', which was related to seven of the nine deaths (Table 43). A common circumstance was for electrocutions to occur due to the failure of insulators or a fault in the equipment (six deaths). The other deaths resulted from the improper use of a fluke metre whilst testing a high voltage transformer, a fall that was caused by a handle slipping when a generator was pull started, and impacting with a portable generator after the worker was hit by a car.

**Table 43 Mechanism associated with each death involving turbines, generators, motors and transformers.**
**Number — Australia, 1989 to 1992**

| Agency | Contact with electricity | Fall from a height | Hit by moving object |
|---|---|---|---|
| Generators | 4 | 1 | - |
| Transformers | 3 | - | - |
| Portable alternator | - | - | 1 |
| **Total** | **7** | **1** | **1** |

An opal miner was killed when he was attempting to pull start a generator on the surface adjacent to the mine shaft. While he was pulling the cord, the plastic handle slipped past the retaining knot on the cord. This slip caused him to stumble backwards and fall into the mine shaft. There was no guarding around the mine shaft and the poor design of the handle on the generator both contributed to the incident.

## Contributing factors to incidents involving turbines, generators, motors and transformers

For the eight incidents involving turbines, generators and motors, common circumstances involved incorrect wiring and energizing equipment, and the person consequently being electrocuted, contacting damp ground while doing electrical work was also a common factor. There were 21 contributing factors identified, the most common being equipment and behavioural factors (Table 44).

**Table 44 Contributing factors identified in deaths involving turbines, generators, motors and transformers. Number and percent — Australia, 1989 to 1992**

| Contributing Factor | Number | Percent |
|---|---|---|
| **Equipment** | **7** | **33.3** |
| Guarding | 1 | 4.8 |
| Other design factors | 3 | 14.3 |
| Other equipment factors | 3 | 14.3 |
| **Behavioural** | **6** | **28.6** |
| **Organisational** | **2** | **9.5** |
| Procedures | 2 | 9.5 |
| **Physical environment** | **2** | **9.5** |
| **Personal protective equipment** | **2** | **9.5** |
| **Other persons** | **1** | **4.8** |
| **Experience / knowledge** | **1** | **4.8** |
| **Total** | **21**[1] | **100.0** |

1: The number of contributing factors exceeds the number of incidents as sometimes more than one contributing factor was identified for each incident.

## Design issues involving turbines, generators, motors and transformers

In three of the eight incidents involving turbines, generators, motors and transformers, design issues were determined to be contributing factors. In one case, there were two design issues related to one death (Table 45).

**Table 45 Design issues identified as contributing factors in deaths involving turbines, generators, motors and transformers. Number — Australia, 1989 to 1992**

| Design Issue | Number |
|---|---|
| Lack of safety railing designed around mine shaft | 1 |
| Generator design not meeting Australian standard | 1 |
| Pull cord design on generator allowed handle to slip off | 1 |
| Design of HXO fuses faulty | 1 |
| **Total** | **4** |

## Recommendations from incidents involving turbines, generators, motors and transformers

Recommendations were provided for four of the eight incidents involving turbines, generators, motors and transformers. All recommendations except one, applied to issues other than the design of the equipment .

### Recommendations related to design

- All single phase generators used on construction sites comply with the requirements of 6.1.6 of Australian Standard 2790-1985.

### Other recommendations

- The provisions of the Mines Inspection Act, 1901, (General Rules 21, 21A, 23 & 36) be publicized, including mention in the local press. In the same publicity campaign, also emphasise that internal combustion engines which can produce toxic exhaust fumes should not be positioned close to the air intake of mine shafts.
- That all relevant electrical bodies:
  1. document a procedure for work on, or in, the vicinity of such fuses which ensures that they are not injured as a result of a failure of the 'HXO' fuses or assembly, having regard particularly to the unrestrained length of 'dropper' where used;
  2. issue the work procedure to all employees and any other persons that may work on the electrical systems; and
  3. require all employees and any other persons that may work on the electrical systems to adhere to the work procedure at all times.
- When persons handle potentially lethal voltages of electricity they should be supervised continuously by another member of staff in an attempt to ensure that all safety precautions have been maintained.
- A full copy of the transcript and documentary exhibits be supplied to the Electricity Commission, to assist officers to formulate a policy to prevent similar occurrences.

- Modification to workplace health and safety legislation regarding earth leakage circuit boards (ELCBs) on construction sites.
- Construction industry advised of hazards introduced by incorrect use of this equipment.

## OTHER PLANT AND EQUIPMENT

There were 22 deaths (20 workers and two bystanders) which had 'other plant and equipment' as one of the agencies. The most common individual agency within this group was mains (Table 46).

**Table 46 Agencies identified in deaths involving other plant and equipment. Number and percent — Australia, 1989 to 1992**

| Agency | Number | Percent |
|---|---|---|
| **Mains** | **6** | **27.3** |
| Water | 5 | 22.7 |
| Other | 1 | 4.5 |
| **Microwave oven** | **1** | **4.5** |
| **Medical laser equipment** | **1** | **4.5** |
| **Milk production and processing plant** | **1** | **4.5** |
| **Knitting machine** | **1** | **4.5** |
| **Other and unspecified production line type of plant or stand alone machinery[1]** | **12** | **54.5** |
| **Total** | **22** | **100.0** |

1: The 'other and unspecified production line type of plant or stand alone machinery' were a dehacking machine, fixed bed catalyst hydrotreater reactor, combiner sower (planter), steam supply pipe, glass forming machine, rail skip, mutton pelting machine, emergency safety shower, steel cylinder, automatic strapping machine and two unknown types of equipment.

The most common mechanism was 'contact with electricity' which occurred in seven of the 22 deaths (Table 47). In two separate incidents involving mains, a person was hit by the excess rod protruding from a Helical Rotor Borehole pump. In both cases, the excess rod had not been trimmed and, when the mechanism turned, the rod bent and struck the person. The other deaths resulted from a variety of circumstances, including electrocutions resulting from improper repairs or work on the system (two deaths), falls from machinery while working (two deaths), and two deaths where persons accidentally activated a machine while part of their body was in its operating space.

**Table 47 Mechanism associated with each death involving other plant and equipment. Number and percent[1]— Australia, 1989 to 1992**

| Agency | Contact with electricity | Hit by moving object | Fall from a height | Hit by falling objects | Trapped by moving machinery | Trapped between stationary & moving objects | Other[1] |
|---|---|---|---|---|---|---|---|
| Mains | 4 | 2 | - | - | - | - | - |
| Other | 3 | 1 | 2 | 2 | 2 | 2 | 4 |
| **Total** | **7** | **3** | **2** | **2** | **2** | **2** | **4** |

1: Other mechanisms included contact with hot object, non-ionising radiation, single contact with a chemical, and explosion

A 27 year old labourer was operating a mutton pelting machine. He stopped the machine to reach through it and grab a carcass. While reaching, the labourer accidentally engaged the machine by bumping the operating pedal with his foot. This caused the labourer to become wedged between the steel hydraulic ram of the machine and a steel support structure above the ram.

## Contributing factors to incidents involving other plant and equipment

For the 22 deaths involving mains and other plant, there were 61 identified contributing factors. Equipment, behavioural and organisational factors were the most frequent contributing factors (Table 48).

**Table 48 Contributing factors identified in deaths involving other plant and equipment.**
**Number and percent — Australia, 1989 to 1992**

| Contributing Factor | Number | Percent |
|---|---|---|
| **Equipment** | **19** | **31.1** |
| Guarding | 4 | 6.6 |
| Controls | 3 | 4.9 |
| Other design factors | 6 | 9.8 |
| Other equipment factors | 6 | 9.8 |
| **Behavioural** | **15** | **24.6** |
| **Organisational** | **15** | **24.6** |
| Procedures | 6 | 9.8 |
| Training | 4 | 6.6 |
| Supervision | 3 | 4.9 |
| Other organisational factors | 2 | 3.3 |
| **Experience/ knowledge** | **4** | **6.6** |
| **Physiological** | **3** | **4.9** |
| **Personal protective equipment** | **3** | **4.9** |
| **Physical environment** | **2** | **3.3** |
| **Total** | **61**[1] | **100.0** |

1: The number of contributing factors exceeds the number of incidents as sometimes more than one contributing factor was identified for each incident.

## Design issues involving other plant and equipment

Thirteen design-related contributing factors were identified in the 22 deaths involving other plant and equipment. There were two independent incidents with Helical Rotor borehole pumps where a piece of metal was not trimmed from the apparatus and, as the machine turned, struck the person in the head. Had machine guarding been present and/or the pump been designed not to function unless the correct size piece of metal was installed, these incidents would not have happened.

**Table 49 Design issues identified as contributing factors in deaths involving other plant and equipment. Number — Australia, 1989 to 1992**

| Equipment Issue | Number |
|---|---|
| **Guarding** | **4** |
| Machine or area not guarded | 3 |
| Bypassed | 1 |
| **Controls** | **3** |
| Poor location to visualise machinery | 1 |
| Location allows accidental activation | 1 |
| Poor design — two control panels: one on console and one on machine | 1 |
| **Other design issues** | **6** |
| Equipment functional with excess metal protruding | 2 |
| Emergency stop sensors inappropriately designed | 1 |
| Two isolation switches on one machine, only one on an identical adjacent machine | 1 |
| Absence of job attachment on forklift | 1 |
| Neutral wire burnt out and house's earth system not connected to ground | 1 |
| **Total** | **13** |

## Recommendations from incidents involving other plant and equipment

Of the 22 deaths related to other plant and equipment, 13 had associated recommendations from the Coroner, OHS body, or other agency. The recommendations relating to design and other issues are listed below.

### Recommendations related to design

- Provide engineering strategies to stop skip spillage.
- Meter boxes of older houses should be immediately covered by earth leakage devices.
- Fast track introduction of shrouds to be utilised over plug connection or a redesign of the three-pin plug and socket to avoid exposure of live pins.
- All older houses should be earthed with an earth stake instead of using the water pipe as earthing.
- The hide-stripping machine be modified by widening the opening between the top and bottom bars and these modifications be drafted and forwarded to the manufacturers to be included in new machines for the meat industry.

- The isolation systems be incorporated into a single system, signs be installed on machines to describe the type and place of the isolation systems, and other wiring changes be made.
- Control of the sump levels, to prevent flooding by level control alarms connected to automatically start the sump pump.
- Cleaning liquor valve be relocated so that it is remote from sumps.
- Review of safety shower localities.
- Suitable guards with interlocks to be provided.
- Fitting of drain lines and valves be considered.

## Other recommendations

- A portable earth leakage device should have been provided and used.
- Personnel entering confined spaces in the refinery:
  1. wear a safety harness and lifeline attachment;
  2. where practical take into consideration the fall risk factors;
  3. in all circumstances have an observer or 'buddy' system as specified by the Australian Standard AS 2865-1986; and
  4. safe work in confined space be the company standard for this environment.
- Ruptured section of pipe requires renewal.
- Deck winch steam valves to be overhauled.
- Tank heating steam lines are not to be used until such time as they have all been pressure and thickness tested.
- All deck steam lines (supply and condensate) are to be pressure tested at the first available opportunity.
- Comply with the Skip Hoist Requirements and the Construction Safety Act.
- Ensure that employees are not allowed to enter an area with moving machinery unless it is isolated electrically.
- Provide written operational procedures.
- Provide effective training.
- Provide multilingual danger signs in strategic locations.
- OHS authority to advise other Australian steel plants of the details of the incident.
- The supervisor of the worker should have visited the site.
- A code of practice concerning the risks involved with water service installations could be drafted and implemented.
- Review work practices ensuring that bad habits or short cuts are not overriding standard work procedures.
- Greater emphasis placed on house keeping and keeping walkways clear of obstructions.
- A warning bulletin be prepared detailing the basics of the incident and warning employers and employees of the dangers.
- A video be prepared for pastoral workers by the OHS authority staff as part of an overall strategy of accident prevention in the bush.

- Wide dissemination by the State Electricity Commission to all appliance manufacturers and distributors (especially for microwave ovens and television sets) and others that there is need for formal training requirements followed by restricted licences for all electrical appliance repair/service personnel. This case also highlights the dangers associated with the failure to ensure that appropriate equipment is used in all electrical work (especially with high voltages) in that:
    1. insulation on pliers, screwdrivers and the like be regularly checked; insulated gloves should always be used when working with high voltage appliances;
    2. clothing should be appropriate for the job in that long sleeve shirts and pants; and
    3. non leather insulating shoes be worn.
- Where high voltage is involved in the repair of microwaves, high voltage testers be used.
- All repairs to be undertaken in high voltage situations (microwaves/TV) should be done without the supply being connected, and testing equipment should be used to check voltage.
- Explanatory literature accompanying devices, medications and equipment for medical and surgical treatment, be, in so far as is possible, translated into English.
- In so far as time permits innovative new procedures be experimentally simulated to provide the treating surgeon with a technique to perform it and monitor safety.
- Employ an operator on each night shift to work as a leading hand who would have responsibility and possession of keys to workshops and other facilities.
- Emphasize the importance of employees not bypassing safety systems, most specifically to those who would act as foremen or leading hands.
- A risk assessment be conducted of the workplace by an independent consultant.
- A system for checking all houses with that style and type of wiring should be put in place.
- An operator manual be provided near the machine.

# DISCUSSION AND CONCLUSIONS

## Problems with identifying design issues

Problems arose when using the coronial files to identify design issues in the fatal incidents. Some of these related to the definition of "design" and the fact that there might be a number of potential design approaches to appropriately control a hazard. This meant that the type of design issue, and the connection to design, was not always clear.

Also, it was costly and time-consuming to identify and access the files, and the files sometimes lacked relevant detail about the equipment or the circumstances. Finally for some types of events, there were (fortunately) too few to allow patterns of design problems to be easily identified or to be raised as a priority. This is less of a problem in a detailed study such as that reported here, but is particularly important for individual coroners, OHS authorities and manufacturers, many of whom usually come across such incidents rarely

## Opportunities to identify design issues

The National Coronial Information System (NCIS), being developed by state and territory coroners, should provide a more complete coverage of work-related fatalities than is currently routinely available, and do so in a more timely manner. This should make it easier to identify design issues on an on-going basis and evaluate the effect of attempts to address the design issues.

Activities such as the 'Safe Design' project help to improve recognition of the ways that poor design can lead to health and safety problems, and how improvements in design can eliminate or control many of the hazards that are currently present in the working environment. They also lead to improved opportunities for collaborative work between the architects, engineers, employers, workers, manufacturers, researchers and governments who can contribute to better health and safety in Australia through consideration of design issues.

## Conclusions

This report has shown that design issues with machinery and fixed plant are an important contributing factor to fatal work-related injury, and that in-depth use of data can provide specific information on the type and extent of particular design issues. This information can be used to support appropriate preventive activities.

# APPENDIX 1

## Brief summaries of all incidents from each agency group

Brief summaries of all of the incidents are listed below, according to the agency group involved.

### Forklifts

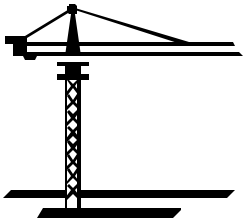
- A container location clerk was killed by a hydraulic hyster forklift, which had a container handling attachment that ran into him while he was directing forklifts. The forklift had visual blind spots, there were no procedures for forklift traffic, and the driver did not keep an adequate lookout.
- While walking to his forklift after a break, a forklift driver was hit by another forklift. He was wearing his reflective vest under a dark jacket. It was a noisy area and the forklift had a blind spot.
- Crates of frozen fish fell on a process worker in a cold storage area of a plant. As he walked by an electrically operated stand on a forklift, which was lowering the crates, the crates fell off and struck him. At the time of the incident, the forklift driver was not permitted to drive the forklift due to a poor driving record.
- A forklift driver reversed too quickly, causing the forklift to rollover. He either attempted to jump free or fell off, and received fatal injuries. The forks were fully extended while he was driving, he was speeding and he was not wearing a seat belt.
- An engineer was standing behind a truck, the trailer of which was at the same height as the forks of a forklift. When the truck moved, it hit the forklift and it rolled over and crushed him.
- An apprentice boilermaker was skylarking on a forklift truck and it rolled over when he turned the forklift too quickly. He tried to jump free but it fell on him.
- A tile stacker was pinned by the roll cage of a forklift he was driving when it rolled over. It is unknown if he was wearing a seatbelt, and the contributing factors to the rollover were not known. It is unlikely that he was trained to operate the forklift.
- A labourer had a forklift driver help him move some awkward shaped wrought iron pieces. The load unbalanced when it was on the forklift so the labourer jumped on it in an attempt to stabilise it. The load moved again and he fell from it to the ground.
- A dairy worker was helping to move a pasteurising machine loaded on a forklift. As he was guiding it, one leg of the machine hit the ground causing it to fall off the forklift and hitting him in the head. There was no jib attachment on the forklift which, if used, could have prevented the incident.
- A storeman was driving a forklift when it fell backwards from a loading dock and he was trapped underneath it. It is unlikely that he was wearing a seatbelt. There is no information explaining what caused him to fall backwards.
- A forklift driver was loading containers and had two stacked on the forklift. When he raised the forklift, the load moved and the top container fell onto the cabin and crushed him. The back guarding of the forklift was inadequate.

- A forklift driver drove onto a road and collided with a semi trailer resulting in the forklift landing on him. A parked semi-trailer on the road may have restricted his vision of oncoming traffic.
- A mechanical fitter was driving a forklift at 30 kph . As he turned he hit an uneven surface on the road and it rolled over and crushed him. A seat belt was present but not worn. The tyres were not properly inflated.
- A forklift was being used to unload railings from a trailer. At the same time a truck driver untied part of the load which then fell on him. The load was packed unevenly and the truck was parked on an angle towards the side where he stood.
- A miner was working on the platform of a forklift in an elevated position, drilling holes in the rock above him with a drill. Some of the rock fell and struck him.
- A farmer was driving an unladen forklift on a downhill slope. It overturned and he either jumped or fell from the forklift and the cage landed on him. He was not wearing a seatbelt, he was using the forklift in an environment for which it was not designed, and his blood alcohol level was high, probably contributing to the incident.
- A forklift was being used to unload timber from a truck. One bundle fell onto the tray of the truck, then rolled off and struck the truck driver who had delivered the timber, who was standing close by.
- A trades assistant was helping move steam pipes by rolling them onto a forklift. He told the driver to tilt the tines back so the load would stay. One tine was stuck under a cement slab, which caused it to jolt, and flicked the load. The assistant tried to settle the pipes, but tripped and landed on his head.
- A warehouse foreman fell off a carton which was on a pallet on the raised platform of a moving forklift. As he was travelling on the forklift he either lost his balance or hit the roof and fell off. There had been a cage to fit to the forklift but it was not used due to the design and dimensions of the cage.
- A farmer was attempting to attach a trellising machine to his tractor. A forklift was used to lift up one end of the implement which was not secured to the forklift. As it was being lowered it fell over and struck the farmer in the head.
- A cleaner was killed when he was crushed by a rolling forklift. He had parked it in front of a bin, put it in neutral and applied the handbrake. When in front of it, it rolled forward and ran him over. The handbrake was faulty which may have been due to sawdust and moisture getting into the mechanism.
- A storeman was travelling in the stillage of a forklift with raised tines. The forklift hit a dip in the floor causing the stillage and storeman to fall to the floor.
- A forklift driver fell from his forklift in a warehouse. It is unknown why he fell.
- A truck driver was standing on the rear of a truck while forklifts on either side were unloading telegraph poles. One pole rolled off the forklift, struck the driver, knocked him off the truck, then landed on him.
- A kiln and boiler supervisor was directing a forklift driver to rearrange bundles of wood at a soft wood mill. As he stood beside some stacked wood three bundles fell on him. The straps on two of the bundles had broken. The bundles only had one strap each which may have led to their instability.

- A forklift driver was killed when his unladen forklift overturned. The left tine hit a barrier pole, which bent. The forklift continued and rolled over after travelling up the pole. The man jumped or fell from the forklift and was crushed under it. At the time it was bright and the pole and surrounds were white or silver. The side of the forklift may have also obscured the driver's view.
- Whilst playing with her brothers at their family business, a young girl was crushed by two stillages pushed together by a forklift driver. The stillages were filled with plastic and the forklift driver was unaware that she was hiding between them. (Bystander)
- An electrician was standing on a pallet on a raised forklift when he fell off. The forks had apparently struck something causing him to lose his balance.
- A sawmill chipper attendant was run over by a forklift at a timber yard. The forklift was reversing at the time. The forklift did not have a reversing mirror, warning lights, nor audible reversing signal.
- A forklift driver fell from a pallet on a forklift with its tines raised. He was working at a tallow factory and his shoes and other surfaces were slippery.
- A factory hand was run over by a forklift truck while repairing it. The forklift had been left in reverse gear, and when he started it (from outside the forklift) it ran him over. It was a home-made forklift which did not meet design specifications.
- A forklift operator was found lying underneath the forklift. Apparently he had been placing wood chocks to load timber, when the fork lift rolled forward and hit him. The parking brake was faulty, but would have held if it was set to the full amount.
- A truck driver was killed when he was standing on a truck tray preparing for timber to be loaded by a forklift. The load slipped off the fork lift hitting him, and knocking him to the ground.
- A handyman was standing on a pallet on a raised forklift to do work on a roof. He hit his head on a beam and fell off the forklift. There was no safety cage on the forklift.
- A car dismantler was crushed when two cars he was lying underneath fell. They had been held up by a forklift, which had rolled backwards.
- A machinery disassembler was crushed under a hay baler which was slung from a forklift with a jib attachment. One of the chain slings dislodged from the load because of the method used to sling the load and the unsuitability of the chain and hook.
- A waterside worker was run over by a reversing forklift. It had an amber light but no reversing beeper. He was not wearing a brightly coloured vest.
- A managing director was pinned under the overhead guard of a forklift after it had rolled over when he drove over an uneven surface on a gravel road. The ground was unsuitable for this type of forklift.
- A truck driver was standing on the rear tray of his truck observing the placement of tanks on the truck. One tank rolled off the forklift onto the truck and struck the truck driver.
- A foundry worker was entering his plant through a door designated for vehicles only when a forklift hit him. It was noisy at night, and the headlights were not working on the forklift.
- A transport driver was crushed between a truck trailer and a reversing forklift. He was standing in the loading area and was hit by a forklift's counterweight. The driver of the forklift had looked behind him, but did not see the transport driver. The forklift had a reversing beeper and warning light, but the beeper was not functioning properly.

- While a labourer was operating a forklift to lift a steam roller it fell onto the cabin of the forklift and crushed him. The forklift could not hold the weight and he was unqualified to operate a forklift.
- A foreman was inside a forklift talking to the driver while he was loading two containers. The containers dislodged and fell towards the cabin. The driver told him to stay inside the cabin, but he left it, and was hit by the containers.
- A forklift driver had been moving bundles of railway sleepers. After alighting from the forklift he removed the wires that held the bundles together and the front bundle fell on him.
- A storeman driver was unloading tyres from the pallet of a raised forklift into a caged area on a truck. During this time the forklift was turned off and the handbrake applied. When he had almost finished moving the tyres he apparently slipped and fell two metres, striking his head and hands on the ground
- A truck driver was reversing a rough terrain forklift from the back of a truck. The ramp of the truck did not have railings and the wheels of the forklift fell off the side. The driver either jumped or was catapulted from the forklift.
- A lab technician was driving a forklift and it rolled over after he drove into a drain and tried backing out. He either jumped or fell out and was crushed between the roof and the ground. The forklift did not have a seatbelt.
- A man was driving a forklift on a gravel surface on a downhill slope when it rolled over as he attempted to turn. He was crushed between the roll bar and the ground. There was no seat belt in the forklift. The man was simply helping out as a friend, and was not employed by the transport company (Bystander).
- A forklift driver was travelling on wet ground. When he attempted to make a quick U turn the forklift rolled over, crushing him. There was no seat belt in the forklift.
- A machine operator was driving a forklift up a ramp that collapsed whilst doing so. He tried to jump free but the forklift roll-over bar fell on him, causing fatal injuries.

## Cranes



- An electricity linesman was electrocuted while conducting maintenance on a high voltage line. He was working from inside a bucket suspended from a portable crane when it twisted and swung towards the wire and he contacted the wire. There was no power in the line but voltage had been induced by its proximity to other nearby live wires.
- A crane operator was operating a crane, which was attached to the rear of a table-top truck, removing steel piping from the rear of the truck. The crane was about 5cm from electrical power lines and the operator was electrocuted when his crane came into contact with the live wires. The handles of the crane were made of metal.
- A crane operator was electrocuted when the crane's jib contacted overhead wires while he was unloading trees at a nursery.
- A truck driver was operating a mobile crane attachment on the back of a table top truck when its arm struck overhead wires causing the truck driver to be electrocuted. He had been warned several times regarding the proximity of the wires.
- A sign erector was electrocuted when he was erecting a billboard which was lying under overhead wires. A mobile crane was lifting the billboard and when it was in place he touched the crane's chains and was electrocuted.
- A crane chaser was helping to off-load equipment from a truck with the aid of a mobile crane when the crane touched a 66 kV overhead power line. This energised the equipment being lifted by the crane. The deceased was holding onto chains securing this equipment and received a severe electric shock. The crane's lights were not working and there was poor lighting at the construction site.
- A timber haul-out machine operator drove the machine under overhead wires and the attached loading crane became entangled in the wires, resulting in the machine's wheels catching on fire. The operator left the cabin to put out the fire and touched the machine and consequently was electrocuted.
- A stone mason was crushed by travertine blocks when he was assisting in their unloading with a scissor crane. After the clamp was released it apparently touched the slabs, causing them to fall on him.
- A fitter was attaching a stab jack to a mining machine when he received fatal injuries. The stab jack was held up by a crane as he entered the mining machine to check the alignment. He accidentally pressed the hoist control when his head was between the stab jack and the main frame and was crushed. The job required two people but he was working alone.
- A crane greaser was crushed by a magnet that detached from the crane due to a faulty pin. He was standing under the load at the time of the incident.
- A stevedore, who was assisting in loading aluminium ingots into a ship's hold, (the ingots weighted 20 tonnes and were being lowered into the hold via the ship's crane) was killed when the load crushed him. He was guiding the ingot's movement when the ship rolled slightly causing him to be crushed.
- A truck driver was crushed between his dump truck and a tractor. He was attaching a chain between the back of a truck and a tractor, to pull it out from being bogged. At the same time the tractor was reversing down the hill when the gear disengaged and the

tractor slid. The driver applied the brakes but the tractor still rolled. Investigations could not find any faults with the tractor's gears or brakes.

- A tow truck driver was attempting to uncouple a garbage truck from the tow truck when one, or both of them, rolled inwards and crushed him. It was thought that the driver may have disconnected an air line which allowed the garbage truck brakes to release. The angle of the hoist ropes also would have drawn the vehicles together.
- A maintenance trades assistant was killed when he was caught between the end carriages of two overhead cranes. A crane operator, who did not know that the trades assistant was working on the crane, had attempted to 'free shunt' the crane he was working on and the trades assistant was killed in the process.
- A welder was removing the chains from an overhead crane which was connected to a metal truss on top of two trestles, when the truss fell on him. The tack welds of the truss to the trestle were not done correctly, as the trestles were designed for smaller trusses.
- A spray painter died from crush asphyxia when the steel panel he was spraying fell on him. The panel had been hooked up to a crane by hooks into holes in the panel and hooks on its side. Due to overloading, the hooks either slipped or failed.
- A painter was spray painting a large steel sheet which was held up by a mobile crane with two chains. One chain slipped from the lug resulting in one side of the metal falling and hitting the painter in the head.
- A truck driver was killed when a bundle of steel tubes fell on him while being loaded onto a truck. He had not parked the truck near enough to the loading bay, and when a crane tried to load the truck, the tubes fell. He had been told to stay away during loading but had come into a danger zone.
- A rigger was hit by falling concrete while standing underneath it as he was attaching it to a crane. Some of the supporting steel in the concrete had broken, resulting in the slab breaking in half and falling on him.
- A transportation contractor was killed when she was hit by a pylon being loaded by a crane onto a truck from a wharf. The pylon had been lifted at an uneven angle and swung and hit her. The sling and the hook of the crane were non-standard.
- A crane driver was killed when he attempted to fix a loose coupling from a crane to a steel pole. He went inside the jib to fix it and the hammer and helmet of the crane fell onto him, and forcing him to the ground. It is uncertain what happened, although the driver may have accidentally dropped them on him.
- A delivery truck driver was killed when a block of sheet glass fell on him as it was being loaded onto his truck using a saddle rack attached to a crane. After the block was on the truck he was moving the grab which contacted the block and it fell on him.
- A pulpit operator was walking across a crosswalk when he was hit by a mobile crane. The crane driver's view was obscured by a concrete pole, the sun, and the jib of the crane. It was noisy and the pulpit operator probably did not hear the crane approach.
- A water-side worker was struck by the grab of a crane and knocked into a ship's hold. His co-worker was absent from work on the day. Additionally, the crane had limited visibility.
- A deckhand was killed when he was hit by a timber pile at a marine construction site. As a crane was putting the load down, the steel wire sling snapped and the pile fell and hit him.

- A general manager of a rigging company and a rigger were both killed when a jib from a crane they were erecting buckled and collapsed, causing them to fall to the ground. The method of erecting the crane was improper, resulting in it being overstressed and failing. They had also used nuts as packers in t he jib slip joint which also contributed to the erection procedure being unsafe.
- Two riggers were inside a tower dismantling sun sails when the tower twisted on its base and fell to the ground. The tower was being supported by a crane which was unable to support the load. The crane driver was not present, and the load indicator was not working.
- A rigger at a construction site died as a result of injuries when a crane's boom collapsed and struck him. The crane had been lifting more than 55% of its maximum load.
- A gantry crane was being used to lift a steel block, which was secured by eye bolts to the chains. A maintenance fitter was standing under the steel block when an eye bolt pulled out, resulting in the steel block falling on him.
- A carpenter was standing on the first floor of a house under construction and stepped back to avoid a crane load of wall frames when he fell three metres off the house and landed on a concrete slab. The crane had overbalanced.
- A labourer fell five metres from an overhead crane when he was walking along the crane's platform. He should have put the crane to the landing platform before disembarking, but he had not been told of this procedure. Since the incident automatic door catches have been installed on the crane.
- A crane driver was on a platform and fell to the ground, approximately 70 metres. He was walking on the platform when it fell from its fixings. One of the bolts had become loose and was not carrying any load. Also, two bolts had had thread damage and the nut and bolt connections were incompatible.
- A fitter, conducting maintenance on an overhead gantry crane, was standing on a work platform that did not have guard rails. When he pulled on a rope to test its tightness he overbalanced and fell. There was a safety harness available but it was not used.
- An apprentice boilermaker was installing a floor on a crane gantry at a height of 30 metres. He fell off the platform which only had one side equipped with a hand rail. He was just finishing a 24 hr shift.
- A crane chaser was run over by a crane when the crane turned and his foot was trapped under the wheel. The crane had a faulty hand brake.
- A crane's dogman was killed when he was holding the load to stop it from swaying as it was travelling. He lost his footing and was run over by the crane. There crane had a blind spot.
- A trades assistant was walking on a maintenance platform when an overhead travelling crane came level with him, snagged his jacket, dragged him along and crushed him. The outside of the crane still had in place a defunct switch which caught his clothing.
- A mobile crane driver was driving down a hill towards a one lane bridge when he jumped from the vehicle. It was likely he was going too fast and could not negotiate the turn at the bottom of the hill.
- While driving a crane, the operator swerved to avoid an oncoming truck. He then hit a concrete curb which made him lose control and swerve into an oncoming car. The driver of the car was fatally injured.

- A passenger in a tow truck was killed when the trailer from a prime mover that was coming towards them became disconnected and hit the tow truck. Possibly the trailer became detached because a safety pin in the towage snapped due to bouncing from bumps on the road. (Bystander)
- A tow truck driver was killed when he lost control of his vehicle and it rolled several times. He had been speeding on a wet road to reach a motor vehicle accident to secure the towing job. He was not wearing a seat belt.
- A part time cleaner was driving his car between cleaning jobs, when his car crossed to the wrong side of the road and collided with a mobile crane. The cleaner had a high blood alcohol level .

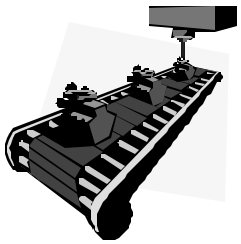
## Hoists and lifts

- A council labourer was electrocuted by telegraph wires while standing on an elevated platform vehicle using a hydraulic chainsaw to lop trees. He had accidentally handled the wires.
- An able seaman walked into a lift well on a ship but the lift was six metres below. The deck area had red lighting, and the lift position indicator was absent at his level. Additionally, the control box on that level was secured by rope instead of bolts, making it easy to open the door.
- A seaman was killed when he put his head into a lift well through a broken glass vision panel to see where it was. The lift was approaching at the time.
- While installing a power climber window cleaner the platform fell from the seventh floor, killing a fitter and turner who was on board. A weld on one davit had failed, and the shock to the equipment made the winch on the other davit fail causing the equipment to fall.
- A linesman who was working on an elevated work platform (EWP) tried to move a mid track insulator which was against the handrail. However, the insulator was live and consequently he was electrocuted.
- A miner died when he fell from a materials lift in a mine shaft. He was holding pipes which were not tied together. It is thought that a pipe was caught on the side supports of the lift, causing it to move, swinging the doors open and causing him to fall out.
- A tree lopper was electrocuted when using a metal screwdriver to fix a door handle on a truck attached to a cherry picker. The cherry picker had come into contact with overhead wires thus making it live.
- An electrician fell 19 metres from a cherry picker when he climbed outside the basket and onto the crane's beam. There was a safety harness available but he was not wearing it.
- Two electrical linesman died when their EWP contacted overhead wires. A fire resulted fuelled by the hydraulic oil in the EWP. The EWP was not made of fire retardant material, and the harness connection points were close to the floor necessitating crouching to disconnect them.
- A linesman was electrocuted when, in a cherry picker, he came into contact with high voltage wires. He was working just prior to 9:00 am when the power was due to be turned off.
- A hoist driver and a building site foreman died when the hoist they were in fell eight floors. The hoist did not have safety hooks, had not been poorly maintained, and had incorrect adjustments on the roller. It is thought that the hoist rocked and struck the building, then due to the excessive load, a support bolt failed and the assembly fell.
- A cleaner died from a fall when operating an EWP. Two bolts had pulled out of the female threads which resulted in a lack of support to the second and third lifting booms, causing the platform to fall.
- A sign writer was electrocuted when he was thrown from a cherry picker onto power lines. His assistant had uncoupled a trailer, which then slid back onto the hydraulic ramps

causing the sign writer to be thrown from the cherry picker. The cherry picker did not have a harness fitted.

- A lift mechanic was working on a lift. While attempting to remove a flywheel using a hammer, the flywheel struck him in the leg. He died approximately a month later from septicaemia.
- A miner was travelling down a mine shaft in an electrically driven hoist. The hoist sped up, the cable snapped, and he fell approximately 23 metres. The hoist was designed for materials only.
- An opal miner fell from a winch in a mine shaft and was covered by rocks from an explosion, when the charges he had previously set detonated. When being raised in the winch his seat and safety wire broke off causing him to fall. The seat was either not attached properly or, lateral movement may have allowed the seat cable to slip from the hook.
- An opal miner was blasting in a mine with ammonium nitrate fuel oil. When the electric winch which was raising him failed (due to being overloaded), he was overcome by the fumes.
- An opal miner fell off a battery operated winch and fell 24 metres down the mine shaft into a hole. The seat had disengaged as the miner had not properly attached the eyelet on the seat to the winch hook.
- A linesman was electrocuted while installing an air break switch on overhead wires from an EWP. While removing a piece of excess conductor, it came into contact with a live conductor and an uninsulated part of the steel pole.
- An electrician died from crush injuries when working on a domestic goods hoist. He was in the hoist, reached out to turn it off and was trapped between the hoist and the suspended ceiling.
- A rigger was driving a scissor lift platform on a slight decline on a roadway when the motor cut out and a valve failure resulted in the loss of the brake system. When he jumped from the vehicle he hit his head on the road. There was no fail safe braking system.
- A lift mechanic was operating a power operated guided work platform when it fell approximately 60 metres at a construction site. The safety brake had partially operated but did not stop the lift. He had attached the safety sling to the handrail instead of using the recommended method.
- A truck driver was painting a suspended truck body when it fell on him. It had been lifted by a hoist attached to the back of a truck. Although he usually used metal supports, he did not on this occasion.
- A linesman was electrocuted while erecting electrical lines. He was in an EWP, and climbed out and up the pole to show a trainee how to do a particular connection. He touched a metal eye bolt and was electrocuted.
- A managing director of a mining contracting company and a mining engineer were killed when they were hit by a falling concrete slab as they were being lifted up a mine shaft by a gig. While being lifted the gig jammed, increasing the pressure on the tripod that held up the system. The tripod lifted out of the ground with the concrete block, which fell down the shaft and struck the workers.
- A meat processing machine operator was killed when the percolator basket he was lifting with a hoist fell on him. The safety latch on the hoist was missing.

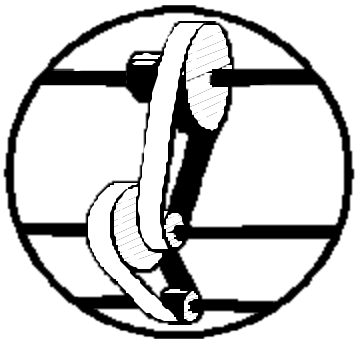
## Conveyor belts, escalators and agricultural conveyors



- A miner was killed when he fell onto a conveyor belt and was caught in the rollers. Although there were no witnesses, he may have tried to climb over the belt while it was running.
- A mill hand was crushed when he had gone into a hole under a log carriage conveyor to clean it. In this position he could not easily be seen. Another cleaner came by and turned on the conveyor which crushed him.
- A sheet metal worker was caught in the drive of a conveyor belt while kneeling under the conveyor to scrape some paint away. For unknown reasons the conveyor was operating at the time of the incident. His overalls were caught in the drive and asphyxiated him around his neck.
- A timber mill hand was cleaning around a waste conveyor system when his arm was caught in the conveyor. His work mate had tried to locate the emergency shut off, but pulled the wrong lanyard.
- A boiler attendant was clearing a blockage between two conveyor belts using a rake when his arm was caught between the belt and an electrical conduit. The conveyor belts lacked guarding and did not have an emergency stop.
- An ore crusher's arms were caught in a conveyor belt causing fatal injuries. He was trying to remove some rocks and straddled the safety rail, overbalanced, and his hands fell into the roller belt. He had a high level of cannabis in his blood at the time of the incident.
- While crouching on a conveyor attempting to bolt a hinged plate onto a chute at the bottom of a shipping bin conveyor, a dock-hand was crushed against the chute. The conveyor was started by an electrician at the other end. The dock-hand had not isolated the main power and did not put danger tags on the system prior to his work.
- A timber mill hand was electrocuted when he came into contact with a wood chip machine and another machine. The wood chip machine had become live as its plug to the power box had its safety shroud removed and was inserted incorrectly.
- A farmer was electrocuted when standing on the ladder of a field bin. The bin was connected to an auger which had a short circuit in the power supply (as the extension cord was wired incorrectly).
- A machinery dissassembler was crushed under a hay baler which was slung from a forklift with a jib attachment. One of the chain slings had dislodged from the load due to the method used to sling the load and the unsuitability of the chain and hook.
- A cartage contractor died from crush injury syndrome when his arm was caught in a soil screener that he was adjusting. The screener's belt apparently could be adjusted only when the machine was running. When the contractor bent over to retrieve a dropped spanner he was caught between the drum and belt. The machine had inadequate guarding and the main guard had also been removed.
- A mill operator was removing crushed ore from a feed chute with a high pressure hose, when he fell in and was exposed to fatal levels of cyanide. The chute was not guarded by a 'grizzly'.

- A soil extractor was doing maintenance on a screening plant for sand. He was standing approximately 3 metres above the ground on an unsecured plank on the screening plant. He lost his footing while pulling a pull lift back and fell, hitting his head on the ground and sustaining fatal injuries.
- During the night shift, an operator was refuelling bulldozers. When he drove to the top of the stockpile the bulldozer fell into a crater. He fell out of the dozer and landed on a conveyor belt, which then moved him, resulting in a delay before the body was found. The incident occurred at night, in rain, and the blade from the dozer had impaired his vision.
- While at a work conference, a company director fell off the escalator at a casino when leaning over to talk to colleagues. He had a high blood alcohol content.

## Mechanical power transfer mechanisms



- A farmer was killed when his tractor rolled over in a dam and landed on him. Two tractors were connected by a steel cable with a silting scoop in the middle when the tractor rolled over. There was no roll bar, cage, or cabin.
- A dairy farmer was killed while using a tractor with a fertilizer spreader attached. When he got off the tractor his pant leg was caught in a bolt from the revolving shaft of the spreader which was not guarded, and he was trapped by the moving machinery.
- A rigger died when an electrical cable fell, causing him to be hurled to the ground and trapped beneath it. He had been on a rigging assembly which collapsed when the cables fell and wrenched the eyebolts from their anchorage.
- A second officer was killed when a mooring rope that was being winched in, flew up and hit him (he had set the winch's speed at maximum), knocking him off the boat and trapping him under a pontoon.
- A crane operator was killed when starting up a mobile pole erecting auger. When he revved the engine, faulty hydraulics caused the Kelly tube to extend, resulting in the winch cable tensing, breaking and then hitting him in the head. The auger also had unmarked and sticking controls.

## Other lifting plant

- A temporary manager of a pig farm and a truck driver were both killed when attempting to align an auger and a hopper from a silo. The auger's supporting structure had collapsed and trapped them underneath. The design of the auger allowed it to easily overbalance, causing the A frame support to collapse.
- While working on a farm digging fence post holes, a farmer's clothing was caught in the post hole borer with an auger causing fatal injuries. The bolt securing the auger to the gearbox was too long. There had been a warning on the machine to use only the proper size bolt.
- A farm assistant was helping with drilling on a farm when he suffered fatal injuries when his jacket was caught on the auger of the drilling rig and he was pulled in. There was no caging around the drill, and it was recommended that the equipment have an interlock and a dead-man control on the operating panel.
- A farmer was trying to clear an auger that was moving seeds. He put his leg in it to do this and it was amputated at the knee and crushed and lacerated up to the thigh. There was no machine guarding. He died later that day from massive loss of blood.
- A farmer was operating a tractor with a post hole digger attachment when she received fatal injuries when her clothing was caught in the auger. The machine was not guarded.
- Two farmers were electrocuted when the top of an auger they were moving touched overhead wires.
- A drill operator was killed when his sleeve was caught in the bar drill he was using and he was pulled into the machine. The absence of machine guarding and his loose clothing contributed to the incident.
- A market gardener was killed when he was using a post hole digger attached to the back of a tractor. His jacket was caught on a bolt at the top of the digger and the machine was not guarded.
- A farmer died when his clothing became entangled in a post hole digger attached to a tractor, and he became wedged between the drill and the tractor.
- A stockman died when his head was crushed by a winch and section of steel that fell on him, while he was attempting to get a bore pump to work. He was working alone at the time of the incident and was not found until three days after the incident.
- A student, playing on a chairlift, became trapped between the anti-sway out support and the top horizontal bull bar. Previously an inspector had asked the owner to guard or remove the ladder that accessed the area where the student was killed. (Bystander)
- A crane operator revved the engine of a mobile pole erecting auger, and due to faulty hydraulics the Kelly tube extended causing tension in the winch cable, which snapped and hit him in the head. The controls of the auger were sticking and were not labelled.
- A reefer attendant was run over by a mobile shipping container transporter (a straddle). Neither the straddle driver nor the person directing him knew that the reefer attendant was present. The straddle had large blind spots, and the reversing warning beeper button's position was such, that the driver could not drive and operate the button simultaneously.
- While working on the family farm, a farm labourer was crushed between an auger and a metal bar on a silo door. He had been standing on the feed-end of the auger and holding the bars on the door when he became trapped. The auger had been recently adjusted which had changed its balancing characteristics.

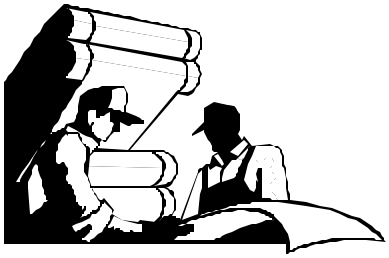
- A deckhand was killed when his jacket hood was caught in the incoming nets and/or rope being winched up, and his head was pulled into the winch drum.
- A young girl died when a hook and block assembly fell on her while she was playing in a factory. The equipment had been standing upright held by a piece of timber and an angle iron. (Bystander)

## Cutting, slicing and sawing machinery

- A sawmill worker was cutting a piece of timber while the trolley to the side of the machine was not in place. This resulted in the cut wood falling to the ground, hitting the saw blade (its hood guard was raised) and hitting the worker in the chest.
- A long time friend of the family that owned and operated a salvage yard company was helping out by sawing a piece of wood with a circular saw. The wood caught on the saw and flew back at him, hitting him on the chest. The saw had nothing on it to stop kick back, the blade was blunt, and the bench top was uneven. (Bystander)
- A timber worker was killed when two pieces of timber flew from a bench saw and hit him in chest. The saw was guarded except for a missing bonnet. The machine was subsequently altered so wood could only go in a forward direction.
- A sawmill worker was killed when a piece of wood he cut with a bench saw hit him in the chest. The top and back guards of the bench saw had not been correctly adjusted.
- While sawing a piece of timber it kicked back and hit the saw operator, producing fatal injuries to his liver. The saw had no riving knife, helmet guard or vee-belt guard. It was uncertain if the guards had ever been fitted or, had been installed and then removed.
- A bench saw operator was hit and killed when the blade flew off a circular saw on a home made bench saw. The blade was unguarded, the motor inappropriate, and the blade and bench were in poor condition.
- A machinist was using a milling machine to machine a steel flange. When it started to vibrate he was told to turn up the revolutions per minute (RPM), which necessitated turning 2 of 3 selectors. He turned all three which made it rotate ten times faster than it should, resulting in the cutter flying out and hitting him.
- A sawmill worker was hit in the head with a crowbar at a sawmill. He had removed the guarding from a chipper machine and placed the crowbar in the cutter wheel to slow it down. The machine kicked out the crowbar which hit him.
- A sawmill worker was killed by a metal scraper which touched a running saw blade which catapulted out and hit him. The bench saw was left running during cleaning, and his co-worker had used a metal scraper to clean debris near the blade.
- A driller was grinding a drill bit without using the safety cover on the grinder when the grinding wheel disintegrated and hit him. He had been using the wrong size wheel.
- A child was killed when operating a lathe in his father's workshop. He had not tightened the bolts sufficiently and an axle in the lathe whipped around and hit him in the head. (Bystander)
- A wood machinist reached through a wood sanding machine to push a piece of wood through, and was crushed when the hoist was activated as the wood was pushed out. The machine was not guarded, and he lacked experience and training with the equipment.
- While holding up a plate on a breast saw bench with a piece of timber to keep a correct height for conducting repairs, a saw mill owner fell forward as the control button was pressed and was caught between the plate and the frame of the machine.
- A mechanic was crushed between a ramp and a piece of metal sheet. He had been pulling back the sheet to access a power point to use a lathe when the sheet fell on him.

- While working as fitter/turner/balancer on a balancing machine an owner/director of a vibration monitoring and balancing factory was killed as his clothing was caught in the machine's drive shaft. The machine had no guarding, and had some bolts protruding which caught his clothing.
- A railway station assistant was killed when he had been trying to push material into a garbage shredding machine with his foot, which was caught and dragged him in. The machine was inadequately guarded.
- A machine technician was electrocuted while repairing a fault in an imported milling machine, which he said needed to be on while he worked. He had touched a faulty wire and received a shock, which later led to him having a stroke.
- A machine operator was electrocuted when he turned off the foam cutting machine and touched one of the wires of the machine. The electrical cables on the floor had been coiled and the insulation had melted causing the cable to become live.

## Crushing, pressing and rolling machinery

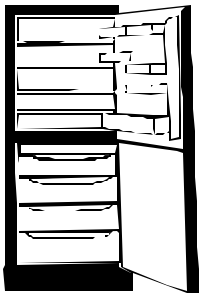


- A maintenance fitter died from injuries while repairing a printing press at a paper mill. Unaware that the fitter had stopped the press for the repairs, a night shift operator saw that the press was not running and therefore pressed the start button to start it. At the time of the machine starting, the worker had been standing on two large rollers and was consequently dragged down and crushed by the rollers.
- A hay baler was accidentally activated while a farm hand was leaning in it to remove trapped hay. Against procedures, cleaning was occurring while the machine was on. A co-worker had thrown down a bale of hay which hit and activated the lever.
- While adjusting a wool press (driven by hydraulics and electric power), the operator accidentally applied pressure to the press arm lever while his head was in the way. There was no machine guarding.
- A truss assembler was working on a roll-a-span machine when he either put his hand into it, or slipped onto the rollers and was pulled in over the safety cut out. He could not reach the emergency stop. Extra guarding was installed after the incident.
- A farmer had his head caught in a wool press. He had reached around the frame and had his head inside the press as the plunger started its upstroke. It was an older model without guarding.
- A machine setter was preparing a power press when he was struck in the head by the setting bar attached to the crank shaft. He had reached over it to operate controls and accidentally stepped on the foot pedal. The guarding had been removed while the machine was being set. There was an interlock available but it was not fitted.
- A textile machine operator was working on a machine for stretching, drying, setting dye and cutting fabric. He had jumped on the machine to cut some trim that had become entangled. He was inside the light curtain (which had a blind spot), and was crushed between the fabric rollers and the frame. The machine should have stopped due to his weight, but was faulty as some screws were sheared off.
- A trotting horse trainer was using a rented pedestrian roller to flatten dirt on the floor of a shed. He had reversed the roller towards a wall and for unknown reasons became trapped and was pinned by the roller against the wall.
- A young man who was not working but visiting a shop, took it upon himself to empty a garbage bin into a semi automatic hydraulic garbage compactor. He looked inside while it was operating and his head was crushed. There was no interlock safety guard, and there was public access to the compactor. (Bystander)

## Heating, cooking and baking equipment

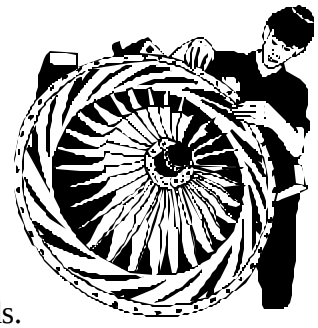
- A rigger fell 18 metres whilst bolting part of a structure which was part of a new boiler installation. His co-worker did not see the cause of the fall but heard something falling and turned to see the rigger just before he hit the ground. Neither worker was wearing fall protection equipment.
- A rigger was standing on a steel beam, dismantling a boiler 15 metres above the floor. He kicked a steel pipe that came loose, which hit him behind the legs and knocked him off the beam.
- A boilermaker was using a sledge hammer to ease down a tubular plate inside a steel pressure vessel. When the plate moved, it caused him to fall and the plate landed on him.
- A maintenance worker was working on a water heater when he hit his head on it. He went to the doctor a month later because of headaches, and died approximately eight weeks after the incident.
- A meat processing machine operator was killed when the percolator basket he was lifting with a hoist fell on him. The safety latch on the hoist was missing.
- A boiler stoker was monitoring a blowdown which involved a reduction of chlorides in water in a boiler on a ship when it exploded. The alarm for low water level had been turned off and the water level was too low.
- A boilermaker was killed from burns when gas escaped from a coke oven and exploded. Staff had been leaving the drain cocks open to reduce condensation. The worker was demonstrating a procedure to someone by letting the coke gas flow at the time of the incident.
- A production foreman was attempting to light a brick kiln with a flint gun gas lighter. Due to a build up of gas in the kiln there was an explosion. The safety shut off valve had malfunctioned. A similar incident had happened previously in a smaller kiln.
- A gas fitter was electrocuted from contact with a copper pipe while installing a gas heater. The neutral earth in the house mains had burnt through and the house earth system was not connected to ground. It was recommended that a system be put in place for checking all houses with similar mains wiring.
- A boilermaker was crushed by a moulding machine at a foundry. He had been working on a safety fence around the machine and entered the fenced area. He was struck by the machine when it moved as part of its cycle.

## Cooling and refrigeration plant and equipment



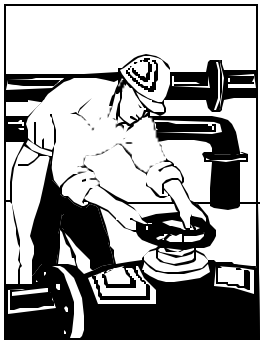
- A plumber was electrocuted while repairing an air conditioner on a roof. He had removed its cover and apparently tried to start it without going to its proper switch, and in the process had exposed and touched live wires.
- A demolition worker was electrocuted when he cut through an electrical conduit with un-insulated pliers and contacted a metal air conditioning duct. He had been told that all power was off to the site, but the electrician had left this conduit live.
- An air conditioning mechanic was attempting to re-gas an air conditioning unit when he was electrocuted. When removing the suction line, his arm came into contact with two live phases which were not insulated.
- A refrigeration mechanic was killed when he walked behind an ice-making machine to turn off the power. His body had simultaneously touched the machine and some metal. The earth had not been working on the machine and it had been overheating causing the insulation to burn.
- An electrician was installing an air conditioner when he was electrocuted. He was using an extension cord and his metal ladder pierced the cord's insulation.
- A trainee locomotive driver was attempting to repair the air conditioning on a railway carrier when he was electrocuted. He had tried to 'bridge out' two contactors using some wire. The switchboard was easily accessible by unqualified persons. He did not have any electrical training.
- A restaurateur was killed when an air conditioning unit fell on his head. He was standing under the unit that he had installed earlier in the day.
- A mechanical fitter was killed when the cold room he was unloading from the back of his utility truck slipped and fell on him. He was working alone at the time.
- A sheet metal worker was working on a scaffold to install air conditioning ducts. As he lifted a duct, the scaffold rolled from the wall and he fell four metres. The brakes were not applied on the scaffold.

## Turbines, generators, motors and transformers



- An electrical linesman was electrocuted while working on a transformer when a two-piece centre phase load side pin insulator on an 'HXO' fuse failed. There had been recognised problems with this fuse type.
- An electrical worker was testing transformers when he was electrocuted. He did not isolate the lead from the electrical distribution board before touching the clips on the ends of the leads. He was working alone.
- An electrician was electrocuted while testing transformers for voltage fluctuations on a newly installed piece of equipment. He had been using a fluke meter incorrectly and his fingers came into contact with metal and the meter.
- An electrician was electrocuted while repairing a portable standby generator when he asked for the power to be turned on.
- A contracted bulldozer operator was electrocuted while doing maintenance on a bulldozer. He started a generator with one hand and touched a rattle gun with the other. The extension cord he used had recently been refitted and the earth conductor and active conductor had been transposed.
- During a party at an unfinished construction site of a house, two guests were electrocuted when trying to move a functioning generator. The extension cord used required two male plugs and one of the men conducted this work incorrectly. (Bystander)
- An opal miner attempted to pull start a generator when the plastic handle slipped past the retaining knots causing him to stumble and fall into the mine shaft.
- Whilst standing on a highway operating a Stop/Slow sign to northbound traffic, a flag person was hit by a car when it veered off the road, pushing the flag person into a parked vehicle where he hit a portable alternator and sustained massive head injuries.

## Other plant and equipment



- An apprentice plumber received a fatal shock while replacing pipes. The source of the electricity was not known, but may have been an extension cord, water mains or electricity from another house.
- An electrician was electrocuted when attempting to repair a packing machine at a dairy. He had turned the main isolation switch off then touched the heater with multi-grips which only had one handle insulated. Unlike an adjacent machine, this one had two isolation switches and the heater was live when he touched it.
- A boilermaker was electrocuted when arc welding a steel cylinder. He was perspiring and touched the live tip of the electrode and was electrocuted.
- A handyman received a fatal electric shock when he touched a washing machine and the cold water tap. The washing machine was live since the earth wire was live due to incorrect alterations made to the circuit.
- An electrical appliance serviceman was fixing a microwave oven when he was electrocuted. He was using pliers with cracked insulation and touched a lug on the end of the cable against a magnetron terminal.
- A gas fitter was electrocuted from a copper pipe while installing a gas heater. The neutral earth in the house mains had burnt through and the house earth system was not connected to the ground.
- A girl was playing in the rear yard of a rural property when she touched an outdoor tap and was electrocuted. Her father had done some wiring and reconnected the wires incorrectly, and the house was not properly earthed. (Bystander)
- A vacuum attendant was killed instantly when he was struck by a large rail skip at a steel production facility as he tried to fix the skip's leaking vacuum pipe. Although there was an emergency stop for the skip, it was not certain if the attendant knew how to use it.
- A bore man's offsider was killed when repairing a borehole pump. He had not trimmed the new rod protruding from the pump and when he started it the centrifugal force made the rod bend and hit him. There had been a manufacturer's warning on the packaging of the rod, on the bore and on the guidelines to trim the rod.
- A windmill expert was installing a borehole pump. He started the pump when it still had 850 mm of excess shaft above the drive head. The excess shaft bent and hit him in the head.
- A dairy herdsman was helping move a pasteurizing machine which was loaded on a forklift. While guiding it, one leg of the machine hit the ground causing it to fall and hit him. There was no jib attachment on the forklift which, if used, would have prevented the incident.
- An iron worker was killed when an iron beam he was trying to paint fell on him. At the time he was trying to hook it up to a crane, he bumped it and it fell off the work horses and landed on his head.
- An electrical fitter fell five metres from a piece of equipment he was working on. There was no other information available regarding the incident.

- A chemical engineer working alone, was inspecting work on a fixed bed catalyst hydro-treater reactor when he fell six metres from a wet rope ladder and died. There was a harness available but he did not wear it.
- A machine operator was crushed by a dehacking machine. He had entered the machine after it had been turned off, but another operator turned it back on while he was in it. The machine had insufficient guarding, and the operator's switch had been located where it could not be easily seen inside the machine.
- An operator who was operating a mutton-pelting machine was crushed when he leant into the machine to remove a carcass and his foot accidentally pressed the pedal.
- A knitting machine operator had bypassed the guard for a cage around the equipment by putting the pin in the leg of the knitting machine. He noticed a part not in place and crawled into the machine. The take-down section was activated and his head was jammed between the fixed leg and the moving right hand support area.
- A strapping machine operator was using an automatic power strapping machine around roof tiles. When the tape jammed he put the controls to 'service', but did not set the controls to manual from automatic. When looking at the machine, he accidentally turned on the local switch and the machine operated on his head. There was no guarding or interlock mechanism.
- An able seaman was opening a valve of steam supply to start some winches on board a ship. The pipe burst and he was burnt by the steam.
- A cleaner was killed when he used a bucket of solvent instead of a degreaser to clean a glass-forming machine which was still warm. He had been given the product by a co-worker who could not read or speak English very well.
- A process worker was found lying in a pool of caustic soda while working in a de-sanding area. He had been splashed by the chemical and was found at the emergency shower.
- A patient with an oesophageal tumour was being operated on with a laser. The laser either touched a silicone stent or due to the high oxygen level, caused an end tracheal fire. The fire seriously damaged the trachea and the patient died within 12 hours of the incident. (Bystander)

# APPENDIX 2:

## Work-related traumatic fatalities in Australia, 1989 to 1992

## General information regarding the overall study

### Data sources

The study was conducted over a four year period, 1989 to 1992. This period was chosen because 1992 was the most recent year for which appropriate data could be accessed at the time the study commenced, and it was thought that four years of data were likely to be needed to answer some of the study questions of interest (such as those concerning sub-groups where only a few deaths occurred).

A list of all external cause deaths was obtained from the Australian Bureau of Statistics (ABS). The death registration numbers from the ABS list were matched to names using the National Deaths Index of the Australian Institute of Health and Welfare. The names thus obtained were used to identify the relevant coronial files for all external cause deaths in each state and territory.

The coronial files were individually inspected by the study research officers to determine whether the circumstances of the death met the study definitions of work-relatedness (ie that the death was a case). For the case files, relevant material was photocopied and returned to the study team in Sydney, who coded the information according to standard criteria, and then analysed the data.

Specifically excluded from the study were suicide deaths, regardless of their apparent relationship to work factors, and all disease deaths.

### Case definitions

A broad definition of work-relatedness was used in this study, and cases were divided into eight separate categories. Working, commuting and bystanders were the main categories of interest in the study.

“Working” comprised working persons who were fatally injured as a result of work activity. This is the main group of interest and the focus of the data presented in this report.

The “working” group was divided into two subgroups - “workplace” and “work-road”. The **work-road** group comprised workers who were killed in motor vehicle accidents on public roads in the course of their work (note that this group does NOT include commuters). The **workplace** group comprised all other workers who were fatally injured as a result of work activity. These people were usually injured in some form of fixed workplace. The separation of the workplace and work-road groups was made for various reasons, including the likelihood that much of the approach to prevention is likely to be different for the two groups.

"Commuters" were persons killed whilst travelling to or from work. There are differing opinions as to whether commuters should be included in a study of work-related traumatic death. They were included in this study because some states and territories pay workers' compensation for injuries sustained whilst commuting, some commuting deaths are clearly related to work activity (eg a shift worker falling asleep whilst driving home from work), and they were included in the first work-related fatalities study (WRFS 1) which was to be used for comparison. The first study covered the three-year period 1982 to 1984.

"Bystanders" were persons who were not working but who were killed as a result of exposure to the work activity of other persons. The bystander group was also divided into two subgroups - "workplace bystanders" and "road bystanders". **Workplace bystanders** were any persons not working who were fatally injured as a result of workplace activities usually not associated with public roads or public transport. However, persons travelling in the cabins of working vehicles were included in this group. **Road bystanders** were persons not working who were fatally injured in motor vehicle accidents on a public road (or public transport) as a result of other people's work, where the working vehicle was primarily 'at fault' in the incident. Examples included pedestrians or persons in vehicles hit by a semi-trailer whose driver had lost control of the vehicle, or pedestrians or persons in vehicles struck by a police car involved in a high-speed chase.

## Contact details

All inquiries about the study should be directed to one of the members of the study team in the Epidemiology Unit:


| | |
|---|---|
| Tim Driscoll | email: driscolt@nohsc.gov.au |
| Sandra Healey | email: healeys@nohsc.gov.au |
| Leigh Hendrie | email: hendriel@nohsc.gov.au |
| Fiona McLean | email: mcleanf@nohsc.gov.au |
| John Mandryk | email: mandrykj@nohsc.gov.au |
| Rebecca Mitchell | email: mitchelr@nohsc.gov.au |

The address of the National Occupational Health and Safety Commission is:

Postal address: GPO Box 58
Sydney NSW 2001