



# **Engineering Expertise and the Glenbrook Rail Disaster**

*A review of the Final Report by the Special Commission of Inquiry into the Glenbrook Rail Accident*

*by Chris Venn-Brown*

*Sponsored by the Public Policy Unit*

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## Author biography

Chris Venn-Brown is a professional mechanical engineer who has been involved in railway engineering, especially rolling stock design and maintenance for over thirty years. He has worked in the railway supply industries in Canada, the U.K. and Australia. He has been active in the National Committee on Railway Engineering, and its successor, the Railway Technical Society of Australasia for many years. He is currently National Secretary of the RTSA, and is Chairman of its sub-committee on Railway Engineering Education.

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## 1 Introduction

The NSW Glenbrook rail accident occurred on 2 December, 1999, when a State Rail Authority intercity passenger train collided with the rear of a stationary Indian-Pacific passenger train in the Blue Mountains outside Sydney. Seven passengers were killed and 51 were injured.

A Special Commission of Inquiry was set up under Commissioner The Honourable Peter Aloysius McInerney to inquire into and report on the causes of the accident and the adequacy of the risk management procedures applicable to its circumstances. The Special Commission was also to consider the reports on six other less severe rail accidents which had recently occurred<sup>1</sup>, and to report on any safety improvements to rail operations which were considered necessary.

The Institution of Engineers, Australia commissioned the author to review the Commission's final report, with a view to identifying any findings of the Commission which reflected on the level of engineering expertise within railway organisations, to outline any references to 'engineers' or 'engineering', and to discuss the implications thereof.

The aim of this review is not to comment on the recommendations of the Special Commission, but, inevitably, some views on the recommendations will be implicit in the discussion.

## 2 Summary of Special Commission of Inquiry Final Report

The main body of the Final Report of the Special Commission occupies some 189 pages, and there are a further 89 pages of Appendices.

The Special Commission heard evidence from approximately 133 witnesses and extended investigations into Canada, France, Germany, the Netherlands, Norway and the UK, as well as Queensland, South Australia and Victoria.

It identified 23 matters which caused or contributed to the Glenbrook accident. One of these was the topography of the area in which the accident occurred. The other 22 were all related to deficiencies in the management of safety by the rail organisations involved. Broadly, these matters can be divided into (not necessarily in order of significance):

- inadequate training of personnel,
- confusing and ambiguous safeworking rules, in particular safeworking unit 245 (which specifies procedures for trains passing a 'stop' signal),
- inadequate and/or incompatible signalling and communications equipment, and
- lack of a sufficiently strong 'safety culture', with greater priority being given to 'on-time running' than safety.

Following its investigations of the Glenbrook accident and the other six incidents, the Special Commission made 95 recommendations concerning the management of rail safety.

These recommendations covered:

- training (7 recommendations),
- management of train drivers (9 recommendations),
- management of trackside workers (3 recommendations),

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<sup>1</sup> Redfern, April 6, 2000; Hornsby, July 9, 1999 & January 11, 2000; Olympic Park, September 2, 1999 & 14 November, 1999; Waverton, December 20, 1999; Kerrabee, August 18, 1998; and Bell, October 15, 1998.

- re-writing of safeworking rules (6 recommendations),
- communications (12 recommendations),
- network control (3 recommendations),
- drug and alcohol testing (3 recommendations),
- interfacing with overseas rail organisations (1 recommendation),
- formation of an independent Rail Safety Inspectorate (35 recommendations), and
- formation of an independent Rail Accident Investigation Board (15 recommendations).

### 3 Direct References to Engineers and Engineering

The only direct references in the report to ‘engineers’ and ‘engineering’, are the following:

**Chapter 3, P. 20**

*‘The practice of developing operational rules appears to have developed as an adjunct to technical standards for rail operations. Railways have historically been dominated by the engineering profession, particularly the civil and mechanical engineering disciplines... The bread and butter of such disciplines are tried and proven technical standards which must be complied with.*

*It is no wonder, therefore, that railway operational rules have been developed and implemented in the rigid, inflexible manner with which engineering standards are regarded. Furthermore, there is an innate synergy between the technical side of railway operation and the operational rules, with rules frequently having their origin in the need to contend with failures to the technical components of the railway.*

*In this respect, the identification of the need for an operational rule, and its initial drafting, are likely to have been done by engineers. Whilst the engineers may have had a perfectly sound rationale for the rule.... this may not have been appreciated by the operational personnel who were required to implement the rule. Furthermore, the engineers responsible for the identification of the need for the rule, and probably the drafting also, were not likely to have the necessary operational experience to assess the practicality of the rule.’*

**Chapter 3, P. 29**

*‘The Rail Safety Act 1993, although ahead of its time, reflected an engineering model in the management of rail safety. The engineering model of safety management has been in existence almost since the inception of railways and relies heavily on technical standards and prescriptive operational rules..... The engineering model of safety, which was heavily dependent on justification of resources expenditure for technical solutions for safety risks, formed the basis for the hazards list which is still used in New South Wales railways.... An examination of this list indicates that technical failures, for which technical solutions can be found, predominate.*

*Apart from the fact that the engineering model only identifies part of the safety risks that need to be properly analysed, another unsatisfactory feature of the model is that when engineering solutions are sought as a means of controlling an identified hazard, the allocation of resources is generally decided on the basis of a cost benefit analysis.’*

**Chapter 3, P. 34**

*‘The existing legislative framework created by the Rail Safety Act 1993 has produced too much emphasis upon an engineering approach to safety management.’*

**Chapter 3, P. 34**

*'Any amendments to the Rail Safety Act need to take into account the fact that ongoing research...has revealed that engineering solutions do not, in all cases, prevent accidents.'*

**Chapter 4, P. 72**

*'This hazard control mechanism, like the safeworking units themselves, suggests an engineering approach to the management of safety by pointing to the existence of controls as if that were the end of the matter.'*

As can be seen from the above quotations, in the most direct sense, at no point does the Final Report:

- identify that inadequate engineering expertise contributed to the disaster,
- make any comments about the level of engineering expertise in the NSW rail sector following the split up,
- state that there was and/or is a lack of engineering expertise in the development and maintenance of safety,
- state that engineering was or was not given the appropriate level of priority within the rail sector, or
- identify the issue of a lack of engineering and engineers in the rail sector.

The references do, however, clearly present the view that engineers have had too much input to the evolution of railway safeworking procedures and imply that their input has been based on too narrow a view of railway operations.

## **4 Indirect References to Engineers and Engineering**

The report does make references to rail operational and safety activities which are not identified as being 'engineering', but to which there must be an engineering input.

Because of the nature of railways, engineering expertise must provide an input to the management and operation of a railway, along with the development of safety regulations and culture. In fact, it is historically true that many rail engineers have gravitated from the engineering departments to operations and management. For this reason, although the following extracts from the Final Report do not specifically refer to 'engineers' and 'engineering', they are considered to be relevant to this review:

**Chapter 3, P. 22**

*The reason for the relative safety of the NSW rail industry until recent years has not been due to the success of the rule based approach to rail safety, but more to the fact that employees acquired their knowledge of safeworking from experienced employees in the course of serving long periods of formal and informal on the job training. It was this master and apprentice approach which provided new recruits with the requisite body of knowledge which enabled railway employees to conduct their activities with reasonable safety.*

**Chapter 3, P. 22**

*'... the conclusion must be drawn that employees have less available time to train less experienced employees on how to perform their duties....'*

**Chapter 3, P. 22**

*'There is no evidence before me to suggest any consideration was given to adjusting the methods of training during the time [of the split of the State Rail Authority into four separate units], to ensure that safeworking personnel properly understood and applied the operational rules and procedures. It should be obvious to the rail management at this time, that the reduction in staff numbers would adversely affect the long standing methods by which new personnel in railways would spend significant amounts of time with highly experienced railway personnel learning the intricacies of safe operation. In the absence of this master and apprentice type of training system, there was a clear need for training methods to be adapted and altered to ensure that new recruits.... developed the necessary knowledge to understand and perform their duties safely.'*

**Chapter 3, P. 35**

*'...there was no transitional period and no proper analysis as to how safety was to be managed at the time of disaggregation. A number of witnesses gave evidence that, in their opinion, the general level of safety in rail operations deteriorated after 1996.'*

**Chapter 3, P. 35**

*'... the general level of safety in rail operations deteriorated after 1996.'*

**Chapter 7, P. 129**

*'The operational rules .... are known as safeworking units. The safeworking units ... have been the main method by which rail safety has been managed for the last one and one half centuries. They were originally borrowed from a United Kingdom set of safeworking units ....where the circumstances of the creation of the rules the evening before the first train was due to run in New South Wales ... is described.*

*It is not necessary to discuss the way in which the rules have been modified... other than by observing that each time an incident or accident has occurred and there was no corresponding safeworking unit to cover the situation, amendments were made to the safeworking units with the result that the safeworking units currently occupy eight volumes of rules and regulations.'*

**Chapter 7, P. 130**

*'Another disturbing feature of the safeworking units, apart from their volume and content, is that they were embraced without modification when the rail network was disaggregated in 1996. This was extraordinary given that they had been developed for an integrated rail network, and were then applied virtually without alteration to a disaggregated structure.'*

To the extent that engineers and engineering expertise had an input to the safeworking rules and the safety culture, some of the comments above do imply that, due to a lack of experienced personnel, inadequate use of engineering expertise contributed to the disaster.

## **5 Relevant Special Commission's Recommendations**

Two recommendations of the Special Commission are relevant to the engineering profession. They concern the recommended formation of two independent bodies: the Rail Safety Inspectorate and the Rail Accident Investigations Board. The detail of these recommendations discuss the organisational structure. They do not discuss staffing levels.

If these bodies are brought into existence, they will be additional to the current structure, and will not draw on existing railway resources.

Due to the work of these bodies, a significant proportion of the staff of both bodies will need to have engineering training and should include professional engineers.

## 6 Discussion on the Special Commission's Perception of Engineering

It appears that when the Special Commission refers to 'engineering solutions' (see quotation from Chap. 3, P. 34), its perception of the real meaning of the term 'engineering solutions' is misguided.

The direct references to engineers and engineering expertise in the railway industry (see Section 3) can be interpreted, at best, to be 'damning with faint praise', and at worst, to contain a significant degree of implied criticism.

A railway is a broad system of technology operated by humans. The Special Commission seems to perceive that engineers are an isolated group only concerned with the 'nuts and bolts', while others are concerned with the rest. However, the engineering approach, correctly applied, must take into account many other issues, including the way in which the 'nuts and bolts' are used by humans. It cannot be any other way.

When considering a piece of equipment, an engineer may appear to be inflexible, because the laws of physics are themselves inflexible. For example, no matter how much an operator may want to carry 95 tonnes of coal in a wagon with an all-up mass not exceeding 100 tonnes, the fact is that this just cannot be done. On the other hand, human beings are all different, and will all find different ways of doing things. Their interaction with equipment can, and usually is, highly complex, and there is no question that the equipment and the rules for operating it, should take this into account.

It is easy to over-simplify these matters, generally through poor training, and it is up to the engineering educators to ensure that professional engineers have a thorough understanding of human behaviour in relation to the operation of equipment, so that at least they know the questions to ask in this regard in any particular field of endeavour.

Furthermore, because of the complexity of the relationship between humans and equipment, nobody, whether they be engineers, managers, operators or safety experts, can predict all of the possible interactions that can cause something to go wrong in a complex system like a railway. The Special Commission is quite correct in pointing out that the 'safety culture' of the railway industry must be such that unforeseen circumstances can be safely negotiated.

It would appear that the Special Commission's criticisms of the safeworking rules (see Section 4) have a degree of validity. But it seems to be unreasonable to sheet the blame home to 'the engineering approach' (ref. the quotation, Chapter 4, P.72). It is more likely that the prime responsibility lies with the management culture within the railway industry.

It should be noted at this point that the Institution of Engineers, Australia, publication 'Railway Engineering Competency Profiles' emphasises the inter-disciplinary approach that must be taken to the training of railway engineers. It also specifies that railway engineers should gain a level of understanding of operations in various areas within the railway systems. Functioning as envisaged, the proposed 'Engineering Passport Scheme', a scheme being developed by the Railway Technical Society of Australasia in which young railway engineers are seconded for limited periods to different employers within the railway industry, would allow railway engineers to gain a wide range of experience in all aspects of railway operations.

The criticism contained in the quotation from Chapter 3 (P. 29) '*...another unsatisfactory feature of the [engineering] model is that when engineering solutions are sought as a means of controlling an identified hazard, the allocation of resources is generally decided on the basis of a cost benefit*

*analysis*’ is worthy of note. In reality, engineers are required to design and specify in compliance with applicable standards and/or best practice. Accountants put in place the cost restraints.

## 7 Conclusions

Indirectly, the Final Report does suggest that an inadequate level of engineering expertise contributed to the disaster (refer to the quotations in Section 4).

The report does not make comments directly about the level in general of engineering expertise in the NSW rail sector following the split up, but it does note that as a result of the split up there was a considerable reduction in the levels of staff. Some of these staff members would have possessed engineering expertise.

The report does not directly state that there was and is a lack of engineering expertise applied to the development and maintenance of safety; in fact, it seems to imply that there was too much engineering expertise involved. It does, however, note that as a result of the split up there was a considerable reduction in the levels of staff, which contributed to a decline in safety levels.

The report does not make a direct statement concerning the level of priority given to engineering within the rail sector, but does, if anything, imply that the level is too high.

The report does not identify that the lack of engineering and engineers in the rail sector as an issue.

The author considers that the Special Commission has formed the inaccurate perception that the role engineering plays in the design, development and operation of a railway system is narrow, being confined to the provision of purely technical solutions to operational problems. This is the most significant lesson to be learnt from the report.

The Report of the Special Commission is a summation of all of the evidence presented by the 133 witnesses, provides conclusions based on this evidence. It is probable that any preconception that the Special Commissioner had of the role of engineers was supplemented and reinforced by evidence presented by many of the witnesses to the Inquiry. It follows, therefore, that the Commissioner’s perception as indicated by the Report, probably reflects that of a large segment of the railway industry.

The Special Commission was critical of a number of aspects of rail system management and operations, mainly those concerned with safety. The Commission perceived that the only input to these matters made by engineers was the drafting of the safety rules. In reality, engineers necessarily provide much broader input to operational and management systems than is apparently perceived by the Commission.

However, the Commission largely blames the ‘safety culture’ and management policies (including the emphasis on on-time running) within the rail systems for the problems. This is probably reasonable criticism, and, on this basis there is no direct relationship between the problems and the quantity or quality of engineering expertise.

## 8 Recommendations

The following recommendations are made:

- Following a disaster which has a significant engineering component, the Institution of Engineers, Australia, should contact the relevant authority which is establishing an investigative commission to encourage the appointment of a professional engineer as a joint commissioner. This will ensure that the engineering dimension is properly understood by the commission.<sup>2</sup>
- The Institution of Engineers, Australia, should, whenever the opportunity arises, present evidence at Inquiries such as the Glenbrook Inquiry, with a view to ensuring that the role of engineers and engineering is correctly understood.
- The Institution of Engineers, Australia, should continue to support initiatives for the ongoing training and professional development of engineers, such as the Engineering Passport Scheme currently being promoted by the Railway Technical Society of Australasia
- When dealing with members of other professions, individual engineers should remember that others may not perceive engineers and engineering the way they do, and should take any opportunity available to clarify their role in the particular industry concerned.

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<sup>2</sup> *The Sydney Division of the IEAust recently wrote to the State Coroner and offered to identify engineers for roles as relevant experts and for appointment to Commissions of Inquiry. See Appendix 1.*

## 9 Appendix 1

*This letter was sent from the Institution of Engineers Australia (Sydney Division) to the State Coroner on 23 April 2001.*

23 April 2001

The State Coroner  
Mr D W Hand  
Level 1, Downing Centre  
143-147 Liverpool Street  
SYDNEY NSW 2000

Dear Sir,

### **Engineering Experts**

The Institution of Engineers Australia (IEAust), is the peak professional association for engineers in Australia. We represent the 'engineering team' and we currently have around 60,000 members. The roles of para-professionals and professions are now covered by our Institution, hence the use of the term 'engineering team'. Among our goals is to ensure that our members contribute to the well being of the community.

Recent inquiries into the Thredbo landslide and the Glenbrook Rail accidents highlight instances where the Institution could assist your office to identify relevant persons as engineering experts.

IEAust stresses that we do not seek this letter to imply any criticism to the quality of any opinions/persons that may have been received/used, in any past inquest or inquiry.

The Institution only seeks to act in a way to help government and its statutory bodies, to independently identify engineers for roles as relevant experts and for appointment to Commissions of Inquiry. The result is to ensure that the Coroners Court will have the advantage of receiving full understandings of all technical evidence and its implications.

We note and support a trend for State Governments across Australia towards increasing emphasis on the self-regulation of professions through their professional associations

The Institution is well placed to assist your office for the following reasons:

1. Since 1990, the IEAust has assumed responsible for the maintenance of professional engineering standards in the areas of engineering associates, engineering technologists and professional engineers – in effect, individuals who have satisfactorily completed 2,3 and 4 years (or equivalent), respectively, of tertiary study.
2. The Institution has created a cohesive structure to recognise education qualifications and competencies of members and non-members, through suitable engineering registers.

Our registers are underpinned by national generic competency standards.

IEAust is a national association and our registers operate in all states across Australia.

Our Registers (the National Professional Engineers Register and the National Engineers Technologists Register) are a joint initiative of the Institution of Engineers, Australia, the Association of Professional Engineers, Scientists and Managers Australia and the Association of Consulting Engineers, Australia. IEAust administers them on behalf of the engineering profession.

The Institution maintains a list of graded conciliators and arbitrators. These engineers have wide experience in processes involving dispute resolution and in the role of an expert witnesses.

Members and non-members of the IEAust who register themselves undertake to be bound by the Institution's Code of Ethics and the Disciplinary Regulations, which underpin it.

IEAust representatives constitute significant numbers on Standards Australia Committees, providing continuous review to standards, to ensure that Australia continues to work towards 'worlds best practice'.

Many other countries accept our registers to identify competent local engineers, enabling Australian engineering professions to provide their services internationally.

Some background literature on how the Institution can be used in the future, as a resource to identify suitably qualified professions as relevant experts, is enclosed.

Yours sincerely

Richard Phillips  
Executive Director