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# A Case Study of Systematic Failure in Rail Safety: *The Waterfall Accident*



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&  
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# Overview of Presentation

## Three Parts

- 1. Outline of the circumstances of the Waterfall accident**
  - Significant contributing factors
  - Lessons from the investigation – international implications
- 2. The Special Commission of Inquiry's (SCOI) Systemic Review of the NSW Regulator and RailCorp**
  - Review findings
  - Implications for regulators and rail organisations
- 3. Current National Safety Initiatives – post Waterfall**



## Concurrent Inquiries

- Ministry of Transport (MOT) investigation into circumstances of Waterfall accident
- Special Commission of Inquiry (SCOI)



## Accident Summary

- 7:14 on Jan 31 2003, *CityRail* passenger train service C311 overturned at high speed and collided with stanchions and a rock cutting approximately 2 km south of Waterfall NSW
- The train was carrying 47 passengers and 2 crew (Normally up to 800 with university students)
- The driver and six passengers were killed with many more injured



# MOT Investigation Objectives

- The objective of the investigation was to determine the circumstances surrounding the accident and to recommend corrective actions that, if implemented, would minimise the risk of similar events occurring



# MOT Investigation Terms of Reference

- 1 The causes of the railway accident at Waterfall on 31 January 2003 and the **factors** that **contributed** to it
- 2 The **adequacy** of the safety **management** systems applicable to the circumstances of the railway accident



# MOT Investigation Components

- Rolling Stock
- Infrastructure
- Human Factors
- Modeling
- Emergency Response



# MOT Investigators

- Investigators and sub-group members included NSW Police, officers from the Rail Safety Regulator who chaired the investigation, SRA and RIC.



# Special Commission of Inquiry (SCOI)

- All evidence gathered by the regulator was supplied to the SCOI
- Much of the evidence was gathered under the specific recommendations of the *Rail Safety Act 2002*



## Accident Description

- Driver suffered heart attack
- Deadman system was inadequate
- Guard failed to intervene
- High speed turnover at approximately 117 km/h
- Train slid on its side until colliding with stanchions and rock cutting



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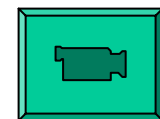
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# Crash Simulation for Waterfall Accident Investigation

- Derailment simulation
- Crash simulation



**Run Simulation**



# Significant Factors

- Driver overweight and unhealthy
- Guard under-trained
- Inadequate medical standards
- Deadman system not failsafe, can be overridden
- Safety Management systems deficient



## Driver Details

- 53 year old Male
- 26 years driving experience
- Enjoyed driving trains



# Driver Medical History

- Body Mass Index 34.3
- 20 year history of hyperlipidaemia (excess fat in blood)
- Very high Cholesterol level



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## Guard Details

- 39 year old male
- 20 years rail experience
- 14 years as a guard



## Guard Fatigue Level

- FAID (fatigue measurement tool) level at end of shift would have been 90.8
- High probability that this level would have impaired performance of the guard



## SRA Medical Standards

- The medical standards for SRA train crews were contained in a document titled *Medical Practices and Procedures*, fifth edition December 1995, published by the State Rail Authority of NSW
- Expert witnesses at the Special Commission of Inquiry (SCOI) testified that medical knowledge had advanced significantly since the SRA document was developed in 1995, but the SRA standards did not advance with them.



## Deadman System (DMS)

- Tangara DMS can remain set due to an incapacitated drivers static leg weight
- Tangara DMS can be over-ridden by jamming feet under heater or by wedging objects such as flag poles under drivers desk



## Deadman System (DMS)

- Documents tendered to SRA in 1988 - 1991 detail these and various other deficiencies in the Tangara DMS



# Lessons from the Investigation

- Organisation structures
- Holistic approach to safety management
- Integrated safety critical systems
- Accountability
- Review of systems via targets, milestones, safety case approach
- Competencies
- Benchmarking
- Accountability of contractors



# International Implications

- Regulators
- Industry
- Design standards
- Data analysis and research
- Streamlining standards approach to safety management
- Hazard perception
- Risk predictability



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# The Special Commission of Inquiry's (SCOI) Systemic Review of the NSW Regulator and RailCorp



Dr Graham Edkins  
Chair

SCOI Safety Management Systems Expert Panel



# Outline

- Safety review purpose and method
- Key findings
- Implications for regulators and rail organisations
- Current National safety initiatives, post-Waterfall





# Safety Management Systems Expert Panel Report

- *Safety Management Systems review of RailCorp and the NSW Independent Transport Safety and Reliability Regulator (ITSRR)*
- **A copy of the report can be obtained by contacting the SCOI at [www.waterfallinquiry.com.au](http://www.waterfallinquiry.com.au)**



# Involvement in The Waterfall Inquiry

- March 2003, Seconded from Qantas Airways Limited to the Special Commission of Inquiry as an expert in safety systems & human factors for Stage 1 of Inquiry.
- November 2003, Director of Public Transport Safety was appointed Chair of Safety Management Systems Expert Panel for Stage 2 of Inquiry.



## Safety Review Objectives

- To provide expert safety assistance to the SCOI for Stage 2
- Stage 2 of the Waterfall Inquiry commenced to address Terms of Reference 2 and 3 for the SCOI, which involves determining:
  - “(2) The adequacy of the safety management systems applicable to the circumstances of the railway accident; and
  - (3) Any safety improvements to rail operations which the Commissioner considers necessary as a result of his findings under matters (2) and (3)”



## Context

- Safety review done at difficult time for NSW rail industry
- High level of acceptance and co-operation
- Willingness to share information
- Purpose of safety review was to identify key areas for safety improvement
- ITSRR and RailCorp have undertaken a number of safety initiatives post-Waterfall and post safety review



## Expert Panel

- The safety management systems expert panel was appointed to the Inquiry in October 2003 by the Commissioner
- The panel's purpose was to assist the Commission in addressing Terms of Reference 2 and 3 of the Inquiry
- The expert panel comprised six people with extensive experience of safety management systems across a wide variety of regulatory and high reliability organisations



## Review Methodology

- The panel appointed:
  - International safety expert in rail from Booz Allen Hamilton U.S., to develop the review methodology and to direct the safety review
  - Booz Allen Hamilton Australia, provided project management function
  - A review team of 11 experienced auditors from regulatory agencies and private industry in rail, aviation and mining/energy sectors



## Safety Review Background

- ITSRR and RailCorp were respectively incorporated on 1 January 2004
- StateRail and RIC continued to operate as accredited entities
- RailCorp and ITSRR were only at the initial formation stage
- Findings relate to the available information at the time of the review



## Safety Review Scope

- Team of 11 auditors worked over **3,800** person hours over 10 weeks
- Over 125 interviews conducted in RailCorp and over 30 in ITSRR
- Over 500 relevant documents subjected to detailed review
- *“It constitutes one of the most exhaustive , detailed and sophisticated examinations of an organisation’s safety practices and thinking I have yet seen”*. Professor James Reason



# RailCorp 29 Safety Review Elements

Item	Safety Element	Item	Safety Element
1.0	Management commitment	16.0	System for managing requirements/changes
2.0	Policy and objectives	17.0	Customer feedback
3.0	Safety representative and personnel	18.0	Contracted goods and services
4.0	Safety committee	19.0	Traceability of goods and services
5.0	Management review	20.0	Measuring equipment/calibration system
6.0	Training and education	21.0	Procurement of goods and services
7.0	Hazard identification and risk management	22.0	Equipment maintenance
8.0	Document control	23.0	Design and development
9.0	Record control	24.0	Management and staff recruitment
10.0	Internal audit	25.0	Medical issues
11.0	Incident/accident reporting system	26.0	Human factors
12.0	Incident/accident investigation	27.0	Safety organisation
13.0	Analysis and monitoring	28.0	Safety awareness
14.0	Emergency response procedures	29.0	System safety program plan
15.0	Change management		



# ITSRR 11 Safety Review Elements

Item	Safety Element
1.0	Regulatory Independence
2.0	Regulatory mandate
3.0	Policy and objectives
4.0	Organisation and function
5.0	Document control and data analysis
6.0	Transition
7.0	Safety enforcement
8.0	Accident/incident investigation
9.0	Audits
10.0	Safety accreditation
11.0	Partnership with rail authority



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# Overview of Findings from SCOI Safety Review





# SMS at Time of Waterfall Accident (StateRail)

- Although StateRail had documented SMS elements, in practice only some elements were found to be applied throughout the organisation
- The SMS was not effective, fully implemented or integrated





# Elements that did not exist or were not fully implemented

- Hazard Identification and Risk Management
- Training and Education
- Internal Audit
- Design and Development
- Change Management
- Human Factors



## Systemic Safety Issues

- Poor supervisory control of drivers and guards
- A post incident management process overly focused on culpability and blame
- Underdeveloped process for asset procurement, management and improvement
- Training not fully integrated or effective
- Inadequately defined safety accountability and responsibilities for senior management including an ineffective performance management system



## Systemic Safety Issues (Contd')

- Primary emphasis on OHS and Safeworking; inadequate coverage of broader system safety
- Senior management instability (several CEOs & Corporate Safety Managers since 1999)
- Ineffective management of information systems
- Inadequate preparedness for emergencies due to inadequate system safety analysis, training and poorly defined policies and plans
- The organisation became reactive to safety issues rather than identifying and examining hazards proactively and systemically



## Conclusions: StateRail

- The organisation was inward looking with minimal learning from high reliability organisations operating in comparably complex environments
- The railway operated in a volatile industrial environment; in certain areas union representatives became de facto managers



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# RailCorp Findings





## RailCorp

- Almost 1,000,000 daily passenger journeys, mostly without major incident
- Primary emphasis on OHS and Safeworking; inadequate coverage of broader system safety
- StateRail did not recognise the critical importance of ensuring that its technical assets were fit for purpose; RailCorp has recognised this and is implementing a program to rectify the problem



## RailCorp

- Lack of an integrated information management system across the whole organisation
- Inconsistent approach to safety occurrences, and persistence of StateRail's punitive response to reporting safety issues
- While some elements of the organisation perform risk management effectively, there is no consistent, integrated approach to risk management throughout RailCorp
- Change is not effectively managed



## RailCorp

- Corrective actions not always effectively implemented, including follow-up
- Lack of knowledge and expertise in contemporary SMS
- Tendency to be inward looking; not yet a learning organisation
- Governance and accountability improvements yet to be tried and proven
- Contemporary approach to human resource management still being developed



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# Safety Climate Review



## Methodology

- Developed as customised rail sector safety climate survey from transport sector questionnaire
- Distributed via SCOI staff member requesting RailCorp, StateRail and RIC staff to complete questionnaire
- Questionnaires completed in February and March 2004 – in parallel with safety review



# Content

- 34 questions on various aspects of safety
- 5-point response scale – from “1 – Strongly disagree” through “3 – Neutral” to “5 – Strongly agree”
- Six questions on personal work behaviour and safety
- Question on perceived level of safety within past 12 months
- Question on perceived change to safety in past 12 months
- Respondent’s occupational group



# Responses

- 459 questionnaires completed
- 99% response rate
- 11.5% respondents recruited by RailCorp since 1 January 2004
- Average period of employment in NSW rail industry 15.4 years



# Summary of key findings: Perceptions of safety climate

- Overall perception barely above mid-points (“Neutral”) of safety climate scales
- Perceptions of Drivers, Guards, Signalling Staff & Maintenance Staff were all below mid-points of safety climate scales
- Compared with all other groups, Drivers perceived that safety climate was significantly worse
- Maintenance Staff, Guards, & Signalling Staff perceived safety climate to be significantly worse than did Station/Customer Service Staff, Management & Supervisory Staff, and New Employees



## Summary of key findings: Safety of rail operations in past 12 months

- Drivers, Guards, & Maintenance Staff considered these were just above “Neutral”
- These three groups considered that safety was significantly poorer than did Signalling Staff, Station/Customer Service Staff and Management/ Supervisory Staff
- No group held the view that rail operations could be considered “Safe” – overall view was just above “Neutral”



## Summary of key findings: Change in rail operations safety in past 12 months

- Overall view – rail operations safety barely improved in past 12 months
- Management/Supervisory Staff were most likely to perceive that rail operations safety had improved – their views differed significantly from those of Drivers & Guards
- Even Management/Supervisory Staff views fell short of the view that rail operations safety had definitely “Improved” in the past 12 months



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# ITSRR Findings



# Limitations of NSW 1993 Rail Safety Act

- Accreditation not risk based
- Limited enforcement tools for the regulator
- No legislative restrictions on ministerial control



# Constraints on previous regulatory regime

- Insufficient internal or external assessment or quality assurance of the regulatory function
- Insufficient resources (people, systems and expertise) to fulfil responsibilities
- Inadequate documentation of safety accreditation, audit and investigation functions
- A lack of policy and guidance material provided to industry to support the accreditation model
- Limited capacity to track previous safety actions arising from investigations



# Acknowledgement of Change for ITSRR

- Rail Safety Act 2002 and Transport Administration (Safety and Reliability) Amendment Act 2003
  - Increased powers and enforcement tools
  - Wider scope for regulator's roles and responsibilities, including investigations
  - Risk based approach to accreditation
  - Limitation on ministerial control
- Formation of OTSI (Independent Safety Investigator)
- Additional resources and expertise
- Strengthened capability for strategy and policy development



## ITSRR Findings

- Approach to accreditation continues baselines established by previous regulator
- Expertise in risk management, human factors and systems engineering still evolving
- Policy and guidance material to support the accreditation model still evolving
- Detailed processes to ensure compliance with accreditation conditions still evolving
- Still evolving data and documentation control system



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# Implications for Rail Organisations and Regulators





# Implications for Rail Organisations (1)

- Do you have Integrated Safety Management Systems – not stand alone?
- Are Risk Management activities system wide and proactive?
- Do you have formal document control processes, particularly for change management activities?
- Does your organisation have expertise and a requisite understanding of human and organisational factors?
- Does your organisation have a program for continued professional development in safety science?



## Implications for Rail Organisations (2)

- Is safety culture measured on a periodic basis?
- Do your employees really **believe** that there is a *just* approach to incident/accident investigation?
- What evidence could you present that indicates your organisation has a learning culture?
- Do you have an integrated safety information management system that drives strategy?
- Do you have a human systems integration program that incorporates principles of *error tolerance*?



# Implications for Rail Regulators (1)

- Is the regulator sufficiently independent and autonomous from government?
- Is there a function for the independent (from regulator) conduct of safety investigations?
- Does the regulator have expertise and an ongoing professional development program in human and organisational factors and safety science?
- How does the regulator ensure that they don't lose touch with current rail industry practices?



## Implications for Rail Regulators (2)

- Does the regulator comprehensively assess the adequacy of safety accreditation and material change applications to ensure that they are rigorous?
- Does the regulator require industry operators to collect causal factors data to an agreed standard so that emerging safety deficiencies can be identified across various sectors?
- Does the regulator have sufficient resources to enable compliance and accreditation activities to be effectively achieved?



# Current National Safety Initiatives

<b>Project</b>	<b>Agency/Group</b>
Development of human factors competencies for rail safety workers	Regulators Panel
Review of deadman and vigilance systems	Various jurisdictions
Development of national health assessment standards	DOI / NTC
Management of change guidelines	Regulators Panel
National Rail Safety Accreditation Package (NRSAP)	NSW / Regulators Panel
Development of National Rail Safety Database	ATSB / Regulators Panel
Development of code of practice for safety investigations	ARA / DOI
Development of key safety competencies and professional development program for regulatory staff	Regulators Panel
Development of national communication strategy and information sharing across jurisdictions	Regulators Panel
Rail safety legislation reviews	NTC / Various jurisdictions
Review of safety management system standards (AS: 4292)	Various agencies



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# Questions?

