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

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
Crash Simulation
for Waterfall Accident Investigation

• Derailment simulation
• Crash 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
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
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 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
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

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<td>Organisation and function</td>
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<td>Document control and data analysis</td>
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<td>Transition</td>
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<td>Partnership with rail authority</td>
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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
Lines of Communication within an Integrated Safety Management System

- Senior management commitment
- Safety reporting system
- Organisational culture
- Data base construction and analysis
- Documentation
- Hazard identification and analysis
- Accident and incident investigation
- Risk management
- Audit and evaluation
- Proactive accident prevention programs
- Training and education
- Individual human factors
- The Reason Model
- Accident and incident investigation
- Audit and evaluation
- Proactive accident prevention programs
- Training and education
- Individual human factors
- The Reason Model
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
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
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
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
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
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

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