INVESTIGATION INTO WATERFALL DERAILMENT

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INTRODUCTION

On 31 January 2003, a passenger train service from Sydney to Port Kembla overturned at high speed and collided with stanchions and a rock cutting near Waterfall NSW. The train driver and six passengers were killed.

The Ministry of Transport completed its investigation into the incident in early 2004, delivering 66 safety recommendations. The Special Commission of Inquiry is due to deliver its final report later this year.

This paper describes some aspects of the investigations conducted into the causes of the incident and the responses of some of the various agencies involved.

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.

INVESTIGATION METHODS

• The Investigation was conducted according to AS 5022-2001, guidelines for Railway Safety 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.

INVESTIGATION COMPONENTS

• Rolling stock;
• Infrastructure;
• Human factors;
• Modelling;
• Emergency Response.

INVESTIGATORS

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

FURTHER INVESTIGATION

• Some of the issues identified during the investigation revealed that further investigation was warranted, but was beyond the scope of this investigation. Where necessary, recommendations have been made to undertake further investigation work.
COMMISSION

- All evidence gathered by the regulator was supplied to the Special Commission of Inquiry.
- Much of the evidence was gathered under the specific recommendations of the Rail Safety Act 2002.

KEY FINDINGS

- Driver and guard overweight and under-trained.
- Inadequate medical standards.
- Dead Man System not failsafe, can be overridden.
- Safety Management Systems deficient.

DRIVER PHYSICAL CONDITION

- Cause of death given as brain stem disruption in association with coronary heart disease.

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 into the Waterfall accident testified that medical knowledge had advanced significantly since the SRA document was developed in 1995, but the SRA standards did not advance with them.

DEAD MAN 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.
- Documents tendered to SRA in 1988 - 91 detail these and various other deficiencies in the Tangara DMS.

KEY RECOMMENDATIONS

- Establishment of medical standards and guidelines.
- Address Dead Man System deficiencies and override issues.
- Safety management.
- Tracking system maintenance.
- Rolling stock standards.

EMERGENCY EVACUATION

- Ingress.
- Egress.
- Emergency evacuation plans.
- Mock exercises incorporating emergency services.
- Integration of the emergency response plans (continual review and evaluation).
- National and international experience and review.

DEVELOPING ISSUES

- Statutory authority.
- National regulatory body.
• Safety Management Systems.
• Incident management.
• Management systems.
• Information systems.

ITSRR RESPONSE

Rail Safety Regulation

• RailCorp
  – Implementation Plan to be agreed between RailCorp and ITSRR.
  – Implementation Plan is part of conditions of accreditation.
  – ITSRR to monitor progress, including thorough compliance audits and inspections.
• Letter sent to other accredited operators requesting they undertake a review of findings of both reports as to impact on their operations.
• Accredited operators to initially indicate how they have re-assessed the risks to their operations in the light of issues identified in the Waterfall inquiries.
• ITSRR to facilitate industry workshops to review risk assessments.
• ITSRR to require operators through special conditions of accreditation, to vary their Safety Management Systems accordingly.
• Special conditions of accreditation will be the mechanism for monitoring implementation of safety actions arising from investigation reports.
• Compliance strategies have commenced and will continue.

National issues

• ITSRR letter to other Rail Regulators re Inquiry findings requesting review of rail operations interstate.
• National implications to be progressed through Rail Regulators.

Monitoring And Reporting

• ITSRR responsible for overseeing implementation of recommendations via compliance functions.
• ITSRR to report monthly to Minister.
• ITSRR to publish plan and implementation process on website.

Non Rail Safety Regulation

• ITSRR requested review by NSW Waterways and Ministry of Transport of implications for ferry and bus modes.

Internal ITSRR Review

• Review activities include:
  – work on competency based human factors training (Victorian led project);
  – research into fatigue implications of returning to work after a period of leave and acceptable upper FAID limits;
  – development of guidelines on competencies required of a rail safety specialist.
• Other modes review (not limited to):
  – medical standards;
  – fatigue management;
  – defenses against driver incapacitation;
  – emergency response.
Terms of reference 2 and 3 - Special Commission of Inquiry

“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) “

- Appointment of expert panel to assist Commission.
- Undertaking formal audit of ITSRR and RailCorp.
- ITSRR audit purpose:
  - to allow Commission to understand the processes by which the then Department of Transport managed accreditation and audit.
  - to examine how ITSRR proposes to manage accreditation and audit functions under the Rail Safety Act 2002.

CRASH SIMULATION FOR WATERFALL ACCIDENT INVESTIGATION

- Derailment simulation
- Crash simulation

FINITE ELEMENT METHOD

- Finite element method (FEM) is a numerical method that allows simulation of complex geometric and material models that can not be solved by classical methods. The finite element method is based on the division of a structure into simple pieces called elements. The behaviour of each of these elements under loading is known and is easily calculated as they are a standard shape, such as a cube or pyramid. These elements are joined together and a series of simultaneous algebraic equations are created and solved to obtain the solution.

DERAILMENT SIMULATION

- Rigid body dynamic analysis.
- Predicts the speed and the location at which the derailment occurred.
- Predicts the speed and the location at which the train is about to hit the stanchion and rock wall.
- Establishes the initial conditions for deformable body crash simulation.
ANALYSIS ASSUMPTIONS AND INPUT PARAMETERS

- Simplified model consists of rigid body carriages and wheels linked with springs and dampers.
- Train carriage and wheel geometry and dimensions (SRA Drawings).
- Mass properties including mass and moment of inertia, Centre of Gravity (CofG) for Control Trailer Car (CTC) and Motor Car (MC).
- The rail track geometry is based on RIC drawing file with 100mm designed super elevation.

THE CRITICAL EVENTS

Refer to diagrams overleaf.
LS-DYNA user input
Time = 1.9499