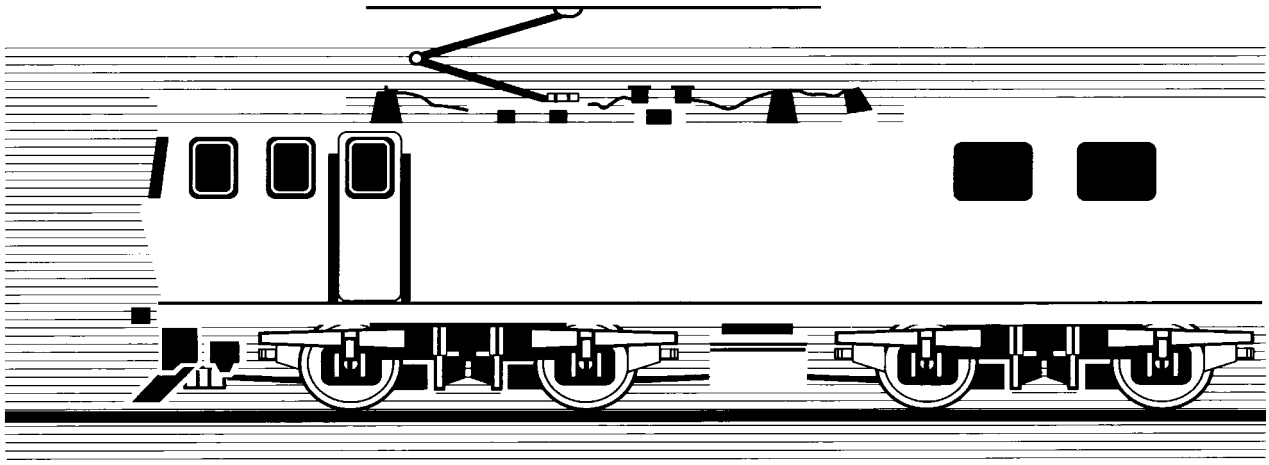
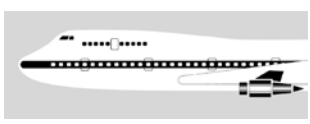
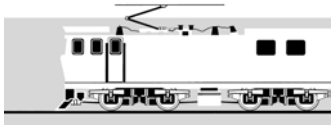


RAILWAY OCCURRENCE REPORT

02-112 passenger fell from the Rain Forest Express, Tunnel 29, Nihotupu Tramline, Waitakere 4 May 2002


TRANSPORT ACCIDENT INVESTIGATION COMMISSION
NEW ZEALAND

The Transport Accident Investigation Commission is an independent Crown entity established to determine the circumstances and causes of accidents and incidents with a view to avoiding similar occurrences in the future. Accordingly it is inappropriate that reports should be used to assign fault or blame or determine liability, since neither the investigation nor the reporting process has been undertaken for that purpose.

The Commission may make recommendations to improve transport safety. The cost of implementing any recommendation must always be balanced against its benefits. Such analysis is a matter for the regulator and the industry.

Report 02-112

passenger Train 1337

passenger fell from train

Nihotupu Tramline, Waitakere

4 May 2002

Abstract

On Saturday 4 May 2002, at approximately 1150, a child fell from a carriage of Train 1337, the *Rain Forest Express,* while it was travelling through Tunnel 29 on the Nihotupu Tramline. The child was seriously injured when he was crushed between a 610 mm diameter water pipeline and the moving train.

The safety issues identified were:

- the lack of physical constraints on passenger carriages to prevent passengers from falling out while the train was in motion
- the adequacy and construction of the compartment doors
- the staffing of the train
- the effectiveness of the risk analysis assessment procedure

One safety recommendation was made to the operator.

The Rain Forest Express

Contents

Figures

Abbreviations

km	kilometre(s)
km/h	kilometres per hour
mm	millimetre(s)
m	metre(s)
Watercare Services	Watercare Services Limited

Data Summary

Train type and number:	passenger Train 1337
Date and time[1]:	4 May 2002 at about 1150
Location:	Nihotupu Tramline, Waitakere
Persons on board:	crew: 2 passengers: 26
Injuries:	crew: nil passengers: 1 serious
Damage:	nil
Operator:	Watercare Services Limited
Investigator-in-charge:	D L Bevin

[1] Times in this report are New Zealand Standard Time (UTC + 12 hours) and are expressed in the 24-hour mode.

1 Factual Information

1.1 Introduction

1.1.1 The 6 km long Nihotupu Tramline was a narrow gauge (610 mm) tramline located in the Waitakere Ranges in West Auckland and ran from Jacobsons' Depot to Seaver Camp, near the Upper Nihotupu Dam. It was owned and operated by Watercare Services Limited (Watercare Services) primarily to provide a maintenance access to a water pipeline that ran alongside it. The route included 10 tunnels and 9 bridges.

1.1.2 Watercare Services held a current Rail Service Licence, issued by the Land Transport Safety Authority under the terms and conditions set out in the Transport Services Licensing Amendment Act (No.3) 1992.

1.1.3 In May 1998 Watercare Services introduced a passenger service known as the *Rain Forest Express* on the tramline. This service was run on a non-profit basis to take passengers such as school groups into the Waitakere Catchment area to view the dams that supplied water to Auckland city.

1.1.4 Since its commencement, the *Rain Forest Express* had conveyed in excess of 58,000 passengers. There had been 3 injury accidents to passengers in that time, 2 of which required hospital treatment. None of the previous accidents had involved passengers falling from the train. The journey from Jacobsons' Depot to Seaver Camp and return was 2 hours 30 minutes and included time for passengers to view the dam while at Seaver Camp.

1.1.5 The *Rain Forest Express* consisted of a diesel-hydraulic locomotive and up to 5 carriages, giving a capacity of about 60 passengers. The service was usually crewed by a train driver only, who was a Watercare Services employee.

1.2 Narrative

1.2.1 On Saturday 4 May 2002, Train 1337 was the *Rain Forest Express* return trip from Seaver Camp to Jacobsons' Depot. It consisted of a diesel locomotive and 3 passenger carriages and was crewed by a train driver and a trainee train driver. There were 26 passengers, including 12 children, on board.

1.2.2 The *Rain Forest Express* had earlier travelled from Jacobsons' Depot to Seaver Camp where it waited while the passengers viewed the Upper Nihotupu Dam. Before the train departed from Seaver Camp at about 1140 (see Figure 1), both the train driver and the trainee driver had checked that all doors on the carriages were secured and the train driver reminded the passengers to remain within the confines of the carriage.

1.2.3 At about 1145 as the train approached House Tunnel, the train driver gave a long blast on the locomotive horn. He announced to the passengers, over the train public address system, that they were now entering House Tunnel and reminded them to keep within the confines of the carriage. Clause 2 of the Operations and Driver Training manual stated that the horn should be sounded before the train entered a tunnel.

1.2.4 About 5 minutes later the train approached Tunnel 29, about one kilometre from Seaver Camp, and the train driver again sounded the locomotive horn and told the passengers they were now entering the longest tunnel.

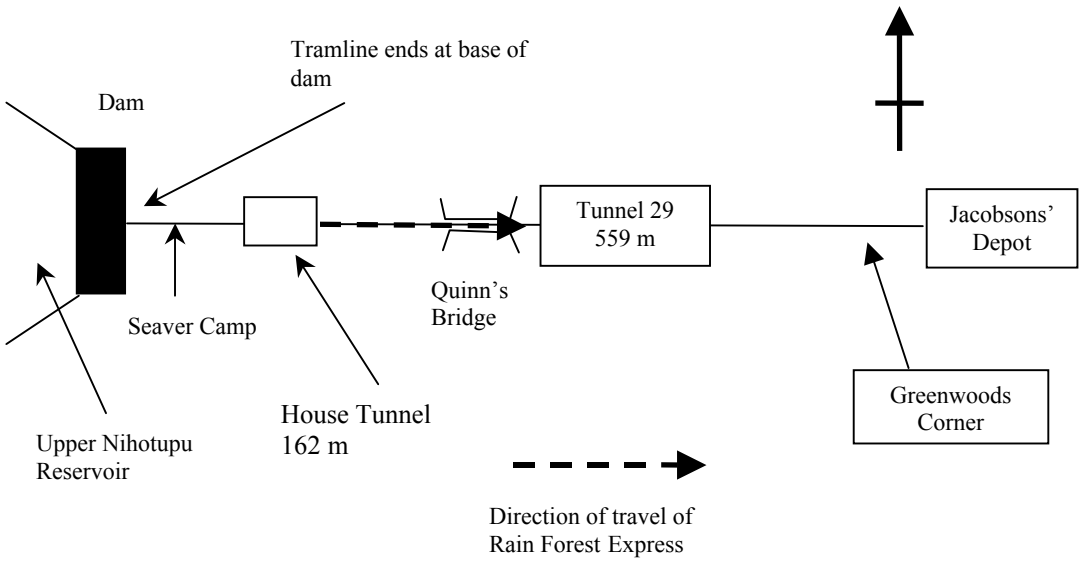


Figure 1
Route of the Nihotupu Tramline
(not to scale)

1.2.5 The train was travelling at about 11 km/h and was about three quarters of the way through Tunnel 29 when the driver heard the alarm bell ring. He immediately applied the brakes and stopped the train within about 13 m.

1.2.6 The train driver became aware that an adult passenger had left the first compartment of the carriage behind the locomotive and was crawling back along the water pipeline towards the rear of the train. He grabbed a torch and also crawled back along the pipeline to the third carriage where he found a child had fallen beside the train.

1.2.7 A passenger who had been travelling in the second carriage had also alighted when the train stopped and was the first person to reach and help the injured child, who lay wedged between the third carriage and the pipeline and appeared to be unconscious. When the injured child's father arrived shortly after, the 2 men were able to lift him up on to the pipeline. They saw some signs of recovery and administered initial first aid before the child was placed in the leading carriage of the train for evacuation from the tunnel.

1.2.8 A bogie on each of the second and third carriages had derailed and immobilised those carriages, so the train driver uncoupled them and moved the locomotive and the leading carriage out of the tunnel, where he used his radio to report the accident to the operator's on-call staff. He advised that a young passenger had been involved in an accident and requested an ambulance be sent to Greenwoods Corner, the nearest road access point, about 1400 m further down the track.

1.2.9 The train driver used the locomotive and the leading carriage to take the injured child to Greenwoods Corner to wait for the ambulance, leaving the trainee driver to walk the passengers from the rear 2 carriages out of the tunnel.

1.2.10 At Greenwoods Corner the train driver ran along the access road to the main road to meet and escort the ambulance back to his train. Another Watercare employee had already opened the gates to the access road and was waiting for the ambulance, so the train driver returned to the train to wait with the injured child and the other passengers in the first carriage.

1.2.11 After the injured child had been transferred to the ambulance, the train driver moved his train down to Jacobsons' Depot where he arranged for another driver to take a second locomotive up to the site and assist the trainee driver with re-railing the remaining carriages. He then attached a second carriage to his locomotive and, with another staff member acting as guard, pushed back to the clearing at the exit to Tunnel 29 to collect the remaining passengers.

1.2.12 The injured child, aged 3 years and 9 months and about one metre tall, suffered serious injuries consistent with him having been trapped between the pipeline and the moving train.

1.3 Site information

1.3.1 The entrance to Tunnel 29 was at the end of Quinn's Bridge. The tunnel was 559 metres long and the train was about 100 metres from the exit when the child fell out of the carriage.

1.3.2 A 610 mm cast iron water pipe ran alongside the tramway through Tunnel 29 and at the point where the child fell, the distance between the pipeline and the side of the carriages was about 100 mm (see Figure 2).

Figure 2
A passenger carriage alongside the water pipe at the point at which the child fell

1.4 Events leading to the incident

1.4.1 When the train left Seaver Camp, the injured child (child A), his father and brother (child B) had occupied the front compartment of the leading carriage immediately behind the locomotive. Child A was sitting on the open or pipeline side of the carriage beside his father facing forward while child B was sitting opposite and facing the rear of the train (see Figure 3).

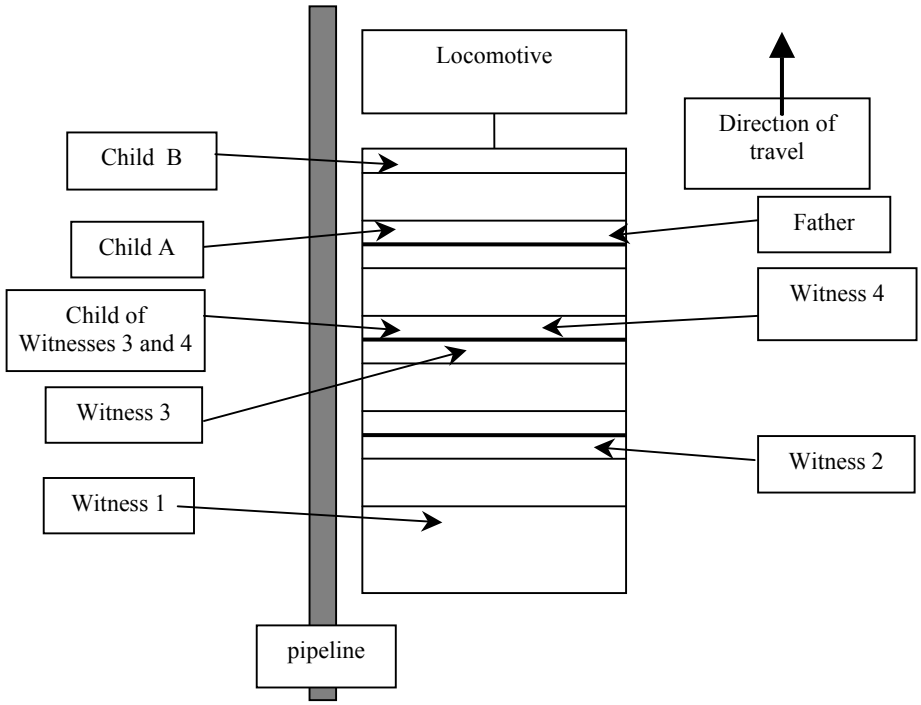


Figure 3
The seating plan showing where witnesses 1 to 4 were sitting in the leading carriage

1.4.2 Child A's father's initially recalled that his son fell out of the doorway having stood up or moved and somehow unlatched the door and that he had briefly held on to the door before being pulled down beside the train. The boy's father said that he had been unable to reach the child before he was pulled down between the train and the waterpipe. However, he later said that he had since been told by child B that child A had not unlatched the door, but had been leaning over it when he fell out. His feeling was that child A had probably stood up in the excitement of going through the tunnel and toppled out.

1.4.3 Witness 1 had been sitting facing forward in compartment 4 when the train left Seaver Camp. She had been aware of child A and child B leaning outside the confines of the carriage as the train went through Tunnel 29 and expressed her concerns to her companion, witness 2, who was sitting opposite. She also commented loudly, "Look at those children, that is so dangerous, why aren't the adults up there stopping them?" However, nobody heeded her warning, probably because she was not heard above the noise of the train.

1.4.4 As witness 1 watched, child A was "just flicked out of the train". She felt that from the speed he fell, he had been hit on the head, rather than having been thrown out by a sudden movement of the train. Immediately prior to this, the children had been side by side and leaning out over the side of the carriage. Witness 1 said that from her position it was hard to say exactly where child A was although she thought he might have been kneeling on the seat but could not be certain as her view was partially obstructed by child B, who she thought was standing between the seats.

1.4.5 Although witness 2 had her back to the front of the carriage, she was sitting at such an angle that she was able to see forward. She also noticed the children at the front of the carriage and later said that she had seen them with their heads continually outside the confines of the carriage. She had just turned back to face her companion when she heard her gasp and thought immediately that one or both of the children had been struck by an overhanging object.

1.4.6 Witness 3, travelling with her partner (witness 4), and their 3 children, was sitting in compartment 3 facing the rear of the train while witness 4 was sitting in compartment 2 facing forward. Their son was of similar age and build to child A and she thought that he would not have had any trouble "rolling out" of the train. In order that their son could see over the side of the carriage, they allowed him to kneel on the seat but he was held from the side by witness 4 and from behind by witness 3.

1.4.7 Witness 3 had noticed that the two children in the front compartment were not staying seated and it appeared to her that the boys' father was having difficulties getting them to sit down. She saw them playing around in their compartment when one of the boys overbalanced and toppled out of the carriage. Her impression was that the child had fallen half over the door and half over the side, and that he had probably been standing on the floor of the carriage before he fell out. The children had seemed to her as if they were restless and that was why they were playing and wouldn't stay seated.

1.4.8 A witness who was travelling in the second carriage recollected that child A was "sort of head level to me" when he fell out, so he thought the child had been standing on the floor immediately beforehand.

1.5 The train driver

1.5.1 Clause 6.4 of the Waitakere Headworks Tramlines Safety System stated that:

> No person may operate any locomotive or powered rail vehicle on any tramline without the direct supervision of an authorised operator until they have completed a course of instruction and passed examinations in the practice and theory of tramline operations as defined in the Manual.

1.5.2 The train driver had 4 years experience driving the *Rain Forest Express* and held current medical and first aid certificates.

1.5.3 On the day of the accident he started work at 0915 to prepare the train. The initial part of his check was a site safety check, and locomotive and carriage check in accordance with the check list and trip report form included in the safety system.

1.5.4 Before the passengers boarded the train, the driver delivered a passenger safety briefing as detailed in the check list and trip report. His briefing covered the tight clearances in the tunnels and the need for passengers to stay within the confines of the carriage.

1.6 The trainee driver

1.6.1 The trainee driver had completed his driver skills and regulations training and a 2-day First Aid course and was on the trip to gain experience with the public aspects of the operation. He had driven the train from Jacobsons' Depot to Seaver Camp and was sitting in the spare seat behind the locomotive driver on the return journey when the accident happened.

1.7 The guard

1.7.1 The duties of the train guard were undertaken by one of the passengers rather than a Watercare Services employee. On the accident trip the guard was seated in the last compartment of the last carriage on the train.

1.7.2 On 17 September 2002 Watercare Services advised:

> There were no references in the Safety Manual to the selection and briefing procedures for honorary guards.
>
> The practice was to select an interested early arrival and invite them to become an honorary guard.
>
> Their first duty was to signal an "all clear" when the driver signalled he was about to move off. This was important if the start was on a curve and the driver couldn't see the end of the train. He needed to know that all passengers were on board.
>
> Their second duty was to act as a lookout if the train ever had to reverse.
>
> The simple signal system was given to them on a laminated sheet.

1.8 Safety briefings

1.8.1 Several witnesses confirmed that the train driver had given an extensive safety briefing prior to departure from Jacobsons' Depot. He had informed passengers that the train passed through several small tunnels with limited clearance en route and that they must not go outside the confines of the carriage. He had told them that the tunnels had been built to the height of a pony, 13 hands, and emphasised this by using a passenger of similar height to demonstrate the dimensions of the tunnels.

1.8.2 Witnesses 3 and 4 and their family missed most of the safety briefing prior to their departure from Jacobsons' Depot because of their late arrival. However, a commentary started as soon as the train departed and included further references to safety issues, particularly about staying within the confines of the carriage. They did not think that there had been a reference to the alarm buttons during the commentary but they quickly identified them and familiarised themselves with their use.

1.8.3 None of the passengers spoken to could remember if a safety reminder had been delivered prior to departing Seaver Camp. However, they all confirmed that the minimum clearance in the tunnels, and the need for passengers to stay within the confines of the carriage, had been repeated continuously throughout the journey from Jacobson's Depot and, regardless of whether another safety briefing had been given or not, they considered that passengers would have been well aware of the requirements, which were further reinforced by the abundance of warning signs within the carriages.

1.8.4 Several witnesses confirmed that the train driver and the trainee driver had ensured that all carriage doors were secured prior to leaving Seaver Camp on the return journey.

1.9 Rolling Stock

The locomotive

1.9.1 The locomotive was a 3 tonne diesel-hydraulic unit, powered by a 40 horsepower Isuzu diesel engine with a maximum speed of about 14 km/h. It had enclosed cabs at both ends for the driver.

The passenger carriages

1.9.2 The passenger carriages were 5.4 m long and 820 mm wide. Each carriage had 4 separate compartments with 2 padded bench seats facing each other. The carriages each weighed about one tonne.

1.9.3 The exterior height of the side on the open side of the passenger carriage was a constant height of about 1000 mm above rail level. However, the carriages were of a well-wagon design which meant that the interior floor in compartments 1 and 4, at either end of the carriages, was raised to accommodate the bogies underneath. As a result the internal height of the side was about 600 mm above floor level in compartments 1 and 4 and about 800 mm above floor level in compartments 2 and 3.

1.9.4 The seats in the compartments comprised a steel plate secured 130 mm above floor level with a 75 mm thick sponge seat with vinyl cover, making a total height of 205 mm above floor level in compartments 1 and 4. The top of the fixed side of the carriage was a further 395 mm above seat level.

1.9.5 There was an internal light, an alarm button, and intercom speaker on the ceiling of each compartment (see Figure 4).

Figure 4
The ceiling of the passenger compartments

1.9.6 An information sticker which warned passengers:

- keep head and limbs inside the carriage at all times
- do not open doors or get out until instructed by the driver
- torches under the end seats are for emergency use only

was also displayed on the ceiling (see Figure 4) in each compartment, adjacent to the interior light and alarm button.

1.9.7 Additional warning stickers were also placed along the carriage ceilings (see Figure 5).

Figure 5
Additional warning signs on the ceiling of the carriage compartment

1.9.8 Alarm buzzers were fitted inside the carriages with the following signal code:

- 1 ring - Stop
- 2 rings - Proceed in same direction
- 3 rings – Proceed in opposite direction

1.9.9 The side of the carriage opposite the pipeline was fully enclosed with perspex windows. There was a gap of 400 mm between the top of the carriage side on the pipeline side of the train and the compartment ceiling.

1.9.10 Access to each compartment was through a doorway about 550 mm wide. The door was 600 mm high and consisted of a heavy-duty vinyl screen, which was riveted to the carriage at one side to act as a hinge. The opposite side of the screen was stiffened by an aluminium tube which was fitted over a stainless steel spike that was secured to the carriage chassis at its base to restrain the bottom of the tube. A latch, which was attached to the side of the carriage, was fitted over the top of the tube to secure the door when it was closed (see Figure 6). There was no strengthening across the top of the vinyl door.

Figure 6
The compartment on the pipe line side of the carriage

1.9.11 The width of the tunnels through which the train travelled meant that it was not possible to use a rigid door. Access had to be such that it could be used to evacuate the train in an emergency and the available clearance between the train and the pipeline meant that a hinged, solid door could not have been fully opened within the tunnels.

1.9.12 When examined following the accident neither the fittings nor the vinyl door showed any evidence of having been forced out of position.

1.9.13 There were at least 2 external lights mounted on the pipeline side of each carriage to provide illumination while travelling through the tunnels. These were operating at the time of the accident.

1.10 Passenger comments about safety of the operation

1.10.1 A passenger travelling in the leading carriage said that she had thought the use of soft fabric on the doors and the way they flapped was "pretty strange" and that the doors should have had a firm top. She noticed that the door also had a slight sag. The passenger thought that child A had fallen from the carriage over the door.

1.10.2 Another passenger who was travelling in the same carriage said that he was more concerned about the alloy latch. His son had managed to open the door of their compartment while the train was stationary and he felt it was "too simple a fastener, too easy to open."

1.10.3 A passenger travelling in the second carriage, said that he didn't think the door was safe and he felt the door opened while child A was leaning on it and he fell out. He said that when he later got back to the leading carriage the door to the compartment from which child A had fallen was open and he had thought at the time that it had been opened when the father hopped out so he hadn't thought anything of it at the time.

1.10.4 A passenger who was travelling in the third carriage said he didn't think the train appeared to be particularly secure, especially given the number of children on board. He felt that the carriage sides were quite low and that the door and its fittings did not appear to be very secure either. This passenger did not see child A fall from the train.

1.10.5 Another passenger said that the train made frequent stops but that the train driver had made visual checks of the doors before the train moved off, although they still had concerns about the security of the doors.

1.10.6 The injured child's father said he didn't have an impression that the train was unsafe but that if he had he would not have travelled on it.

1.10.7 On the return trip a passenger had commented to her husband that she felt the train was going quite fast considering the number of children on the train and the darkness of the tunnel. She had not felt secure in the carriage and had concerns about the flimsiness of the door and about the seat height and how easy she thought it would have been for a child to climb up on the seat and flip over the edge.

1.10.8 A passenger later said that she could see an accident was about to happen and wished that she had pressed the alarm button to complain to the train driver after her initial comments regarding the children leaning out of the carriage had gone unheeded.

1.11 Safety system, procedures and equipment

1.11.1 Watercare Services' safety system was contained in a document entitled Waitakere Headworks Tramlines Safety System (the safety system), which amongst other things included references to:

- Safety Management
- Safety System Standards
- Procedures for ensuring compliance with standards
- Accidents and Incidents
- Auditing of Safety System.

1.11.2 Clause 12.3 of the Operations and Driver Training Manual stated in part:

> Injury Accidents
>
> (a) Administer first aid and make patient comfortable.
>
> (b) If the train is mobile and the patient can be moved, then transport her/him to the nearest road access and call an ambulance or arrange own transport to doctor or hospital.
>
> (d) Ensure that incoming assistance is met at an appropriate point and escorted to patient.

1.11.3 The safety procedure included among other things:

- a safety briefing prior to departure from Jacobsons' Depot
- a check to ensure the vinyl doors to compartments were secured before moving off after stops
- a commentary over the train public address system including reminders of safety requirements
- a safety reminder before departing from Seaver Camp.

1.11.4 Watercare Services' safety system stated that at least one adult shall be carried in each carriage to supervise children under the age of 13. The company's advertising stated that supervision was to be provided as 1 adult to 2 children aged under 5, 1 adult to 4 children aged 5 to 7 and 1 adult to 8 children aged 8 to 14.

1.11.5 A complete audit of the safety system was required to be carried out annually by an LTSA approved independent auditor. The purpose of the audit was to check that the safety system was adequate and was being complied with. A copy of the auditor's report was submitted to the Director of Land Transport Safety. The last audit prior to the accident had been carried out in August 2001 and no significant operating or safety issues had been identified.

1.11.6 An audit was undertaken on 12 August 2002 which, apart from routine audit matters, also addressed Watercare Services' response to the accident. The findings of this audit are included in Section 5.3 of this report.

1.11.7 A risk analysis chart that was included in the safety system had identified "evacuation in tunnels" and "passenger injury from lineside object" as potential risks but had not identified the risk of a passenger falling from the train.

1.11.8 Section 10 (c) of the Passenger Safety Briefing Sheet stated in part:

> Two torches are carried in each carriage for emergency purposes. There is one under each end seat. They are not to be touched or used unless you are instructed to by the driver.

1.11.9 A witness stated that none of the torches were working which was confirmed by another passenger who said that it "affected the ability of us to get that little boy from underneath the train. We were in the dark there". However, the injured boy's father said that there was a torch there.

1.11.10 On 28 May 2002 Watercare Services advised regarding the torches:

> The torches were checked as operating by the driver of the R.F.E. on the day of the accident (May 4). Earlier in the week he had tested them for brightness and had put a new battery in one of them (Wed May 1). Another driver who drove 3 trips on 2 and 3 May is currently in Europe. He is thorough in his testing of equipment and had just ordered and received 18 new batteries a few days previously.

1.11.11 Tunnel evacuation procedures contained in the manual stated that in the case of an emergency in a tunnel the passengers must be walked out to the nearest road. In this instance they were escorted out of the tunnel to a suitable clearing by the trainee driver who then remained with them until they were collected by the relief train about 1 hour later.

2 Analysis

2.1 The outward journey from Jacobsons' Depot to Seaver Camp had been uneventful. The safety briefing given by the train driver before departing from Jacobsons' Depot had been such that the safety issues were covered to the satisfaction of the passengers. The use of a passenger to demonstrate the height of the tunnels on the line was an effective illustration of what to expect in the confines of the tunnels.

2.2 Many of the passengers had prepared themselves by developing their own safety plans in conjunction with the safety briefing by looking for and identifying safety equipment and notices when they boarded the train. Some of those with families ensured that their seating arrangements were such that their children, while still being able to see out of the carriage, were positioned safely.

2.3 The requirement for passengers to stay within the confines of the carriages at all times had been emphasised in the safety briefing before departure and by reminders en route. There was also adequate signage within the carriages which, although probably not understood by children, was conspicuous enough to have reinforced this requirement with adults and caregivers of children. However, on the pipeline side there was no physical restraint between the top of the carriage side and the roof of the carriage to prevent the passengers leaning out or reaching out and a safety recommendation covering such a restraint has been made to the operator.

2.4 Some passengers had expressed concerns about aspects of the train, including the doors, but none declined to take the trip. Those spoken to had anticipated a safe trip by following the instructions given during the safety briefing and by personally monitoring their children. The ratio of adults to children on the train complied with that specified in both the company's safety system and advertising. The family who had arrived late and missed most of the original safety briefing had been comfortable with taking the trip and had quickly familiarised themselves with the safety features and requirements. Improvements to the door and latches are included in a safety recommendation made to the operator.

2.5 After the stop at Seaver Camp the passengers re-boarded the train for the return journey, many in different seats from where they had sat on the outward trip. Although passengers spoken to could not remember if a safety reminder had been given by the train driver prior to departing from Seaver Camp, it is reasonable to assume, based on the train drivers' continual emphasis on safety, that one was given but that this had either been missed in the confusion of finding seats when re-boarding the train or had been forgotten as a result of the accident. There is, however, no doubt that the doors were checked by the train driver prior to departing and were correctly secured.

2.6 The train driver's action in sounding the horn as he approached Tunnel 29 was in accordance with the requirements of the safety manual and reflected his overall safety-conscious approach to the operation of the train and his concern for the passengers' wellbeing.

2.7 There had been no reported incidents of children leaning outside the confines of the carriages on the outward trip to Seaver Camp. This was probably because the trip had lasted only about 45 minutes and there had been several stops en route that had held the children's attention and interest. On arrival at Seaver Camp the passengers disembarked and had about 60 minutes of free time to view the dam or follow other pursuits before the return service departed.

2.8 By the time the train left Seaver Camp the journey time had extended to about 1 hour 45 minutes and it is likely that some of the children amongst the passengers were getting restless. Child A and child B had been seen playing around in their compartment and leaning outside the confines of the carriage as the train travelled through Tunnel 29.

2.9 Child A was sitting beside his father when the journey started at Seaver Camp and probably up until the train entered Tunnel 29. The side of the carriage would have been obstructing his view while he was seated so it is possible that he stood up on the carriage floor, or kneeled on the seat, to get a better view. Another family had allowed their 3 year old child to kneel on the seat while they restrained him so he could see over the side for this reason.

2.10 In the aftermath of such a traumatic event, witness accounts varied and it was not possible to determine exactly where child A was immediately before he fell. However, based on the various information the following possible scenarios were developed:

- as the train entered Tunnel 29 child A knelt on the seat beside his father to get a better view then, in the excitement stood up on the seat and perhaps leaned out to touch the tunnel walls or roof. Standing on the seat would have meant that he was about 200 mm higher against the side of the carriage than he would have been if standing on the floor and the resulting higher pivot point, together with the momentum from standing up and leaning out, could have propelled him over the side
- child A had been standing on the floor with his brother after the train entered the tunnel and in his excitement he had stepped up on to the seat to perhaps better reach the tunnel walls. Again, his higher pivot point, together with the momentum from stepping up and leaning out, could have propelled him over the side
- child A had been standing on the floor of the compartment and, while leaning on or over the door, he had inadvertently unlatched it and fallen through the doorway as the door partially opened. His father could not remember if he had unlatched the door when he exited the compartment immediately following the accident or not, although child B had said that child A had not unlatched the door before he fell.

2.11 The injuries sustained by child A confirmed that he had not been struck by any object before falling from the carriage.

2.12 The crewing of the train by 2 Watercare Services staff was unusual and generally only occurred during staff training, as in this case. There is no doubt that the post-accident activities were better managed as a result of the second person being there. The train driver was able to concentrate on getting assistance to the injured child while leaving the tunnel evacuation and care of the remaining passengers to the trainee driver.

2.13 While the train was moving, the train driver was enclosed in a cab at the leading end of the train and was reliant on rear vision mirrors to watch what was going on behind him. Given the requirement for him to be watching the track ahead, his ability to monitor passenger activity in the carriages was therefore limited.

2.14 The practice of appointing an honorary guard from among the passengers added little safety value to the operation of the train. Because of a lack of training, the person filling this role at any time had limited responsibilities and would therefore have been of limited use to the train driver in the case of an emergency. In many cases the appointed guard would probably have been travelling with a family and their responsibilities in this regard would have severely limited their ability to perform other than the most basic of duties. The presence of a dedicated and suitably qualified guard with the added responsibility of monitoring passenger behaviour may have prevented this accident.

2.15 The potential risk of a passenger falling from the train had not been identified in the safety system risk analysis. Although strong focus was placed on the requirement for passengers to remain within the confines of the train at all times, this seems to have been primarily to prevent injuries from passing objects. This potential risk was also not reflected in the design of the passenger carriages which had not included any physical constraints between the top of the side and the roof of the carriage. It is perhaps fortunate that a similar accident had not happened before.

2.16 The doors were constructed of a flexible material to allow evacuation of the train in a tunnel if necessary. This flexibility gave the impression the doors were insecure because of the visible slackness in the vinyl and the sag created along the top of the door when it was secured in position. The strengthening which has since been introduced across the top of the doors should improve their effectiveness.

2.17 The door latches were relatively easy to operate but again there was a requirement for this in case of an emergency evacuation, particularly in circumstances which prevented the train crew being able to provide assistance. Because of this, the fitting of child-proof latches was not a viable option but the action since taken by the operator will ensure that the train brake is applied immediately the latch is tampered with while the train is in motion.

3 Findings

Findings are listed in order of development and not in order of priority.

3.1 The operator's Rail Service Licence was current.

3.2 Train 1337 was being operated correctly at the time of the accident.

3.3 The child fell from the moving train after losing his balance over the open side of the carriage or, over or through the doorway. His injuries were consistent with him having been trapped between the pipeline and the train.

3.4 The actions of the train driver and trainee driver immediately following the accident were in accordance with the safety system in that timely assistance was given to the child while ensuring the safety and wellbeing of the other passengers. They exhibited a high level of professionalism and safety-consciousness throughout.

3.5 The train driver was not in a position to effectively monitor the behaviour and safety of the passengers while the train was in motion.

3.6 The operator relied on parents and caregivers to control the behaviour of the children in their care.

3.7 The operator also relied heavily on visual and verbal safety instructions to enforce the requirement for all passengers to remain within the confines of the carriage.

3.8 The presence of the trainee driver highlighted the need for more than one qualified person to crew the train.

3.9 The presence of a qualified staff member in the passenger carriages may have prevented this accident.

3.10 The potential for a person to fall from the train had not been recognised in the safety system risk analysis and this was reflected in the design of the passenger carriages.

3.11 The environment in which the train operated placed constraints on the type of door that could be used on the carriages.

4 Safety Actions

4.1 On 2 July 2002 Watercare Services confirmed that they had suspended the *Rain Forest Express* immediately after the accident until a comprehensive review of its operation and systems had been completed.

4.2 On 17 September 2002 Watercare Services advised:

> Since the May 4 accident Watercare has decided to appoint a permanent trained guard for passenger trips and this is written into the new approved Safety System…
>
> Section 2, paragraph 2.2 of the new Safety System states that:
>
> For public trips on the "Rain Forest Express" a "guard" shall be included in the train crew to ensure the safety of passengers by checking doors are secure and by monitoring passenger behaviour. The guard shall stop the train when he/she considers that the behaviour of any person is likely to cause harm to that person or any other person on the train. The guard will be responsible to the operator (driver).

4.3 In view of the safety action taken no safety recommendation covering the staffing of the train has been made in this report.

4.4 Watercare Services also advised that following the accident the risk analysis chart had been revised and a risk assessment of a passenger falling from the train had been included in the updated version of the Safety System.

4.5 In view of the safety action taken no safety recommendation covering a review of the risk analysis process has been made in this report.

4.6 Following on from their own investigation Watercare Services advised that the following improvements to enhance passenger safety had been made:

- removal of the switch that operates the outside carriage light
- labelling of the switch that operates the inside carriage light
- installation of additional information signs/stickers (safety, emergency, behaviour)
- installing a red light next to the emergency button
- the use of an intercom during the trip (each time the train stops and before entering the first long tunnel) to remind passengers to keep within the carriage frame
- having all passengers seated in carriages prior to briefing them on safety requirements for the trip
- improving documents to capture safety items, briefings, passenger numbers and personal details should an accident occur at start of journey and start of return trip
- updating documents to reflect the above information
- training the drivers on new protocols for operating the RFE

5 Safety Recommendations

5.1 On 16 May 2002 the Commission recommended to the Operations Manager, Water, Watercare Services, that he:

5.1.1 take immediate steps to improve the safety of the passengers by installing a suitable barrier and door arrangement, with child resistant locking devices fitted to any moveable components, at such a height along the open side of each passenger carriage to minimise the risk of children falling from the carriage (022/02).

5.2 On 7 June 2002 the General Manager, Water, Watercare Services replied:

5.2.1 Watercare has already decided to take steps to further improve the safety of the Rain Forest Express. It is placing a barrier arrangement on the open side of the carriages, so that children standing on the seats cannot fall out. The top of the vinyl doors to the carriages is to have a stiffening aluminium rod placed in it.

As for your recommendation on child resistant locking devices is concerned, any locking device on the door needs to be simple enough to allow urgent egress from the train whilst it is in a tunnel, should any emergency occur. Rather than having a childproof locking device, Watercare proposes to install switching equipment on the door locks so that if the door lock is lifted or tampered with in any way, the train immediately comes to a halt.

Watercare is firmly of the view that the further safety enhancements to the Rain Forest Express identified above are well in excess of those recommended in your letter.

5.3 On 16 August 2002 the Operations Manager, Water, Watercare Services wrote:

5.3.1 Enclosed is a copy of the annual audit report of the Waitakere Headworks Tramlines as conducted by the LTSA approved auditor on 5 August 2002.

Apart from routine audit matters the audit has addressed the matter of Watercare's response to the accident of 4 May and in particular to TAIC's safety recommendations of 16 May. Para 12d of the audit schedules the changes that Watercare has introduced and the auditor in his conclusion states:

17.c "From the evidence shown or demonstrated to me during the audit I am of the opinion that the operational / procedural changes and / or modifications will be effective and meet the recommendations of both the TAIC and the company's own investigations."

Included in the audit is a drawing of how steel bars have been fitted to the compartments.

Please advise if the modifications done and the inclusion of a staff guard on all Rain Forest Express trips are sufficient to meet the final safety recommendations in your letter of 16 May 2002.

Watercare Services advised that the vinyl doors had been strengthened by the addition of an aluminium tube that was inserted in the sleeve across the top of the door. Also a sensor had been installed in the side panel edge which interfaced with the closed door and was connected to the train braking system to stop the train if the door was opened.

5.4 On 21 August 2002 the Commission wrote to the Operations Manager, Water, Watercare Services:

> On 16 May 2002 the Commission recommended that you:
>
> take immediate steps to improve the safety of the passengers by installing a suitable barrier and door arrangement, with child resistant locking devices fitted to any moveable components, at such a height along the open side of each passenger carriage to minimise the risk of children falling from the carriage.
>
> The Commission is satisfied that the recommendations have been acted upon and the status of the safety recommendations are closed-acceptable.
>
> The Commission commends you on this positive course of action to improve transport safety and thanks you for your co-operation.

5.5 On 2 December 2002 the Commission recommended to the Director, Land Transport Safety, that he:

> circulate to all heritage and narrow gauge railway operators the lessons learned from this investigation and require an assessment of risk focused on passenger safety, be undertaken by each operator with the results being submitted to Land Transport Safety Authority for approval (052/02).

5.6 The Manager, Rail Safety of the Land Transport Safety Authority responded to the preliminary safety recommendation, which was subsequently adopted unchanged as the Commission's final safety recommendation. That response, dated 29 October 2002, was:

> The Land Transport Safety Authority (LTSA) notes and accepts your preliminary safety recommendation that LTSA circulate to all heritage and narrow gauge railways the lessons learned from the investigation into this accident. This circular will be drafted (to include a copy of your final report) and be issued as soon as the above report is released by TAIC.

Approved for publication 27 November 2002

Hon. W P Jeffries
Chief Commissioner

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Transport Accident Investigation Commission
P O Box 10-323, Wellington, New Zealand
Phone +64 4 473 3112 Fax +64 4 499 1510
E-mail: reports@taic.org.nz Website: www.taic.org.nz

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