



Report 98-117

Train 700

collision with No. 2 shunt

Rangiora

21 October 1998

Abstract

On Wednesday 21 October 1998, at approximately 0840 hours, Train 700, the northbound *Coastal Pacific* express passenger, collided with No. 2 shunt standing in the loop at Rangiora. Train 700 was unintentionally routed onto the loop as it approached Rangiora on the main line. A passenger and crew member sustained minor injuries in the collision.

Factors contributing to the collision were: the excess tonnage being hauled by the shunt, the limitations of the automatic points operation logic designed into this type of Track Warrant Station and the failure of the LE of Train 700 to register and respond to the points indication displayed which gave warning of a loop setting ahead which he did not expect.

Safety issues identified included:

- the suitability of procedures for controlling tonnage
- the desirability of the locomotive engineers of passenger trains being required to determine stopping needs at certain localities in Track Warrant areas
- the visibility of the purple loop light on points indicators
- the reliance on compliance with regulations as the only defence against foreseeable human error without sufficient additional defences to minimise risk exposure.

Five safety recommendations were made to the operator.

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List of Abbreviations

km/h	kilometres per hour
LE	locomotive engineer
m	metres
MNL	Main North Line
RO	rail operator
t	tonnes
TCO	train control officer
Tranz Rail	Tranz Rail Limited

Rail Incident Report 98-117

Data Summary

Train type and number:	express passenger 700
Date and time:	21 October 1998, 0840 hours
Location:	Rangiora
Type of occurrence:	collision with stationary No. 2 shunt
Persons on board:	crew: 3 passengers: 39
Injuries:	crew: 1 minor passenger: 1 minor
Nature of damage:	minor damage to the cab of the locomotive of Train 700 and the derailed wagon on No. 2 shunt
Operator:	Tranz Rail Limited (Tranz Rail)
Investigator-in-Charge:	R E Howe

1. Factual Information

1.1 Narrative

- 1.1.1 Train 700, the scheduled northbound Tranz Rail *Coastal Pacific* passenger express, was operating from Christchurch to Picton on Wednesday 21 October 1998. The consist was DX5241, freight wagons HKP74 and ZH2051, and carriages AG182 (carriage/van), AO221, AO238, AS0027 and AO3022.
- 1.1.2 The train was crewed by a locomotive engineer (LE) and 2 train crew, and carried 39 passengers as it approached Rangiora at about 0840 hours.
- 1.1.3 The LE had been requested by the train manager to look out for passengers on the platform and stop if required. The train was travelling at approximately 59 km/h when it reached the south end points at Rangiora which allowed access to either the main line or the loop dependent on the setting. The LE believed the points were set for the main line as his train approached Rangiora.
- 1.1.4 The south end points were, however, set for the loop as a result of earlier shunting carried out by No. 2 shunt while berthing in the loop to allow Train 700 to overtake.
- 1.1.5 The LE of Train 700 did not realise that the points were not set for the main line until he felt his train divert to the loop. He immediately applied emergency braking but this was insufficient to avoid Train 700 running into the rear end of No. 2 shunt at approximately 15 km/h opposite 29.856 km Main North Line (MNL).
- 1.1.6 The collision resulted in minor injuries to a passenger and a crew member of Train 700, and derailed the rear wagon on No. 2 shunt.

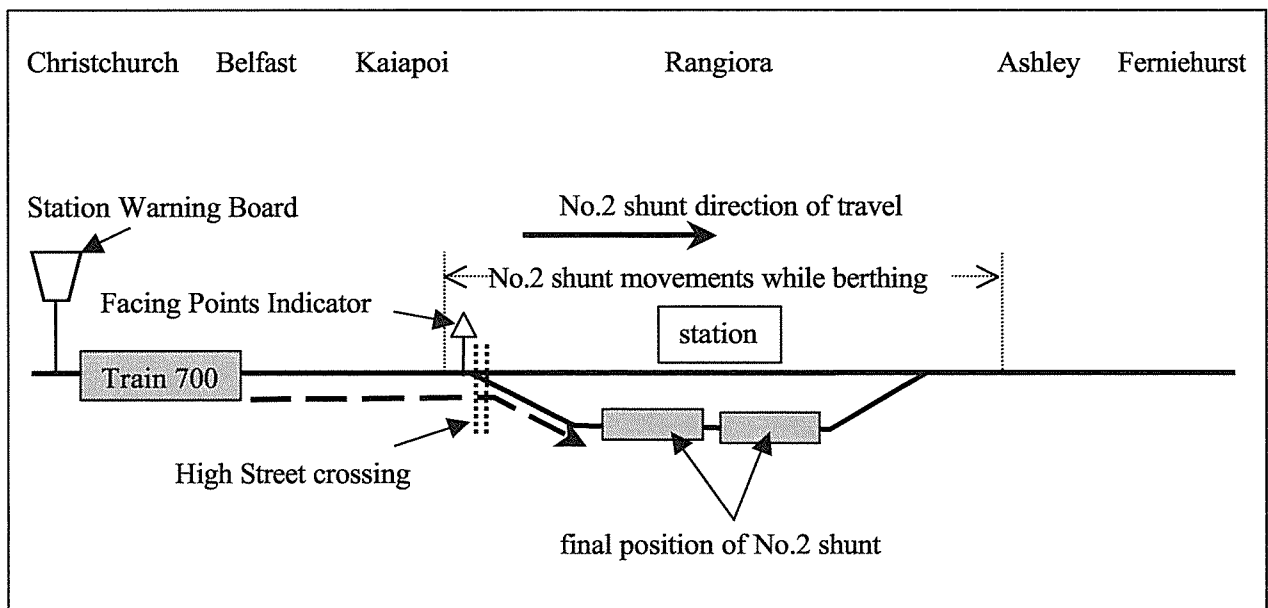


Figure 1
Train movements

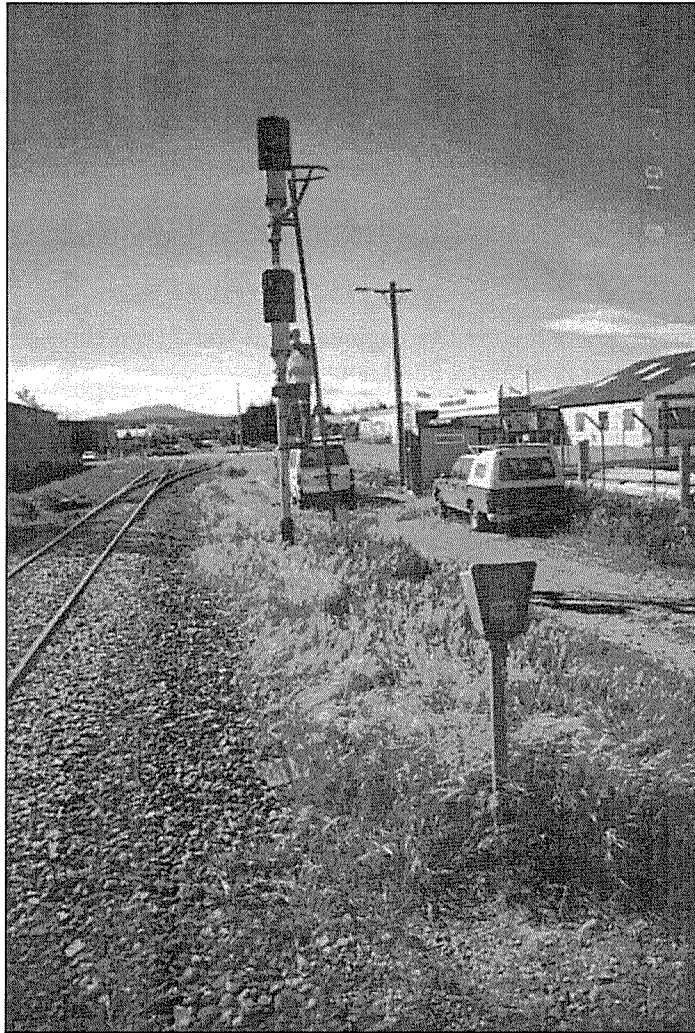


Figure 2
Facing Points Indicator 3FI

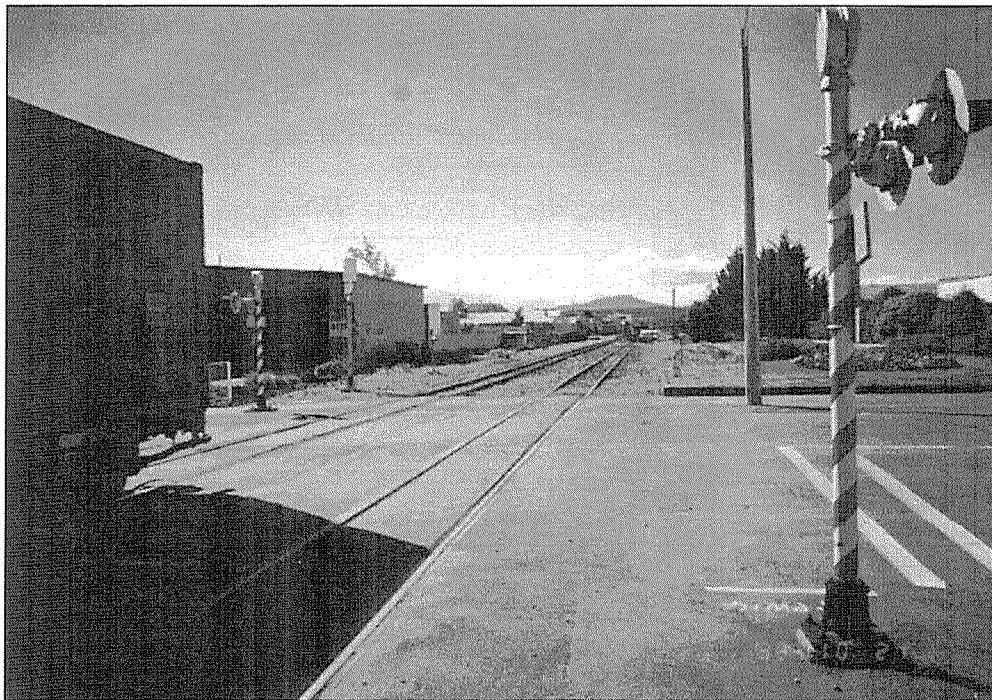


Figure 3
Rangiora loop viewed from High Street level crossing near the south end

1.2 Rangiora station

- 1.2.1 Rangiora was a Warrant Station equipped with motor points, with the approaches marked with a Station Warning Board. For the loops at such stations (referred to as indicator loops) the operation of points at each end was based on motor points linked to points indicators, activated by the approach of a train or operated manually by train crews. The operation of one end was not linked to the opposite end. A simple logic was built into each end that recognised the usual operating movements likely to occur, which then resulted in a points setting at that particular end based on the 3 track circuits (2 main line and one loop) either side of the points. The points indicators at that end then responded and indicated the setting of the points.
- 1.2.2 The Signalling and Interlocking arrangements for Rangiora are shown on the copy of Circular S and I No. 2437, Sheet 2 of 2, attached as Appendix 1. The relationship of the localities referred to in the report and the train movements are shown in Figure 1.
- 1.2.3 The Station Warning Board at the south end of Rangiora was 1100 m from the Facing Points Indicator. Tranz Rail Track Warrant Control Regulations included in Regulation 8(b):

Where an Arrival signal is not provided a Station Warning Board will be situated approaching the station.

After passing a Station Warning Board for a Warrant Station equipped with Points Indicators, the Locomotive Engineer must be prepared to stop his train at the Points Indicator at the entrance to the station.

and in Regulation 9(e) required:

(e) Points Indicators are provided solely for the purpose of indicating which way the points are set and the addressee must ensure that the correct indication is displayed before the movement passes over the points. The Indicators are not permanently lighted.

In the case of Rangiora the Indicators were permanently lighted¹, as notified in Section L7 of the Working Timetable, instruction 2.5.1.

- 1.2.4 Figure 2 shows 3FI, the Up Facing Points Indicator, at the south end of Rangiora with High Street level crossing and Rangiora station in the background and the loop diverging to the right.
- 1.2.5 Figure 3 is a view looking north from High Street level crossing showing the main line on the left and the loop on which the collision occurred on the right, with Rangiora station in the background.

1.3 The actions of No. 2 shunt

- 1.3.1 No. 2 shunt comprised locomotive DBR1213 and 27 loaded USL log wagons and was operating under Track Warrant control. The train list showed a gross tonnage of 1200 t, although subsequent weighing showed a weight of 1152 t. The shunt departed Belfast on Track Warrant 38 at 0709 hours to proceed to Rangiora and enter the loop to let Train 700 overtake. The passing movement was scheduled for approximately 0800 hours on the train control diagram.
- 1.3.2 The locomotive load schedule for a DBR locomotive between Kaiapoi and Rangiora was 900 t maximum as defined in section G3, clause 6.5 of the Working Timetable.

¹ For the proposed crossing at Rangiora “permanently lighted” meant the indicator was at red until Train 700 had entered the track circuit approaching the Facing Points Indicator, at which time the indicator changed to indicate the setting of the facing points.

- 1.3.3 At approximately 0740 hours No. 2 shunt stopped at 3FI, the Up Facing Points Indicator at the south end of Rangiora. After the LE had operated the indicator control box to gain entry to the loop he could not start his train on the relatively steep ascending grade (1 in 71 leading to 1 in 122) on which most of the 370 m train was standing.
- 1.3.4 At approximately 0746 hours the LE contacted the train control officer (TCO) to advise him that he could not lift his train and that he intended to break it in half and “back it in from the other end”.
- 1.3.5 Track Warrant 38 did not permit No. 2 shunt to use the north end entry to the loop. To overcome this, Track Warrant 38 was cancelled by the LE and the TCO issued a new Track Warrant 42 at 0750 hours. Track Warrant 42 permitted No. 2 shunt to work between Kaiapoi and Ashley and thus allowed shunting from both ends of Rangiora.
- 1.3.6 On receipt of Track Warrant 42 the LE and rail operator (RO) of No. 2 shunt carried out the following movements:
- broke the train into 2 portions and secured the rear portion (15 wagons) on the main line
 - hauled the front portion of the train (12 wagons) into the loop from the south end and secured it
 - cut off the locomotive, exited the loop at the north end, and returned on the main line to pick up the rear portion of the train
 - hauled the rear portion through the main line clear of the north end of Rangiora, set the north end points for the loops and propelled back into the loop
 - returned the north end points to a main line setting ready for the passage of Train 700 northbound.

The LE then reported to train control that he was in and clear at Rangiora and cancelled Track Warrant 42. The 2 portions of No. 2 shunt were not coupled at the time, with a gap of about 55 m between them.

- 1.3.7 The TCO was now able to issue Track Warrant 43 for Train 700 to leave Belfast. The delay in berthing No. 2 shunt had resulted in Train 700 being delayed at Belfast for approximately 30 minutes.
- 1.3.8 As a result of the movements made by No. 2 shunt the logic controlling No. 3 points at the south end of Rangiora assumed a crossing had taken place with a main line train departing to the north and a train on the loop waiting to depart southbound.
- 1.3.9 This occurred after the RO of No. 2 shunt took manual control at 3FI, the Up Facing Points Indicator, to return the locomotive to the second portion of the shunt. As soon as this was done the direction of the first portion of the shunt on the loop was reset by the system. From being recorded as an up train (entering the loop from the south end) its direction information was lost from the system memory.
- 1.3.10 When No. 2 shunt proceeded north on the main line over No. 3 points with the rear portion of the shunt, the system logic interpreted this as a crossing movement. The “non-directional” first portion of the shunt was now classed as a down (southbound) train because the movement over No. 3 points was in an up (northbound) direction. As a result No. 3 points were automatically set to the reverse position following a short time delay after the shunt had cleared the points. This automatic setting was based on the system assuming that the next south end movement would be the train in the loop departing to the south.

- 1.3.11 Circuit testing following the incident confirmed all circuits, points and points indicators were working as intended. Subsequent computer modelling confirmed that the design outcome of the movements of No. 2 shunt resulted in No. 3 points setting to reverse.
- 1.3.12 The crew of No. 2 shunt were unaware that the south end points had set to the loop as a result of the shunt movements.
- 1.3.13 All procedures followed by the crew of No. 2 shunt when splitting and berthing the shunt in 2 portions were consistent with Tranz Rail requirements for the operation of indicator loops.
- 1.3.14 The stalling and subsequent splitting of No. 2 shunt to place it in the loop in two portions resulted in the level crossing alarms at High Street at the south end of the yard being activated continuously for about 25 minutes.

1.4 Control of tonnage

- 1.4.1 Tranz Rail were asked to supply details of the procedures in place to control tonnage allocated to shunt services to avoid potential overloading, and how this was intended to be achieved, and by whom on the day.
- 1.4.2 In their reply Tranz Rail referred to the portion of instructions 1.3 in Section L7 of the working timetable which stated:

the area, hour, and work of shunting trains will be arranged and advised by the terminal manager.

as the procedure in place to control tonnage allocated to shunt services to avoid potential overloading.

1.5 The actions of Train 700

- 1.5.1 Track Warrant 43 authorised Train 700 to proceed from Belfast to enter the main line at Ferniehurst, including, under “other instructions”:

No. 2 may be on the loop at RANGIORA

- 1.5.2 The LE of Train 700 stated that he had been asked by the train manager to check for passengers at Rangiora, and if there were passengers to stop. He was aware of the Station Warning Board advising of the approach to Rangiora, and its distance from Facing Points Indicator 3FI.
- 1.5.3 About 600 m past the Station Warning Board, Train 700 passed over an insulated joint which changed the red indication on 3FI, the Up Facing Points Indicator to the specific indication of the main line points setting, a process termed “approach cleared” by Tranz Rail. The insulated joint was sited 514 m before the south end points. As the train passed over the insulated joint and activated the track circuits 3FI displayed a red over purple indicating the points were set in reverse for the loop.
- 1.5.4 The LE stated that he was aware where the indicator trip (the insulated joint which cleared the Facing Indicator) was because such trips were marked with “a post with a reflectorised sticker on it. Although these Circuit Marker Posts were the approved way of marking such trips there was no such marker post at the south end trip at Rangiora on the day. The LE did not specifically recall at what stage he passed over that particular trip on the day of the incident.

- 1.5.5 The LE stated he was aware of the position of 3FI points indicator but could not recall when he first saw the indicator, what indication was displayed, or any change from the red indication to a main or loop indication which occurred as he approached. What he did recall was that as he was looking out for passengers, he saw a lot of school children “milling around on the main line at the platform”. At the same time he registered a purple indication, but he could not recall its position, i.e. whether it was purple over red, indicating a main line points setting (purple on the top), or red over purple indicating a loop points setting (purple on the bottom). In the LE’s words “I expected a purple, I got a purple. I expected a purple on the top. Everything happened in those few seconds, including the children milling around. I registered a purple, expected it to be on top because that’s what always happens.”²
- 1.5.6 The LE first became aware that his train was routed to the loop when he felt the lurch at the loop entry points. He immediately applied emergency braking and slowed his train down from 59 km/h to approximately 15 km/h in the 180 m distance to the rear of No. 2 shunt. When he saw a collision was imminent he pressed the emergency button on his radio unit and lay on the floor.
- 1.5.7 The train manager was collecting tickets at the time of the impact and was thrown to the floor, sustaining bruising and a minor head cut. The train assistant was on the telephone at the time and was propelled into fittings, but was not injured. The crew immediately checked the passengers and found that although the impact had thrown some passengers about, causing some minor cuts and bruising and one broken nose, there were no serious injuries. A window was broken in a passenger car, and the passenger train locomotive and the rear wagon on No. 2 shunt suffered moderate damage. The impact moved the rear portion of No. 2 shunt approximately one metre and derailed the trailing bogie of the rear wagon.

1.6 Points Indicator 3FI

- 1.6.1 Points Indicator 3FI was a typical points indicator as used in Tranz Rail indicator loops. All bulbs were standard bulbs with double filaments, except the top purple used for the main line points indication, which was a single-filament halogen bulb. Halogen bulbs were installed as a trial on main line indicators to assess the improved visibility of the purple indication they gave. Purple is not a widely used international railway signal colour, and does not have the visual impact of the commonly used red, green and yellow. It was used by Tranz Rail to avoid confusion with existing signal colours and had been a yard points indication in New Zealand for over 50 years.
- 1.6.2 Tests following the incident showed that from the 3FI trip the purple over red main line points indication was clearly visible about 500 m ahead. However, the red over purple loop points indication was not visible on the purple light. The purple light on the bottom started to be visible at 300 m from 3FI.
- 1.6.3 Tranz Rail advised that halogen bulbs were installed on a limited trial at the time, pending a review of their effectiveness. They did not have a backup filament and an assessment of their in-service performance (service life) was required.
- 1.6.4 The LE of Train 700 stated that when driving freight trains he had equal chances of receiving a purple on the top or bottom depending on timetabling, and he was not aware of any visibility difference between the 2 points indications.

² For a normal crossing at Rangiora involving the first train going into the loop, whether opposing or being overtaken by the second train, the design logic ensured the main line points were automatically set for the main line route with the facing indicator at red ready to be approach cleared to purple over red by the approach of the second train.

1.7 Stopping at Rangiora

- 1.7.1 Recent changes to the timetabling and control of passenger trains meant that Rangiora was no longer a mandatory stopping place for the *Coastal Pacific*.
- 1.7.2 The Train Attendant Manual, Issue One of 4 September 1998, contained the procedure for keeping passenger trains to timetable at main stations, as follows:

Procedure Follow these steps to keep the train to timetable at main stations.
note: Main stations are indicated by bold print on the Passenger Count Sheet

Step	Action
1	Check the waybill for <ul style="list-style-type: none">• en route stops• special request pick-ups• special request drop-offs
2	Advise the Loco Engineer: <ul style="list-style-type: none">• of pending passenger pick-up and drop-off points• to check when approaching stations for anyone standing on the platform (possible pick-ups)• to stop if there are possible pick-ups Advise Train Control of pending passenger pick-up/drop-off stops.

Christchurch, Kaikoura and Picton were main stations for Train 700.

- 1.7.3 The request from the train manager for the LE to check for possible pick-ups was the appropriate procedure for an en route stop such as Rangiora.

1.8 Train event recorder

- 1.8.1 The train event recorder was extracted and the long and short logs were supplied for analysis.

1.9 Weather

- 1.9.1 It was fine and sunny at 0840 hours on the day of the incident. The sun was bearing north 83° east and at an angle of 22.5° from the horizon.
- 1.9.2 The LE of Train 700 recalled the morning being sunny, and had the sun visor down at Belfast, but could not recall if it was still down when approaching Rangiora. He did not recall any particular problem with glare or dazzle, and did not recall any problem in reading points indicators on his journey north that day.

1.10 Personnel

- 1.10.1 The LE of No. 2 shunt had 21 years rail experience, of which 17 were as an LE. He had over 2 years experience on the MNL and was widely experienced in Track Warrant control areas. He held a current operating certificate for the duties concerned. On the day of the incident his shift commenced at 0430 hours and went until 1300 hours. His work pattern prior to that had included a weather delayed coal train shift of 10 ¼ hours on Monday, and a 9-hour day shift depot shunt on Tuesday starting at 0615 hours. Sunday had been a day off. He was in good health, under no stress, and did not feel fatigued on the morning of the incident.

- 1.10.2 The RO of No. 2 shunt had 13½ years rail experience. He held a current operating certificate for the duties concerned. His shift commenced at 0500 hours and went until 1300 hours. He had been on sick leave for 5 days and Wednesday was his first day back on duty. He stated his sick leave was stress-related, due to redundancy prospects at work and a domestic problem at home. However, he stated he felt confident in the job, and did not feel fatigued or under pressure when he reported for work that day. The RO was working his last few days before taking redundancy when the incident occurred.
- 1.10.3 The LE of Train 700 had 33 years rail experience. He had been an LE when Track Warrant control was first introduced, and had considerable experience on the MNL. He held a current operating certificate for the duties concerned. On Wednesday 21 October 1998 he booked on at 0640 hours for a planned 10½ hour shift, which was normal for that job. His work pattern prior to the incident had been Sunday off, Monday on the coal train involving a weather-delayed shift which went from 0900 hours to 2055 hours (11 hours and 55 minutes), and Tuesday a 10-hour (0800 hours to 1800 hours) shift doing passenger/freight on the Midland Line. He was happy with the hours on day shift, was sleeping well, and did not feel fatigued. He was under no worries or pressures and enjoyed good health.
- 1.10.4 The Tranz Rail “Rail Operating Manual”, Section 3 Instruction 4.2.2, defined “Maximum Rostered Daily Hours/Footplate Time”. This included a requirement that shifts beginning between 0801 hours and 0900 hours should be of 11 hours maximum duration with mandatory relief after a shift period of 11.5 hours.

1.11 Alternative Track Warrant loop designs

- 1.11.1 Approximately 40 of Tranz Rail’s 43 loops at Track Warrant Stations were similar in design to Rangiora. The 3 dissimilar designs fall into 2 categories:
- an enhanced indicator loop at Scargill on the MNL installed as a trial. This loop has distant indicators instead of Station Warning Boards. A flashing purple on the distant indicator tells the LE both main line points are normal (with the possibility of a train standing in the loop) and main line tracks are clear. Any other conditions results in the distant indicator displaying a yellow light. To achieve these indications there is an electrical connection between both ends of Scargill loop. The enhancement was installed due to braking limitations on the grade at Scargill and because cabling was already present.
 - Kai Iwi and Whangaehu (renamed Ruatangata) were Track Warrant Stations equipped with arrival/starting signals. Their operation is described in the Commission’s Rail Occurrence Report 99-102 regarding a Track Warrant overrun at Whangaehu on 9 March 1999.
- 1.11.2 A feature of the control logic of Kai Iwi and Whangaehu was that they did not forget train directions, the indicator loop design feature which caused the south end points at Rangiora to automatically reverse.

1.12 Track Warrant Control risk study

- 1.12.1 In late 1998 Tranz Rail completed a quantified risk study comparing operation of the North Island Main Trunk under the centralised train control system with operation of the MNL under Track Warrant Control. Tranz Rail advised that the study showed the risk exposures were similar, which confirmed to Tranz Rail that the risks associated with Track Warrant Control operation were acceptably low.

2. Analysis

2.1 The stalling of No. 2 shunt

- 2.1.1 The initial catalyst to the events that occurred was the stalling of No. 2 shunt outside Rangiora, and the unusual shunting pattern this initiated. The procedure in place to control tonnage (paragraph 1.4.2) was a general statement of intent which did not refer to tonnage control, and was not supported by specific procedures to ensure this was achieved.
- 2.1.2 Although the unusual shunting was initiated by the overloading of No. 2 shunt, the logic which resulted in the system losing the direction of the train in the loop was such that it could have happened with other unusual, but accepted, operating practices.
- 2.1.3 However, the lack of tonnage control, which resulted in non-compliance with load schedules, caused an unnecessary shunting requirement which was outside the logic of indicator loop design. Without this catalyst it is most unlikely that the incident would have occurred. Although not a direct cause of the incident, the avoidable overloading resulted in the LE of a passenger train being presented with an unnecessary and unusual indication in a situation where there were competing demands for his attention.

2.2 The shunting carried out by No. 2 shunt

- 2.2.1 The movements undertaken by the crew of No. 2 shunt once the stalling had occurred were carried out with the knowledge and approval of the TCO and were within established procedures for operating indicator loops. The shunt crew and TCO did not appreciate, and could not be expected to appreciate, the limitations of the logic of the indicator loop design which automatically reset the south end points to reverse on the day of the incident.
- 2.2.2 Tranz Rail were aware of the limitations of the logic of indicator loops such as Rangiora. Outside of the standard movements which the Rangiora system was designed to respond to there were a number of other possible combination of events which could not be individually allowed for. The defence against the sequence of events which occurred, or any other sequence resulting in loss of memory of the direction of the movement, were the Regulations referred to in paragraph 1.2.3. This defence proved inadequate on the day.

2.3 The approach of Train 700

- 2.3.1 Analysis of the event recorder log showed that Train 700 was travelling at about 63 km/h when it passed the Station Warning Board at 28.536 km, and remained steady at this speed up to the points indicator trip at 29.138 km. Speed then reduced to approximately 59 km/h at the south end points as the LE throttled back at the top of the grade at 29.44 km. Emergency braking was applied just after the south end points and the train slowed from 59 km/h to approximately 15 km/h at impact over a braking distance of about 180 m.
- 2.3.2 The LE was aware of the Station Warning Board and its distance from the points indicator. At 63 km/h Train 700 required approximately 200 m to stop based on the average grade in that locality, and the speed was appropriate for the intended main line passenger stop.
- 2.3.3 The points indicator trip was 514 m from the south end points. Although the LE did not know when he passed over the trip, he saw a purple as he approached Facing Points Indicator 3FI. The purple light that the LE saw was visible at 300 m from the points and formed part of the red over purple indication of the loop setting. Prior to this point the only visible indication was red, with the clear message be prepared to stop at the Facing Points Indicator.

- 2.3.4 The top of the grade, where the LE could first see Rangiora station, was some 80 m past the point at which the bottom purple became visible, and 220 m from the points. This was the approximate latest position at which the LE would have required to commence braking to be able to stop at 3FI. The train travelled this 80 m in about 5 seconds. It was at this point that the LE could see the children in the vicinity of the main line. From the time the LE first registered the purple light up to the time Train 700 entered the loop, the LE interpreted it as a purple indication for a main line setting. There was sufficient time for him to have seen and correctly responded to 3FI indication.
- 2.3.5 A number of factors are likely to have contributed to the LE's erroneous belief that the purple light he saw on the day was for a main line points setting. These were:
- his experience and route knowledge related to the running of Train 700. Rangiora was an advertised intermediate station for passengers. As such the normal routing of Train 700 was on the main line irrespective of whether a crossing or passing movement was involved. The Track Warrant held by the LE reflected this, and advised that "No. 2 may be on the loop at Rangiora". The signalling logic under which Rangiora operated meant it was very unusual for a train holding a main line track warrant, including a crossing, not to get a main line points indication
 - the requirement for the LE to observe, interpret, and act on passenger activity at Rangiora station. This required judgement as to speed related to distance, and called for his attention when only 80 m beyond the point at which the first indication of an unusual points setting was visible to the LE. The train was under control with respect to a possible main line passenger stop when it entered the loop
 - the range of visibility of the bulbs used for the purple loop light. A halogen bulb would have been visible approximately 200 m earlier and may have provided the necessary total indication (red over purple) in time for the LE to observe, evaluate and act before the added complication of the possible Rangiora stop took his attention
 - the lack of a Circuit Marker Post at the points indicator trip. If the LE had seen such a post, looked for his indication and registered the visible red but no purple light it may have prompted a speed reduction because of the lack of an expected purple on the top at that point.
- 2.3.6 Although Train 700 was running approximately 30 minutes late there was nothing to suggest this influenced the LE's actions.
- 2.3.7 The position of the sun was perpendicular to the track approaching Rangiora and is unlikely to have adversely affected the LE's view of the points indicators.
- 2.3.8 Although the hours worked by the LE had marginally exceeded Tranz Rail's shift limit criteria 2 days before the incident, there was no evidence that this adversely affected the LE's action on the day of the incident.
- 2.3.9 The Track Warrant regulations were clear as to what was expected from the LE of Train 700 as the train approached Rangiora, and correctly responding to points indicators was a fundamental requirement of an LE; equally, the LE was fully aware of the Track Warrant Regulations and had no intention to violate them, nor did he intentionally misinterpret Points Indicator 3FI. His erroneous belief that he had a route set for the main line was caused by what is considered within the framework of human factors ideology, as a slip brought on by an automatic mode of behaviour based on previous experience, in which conscious attention is diverted elsewhere, common human error. The circumstances of this incident, and the factors that possibly contributed to the LE misinterpreting Points Indicator 3FI, indicate a system that is totally reliant on human performance as its only defence against incidents of this type.

- 2.3.10 Consequently it is essential that LEs in such circumstances are assisted by as many visual aids as possible, and that secondary distractions are minimised. The lack of a Circuit Marker Post and the use of a standard bulb in the purple loop indicator, deprived the LE of 2 visual aids which may have avoided his misinterpretation of the indications displayed. The conflicting demands for the LE's attention when the train was between 300 m and 200 m from the south end points probably contributed to him misinterpreting the points indication. However, the prime reason for the LE's misinterpretation was his expectation of the indication which he would receive at Rangiora based on many previous shifts involving Train 700.
- 2.3.11 There was no evidence of any specific circumstances relating to the particular LE which could account for his actions. This suggests the misinterpretation could have occurred regardless of the LE involved, and that the Track Warrant indicator loop system may have insufficient defences to avoid such a low-probability, high-consequence event which placed passengers and staff at an unacceptable risk. The possibility of these particular defence deficiencies is not in conflict with the overall results of the risk study referred to in paragraph 1.12.1. However, when considering the safety recommendations made in Section 5.1 it would be prudent for Tranz Rail to check the validity of the assumptions made in that study.

3. Findings

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

- 3.1 All train staff involved were appropriately certified for the duties concerned.
- 3.2 There were no effective procedures in place to control the tonnage on No. 2 shunt.
- 3.3 The actions of No. 2 shunt after stalling on the grade were within the requirements laid down by Tranz Rail for the operation of indicator loops.
- 3.4 The automatic return of the south end points to reverse was the outcome to be expected from indicator loop design based on the series of moves carried out by No. 2 shunt.
- 3.5 Tranz Rail were aware that the design parameters of indicator loops could result in an unintended points setting and indication to an approaching train.
- 3.6 Tranz Rail's Regulations anticipated and allowed for such unintended points settings and indications.
- 3.7 The lack of a Circuit Marker Post at the points indicator trip deprived the LE of a visible reminder of the position from which he could first get a main line or loop points indication.
- 3.8 The restricted visibility of the purple loop light reduced the time available to the LE to observe, interpretate and act on the full indication displayed before his attention was drawn to secondary tasks.
- 3.9 The requirement for the LE to check for people standing on the platform, and stop if there were possible pick-ups, was an undesirable distraction under the circumstances at Rangiora, as it had the potential to divert his attention from his prime purpose of operating his train safely.
- 3.10 The reduced prompts for the LE, together with his high workload as Train 700 approached Rangiora from the south, increased the likelihood of his not registering the unexpected points indication.
- 3.11 The design logic of the indicator loops and the reliance on a single person to recognise and act on unusual points indications rendered the system susceptible to one-person errors.

- 3.12 Tranz Rail's reliance on the LE of Train 700 complying with the Regulations as the only defence to the unexpected points indication presented was insufficient when considering the risk involved in non-compliance and the particular features which could adversely affect compliance.

4. Safety Action

- 4.1 Tranz Rail advised that immediately following the incident the importance of Regulations 8(b) and 9(e) were highlighted in the "rule of the week" which is faxed out to terminals and other locations, posted on Track Work Orders received by operating staff, and also posted on Train Work Orders received by locomotive running staff.

5. Safety Recommendations

- 5.1 On 14 February 2000 the Commission recommended to the managing director of Tranz Rail that he:
- 5.1.1 ensure that all Circuit Marker Posts marking the track circuit approaching the Facing Points Indicators in Track Warrant areas are maintained in position (082/99); and
 - 5.1.2 review the desirability of requiring the LEs of passenger trains to assess stopping requirements at stations, on a location by location basis, to ensure that there is no potential conflict with safe train operation, and take appropriate steps where such conflict exists (083/99); and
 - 5.1.3 install halogen bulbs in all purple loop points indicator lights at Track Warrant Stations (084/99); and
 - 5.1.4 carry out a comparative risk analysis on the operations of indicator loops compared to loops equipped with arrival/starting signals in Track Warrant areas to assess the risk exposure at indicator loops and take action to bring the risk exposure within acceptable limits where necessary (085/99); and
 - 5.1.5 implement procedures to ensure tonnage limitations are not exceeded on shunting services (086/99).
- 5.2 On 17 February 2000 the managing director of Tranz Rail responded as follows:
- 5.2.1 Tranz Rail accepts safety recommendation 082/99 and has no further comments to add.
 - 5.2.2 Tranz Rail does not accept safety recommendation 083/99. Tranz Rail does not agree that requiring the LE's of passenger trains to assess stopping requirements at stations conflicts with safe train operation. This task is considered to be but one of many that LE's are required to undertake as part of their duties.
 - 5.2.3 Tranz Rail accepts safety recommendation 084/99 and has no further comments to add.
 - 5.2.4 Safety recommendation 085/99 will be considered alongside other potential actions that could derive from the output of a Working Party currently tasked with identifying the recommending improvements to Track Warrant procedures in order to reduce the risk exposure from human failures.

5.2.5

Safety recommendation 086/99. Tranz Rail is taking steps to reinforce existing procedures in this area.

Approved for publication, 16 February 2000

W P Jeffries
Chief Commissioner

