



No. 95-114

Y3 Shunt

Ravensbourne

8 August 1995

Abstract

On Tuesday 8 August 1995 at about 1025 hours Y3 Shunt operated by New Zealand Rail Limited was shunting at Ravensbourne. Two shunters were riding on the footplate on the front of the locomotive. As the locomotive negotiated a turnout the left hand side of the footplate caught under the head of a rail on the adjacent road and the footplate buckled. The shunter on the left hand side was thrown off the footplate and trapped under it, suffering serious injuries. The causal factor was the relative heights of the rails on the converging tracks. Safety deficiencies identified were the lack of standards and inspection procedures governing such relative heights. Safety issues identified were the lack of compliance with track inspection requirements.

Transport Accident Investigation Commission

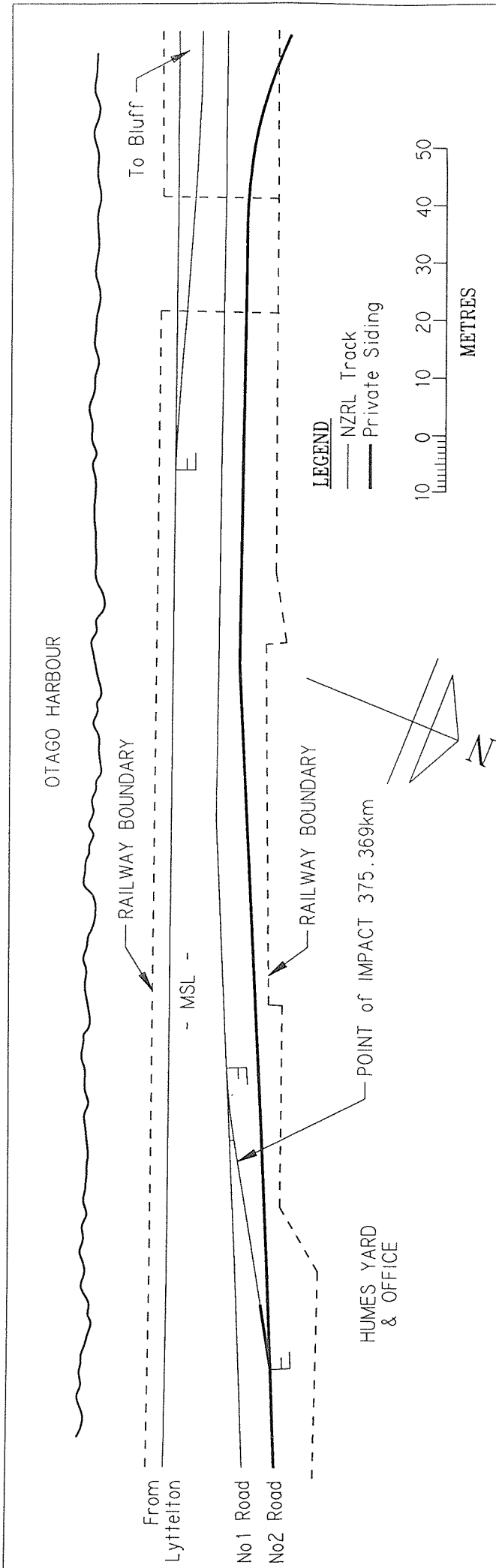
Rail Accident Report No. 95-114

Train type and number:	Y3 shunt
Date and time:	Tuesday 8 August 1995, 1025 hours
Location:	Ravensbourne
Type of accident:	Fall under a moving train
Person on board:	Shunting crew: 3
Injuries:	Shunting crew: 1 Serious 2 Nil
Nature of damage:	Buckled locomotive footplate
Information sources:	Transport Accident Investigation Commission field investigation
Investigator in Charge:	R E Howe

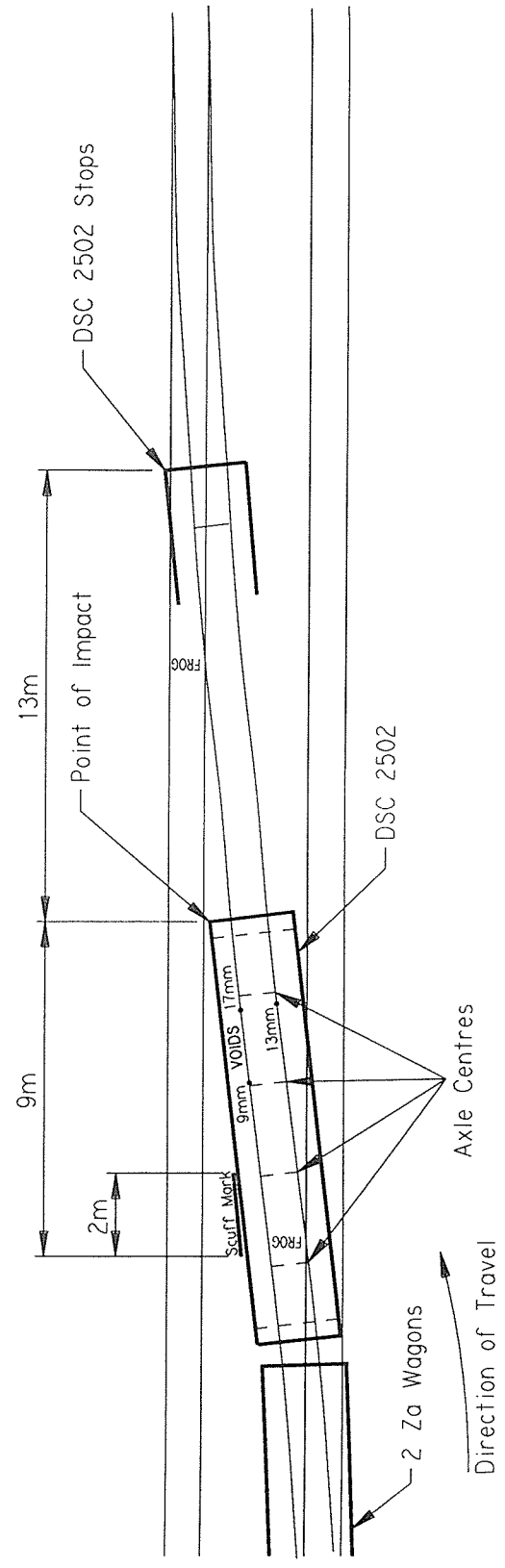
1. Factual Information

- 1.1 On Tuesday 8 August 1995 Y3 shunt operated by New Zealand Rail Limited (NZRL) (now Tranz Rail Limited (TRL)) was carrying out rostered shunting duties at Ravensbourne. The shunt crew consisted of one Locomotive Engineer (LE), one shunter and one shunter under training (second man).
- 1.2 At approximately 1025 hours Y3 had completed shunting at Ravensbourne and was pulling out of No. 2 Road with locomotive DSC 2502 and two ZA wagons attached. The shunt was heading to Blackjack siding, between Ravensbourne and Dunedin, to pick up additional wagons. The shunter was riding on the left hand side of the shunters' footplate¹ on the front of the locomotive and the second man on the right hand side.
- 1.3 A plan of the accident scene is shown in Figure 1.
- 1.4 As the locomotive negotiated the crossover between No. 2 Road and No. 1 Road the left hand side of the footplate caught under the head of the rail of the converging track.
- 1.5 The shunter stated his first indication of contact was a scraping noise and sparks. He was facing forward and holding onto the handrail with his right hand at the time. His reaction was to start to move towards the centre of the footplate away from the sparks but as the footplate buckled and the locomotive lurched he fell face forward. As he fell he recalled twisting his body and landing on his right side. His feet went under the footplate and he held himself up on the footplate and was pushed by the locomotive until it came to rest.
- 1.6 The LE was in the driver's position on the left hand side of the locomotive. He estimated the shunt speed at 10 km/h as it negotiated the crossover. He felt the locomotive jerk and immediately applied the brakes. He recalled being lifted in the air and likened it to 'running over a stop-block' (an approximately 125 mm high physical barrier placed over rails to stop rolling stock). He stated he saw the shunter move and fall but lost sight of him as he fell.
- 1.7 The second man heard the shunter call out and looked across to see the footplate buckle and twist and the shunter trying to get off the footplate. The second man then turned, faced the locomotive and held on with both hands until the locomotive came to rest.
- 1.8 As soon as the locomotive stopped the second man dismounted and ran to assist the shunter. He found him lying on his back with his left leg trapped under the footplate.
- 1.9 The LE dismounted and supported the shunter while the second man contacted the NZRL Operations Control on his radio and advised of the accident and requested an ambulance.
- 1.10 Having advised Control of the accident the second man went to the adjacent Hume's Yard Office to get assistance, including lifting equipment to lift the footplate from the shunter. Humes' staff responded, with some going to the site with medical assistance and others mobilising an available seven tonne Hamilton crane.
- 1.11 At approximately 1030 hours the second man received a telephone call from Control requesting more details of the accident site and he arranged to go to the main road a few hundred metres away to direct emergency services.

¹ Also known as "cowcatcher"



General Layout Plan



Site Detail Scale 1:200

Figure 1

- 1.12 The Hamilton crane arrived at the accident site with chains attached to attempt to lift the locomotive. By then ambulance staff were in attendance and advised against the lift due to possible adverse effect on the trapped shunter.
- 1.13 The Operations Controller had received the call from the second man at 1026 hours and after obtaining sufficient information he rang 111 at 1028 hours. Ambulance services were on site at 1031 hours and the first fire service unit at 1038 hours. The fire rescue unit was on site at 1042 hours and air bags from it were used to lift the front of the locomotive and free the shunter at approximately 1048 hours.
- 1.14 The ambulance departed the site at 1054 hours and the shunter was admitted to Dunedin Public Hospital at 1100 hours.
- 1.15 The fire service notified the police at 1051 hours and they attended and secured the site.

Weather

- 1.16 The day was cold and overcast with some cloud but no rain. Shunting staff described visibility as “good”.

Shunt details

- 1.17 Shunt Y3 was the NZRL regular shunt covering the area Mosgiel to Ravensbourne. It had historically been serviced with a DSG locomotive although for some months prior to the accident DSC locomotives had been increasingly used. The shunter’s recollection was that the DSC had seldom been used for shunting Ravensbourne. He estimated that DSG locomotives were used on approximately 80% of the Y3 shunts he had recently worked.

Locomotive details

- 1.18 The latest locomotive maintenance certificate (Loco 304) for DSC 2502 had been issued on 25 July 1995. This service check had included measurement and recording of the cowcatcher heights. These were recorded as:

No. 1 end	100 mm above rail level
No. 2 end	105 mm above rail level

No. 1 end was the footplate on which the shunter was standing.

- 1.19 No maintenance work was carried out on DSC 2502 from 25 July 1995 to 8 August 1995.
- 1.20 Following the accident the height of the No. 2 end was checked and confirmed at 105 mm. Damage to No. 1 end did not allow confirmation of height.
- 1.21 The DSC locomotive has a shunters’ footplate with a nominal height of 100 mm above rail level. This is in contrast to the DSG locomotive which has a shunters’ footplate with a nominal height of 140 mm above rail level.
- 1.22 The NZRL Mechanical Code in effect at the time of the accident specified that the bottom of any cowcatcher on shunting locomotives must be between 100 mm and 150 mm above the top of the rail. This code came into effect on 1 July 1995 and replaced NZRL Code CSN06 which specified a minimum dimension from rail of 75 millimetres for shunting locomotives.

- 1.23 The Loco 304 certificate for DSC 2052 issued 25 July 1995 included guide lines for maximum and minimum cowcatcher heights which did not include shunting locomotives and did not reflect the new code requirements brought in on 1 July 1995.
- 1.24 A full inspection of Locomotive DSC 2502, including spring height measurements, was made following the accident.
- 1.25 NZRL advised that DSC locomotives have a nominal 28 mm available spring deflection in the primary springing and 45 mm available spring deflection in the secondary springing giving a total of 73 mm spring deflection and thus allowing in excess of 73 mm dynamic vertical movement of the locomotive corners.

Site tests

- 1.26 Site tests were carried out with DSC 2325 on the afternoon of 8 August 1995. The nominal height of shunters' footplate on the leading end left hand side was measured at 110 mm. A slow speed run through the crossover showed considerable dynamic movement of the track under load prior to the point of impact and scraping of the footplate on the rail head of the right rail of No. 1 Road. When measured at rest in the impact position the shunters' footplate had 20 mm clearance above rail level.
- 1.27 Stopping distance tests were carried out with DSC 2502 locomotive and the wagons attached at the time of the accident. Stopping distances, including reaction time, were recorded as:

at 10 km/h	11.5 m
at 15 km/h	15.2 m

Track details

- 1.28 The point of impact occurred on track owned and maintained by NZRL although the shunt had just travelled through a turnout forming part of the siding servicing Ravensbourne Fertiliser Co-operative Limited (refer Figure 1).
- 1.29 The track between the turnouts forming the crossover was 91 pound per yard rail on hardwood sleepers with N type fastenings, laid with second hand materials in 1992. Ballast was satisfactory for yard use but loose under the sleepers resulting in vertical track movement under load.
- 1.30 The private siding (northend) turnout was installed with second-hand materials in 1992. It was a 1 in 7½ turnout (sharp angle) and replaced a 1 in 9 turnout (shallow angle). Reports indicate that the replacement in this manner resulted in a reduction in the crossover length from 17 m to 15 m approximately. The nominal ascending grade through the crossover was approximately 1 in 120 although due to the low and moving track an effective grade of 1 in 60 applied over 8 m just prior to the impact point.
- 1.31 The track on No. 1 Road was in good condition and the rail was not moved in or dislodged from the fastenings when the shunter's footplate caught under the head.
- 1.32 Movement under load indicated by the tests referred to in paragraph 1.26 above prompted a full measure-up of track geometry including vertical movement (voiding) under load. This showed a low uneven and moving joint 5 m prior to the point of impact. The right rail was approximately 45 mm lower than desirable to transition smoothly from No. 2 Road to No. 1 Road with a further 9 mm voiding. The left rail was correspondingly 60 mm lower than desirable with an additional approximate 7 mm voiding. The track was thus low and

effectively canted 13 mm to the left (towards the adjacent No. 1 Road) under load. Similar measurements taken approximately 2.5 m prior to the point of impact showed:

left rail nominally 37 mm low and voiding 17 mm
right rail nominally 32 mm low and voiding 13 mm

resulting in 9 mm cant to the left (toward No. 1 Road) under load.

- 1.33 NZRL Track Code had no requirements covering the difference in level between converging tracks at a turnout.
- 1.34 Inspection requirements for yards were covered by code P26 (length ganger's inspection) Code P28 (track and structures supervisors' inspection, now track and structures manager's (TSM) inspection) and Code P29 (line inspector's inspection).
- 1.35 Codes P25, P26 and P27 required the length ganger's yard inspection for Ravensbourne to be carried out on foot each six weeks. Code P26 included, inter alia,

“The purpose of the inspection is to provide detailed information on the condition of the track materials and geometry”

and included a requirement that:

“all aspects of the track that are not within tolerances, and are not on the current worklist or EM80 exceedance report are to be recorded”.

Investigation revealed no inspection to Code P26 had been made for over two years. At that time the TSM had formed a temporary yard gang under the control of an Acting Ganger which covered the Dunedin area, including Ravensbourne. The Length Ganger concerned was advised he was not required to carry out yard inspections and the TSM's expectation was that the Acting Ganger would inspect the yards. In the event the demand on this gang's time for “fire fighting” work (the TSM's description) was such that no Code inspections were carried out by the three track staff who shared the Acting Ganger position during this period. The gang relied on feedback from shunting staff to define problem areas. The TSM was aware of this but chose not to enforce code inspection requirements for the same workload reasons.

- 1.36 Code P28 required TSM's to inspect each yard at least once over a 12 month period in conjunction with the length ganger. The TSM concerned did not carry out regular inspection of yards in accordance with Code P28. He saw yards under his control on an “as required” or “as reported” basis. In the particular case of the temporary Dunedin area yard gang he did not carry out any inspection with the Acting Ganger from the gang's inception although he went out with the Acting Ganger on certain jobs. His last “inspection “ of the Ravensbourne crossover was approximately one year prior to the accident in response to shunt crew reports (paragraph 1.47 below).
- 1.37 Code P29 required the Line Inspector to carry out detailed inspections of all yards twice in a 12 month period, the period between inspections being at least five months but not more than seven months. Some dispensation for one inspection or a delegated inspection was allowed for in the Code but had not been approved for the track in question. The track concerned was last inspected on 3 August 1994, ie. some 12 months prior to the accident, and no fault was recorded with respect to this crossover.
- 1.38 Dunedin Operations Control had a formalised system for reporting track faults in sidings complementing the Loco 346 system for reporting main line track faults. A form entitled “Report on Track Faults” was completed by the Operation Controller based on verbal reports

from shunt crew on shift completion. This was faxed to the TSM. Notification of repair complete was faxed back to the Operations Controller in due course. There were no "Report on Track Faults" incidents reported to the TSM for the No. 1 Road to No. 2 Road crossover at Ravensbourne for the two months prior to the accident.

- 1.39 All outstanding work requirements revealed by inspections or reports were consolidated by the TSM on a personal computer based "Track Inspection Diary". At the time of the accident there was no entry for the crossover in question.

Impact marks

- 1.40 A recent impact was indicated by a fresh heavy score mark on the outside web of the right rail on No. 1 Road. This score mark ran from opposite 375.369 kilometres Main South Line for 2 m towards the point where the right rail of No. 1 Road and the left rail of No. 2 Road met and crossed (frog of the turnout). It started 1.2 m from the centre line of No. 2 Road which is the distance to the outside edge of the shunters' footplate on a DSC locomotive.
- 1.41 Between 7 m and 9 m prior to the impact point a recent deep scuff mark was found in the ballast on the left hand side of the crossover road, parallel to it, and approximately 1.1 m to 1.2 m from the centre line of the crossover road.
- 1.42 The rear shunters' footplate on DSC 2502 showed signs of ballast dust on the lower horizontal surfaces.

Personnel details

- 1.43 The LE was currently certified for the duties being carried out at Ravensbourne.
- 1.44 The second man was allocated as an extra man gaining experience prior to certification. His recent background was as a signaller although his previous shunting experience went back to 1974.
- 1.45 The shunter had 15 years' experience shunting and was currently certified for the duties being carried out at Ravensbourne. His shift, sleep and recreation patterns prior to the accident were normal. He was not suffering from any illness but was taking medication to control his blood pressure.
- 1.46 The shunter was appropriately attired for his duties, including safety boots with no visible tread wear and a hi-visibility vest.

Previous related site history

- 1.47 The shunter concerned recalled an incident approximately one year prior to the accident at the same crossover while making a similar movement. He was riding in the locomotive cab at the time when he heard a scrape. This was reported to the TSM and the shunter recalled taking the TSM to the site on the engine and the TSM arranging for packing and lifting to be carried out that day. This was confirmed by the TSM.
- 1.48 Approximately three weeks prior to the accident a further incident occurred at the crossover involving DSC 2678. A shunt crew had inadvertently taken out this locomotive with a low cowcatcher, overlooking the most recent repair book entry which recorded that springs had been replaced at one end of the locomotive only and that the locomotive was not to be used. During the following shunting operations early that day a few scrapes were noticed. However on making a similar movement through the crossover at Ravensbourne later in the day a bang was heard and the locomotive jumped. The locomotive was propelling two wagons, with the

shunter on the front wagon at the time. The locomotive was stopped and the crew found the left hand side of the cowcatcher bent under approximately 75 mm to 100 mm (touching the ground). They proceeded slowly back to Dunedin contacting the ground at level crossings and high ballast points en route. The incident was reported verbally to the Operations Controller who was aware of the previous low cowcatcher and that the locomotive should not have been put into service. The springs were later replaced and the cowcatcher straightened. The TSM was not advised of the incident and no specific track inspection was made as a result of it.

2. Analysis

- 2.1 The equal distance from the crossover track centre line to the left hand edge of the shunters' footplate and to the heavy score marks on the outside of the right rail on No. 1 Road confirmed the point of impact, and the locomotive stopping position as 13 m beyond the point of impact.
- 2.2 The stopping test carried out on 9 August 1995 (paragraph 1.27) indicated a maximum speed of 12 km/h at impact which confirms crew recollections.
- 2.3 Reconstruction of DSC 2502's static position at impact by superposition of axles on the 'as loaded' track profile at the point of impact showed that without allowing for any spring deflection effect the left hand side top of the footplate was approximately 30 mm above the under side of the head of the rail. Allowing for dynamic effect at the locomotive corner it is likely that the top of the footplate was able to enter under the head of the rail and contact and ride along the outside web of the rail. Site markings confirmed this had occurred. The nature of the damage to locomotive DSC 2678 which occurred in mid July (paragraph 1.47 above) indicated that this shunters' footplate had entered under the head of the rail although this could not be confirmed, or related to actual footplate height above rail level prior to the incident.
- 2.4 The heavy scuff marks in the ballast on the left hand side prior to the point of impact and ballast dust on the rear footplate confirmed the LE's report of being lifted in the air (paragraph 1.6 above). It is considered that as the footplate buckled approaching the frog it was freed from under the head of the rail and the locomotive sat back on its springs accordingly causing the rear shunters' footplate to ride along the ground for approximately 2 m.
- 2.5 The position of the scuff marks indicated the front of the locomotive was still riding high as it passed through the frog area which allowed the trapped shunter to cross from the crossover Road to No. 1 Road at rail level.
- 2.6 The previous practice of using DSG locomotives for shunting Y3 shunt had recently and progressively changed to a mix of DSG and DSC locomotives at the time of the accident. DSG locomotives have a shunters' footplate nominally 40 mm higher than a DSC's and it is likely they would have ridden over or at worst scraped the top surface of the rail on No. 1 Road when negotiating the crossover from No. 1 Road to No. 2 Road at Ravensbourne under similar circumstances to DSC 2502. By comparison a DSC's footplate was likely to enter under the head of the rail, or if it did not, it was almost certain to scrape the top of the rail.
- 2.7 The lack of any "Report on Track Faults" from Operations Controller to TSM for this crossover for the two month period prior to the accident, even though it was frequently used, adds weight to the reported low use of DSC locomotives on this shunt.
- 2.8 The fact that the incident involving DSC 2678 did not result in any report to track maintenance staff can be attributed to the operating staff concerned being retrospectively aware of the low shunters footplate and attributing the problem solely to this factor.

- 2.9 The inspection regime for Ravensbourne yard was not to NZRL Code requirements. In particular:
- The “Length Ganger’s inspection” was not carried out on a six weekly basis. As a key requirement of this inspection was to record all aspects of the track not within tolerance, and no such tolerances were defined for the relative levels of converging tracks at turnouts, it is considered unlikely that such inspections, even if carried out to Code, would have revealed the problem.
 - The TSM did not carry out yard inspections at least once over a 12 month prior in conjunction with the length ganger. The TSM was not required to inspect track in detail, but was required to inspect sufficiently to ensure maintenance, construction and material standards were being complied with. In the particular circumstances the TSM had been on site at the crossover in question some 12 months prior to the accident when initiating maintenance work, and this complied with the intent of the Code.
 - The Line Inspectors last detailed inspection did not comply to Code frequency requirements. It is not known whether his last inspection on 3 August 1994 was before or after the work carried out under the TSM’s direction (paragraph 1.47 above). Again it is considered the lack of defined tolerances for the relative levels of converging tracks at turnouts would have meant it was unlikely that inspections at the required frequency, ie. February 1995 and August 1995, would have revealed the problem.
- 2.10 It is considered the lack of any specific requirements for control of relative heights, including procedures for measuring them, meant that it was unlikely that visual inspection or normal track geometry measurement would have revealed the extent of the problem. In this respect the fact that inspections were not to Code requirements is not considered to have materially contributed to this accident. In addition the diversity of heights of shunter’s footplates and the recent mechanical Code change in this area would have added to the problem of assessing any potential problem.
- 2.11 Although it was common practice for Y3 shunting staff to return to Dunedin in the cab of the locomotive following completion of shunting at Ravensbourne it was not mandatory and depended on such factors as weather and shunting requirements. On the day in question Y3 was picking up wagons at Blackjack siding, the entrance to which was approximately 500 m south of Ravensbourne, and the decision of the shunter and second man to ride on the front of the locomotive was practical in the circumstances.

3. Findings

- 3.1 The LE was operating the shunt normally and was currently certified for the duties concerned.
- 3.2 The shunter was currently certified and correctly dressed for the duties concerned and he was in an appropriate and permitted position on the shunters’ footplate prior to the accident.
- 3.3 The speed of the shunt at the time of the accident was appropriate for the operation.
- 3.4 The height of the shunters’ footplate above rail level on DSC 2502 was within the permitted range.
- 3.5 The spring heights on DSC 2502 were even and normal for this class of locomotive.

- 3.6 The low and voiding track on the crossover road approaching No. 1 Road allowed the left hand leading edge of the shunter's footplate on DSC 2502 to enter under the head of the right rail on the adjacent No. 1 Road.
- 3.7 The shunter fell from the front of the footplate as it buckled under the restraint of the right rail as the tracks converged and he was trapped under the footplate and pushed ahead of the locomotive.
- 3.8 The LE took immediate and appropriate braking action on impact thus minimising the distance over which the shunter was pushed.
- 3.9 The NZRL Track Code had no requirement covering the relative height of converging tracks to ensure safe passage of shunter's footplates.
- 3.10 Although the inspection of Ravensbourne yard was not to Code requirements the lack of any specific standards and inspection procedures for the relative heights of converging tracks meant it was unlikely normal inspection procedures to Code requirements would have identified the potential safety problem associated with the low and voiding portion of the ascending grade through the crossover road.
- 3.11 Since its renewal in 1992 the crossover had two recorded incidents involving shunter's footplates fouling adjacent track.
- 3.12 The first incident some 12 months prior to the accident had resulted in appropriate maintenance action.
- 3.13 The second incident some weeks prior to the accident was considered a locomotive fault and not reported to track staff.

4. Safety Recommendations

- 4.1 As a result of the investigation of this accident it was recommended to Tranz Rail Limited that it:

Develop appropriate track maintenance standards and inspection procedures governing the relative heights of converging lines. (083/95)

- 4.2 Tranz Rail Limited responded:

Safety Recommendation 083/95 is noted. However, further analysis is required to be undertaken to evaluate alternative options to avoid this type of occurrence.

5. Safety Actions

- 5.1 TRL has taken appropriate action to reinstate six weekly length gang inspections for the Dunedin area yards and ensure compliance with Code inspection requirements generally.
- 5.2 In late 1995 TRL extended the use of the centralised Total Asset Management System (TAMS) which was in place for main line locomotives to include shunting locomotives. The system currently covers scheduled maintenance, equipment changes and items which cause delays to trains. A more sophisticated version of TAMS is being developed which will record all work carried out on locomotives.

5.3 The shunting review recently carried out by TRL and referred to in paragraph 4.3 of Railway Occurrence Report 95-112 has similar relevance to this accident with regard to overall risk reduction in the potentially hazardous shunting operation area.

17 April 1996

M F Dunphy
Chief Commissioner

Glossary of Railway Terms

ASP	Audio Shunting Procedures.
Catch on	To attach vehicles by dropping the hook.
Consist	The locomotive(s) and vehicles making up a train.
Couple	To connect brake hoses ready for use.
Cut off	To lift the hook between vehicles.
Kicking	To separate wagon(s) by accelerating the movement a short distance in the direction that is being operated with the hook lifted.
Leading en	The front end of a locomotive or vehicle in direction of travel.
Loose shunting	Kicking or slipping.
Operator	New Zealand Rail Limited, now known as Tranz Rail Limited.
Propelling	Pushing a rake of vehicles.
Rake	A group of vehicles.
Run about	The action of detaching a locomotive from its train and reattaching it at the opposite end.
Slipping	Separating wagon(s) by pulling them, lifting the hook and accelerating the locomotive forward. After the locomotive clears, points are reversed and the following wagon(s) proceed to another road.
Uncouple	To disconnect brake hoses.

