No 93-112

Train 901

Collision with Motor Vehicle

Rolleston, Canterbury

25 August 1993

ABSTRACT

This report describes a collision between Train 901—the "Southerner" passenger express—and a concrete mixer truck on a level crossing at Rolleston on 25 August 1993. Three passengers on the train were fatally injured and seven seriously injured. The truck driver received minor injuries.

TRANSPORT ACCIDENT INVESTIGATION COMMISSION

RAIL ACCIDENT REPORT NO 93-112

Train Type and Number:	Express Passenger, 901
Locomotive:	DF 6202
Date and Time:	25 August 1993, 0902 hours*
Location:	Main South Line, 33.03 km, George Holmes Road crossing, Rolleston
Type of Occurrence:	Collision with motor vehicle (concrete mixer truck)
Persons on Board:	Crew: 3 Passengers: 91
Injuries:	Crew: 3 Nil Passengers: 3 Fatal 7 Serious 81 Minor or none Other#: 1 Minor
Nature of Damage:	Locomotive: Minor Train: 2 cars substantial 2 cars minor Truck: Substantial
Information Sources:	Transport Accident Investigation Commission field investigation
Investigator in Charge:	Mr A J Buckingham

*All times in this report are NZST (UTC + 12 hours)
#Truck driver

1. NARRATIVE

1.1 New Zealand Rail Limited (NZRL) Train 901, the Christchurch-Invercargill "Southerner" express passenger service, was hauled by DF 6062 and consisted of three passenger cars (or carriages), AL 2050 (Car U), AS 18 (Car B), A 2100 (Car A) and AG 60, the power/baggage van (see Diagram 1). The laden weight of the train, including the locomotive was approximately 205 tonnes. In addition to the Locomotive Engineer, the train was crewed by a Train Manager and a Train Attendant, and there were 91 passengers on board.

1.2 Departure from Christchurch Station was on time at 0840 hours, and the train proceeded at normal speed towards its first scheduled stop at Ashburton. Approaching the Rolleston Station yard, the Locomotive Engineer sounded the air horn as a warning to a track gang working in the yard, and again for the level crossing at the south end of the yard. The train speed was approximately 100 km/h at this stage. The weather was fine and clear, and in accordance with normal practice, the locomotive's headlight was set at maximum brightness.

1.3 While still several hundred metres from the crossing, the Locomotive Engineer became aware of a line of traffic to his front left on State Highway 1; several cars had "bunched up" behind a truck as they approached the 70 km/h speed restriction through Rolleston. It became apparent to the Locomotive Engineer that the truck driver's intention was to turn right into George Holmes Road, on which the level crossing was located.

1.4 The truck slowed and pulled to the right of the southbound lane; the car immediately following did not move to the left to overtake the truck, but the second and subsequent cars did so. After some northbound traffic had passed, the truck commenced its turn to the right. The Locomotive Engineer was not concerned at this point, as he could see that there was sufficient space for the truck to stop between the main road and the railway crossing. Nevertheless, as a precaution, he sounded a continuous blast on the air horn for several seconds before reaching the crossing. At this point, even had the Locomotive Engineer considered it necessary to stop the train, there was insufficient space available to do so before reaching the crossing.

1.5 The long horn blast attracted the attention of several witnesses in the area, who looked at the train in time to see the truck collide with the side of the locomotive on the crossing. Some of these witnesses were able to confirm that the crossing alarms (flashing lights and bells) were operating at the time. The fully-laden concrete mixer truck struck the locomotive in the vicinity of the front bogie, and was spun violently to its left, in the direction of the train's travel. The concrete mixer bowl struck the side of Car U, about halfway down its length, tearing the side out of the trailing half of the car as well as the leading third of the side of Car B. Car A was struck on its front left corner, shattering the first three windows on that side and damaging the corner framing, but the car interior was not penetrated. The power/baggage van suffered comparatively minor damage.

1.6 The Locomotive Engineer applied emergency braking, and the train came to rest with its head end 725 m past the crossing. The collision had shattered the left rear brake cylinder on the locomotive's front bogie, resulting in the rapid bleeding off of all brake cylinder pressure on the locomotive. The train brakes had to stop not only the consist but also the unbraked 86-tonne locomotive.

1.7 Emergency services were alerted by several witnesses, and were on the scene within minutes. Police, Fire Service and Ambulance personnel were assisted by the train crew, a number of motorists who stopped to render assistance, and Army personnel from nearby Burnham Military Camp.

1.8 At the time of the collision, the Train Manager was checking the ticket of the passenger seated in the front left window seat of Car A, and the Train Attendant, who had just finished distributing light refreshments, was at the front of the passenger compartment of Car U. Neither was injured, and they both rendered prompt attention to the injured and distressed passengers.

1.9 One female passenger was found to have died in the collision, and several seriously injured passengers were taken to Christchurch Public Hospital by ambulance or rescue helicopter. Two female passengers later died in hospital as a result of their injuries. Some minor injuries were treated on site. A casualty clearing station

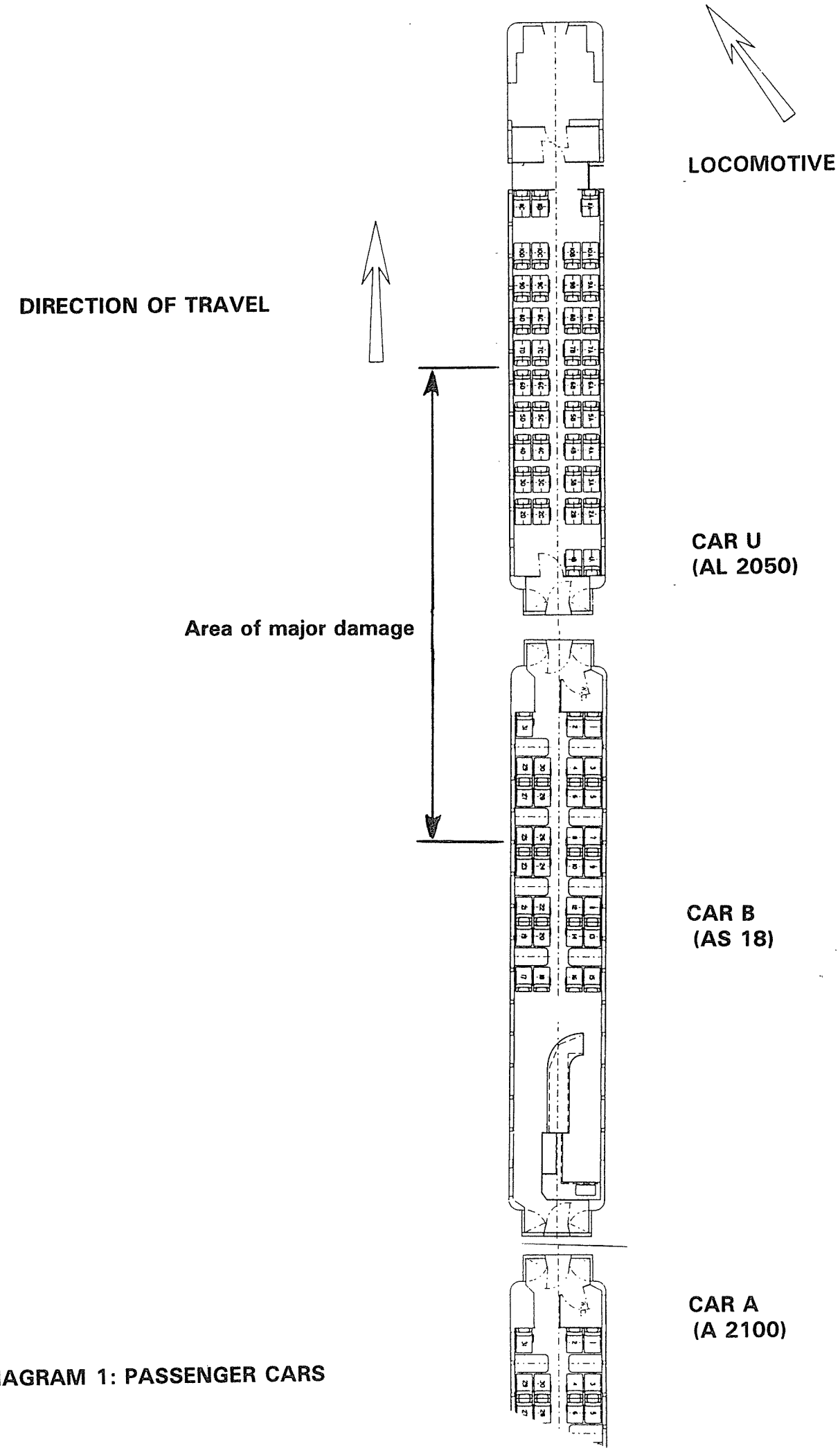


DIAGRAM 1: PASSENGER CARS

was established at the Rolleston Fire Station, and those passengers fit to travel later continued their journey south by bus.

1.10 The truck driver, despite severe damage to the cab of the truck, was able to crawl clear of the wreckage and was admitted to hospital with foot injuries. He was released the next day.

1.11 The truck had been dispatched from its owner's batching plant at Riccarton at 0830 hours, and was to deliver a full load of 4.6 cubic metres of concrete to a property near Burnham. The laden weight of the Hino truck was approximately 20 tonnes.

1.12 On the journey, the driver travelled at a maximum speed of 80 km/h on the open road, and was frequently overtaken by faster traffic. As he approached Rolleston, a number of cars had queued behind him, apparently awaiting an opportunity to pass. The driver slowed as he entered the 70 km/h restriction through Rolleston, intending to turn right at George Holmes Road. He pulled to the right of the southbound lane, allowing room on his left for the following traffic to move through, but the vehicle immediately behind the truck remained in that position, as if its driver also intended to turn right.

1.13 After allowing a car and van travelling in the opposite direction to pass, the truck driver commenced his turn into George Holmes Road; he had not needed to come to a full stop on State Highway 1 before making the turn. He was watching the rear vision mirror in the turn to see what the following traffic was doing, and estimated his speed as he approached the crossing to be between 20 and 30 km/h. The truck driver's description of the road traffic and the movements of his vehicle were consistent with the Locomotive Engineer's observations.

1.14 At this stage the truck driver had neither heard nor seen the crossing alarms or the train, and did not see the train until it had entered the crossing and was only one or two metres in front of him. He was unable to react in time to prevent the collision.

1.15 During the investigation, the possibility that the sun may have been a factor was considered. It was found that the sun's elevation and azimuth at the time of the collision had the potential to dazzle the truck driver and impair his view of the train, both via his external rear vision mirror as he was driving on State Highway 1, and while approaching the railway line. However, the driver stated that the sun's glare had not caused him any difficulty.

1.16 It was recognised early in the investigation that the design of the road intersection (see Diagram 2) adjacent to the railway crossing was probably a major factor in the accident. The Commission had investigated a similar type of accident near Levin on 28 May 1993, and found that the main road intersection adjacent to the railway crossing presented a high workload for drivers turning right from the main highway into the side road. The proximity of the railway crossing to the highway intersection gave drivers little recovery time or distance after having turned, in which to recognise that there may be a conflict with rail traffic (see Report 93-105).

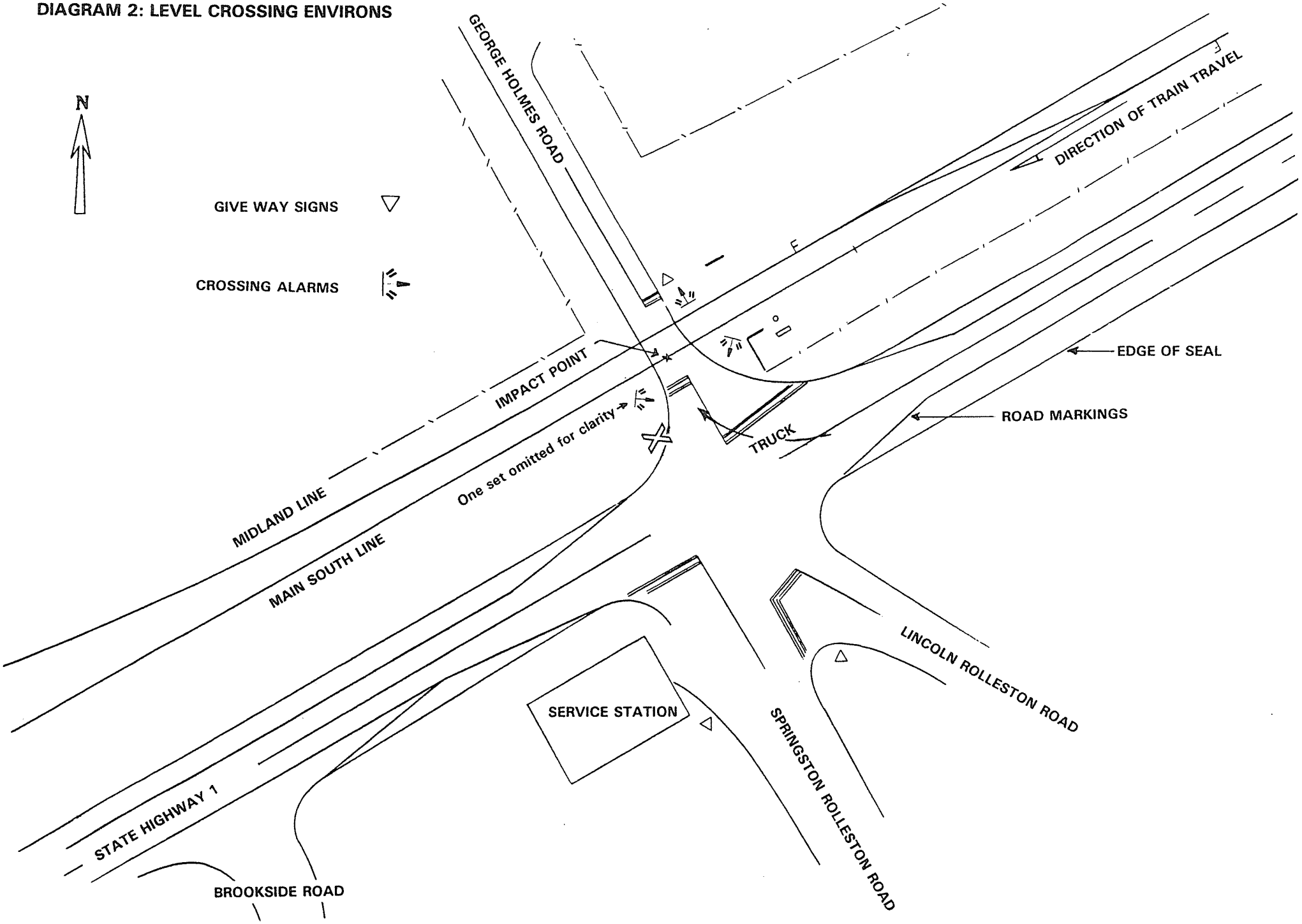
1.17 The following significant aspects of the State Highway 1/George Holmes Road intersection were noted:

a. State Highway 1 is only two lanes wide through Rolleston, with no turning or merging lanes. The layout of the intersection dictates that southbound traffic turning right from State Highway 1 into George Holmes Road often forces following traffic to move outside the marked lane onto the (sealed) road shoulder in order to pass. This can be distracting for drivers turning right, especially as the following traffic may not necessarily have slowed to the 70 km/h limit by this point.

b. Two additional side roads form a common intersection with State Highway 1 opposite George Holmes Road, and a third side road joins within 50 m of, and on the same side as these two. Traffic emerging from or turning into these side roads can present an additional distraction.

c. State Highway 1 runs close to the railway line at this point, so that the available stopping distance on George Holmes Road between the highway and the railway line is only 13.7 m. This represents very little distance or time in which to stop if a driver turns into George Holmes Road, and only realises that the level crossing is active after the turn has been completed. Additionally, there is not sufficient space for a truck and trailer unit, after entering George Holmes Road, to stop clear of the railway line without obstructing the highway, or conversely, on emerging from George Holmes Road, to stop clear of State Highway 1 without the rear of the combination sitting foul of the railway line.

DIAGRAM 2: LEVEL CROSSING ENVIRONS



1.18 The two-track railway crossing was protected by flashing lights and bells, as well as a supplementary "second train coming" sign on each side of the crossing, arranged to flash if two trains approached the crossing on different tracks. Three pairs of flashing lights were sited on the highway side of the crossing, one pair facing the intersection on the opposite side of the highway, and the other two aligned so as to provide advance warning for traffic approaching either way on State Highway 1 and intending to turn into George Holmes Road.

1.19 The three passenger cars on the train were variants of NZRL standard passenger stock, having been constructed originally in 1937 (Car A), and 1940 (Cars B and U), to a 1937 design. The cars consisted essentially of a steel underframe, wooden body framing with sheet steel sheathing and steel "anti-collision ends". The latter were steel frames, attached directly to the underframes, which enclosed the vestibule area at each end of the cars, and were incorporated primarily to protect the cars from "telescoping" in the event of a longitudinal collision.

1.20 The car body frames consisted of hardwood uprights, bolted to steel brackets welded to the underframe at the bottom, and bolted at the top to steel brackets connected to a timber rail which formed the edge of the plywood and timber roof diaphragm. Timber framing between the uprights and around the windows incorporated steel bracing which enhanced the longitudinal bracing. Transverse bracing was effected by the uprights themselves, and by the roof diaphragm and its connection to the steel end frames. The uprights were 100 mm by 100 mm, of good quality Australian hardwood.

1.21 This type of car has been the mainstay of NZRL's express passenger fleet since the early 1940's, and with progressive modernisation and modification, has continued to be so to the present day. Improvements to the basic cars in recent years included the replacement of the bogies by smoother-riding high-speed bogies, soundproofing, fixed seating as opposed to the earlier reversible seats, the use of fire-resistant materials in the interior finishings, and the replacement of the original laminated glass windows with tempered safety glass.

1.22 Car U (AL 2050) had been converted from its original configuration as a class "A" passenger car into an "AL" car-van, by the inclusion of a baggage compartment and a guard's compartment at one end. This configuration accommodated 41 passengers in the main body of the car, in a "high-density" seating arrangement. Car B (AS 18) had been modified by the incorporation of a servery counter at one end, and provided seating for 31 passengers in a "club" arrangement, with tables between each facing set of seats. Car A (A 2100) was configured in a similar "club" fashion and seated 45. AG 90 was a former "FM" brake van ("guard's van") to which had been added a diesel-powered 230-volt alternator, the train's primary electrical supply.

1.23 When the truck struck the locomotive and was spun to its left, the rear portion of the truck with some 10 tonnes of concrete continued in its original direction of travel, and struck the side of Car U. The worst effects of the impact began at row 6, and the penetration of the side of the car increased progressively towards the rear of the car. By the time the leading end of Car B was struck, the depth of penetration had reached approximately 750 mm. The concrete mixer rebounded clear of Car B by about the third set of seats from the front, and the total time taken to inflict the severe damage on the two cars was in the order of half a second.

1.24 Although the anti-collision framing at the trailing end of Car U and the leading end of Car B was severely damaged, it was evident that it had played a major part in flinging the concrete mixer clear, after which only comparatively minor damage had been inflicted on the following cars. On Car U, the wooden side framing members, and effectively the side of the car rearward of row 7, had broken inwards with the impact. The car had heeled over appreciably when struck, as had the locomotive, the latter to such a degree that the Locomotive Engineer thought that it would derail.

1.25 Two modes of failure of the upright framing members impacted by the concrete truck were evident. Several which bore the initial impact of the truck showed shear fractures at the level of the windowsills, and bending failure at the bolted brackets at the bottom. Uprights which were not impacted directly, but were loaded by the movement of the train past the truck, tended to fail initially by the tearing of the top bracket from the top rail, followed by a bending failure at the bottom bracket. The breaking of the uprights enabled the concrete mixer bowl to intrude into the leading car. It was in this area that the three fatalities and the most serious injuries occurred.

1.26 If the car body frames had been steel instead of wood, it is possible that the occupants would have been afforded better protection from the effects of the intrusion of the concrete mixer body. However, it was not practicable to determine if steel frames would necessarily have prevented any of the deaths or serious injuries that occurred in this accident, nor could it be said that the wooden-framed cars were inherently unsafe. The majority of railway accidents world-wide involve longitudinal impact forces, and design standards take this consideration into account, but it is unlikely that any rail passenger vehicle currently in service is designed to resist the type of impact experienced in this accident.

1.27 Other passenger vehicles acquired new by NZRL in more recent times have, consistent with international standards, all been steel-framed, examples including the "Silver Star" fleet, the "Silver Fern" railcars and the Ganz-Mávag electric multiple units.

1.28 No derailment occurred as a result of this accident, and this was probably significant in keeping the casualty numbers as low as they were in the circumstances.

1.29 The seats in all cars on the train were of a modern design with square-section steel tubular frames, attached to the car floor at two points, unlike their predecessors which attached to the floor at the aisle end and attached to a wall-mounted bracket at the other. Despite severe bending of their legs in the worst cases, all seats remained attached to the floor.

1.30 All windows in the passenger areas of the cars were of tempered safety glass, which breaks into small granules rather than sharp fragments. Eleven windows were broken on the impact side of Car U, and nine on Car B, resulting in the showering of the occupants with a considerable amount of shattered glass. However, no serious injuries resulted from the glass alone, but rather from the direct effects of the impact, flying debris and baggage, or a combination of these. The contrast between tempered glass and laminated glass was demonstrated when the window in an entry door was examined, the door having laminated glass which had broken into long sharp shards still partially attached to the plastic inner laminate.

1.31 Staff of NZRL could not recall any accident in which this type of passenger car was damaged to the same degree, since the Tangiwai accident in 1953.

2. FINDINGS

2.1 The train was being operated properly prior to the accident.

2.2 The crossing alarms were functioning normally at the time of the accident.

2.3 One set of warning lights was aligned towards the approaching truck driver as he made his turn into George Holmes Road.

2.4 The truck driver turned right into George Holmes Road from State Highway 1, but did not stop before the railway crossing.

2.5 The truck collided with the side of the locomotive, and was thrown off the road.

2.6 The concrete mixer bowl struck and severely damaged the first two cars of the train, and damaged the remaining two to a lesser extent.

2.7 Three persons seated in the leading car received fatal injuries as a result of the collision with the concrete mixer.

2.8 The truck driver had not noticed the crossing alarms before the collision, and did not see the approaching train until the collision was unavoidable.

2.9 A number of factors could have contributed to the truck driver's failure to notice the crossing alarms, but the layout of the road intersection, and the need to consider conflicting traffic were probably the major influences.

2.10 If the driver had noticed the crossing alarms after completing his turn into George Holmes Road, he would have had insufficient time or distance in which to stop his vehicle.

2.11 By the time the truck had turned into George Holmes Road, there was insufficient space in which to stop the train before it reached the crossing.

2.12 The passenger cars on the train, although constructed over 50 years ago, had been progressively modernised over their working lives.

2.13 The fact that the cars did not derail contributed to minimising the casualties.

2.14 It was not possible to determine if steel-framed passenger cars would have provided more passenger protection in this accident.

3. OBSERVATIONS

3.1 This accident had similar features to another accident investigated by the Commission, at Kimberley Road near Levin on 28 May, 1993. (Transport Accident Investigation Commission report 93-105). The Kimberley Road level crossing is also close to the intersection with the State Highway. There are many places throughout New Zealand where the railway runs parallel and adjacent to a major road, with the consequence that there is little room between the intersections with side roads and the level crossings. In many cases the gap between the intersection and the crossing is less than 20 metres, which is the legal maximum length of heavy truck and trailer combinations, so that such combinations must obstruct either the railway crossing or the intersection (or both) if they stop. For traffic turning from the main road towards the crossing, the distance is so short that it can be covered too quickly for some motorists to observe the crossing, react to any train approaching, and take action to avoid an accident.

3.2 Following the Kimberley Road investigation, it was recommended to Transit New Zealand that:

> They develop a code of practice for the design of intersections with closely adjacent railway crossings, taking into account the combined risks of accident that the two hazards present (056/93), and
>
> They develop a programme to review the adequacy of warnings to motorists at all intersections on State Highways which have railway crossings in close proximity (057/93).

Transit New Zealand responded as follows:

> *Recommendation 057/93 is being actioned through a working party involving Transit New Zealand, Land Transport Safety Authority, New Zealand Rail and local authority representatives considering revisions to signing and road marking at rail crossings. This activity is also a first stage toward developing a code of practice as in recommendation 056/93.*

9 February 1994

M F Dunphy
Chief Commissioner