



NO. 95-110

**WHARF SHUNTING SERVICE
COLLISION WITH FRONT END LOADER
KINGS WHARF, WELLINGTON
18 MAY 1995**

ABSTRACT

On Thursday, 18 May 1995 at about 0710 hours a remote controlled locomotive operated by New Zealand Rail Limited (NZRL) was returning light from Kings Wharf to Wellington Yard when it struck a front end loader foul of the line. As a result of the impact the Remote Control Operator riding on the front of the locomotive was thrown to the ground and picked up and dragged by the cowcatcher of the locomotive. The causal factor was the uncontrolled operation of the front end loader obstructing a main shunting leg serving Wellington Wharf. The safety deficiencies addressed in this report are the operational constraints necessary to ensure controlled integrated operation within Port of Wellington property, and the adequacy of operational agreements for similar rail served complexes.

TRANSPORT ACCIDENT INVESTIGATION COMMISSION

RAIL ACCIDENT REPORT NO. 95-110

Train Type and Number:	Wellington Wharf Shunt
Date and Time:	18 May 1995, 0710 hours
Location:	Kings Wharf, Wellington
Type of Occurrence:	Collision with front end loader
Persons on Board:	Shunt: 2 Front End Loader: 1
Injuries:	Shunting Crew: 1 Serious
Nature of Damage:	Minor damage to locomotive and front end loader
Information Sources:	Transport Accident Investigation Commission field investigation
Investigator in Charge:	R E Howe

1. NARRATIVE

- 1.1 On 18 May 1995 NZRL's normal Wellington Wharf shunt was operating within its defined work area on Port of Wellington Limited property in the vicinity of Kings Wharf when it collided with a front end loader foul of the track. Photographs of the accident site are shown as Fig. 1 and Fig. 2, and a plan of the area as Fig. 3.

Locomotive Movements

- 1.2 The wharf shunt on that day was provided by DSG 3249, a Remote Radio Controlled Locomotive (RCL) controlled by a Remote Control Operator (RCO) with one Train Examiner Operations (TXO) making up a two-person shunting service. In addition, the Wharf Wagon Recorder was assisting with protection of level crossings. All staff were appropriately certified for the duties being carried out.
- 1.3 At approximately 0710 hours the RCL was proceeding north from Kings Wharf towards Wellington Yard on the main shunting leg. The RCL was running light, ie, with no wagons attached, having just placed wagons on Kings Wharf.
- 1.4 The weather was fine at the time and the visibility was quoted as "reasonable" in the half light of sunrise. The locomotive headlight was operating in the direction of travel.
- 1.5 The RCO was riding on the left hand side cowcatcher step on the front of the RCL in direction of travel. The TXO was riding on the right hand side cowcatcher step on the rear of the RCL.
- 1.6 After leaving Kings Wharf and approaching the level crossing approximately 50 m south of the impact point, the RCL horn was sounded and the RCL was slowed down to approximately 10 km/h. The RCO was prepared to stop the RCL to allow the Wharf Wagon Recorder to finish recording the wagon numbers placed in the storage roads and then return with the RCL if desired. The flashing lights and bells were operating, having been switched on manually by the Wharf Wagon Recorder.
- 1.7 In the event, the RCL was not stopped as the Wharf Wagon Recorder had his car alongside the crossing and indicated to the RCO to proceed.
- 1.8 The RCL accelerated from the level crossing towards the impact point in response to commands from the RCO.
- 1.9 At a point approximately 18 m from the point of impact, the RCO saw the front end loader bucket appear on the left hand side of the track from behind the Maritime Building and moving towards the track. He realised the bucket was foul of the track, and his standing position, and immediately took evasive action by turning his back on the front end loader as he climbed over the buffer and took hold of the handrail on the opposite side of the locomotive.
- 1.10 As soon as the RCO took this action he released his hold on the "push to operate" control (PTO) on the transmitter control box.
- 1.11 On securing a hold on the opposite handrail, the RCO felt the impact with the front end loader which propelled him onto the ground in front of the RCL.



Fig. 1
General view of the approach to the point of impact looking South
towards Kings Wharf
(RCL in position it stopped)



Fig. 2
General view looking North towards the impact point
from Kings Wharf level crossing
(Taken following the erection of the barrier fence)

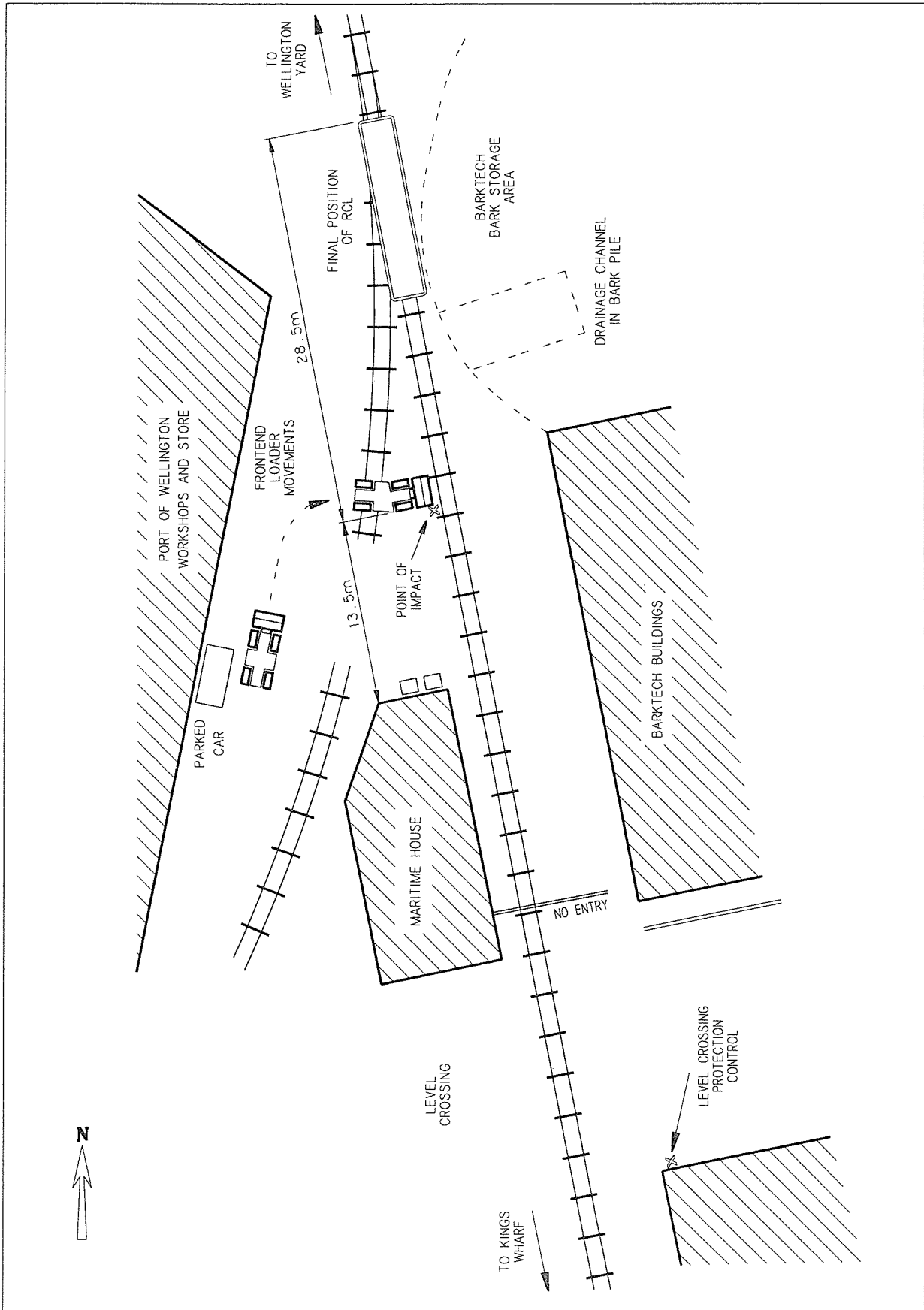


Fig. 3
 Layout Plan
 (Not to Scale)

- 1.12 As he rolled the RCL caught up with him and he was dragged feet first under the cowcatcher in a face down position. Whilst trapped under the cowcatcher and being pushed forward the RCO used his left arm on the cowcatcher to support his upper body and keep his head up. He estimated the locomotive then pushed him five metres before coming to a stop.

Front End Loader Movements

- 1.13 The one cubic metre capacity front end loader was under the control of a front end loader driver (Plant Operator) employed by Barktech, a division of Port of Wellington Limited. He was appropriately certified for the duties being carried out and was aware of the shunt working in the area. He had been with Port of Wellington Limited since February 1995 and had been specifically briefed on the rail line and the need for caution during Barktech operations. His previous employment had included forklift operation for which he had successfully completed a training programme in 1992.
- 1.14 On the morning of 18 May 1995 he had commenced his shift at approximately 0700 hours. On picking up the front end loader from its storage site he had driven it to the store, approaching from the south, and parked adjacent to it (refer Fig. 3). The front end loader headlights were not on but a flashing orange light on the cab roof was operating.
- 1.15 On completing his requirements at the store he drove the front end loader towards the track. His stated intent was to drive to the drainage access recently constructed through the bark pile and carry out maintenance work.
- 1.16 As he approached the track at slow speed he saw the RCL approaching on his right hand side at a distance of “20 to 25 m” and immediately stopped. He did not notice the RCL headlight, and stated his attention was caught by the high visibility chestpack worn by the RCO.
- 1.17 Eye witness reports and impact marks on the front end loader indicated that when stopped the front end loader was aligned skewed clockwise to the track (refer Fig. 3).
- 1.18 The front end loader driver saw the RCO move from the left hand side to the right hand side of the RCL. Realising he might be foul of the line and knowing he did not have time to engage reverse gear and back away, the Plant Operator turned his wheel while stationary to swivel the bucket anti-clockwise and thus bring it towards parallel to the track and further from centre line. While he was swivelling the bucket the collision occurred.
- 1.19 Impact occurred at a point 680 mm above rail level when the left hand leading side of the RCL hit the bottom of the front end loader bucket. Damage marks indicated a glancing blow which jolted the RCL and moved the front end loader.
- 1.20 The TXO was riding on the right hand side rear of the RCL facing back towards Kings Wharf when he heard a loud bang and felt the RCL shake. Fearing a derailment he looked towards the front and saw the RCO’s head and shoulders being pushed ahead of the RCL.
- 1.21 He dismounted and used his radio to contact the Wharf Wagon Recorder and request him to call an ambulance and then proceeded to the front of the now stationary RCL where the RCO lay under the cowcatcher.
- 1.22 The RCO was conscious and lying face down and trying to free himself. The TXO tried to assist, but realising he was making no headway, he instinctively climbed into the cab of the RCL intending to drive it in manual mode to free the RCO. He realised his lack of training and knowledge meant he could not do anything in this regard and he dismounted.

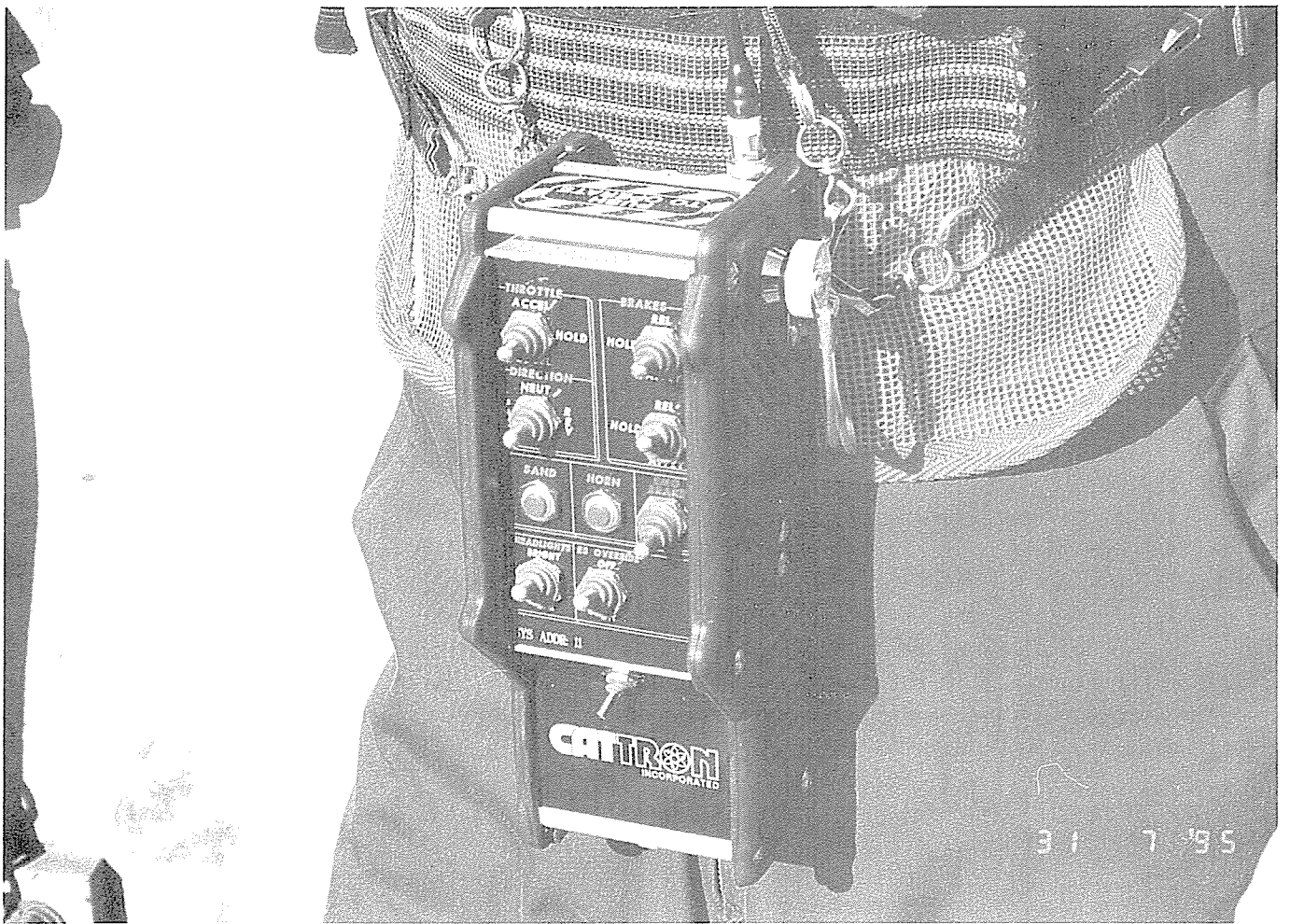


Fig. 4
Transmitter Control Box for Remote Controlled Operation

- 1.23 The front end loader driver had now arrived at the site and was asked whether he could lift the RCL. He ran back to his machine and drove it to the front of the RCL.
- 1.24 The bucket of the front end loader was used to lift the left front of the RCL approximately 50 mm, allowing the RCO to be freed. (During this operation the left hand side of the cowcatcher plate used as a lifting point was buckled.)
- 1.25 At approximately 0715 hours the ambulance arrived, and after attention the RCO left the site at 0731 hours, arriving at hospital at 0742 hours where he was admitted with serious injuries to his right leg.
- 1.26 The ambulance had been called at approximately 0712 hours by the Wharf Wagon Recorder. On receipt of the radio alert from the TXO he had driven the short distance to the front gate and dialled 111.
- 1.27 A further ambulance call had been initiated by the front end loader driver. After dismounting from his cab following impact, he ran to the front of the RCL. On seeing the situation he ran back to the store and advised the Supply Purchasing Officer of the accident and requested an ambulance. He then ran back to the accident site at which time the request to lift the RCL was made.

2. ANALYSIS

- 2.1 The damage marks on the RCL and front end loader confirmed that the front end loader bucket was almost parallel to the track at the time of impact. Initial contact was made on the right hand bottom face of the bucket with three further impact marks across the face. The damage to the RCL was minor.
- 2.2 The front cowcatcher height of the RCL (excluding that damaged by the lift) varied between 80 mm to 100 mm above rail level which complies with the minimum dimension from rail of 75 mm laid down in NZRL's Mechanical Code.

Remote Controlled Operations

- 2.3 Remote controlled operations are relatively new to NZRL's operating practices. Following original feasibility trials which commenced in 1987 and culminated in extensive trials and training during 1994, Wellington Wharf became one of the first operational systems in December 1994. The concept has now been extended to other locations and will be progressively introduced on a wider basis where operationally justified. When operating in Remote no staff is required in the locomotive cab.
- 2.4 Because of the short time since the introduction of remote controlled operations the investigation of this accident took particular note of the intended and actual performance of the equipment, and the staff trained and certified in its use.
- 2.5 Remote controlled operation is based on controlling a locomotive using a radio transmitter (Fig. 4). As used on NZRL the transmitter is mounted on a high visibility chestpack worn by the RCO (Fig. 5).
- 2.6 The system makes use of digital transmission. This means that over the radio link between the remote control transmitter and the locomotive, the operation of the control sends a string of



Fig. 5
Chestpack mounting of controls for Remote Controlled Operation

pulses just like a message in morse code. The first part of this code is used to ensure that only the specific locomotive to which the instruction is addressed will accept and act on it.

Each radio control transmitter is pre-set to work with the receiver mounted on the locomotive and programmed to recognise only commands addressed to it by that transmitter.

After accepting the signal the receiver passes the command to the interface decoder. This unit identifies the type of command and sends instructions through various electrical circuits and relays to the locomotive controller.

The controller unit in turn operates the locomotive producing the same responses as when the locomotive is driven manually.

- 2.7 The main feature of the transmitter control box relating to this accident was the functioning of the PTO. The PTO must be depressed to operate the throttle and to release locomotive and train brakes. If the PTO is released the throttle will immediately dump to idle and the locomotive brakes will begin to apply.

The PTO is also programmed to act as a vigilance control with the following functions:

- Three seconds after the release of the PTO the locomotive train brakes will also be commanded into an emergency application (all pressure dumped from the brake pipe).
- If the PTO is released for more than one minute the horn will begin to sound automatically.

The PTO bar is provided as a “dead man’s handle” feature and is operated with the palm of the hand leaving fingers free to operate the other controls.

- 2.8 A further feature built into the transmitter controller is a tilt switch. If the controller tilts for more than three seconds, the throttle will immediately be returned to idle and locomotive brakes will begin to apply.

Three seconds after the tilt has occurred the train brakes will be commanded into an emergency application (all pressure dumped from the brake pipe). If the controller has tilted for more than one minute the horn will begin to sound automatically.

Control of the locomotive will be returned to the operator upon returning the transmitter to its upright position and depressing PTO.

- 2.9 The transmitter control box in use on the day of the accident was damaged and inoperable following the collision. The position of all control levers on the recovered box were consistent with the operation of the RCL prior to the impact based on the RCO’s reported action of releasing the PTO when taking evasive action, with the exception that the emergency brake control was in the “applied” position. This switch is not spring loaded and its position is considered to be a result of the damage suffered following impact.

- 2.10 To confirm the response of the RCL to commands received during the accident a different transmitter control box was tuned to Locomotive DSG3249 and trials were carried out at a range of speeds using release of PTO to command the locomotive. Tests were also made using the emergency brake switch for comparative purposes. Results of the trials when applied to the known facts relating to the accident were consistent with a PTO release stop, based on the following assumptions:

- The speed of the RCL at the time the RCO and front end loader driver saw one another was approximately 24 km/h.
 - The RCL slowed from 24 km/h to 20 km/h during the approximate three seconds from sighting to impact (the time recollected by the witnesses). No emergency braking would have been applied and deceleration due to throttle release and normal brake application would have been minor over the short distance involved.
 - The reaction time for the RCO to release the PTO following sighting was 0.5 seconds.
- 2.11 The above results in a distance of 44 m from hands off PTO to RCL at rest position, which is consistent with a PTO stop at 24 km/h in the trials.
- 2.12 The assumed speed of 24 km/h is consistent with the acceleration characteristics of a DSG locomotive in remote control mode accelerating from 10 km/h over the approximate 30 m from the southside of the level crossing to the point where the RCO reported first seeing the front end loader, ie, approximately 18m from the point of impact.
- 2.13 Sand on the rails immediately after the impact point was consistent with emergency braking being applied three seconds after the PTO release (sand is automatically released to the head of the rails on emergency brake application).
- 2.14 25 km/h is the maximum allowable speed over the shunting leg from Kings Wharf to Wellington yard.
- 2.15 The NZRL alternative to remote control operation is Audio Shunting Procedure (ASP). This is the most common shunting system used on NZRL. To further assess the significance of remote control operation to this accident, the likely scenario had ASP operation been in place was considered.
- 2.16 ASP is based on maintaining contact between the locomotive engineer and ground shunting staff with a system of instant audio contact by use of radios. Had ASP been in effect when returning from Kings Wharf a three person shunting gang would have been involved, ie:
- One locomotive engineer
 - One senior shunter
 - One shunter
- 2.17 When running light to Wellington Yard under previous ASP operations on Wellington Wharf, common practice was for both the senior shunter and shunter to ride on the front of the locomotive, although one on the front and one on the back also occurred. One member of the gang had to ride on the front to maintain line of sight, a requirement of ASP operation due to the restricted vision of the locomotive engineer from the cab.
- 2.18 In the movement in question, one member was required to ride on the front left hand side of the locomotive to maintain line of sight around the approaching right hand curve (the position of the RCO prior to the accident) with the possibility that a second member could have been present on the front right hand side.
- 2.19 It is considered unlikely that a locomotive engineer would have seen the front end loader from his cab driving position. Under ASP he is not relied upon to ensure a range of vision because of the limited visibility from the cab. It is for this reason that a member must ride on the front of the locomotive with instant audio contact with the locomotive engineer by radio.

- 2.20 Assuming similar speed and sighting warning, and taking account of the instinctive self preservation actions exhibited by the RCO prior to the accident, it is considered any shunting staff on the left hand side of the locomotive would have acted similarly and there would have been no radio contact with the locomotive engineer.
- 2.21 With one person on the front of the locomotive a scenario similar to the accident is considered just as likely. With two on the front the outcome would depend on whether the member on the right hand side remained on the locomotive prior to impact or jumped off. Either way the probability that one man was propelled ahead of the locomotive is considered at least the same as the accident scenario.
- 2.22 The key variable factor in comparing the two operations is the locomotive stopping distance. For ASP operation the worst scenario is that the locomotive engineer would have had no warning prior to impact. Impact at 24 km/h with due allowance for reaction time to apply emergency brakes would have resulted in the locomotive stopping within approximately 35 m from impact point. In the event the RCL came to rest 28.5 m from the impact point. Any sighting of the front end loader by the locomotive engineer under ASP operation would result in a related shorter stopping distance.

Front End Loader Operation:

- 2.23 The front end loader driver's stated intent was to drive over the shunting leg at about the impact point and turn and proceed north towards the drainage channel. The indicated position of the front end loader with respect to the track at impact (i.e. skewed clockwise to the track) did not fully support this intended manoeuvre. The front end loader driver could not explain this apparent misalignment.
- 2.24 Access to the bark pile was required approximately once or twice a week from the rail track side for maintenance purposes. As well as maintenance at the formed drainage channel there was a need to remove excess bark from the track vicinity and tend to potential fires.
- 2.25 Eye witness reports indicated the front end loader had also been driven to the store on many occasions for "bits and pieces", at which times it was normal to approach the store from the south, park adjacent, complete requirements, and then do a three point turn towards the railway line and exit to the south.
- 2.26 It was apparent that front end loader movements with the potential to foul the shunting leg were relatively common in the vicinity of the point of impact.

3. FINDINGS

- 3.1 The RCL was being operated normally prior to the accident.
- 3.2 The front end loader was being operated normally prior to the accident and was carrying out a common movement associated with operations between the store and the bark pile.
- 3.3 The front end loader was allowed to obstruct the rail track in such a position and manner that collision was unavoidable.
- 3.4 The RCO's actions from sighting to impact were instinctive.

- 3.5 The behaviour of the RCL was to NZRL's performance requirements in terms of response times and actions.
- 3.6 There was no evidence that the remote controlled operation contributed to the collision or its consequence.
- 3.7 The RCO's presence of mind in supporting his torso while being pushed was a major factor in limiting his injuries.
- 3.8 The prompt emergency call and particularly quick response of emergency services ensured early and effective medical attention.
- 3.9 There are no agreed procedures for the control of potentially conflicting operations arising from the activities of NZRL and Port of Wellington Limited on Port of Wellington land.
- 3.10 Port of Wellington Limited had insufficient barriers and procedures in place to avoid common and accepted front end loader operations in the impact area obstructing the NZRL shunting movements in an area of restricted view lines.

4. SAFETY ACTIONS

- 4.1 As a result of the accident and liaison during the course of the investigation the following safety actions have been taken by Port of Wellington Limited:
 - 4.1.1 The bark pile has been pushed back from the rail track and a drainage channel has been formed.
 - 4.1.2 A one metre high permanent Armco barrier has been erected between the rail track and the adjacent sealed area (a temporary barricade was erected immediately following the accident).
 - 4.1.3 A contract has been let to install electronic gates to control the rail access to Kings Wharf.
 - 4.1.4 Since the accident the Plant Operator has passed the requirements for a Class G & I licence covering operation of the front end loader off Port of Wellington Limited land. (This was not a mandatory requirement for operations on Port of Wellington Limited land but considered desirable by Port of Wellington Limited.) In addition he has attended a further forklift competency course.
 - 4.1.5 NZRL and Port of Wellington Limited have commenced meetings to establish operational constraints necessary to ensure controlled integrated operation of both companies on Port of Wellington Limited property.

5. SAFETY RECOMMENDATIONS

- 5.1 It was recommended to the Managing Directors of NZRL and Port of Wellington Limited that they:
 - 5.1.1 give priority to completing workplace operating plans for both NZRL and the Port of Wellington Limited covering the operational constraints necessary to ensure

controlled integrated operation of both companies on Port of Wellington Limited property, and that such plans are reviewed, updated and compliance checked to continually maintain a safe operational and work environment. (039/95, 041/95)

5.2 It was recommended to the Managing Director of NZRL that he:

5.2.1 review the adequacy of similar integrated workplace operating plans for NZRL and other port authorities or other similar operating complexes where the size of operation and/or scope of activities are such that unacceptable operational conflict may exist, and initiate action where necessary to ensure a safe operational and work environment. (040/95)

5.3 The Managing Director of NZRL responded:

“NZRL notes the recommendation as amended following our comments and advises that action has been initiated to implement the safety recommendations.” (039 and 040/95)

5.4 The Managing Director of Port Of Wellington responded:

- a) *“Port of Wellington intends to comply fully and adopt the Safety Recommendation, and has already implemented measures to do so.*
- b) *Implementation is already under way, and continuous improvements to operations will progress. A first joint operational plan is already in place.*
- c) *Port Wellington has no impediments to implementing a joint operating plan.” (041/95)*

17 October 1995

M F Dunphy
Chief Commissioner