Rail Corridor Safety in New Zealand – Issues and Observations

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Abstract

This paper considers whether rail transport is inherently safe, and argues that it is not, and that the relatively good safety record is the result of sound systems and the vigilance of management and staff.

The weakest aspect of rail safety in New Zealand is the interface between the public and rail, at level crossings and along the corridor where trespassing is common. Problems with legislation and policies, funding, technology, land-use planning and traffic management are briefly described, and some possible courses of action suggested.

About the Author

Bill Guest is a civil engineer who has spent all of his career in transport, mainly in railways. He completed a BE at Canterbury in 1968, and an ME from Auckland in 1976. He has recently worked in the Rail Safety Section of the Land Transport Safety Authority as Senior Engineer Special Projects, and has just taken up the position of Safety Manager with Connex Auckland Ltd.

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Introduction

This paper considers whether rail transport is inherently safe, and argues that it is not, and that the relatively good safety record is the result of sound systems and the vigilance of management and staff.

The weakest aspect of rail safety in New Zealand is the interface between the public and rail, at level crossings and along the corridor where trespassing is common. Problems with legislation and policies, funding, technology, land-use planning and traffic management are briefly described, and some possible courses of action suggested.

The appendix refers to sections of legislation that have a bearing on level crossings and corridor safety.

Is Rail Inherently Safe?

A dictionary defines "inherent" as an adjective meaning "existing in someone or something as a natural and inseparable quality, characteristic, or right; innate; basic; inborn." Inherently, of course, is the adverb.

From time to time I have seen rail transport described as "inherently safe" by contrast with road transport, with the difference in deaths and injuries between the modes cited as the "proof" of the statement. It is a fallacious argument.

To be inherently safe, a thing (object, person, animal, machine, or system) must not cause or contribute to harm in the event of any unexpected or unplanned event involving it.

Consider the nature of a railway. Rail's fundamental economic advantage for some types of transport is the low rolling friction of the steel wheel on the steel rail. This enables low power to weight ratios, so that large trains can be pulled with just a few locomotives. But the low rolling friction derives substantially from the low deformability of the steel wheel, and this in turn affects the adhesion of the wheel on the rail[1]. Low adhesion makes trains impossible to brake in short spaces, while the guided nature of the track makes it impossible to swerve. In addition, the cost of the track makes it essential on all but densely trafficked routes that trains move in both directions on a single line, using occasional crossing loops to pass.

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[1] The American Railway Engineering and Maintenance of Way Association (AREMA) cites adhesion figures as <10% on "slimy wet rail" ranging to 40% on dry rail under a locomotive with sand applied. Hay (1982) states that typical design and analysis values are in the range 18% - 25%. By contrast, Noon (1994) gives common friction coefficients for motor vehicles as 50% on wet asphalt and 65% on dry asphalt.

In other words, a railway typically consists of heavy masses of vehicles moving in conflicting directions along a single track, when the vehicles are unable to swerve, and unable to brake in short distances. A railway is not inherently safe.

Comparative statistics, however, show that modern rail traffic is safe[2]. Why is this so?

The answer lies in the controls that have been developed over almost 200 years of railway history. There are three broad classes of controls:

1. Signalling systems have been devised to ensure that only one train has a right to occupy a section of track at any time. The signals, supported by rigorous inspection and maintenance procedures, are highly reliable. A fundamental principle of the signal engineers' art is that signals should "fail safe" i.e. if a fault occurs, a red (stop) indication will display rather than green (go).

2. Operations systems provide additional control by planning achievable schedules, providing clear and unambiguous rules for train operations, and monitoring the progress of trains during their journeys. Nowadays computers are integral to train control. Increasingly, software monitors data from remote control sensing devices and alerts Train Control if unexpected conditions are occurring.

3. Railway staff are all bound in a common cause by employment and commercial contracts that treat the railway as a system. Locomotive Engineers, for example, are well aware of the need to obey the speed limits set down by the engineering and operating staff. Similarly, they do not deliberately disobey any signal or operating instruction, not because there may be a prosecution or infringement notice issued, but because they understand the consequences. Training and regular refresher courses are a feature of every railway staff member's life. Operating irregularities are routinely recorded and investigated with a view to avoiding repetitions.

I listed these classes as "controls" because deviations from them are monitored and investigated as part of safety management. Of course, a great deal of design and construction work also contributes to safety – automatic train brakes, robust drawgear, modern track design, and so on. A railway is a highly technological enterprise.

Even in electrified areas where the overhead traction may have a potential of 25,000 volts, accidents are rare. The design and construction of electrical systems is so robust that circuit breakers will normally trip before any serious harm is done (except, perhaps, to the occasional individual who is foolhardy enough to climb on to the top of a train or structure).

[2] See, for example, the paper "Crossmodal Safety Comparisons" posted in the Aviation Safety Research section of the website of the Australian Transport Safety Bureau.

It may not come as a surprise, therefore, that the main sources of trauma associated with rail transport are collisions (1) with vehicles or persons at level crossings, and (2) with pedestrians trespassing on the railway corridor.

Figures from the Auckland Metro area[3] for the last 10 years are:

	Deaths	**Serious Injuries**
Level Crossings - motor vehicles	2	7
Level crossings - cyclists and pedestrians	6	3
Train collision with pedestrians (inc suicide)[4]	40	17

A current concern is that the trebling of train services in Auckland as planned over this decade will lead to an increase in deaths and injuries.

Defences Against Accidents

A defence is a technique, procedure, object, or system that can reduce or eliminate the probability that harm will be caused by a hazard. In other words, anything that can protect against an accident.

All defences are designed to serve one or more of the following functions[5]:

No.	Description	Examples
1	to create understanding and awareness of the local hazards	warning signs, lighting, training/education
2	to give guidance on how to operate safely	manuals, operating instructions, training
3	to provide alarms and warnings when danger is imminent	alarms eg flashing lights, bells, sirens, smoke alarms
4	to restore the system to a safe state in an off-normal situation	cut-out devices, emergency lighting, smoke removal fans
5	to interpose safety barriers between the hazards and potential losses	guards, fences and gates, half-arm barriers, fire doors, overbridges, underpasses, gas masks, safety goggles
6	to contain and eliminate the hazards should they escape the barrier	water sprinklers (fires in buildings), trap points (railways), overshoot areas (on roads), bunds (around oil tanks)

[3] Data reported by Train Control to LTSA at time of occurrence.
[4] It is not possible to say with certainty how many trespasser deaths were suicide. The author's brief review of the descriptions of the collisions leads him to believe that about 40% of the deaths probably were deliberate. The serious injuries were probably mostly or all accidental.
[5] Table adapted from "Managing the Risks of Organisational Accidents", James Reason, (1997) Ashgate Publishing, p7

7	to provide the means of escape and rescue should hazard containment fail	fire escapes, life rafts, rooftop helicopter pads

Defences may not be equal in either cost, or effectiveness. For example, signs are likely to be cheaper that a barrier, but they are quite ineffective if they are not read, understood, and acted upon.

Defences-in-depth is the concept of having multiple defences in order to reduce the probability that harm will be caused. The idea is that all defences in place against a hazard must fail for an accident to happen. It might be better, for example, to use two or three moderately priced defences rather than a single expensive one.

Economically, it is sensible to keep the cost of defences commensurate with the risk that an accident will occur. The Land Transport Safety Authority is charged in section 189 of the Land Transport Act 1998 with promoting "safety at reasonable cost". This section reads:

> **189. Principal Objective of Authority –** (1) The Authority's principal objective is to undertake activities that promote safety in land transport at a reasonable cost.
> (2) For the purposes of subsection (1), a cost is a reasonable cost if the value to the nation is exceeded by the value of the resulting benefit to the nation.

A problem in this concept is that the responsibility for assessing the costs and values, and for paying for the defences may not always be clear. In respect of railway level crossings, and especially when considering any one crossing in isolation, my experience as a railway engineer is that it is very difficult to make such an assessment. There are some 1400 or so level crossings over the New Zealand railway network. The cost of providing defences such as signs, road markings, flashing lights and bells, and half arm barriers at a single crossing can be estimated fairly readily, but the probable benefits of the defences are very hard to estimate.

LTSA will shortly be replaced by a new entity, Land Transport New Zealand (LTNZ), which will be charged with implementing the government's 2010 transport policy. The present funding agency, Transfund, will also be subsumed into the new LTNZ. It is not yet clear how the tension between funding and safety will be balanced.

Defences at Level Crossings

The defences available to prevent collisions between trains and vehicles or people at level crossings or places along the rail corridor are:

No.	Description of Generic Defence	Examples
1	to create understanding and awareness of the local hazards	Warning signs, lighting, training/education
2	to give guidance on how to operate safely	Signs, training/education
3	to provide alarms and warnings when danger is imminent	Alarms eg flashing lights, bells
4	to restore the system to a safe state in an off-normal situation	Not generally applicable on level crossings – but perhaps restricting the speed of trains approaching crossings would enable errant motorists and pedestrians time to recover. (Not a popular concept for the railways.)
5	to interpose safety barriers between the hazards and potential losses	Fences and gates, half-arm barriers, overbridges, underpasses
6	to contain and eliminate the hazards should they escape the barrier	Not applicable to level crossings
7	to provide the means of escape and rescue should hazard containment fail	Not applicable to level crossings

Not all of the defences listed in the table are yet used widely in New Zealand. In particular:

- Although some education has been undertaken in schools at the expense of Tranz Rail Ltd, there is no regular funding for on-going safety programmes in schools.

- Automatic gates are not in use on pedestrian crossings.

However, there is a range of other fundamental problems in improving rail corridor safety in New Zealand.

Legislation and Policy

There are two broad classes of crossings – statutory and granted. The rights attached to each are different, but the risks are the same. History has altered the circumstances under which many crossings were formed.

There is no statutory obligation on either road or rail authorities to:

- Make reasonable and regular risk assessments of crossings
- Develop safety improvement plans for crossings
- Install active alarms
- Provide funds for crossing improvements including alarms
- Provide fencing of the road and rail corridors – even near or at crossings in urban areas

There is no procedure in statute or anywhere else for reviewing crossings with a view to closure of some.

The options available to Police and Councils to enforce laws and regulations relating to trespass on the railway are not as effective (potentially) as they are for road. For example, instant fines (infringement notices) are not available.

The Land Transport Safety Authority (LTSA) does not have the power to require alarms to be installed or upgraded at crossings. The Authority can require a variation to the rail safety system of an operator if it "….considers it necessary in the interests of avoiding a significant risk of death or injury" (section 6F(1) of the Transport Services Licensing Act 1989). The most likely action that LTSA could take using this power would be to stop trains, or require speed restrictions (as was done for unstable CWR when LTSA could not issue an order to fix the problem).

Funding of Level Crossing Safety Measures

Responsibility for funding new or upgraded crossing alarms is not laid down in statute. Tranz Rail continued a practice inherited from the former government-owned railways of providing some funds, but had a policy of requiring a contribution from the roading authority concerned. Tranz Rail also specified the level of protection it would fund, and set the priority for work. If a roading authority wanted work done earlier than Tranz Rail's priority list, or wanted a higher (more expensive) level of protection, Tranz Rail expected the roading authority to pay all the costs.

However, Tranz Rail then accepted responsibility for inspections and maintenance of active alarms.

There has been no obligation on Tranz Rail, or on any roading authority, to provide a budget for alarms and other improvements at crossings.

It is not at all clear that past policies have led to an acceptable outcome for New Zealand. LTSA has not had a direct say in the setting of policies, priorities, and standards for level crossing safety other than for road signs. Tranz Rail placed its level crossing policies and standards into its rail safety system (of which they formed a very small part) and the entire system was approved in accordance with the relevant sections of the Transport Services Licensing Act 1989.

Technology

The technology of level crossing alarms in New Zealand is very traditional i.e. old. For examples:

- While some crossings have been fitted with LED lights, most still have low powered lamps that rely on a focused lens with a narrow field.
- The activation time is mostly fixed, and not related to the speed of the approaching train.
- Alarms are all linked to track circuits. There have been no trials of alternative methods of train detection and alarm activation.
- Automatic pedestrian gates have only been installed in two places, and one of those has since been removed. Tranz Rail considered them unsuccessful. However, the writer believes that the design was poor and the locations very difficult, and the results should not have been interpreted to be a conclusive rejection of all pedestrian gates.
- Bells may be outmoded as an aural alarm. There is anecdotal evidence that they are especially unsuitable in double tracked areas where trains may be on either track.

The current Toll Rail method of assessing priorities (inherited from NZ Government Railways via Tranz Rail) could be upgraded with a more comprehensive risk assessment method e.g. a method developed in recent years by Queensland Transport to take into account a wider range of risk factors than the number of trains and the vehicle counts.

One advantage of the Queensland methodology appears to be that it requires the active input – and hopefully, therefore, part ownership of the results – by the territorial authority. The understanding of the risks associated with a crossing, or group of crossings is therefore spread more widely than just the railway authority

Note that a priority list is of little value if funds are not available to ensure that installation proceeds.

There appears to be no sound method used in New Zealand for calculating cost-benefit analyses for individual level crossings. Safety alone is not generally a sufficient reason for installing alarms, and a combination of safety and impacts on traffic delays needs to be considered.

The regulator (LTSA) does not have a comprehensive database of information relevant for assessing the risk of crossings. Toll Rail/TrackCo does have a comprehensive list of crossings, but does not have up-to-date data on vehicle and pedestrian counts. The Queensland assessment model does require a lot of information that we do not currently have electronically, or do not have at all.

Land-Use Planning and Traffic Management

A recent proposal to close a crossing in Auckland foundered when it became obvious that the narrow street provided a useful route for a significant number of motorists who were otherwise unable to make turns between Dominion Road and New North Road. The generic issue is the management of traffic in relation to the railway corridor and the crossings.

When a station is close to a crossing, a train that has stopped for passengers will still activate the alarms. This leads to excessive delays to motorists, and provokes impatience – and occasional unsafe acts such as "racing the barriers" or worse still, "zig-zagging". The author recently observed a 2 minute 30 second delay at Takanini while three trains (two northbound, one southbound) passed. By the time the alarms cancelled, the stacking of traffic extended well into the nearby intersection with Great South Road. This is a traffic management issue that has a bearing on decisions about closure, or grade separation.

People often have legitimate reasons for crossing the rail corridor. The demand for crossings can be reduced by attention to land-use planning. Two recent examples:

- Behind the old Auckland Railway Station, high density residential apartments have sprung up on the site of the old Road Services Depot. Access to these homes is by way of the Strand. However, the nearest fast food outlets – McDonalds, KFC, and Subway – are on the other side of the main lines into Britomart Station. They front on to Quay Street. The nearest legal crossing is the Strand overbridge, about 400 metres to the east. In other words, about an 800 metre longer route than cutting directly across the railway. And cutting is exactly what is done. The fences have been cut many times to allow trespassers to move directly to the outlet of their choice.

- In the Hutt Valley near Wellington, a private secondary school received resource consent to be established on a site near to the railway corridor. A short time after opening on the site, the school demanded that a new pedestrian crossing with alarms and barriers be established to cater for pupils who were taking a direct route to the nearest shops.

In many places the rail corridor is significantly wider than is required by the tracks. Sometimes this is because a station once had freight sidings that have long since been removed. The surplus land appears to be open public space, and there is usually easy access for people. The grassy spaces are inviting to people for walking, playing , or exercising animals. However, the railway tracks are not fenced off from the open spaces.

Speed of Trains Over Level Crossings

I am not a lawyer. However, I am able to advise how I have interpreted the law in recent years. I believe that my views are the same as many other persons in the railway industry. The key issues in my interpretation are:

- Section 3(1) of the Railway Safety and Corridor Management Act (RSCM Act) makes it clear that a railway operator is entitled to assume that all persons will be kept clear of rail service vehicles using the line.

- Section 3(4) eliminates the right of any person to be on the track when any rail service vehicle is within 800 metres.

- Section 4 of the RSCM Act makes clear that all persons must keep clear of the railway if there is any risk of collision with a rail service vehicle.

- Section 24(1)(g) of the RSCM Act provides for a penalty upon summary conviction to imprisonment for a term not exceeding 6 months or to a fine not exceeding $20,000 for anyone who knowingly enters the railway without lawful authority.

On the basis of these provisions, I have always considered that a railway operator is entitled to assume that the track is clear in front of a train, and may therefore travel a normal line speed. I cannot speak on behalf of all operators, but I note that trains in New Zealand pass over level crossings every day at normal line speed, which may be 100 km/hr for passenger trains and 80 km/hr for freight trains.

Note that the penalties in the RSCM Act are considerably greater than the $10 fine imposed on pedestrians under the Traffic Regulations for failing to comply with traffic signals.

Observations

1. A railway operator is not obliged to install alarms and barriers at level crossings. (Section 5(3) of the RSCM Act).

2. Both road or rail operators are exempt from the provisions of the Fencing Act, even at level crossings.

3. Tranz Rail Ltd maintains a list of crossings that the company believes are the top priorities for installation of new or upgraded alarms.

4. Tranz Rail Ltd assigns a budget for crossing alarms, and expects the roading authority to make a contribution towards the capital cost of installation.

5. The size of Tranz Rail’s budget is not under the control of LTSA.

6. LTSA is not a funder of crossing alarms. (It is possible that the new LTNZ may have such a role.)

7. LTSA does not direct or regulate the type of alarm installation to be installed at any crossing.

8. Nothing in the law requires roading authorities to make their own assessment of the safety of level crossings, prepare crossing priority lists, prepare crossing improvement plans for the safety of the public in their areas, or assign funds for such work. (It is acknowledged that some authorities have done so, however.)

9. The law as it stands does not encourage efforts to achieve safety at reasonable cost at level crossings. However, a combination of the law and Toll Rail Ltd’s policies as I understand them places the decisions on crossing alarms where they probably should be: a matter for negotiation between the railway and the roading authorities.

10. Following the two accidents on the Silverstream railway pedestrian crossing in 2003, Toll Rail Ltd has indicated a willingness to include automatic gates in the list of possible defences for installation at pedestrian crossings. However, this does not guarantee that funding will ever become available and such gates installed. Nor does it mean that more money might become available for new and upgraded alarms throughout New Zealand.

11. The law makes it an offence to be on the track when a train is near. This approach is of no use in considering how to deal with human error. The law does not encourage modern “systems” thinking in dealing with level crossing safety, or corridor safety generally. While it does not forbid such an approach, there is no obligation for all the relevant parties to engage in the process. Funding appears to me to be part of the problem.

12. Surplus land on the rail corridor, especially in urban areas, looks like open public space, especially where the land is reasonably flat and grass is mown to keep weeds down. This encourages trespassing. However, the tracks are not fenced or marked off with some sort of barrier.

13. Public education programmes about rail corridor safety have been undertaken almost solely by Tranz Rail Ltd. There is a need to broaden the support base by including other operators, and the regulator.

Suggested Courses of Action

I have refrained from saying just which organization or person I think should take the lead in initiating or managing the courses of action outlined below, because it is not my place to do so.

However, the outcomes expected from each course of action are (I believe) reasonably clear.

Legislation and Policy

There is clearly a need for a comprehensive review of existing legislation, regulations and policies to identify amendments that would improve rail corridor safety. A harmonization of the principles of managing transport corridor safety across all modes would be beneficial, as would clarification of the responsibilities for providing programmes and priorities for safety improvements.

A review of legislation needs political support. Consultation with rail operators, Railways Corporation, Regional and territorial authorities would be essential.

Funding

Responsibility for level crossings (from a railway perspective) will pass from Tranz Rail/Toll Rail to the Railways Corporation shortly. Now would be an appropriate time for a review of responsibilities funding safety improvements. A study should also be made of cost-benefit methods used overseas for level crossing safety expenditure for the purpose of preparing a standard practice in New Zealand. The review should include consideration of the sources of funding crossing safety improvements.

Technology

1. Responsibility for defining the range of active and passive warnings at level crossings should be placed with the Railways Corporation with strong formal input from LTSA/LTNZ. (At present, LTSA has to influence codes and standards through the rail safety system).

2. A comprehensive database of level crossings should be constructed, with access available to all interested parties. Railways Corporation should would clearly be involved in this work, hopefully with strong formal input (and possibly some funding) from LTSA/LTNZ.

3. The Queensland Transport risk assessment technology for crossings should be trialled in New Zealand, with a view to adopting a better methodology than the current method used by Tranz Rail and its predecessors.

Land Use Planning and Traffic Management

Organisations such as the Local Government Association, the Transportation Engineering Group of the Institution of Professional Engineers, and the New Zealand Planning Institute should be encouraged to recognise the potential for land-use planning to reduce conflicts between trains and vehicles and people.

Education and Training

Road safety education programmes, especially in schools, should be broadened to include rail corridor safety.

Appendix

References to Legislation and Regulations Relevant to Level Crossings and Rail Corridor Safety

Legislation *(Numbers cited are the sections of the Acts)*

Public Works Act 1981

166. Power to make railways, railway stations, etc—
169 Access to land cut off from road or separated by railway—

Railway Safety and Corridor Management Act 1992

3.Rail service vehicles to have right of way—
4.Traffic at level crossings—
5.Warning devices at level crossings—
8.Railway crossings—
24.Safety offences—

Fencing Act 1978

3.Application of Act—

Regulations Specific to Level Crossings *(Numbers cited are the regulation numbers)*

The Traffic Regulations 1976

11.Railway crossings—
56.Compliance with traffic directions—
136.Offences—
137.Penalties—

The Role of the Roading Authorities (Mainly Territorial Authorities) in Level Crossings

Local Government Act 2002

10. Purpose of local government—
11. Role of local authority—

The Role of Regional Councils in Level Crossings and Rail Corridor Safety

The Land Transport Act 1998

175.Regional land transport strategies—
176.Currency of regional land transport strategies—
178.Regional land transport committees—
181.Effect of regional land transport strategies—