Review of National Level Crossing Statistics

Railway Safety Regulators' Panel

September 2008

Rail Safety
Regulators' Panel

Acknowledgments

This report has been prepared by the NSW Independent Transport Safety and Reliability Regulator (ITSRR) on behalf of the Rail Safety Regulators' Panel. ITSRR gratefully acknowledges the considerable amount of work undertaken by the rail safety regulators in each of the States and Territory in compiling the data required for the study.

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Glossary of Terms and Abbreviations

AHB	Automatic Half Barrier
FRA	Federal Railways Association (USA)
ITSRR	Independent Transport Safety & Reliability Regulator
NROD	National Rail Occurrence Database
ON-S1	Occurrence Notification Standard One
OC-G1	Occurrence Classification Guideline One
RSRP	Rail Safety Regulators Panel
RMV	Road Motor Vehicle
RSSB	Railway Safety and Standards Board (UK)

Summary

RSRP has produced a report on national level crossing safety occurrence data. This report analyses data for a range of level crossing–related incidents including fatalities, train collisions with road vehicles and precursor incidents such as near misses. It also considers data quality issues which influence industries and governments' ability to assess safety performance.

The analysis was limited by a number of data quality issues. However, findings from this report indicate:

- Nationally, there is no evidence of a temporal trend in the apparent rise in the a rate of fatalities over time. There is, however, a statistically significant decrease in level crossing fatalities over time for two of the States with a relatively high number of level crossings;
- Nationally there is the suggestion of a decrease in annual number of of collisions between train and road vehicles over the most recent 7 years of data. This trend remains after adjusting for changes in the number of level crossings over time:
- There is a statistically significant decrease in the number of collisions with road vehicles over time for two with some of the largest numbers of level crossings in Australia;
- There is a statistically significant increase in the number of near miss incidents over time for all States with sufficient data to test. This is likely to represent improved reporting rather than an increase in underlying risk.
- National collision rates per crossing compare reasonably favourably with US and European railways.

In order to improve the quality of safety–related information in this area, a number of classification issues will be referred to the National Rail Occurrence Database (NROD) Working Group for consideration during revision of ON-S1 OC-G1, as well as other projects such as the NTC Data Strategy. These include:

- Separating equipment failures by general crossing type (ie active, passive, pedestrian only etc) and providing further subcategories for active crossing failures (ie complete or partial failure, boom strike);
- Define road types so more accurate populations of crossings can be established;
- Collect normaliser data in each state such as annual number of trains over crossings for each major crossing type;
- Introduce sub - categories for active crossing occurrences that distinguish between Light and Bell and Automatic Half Barrier crossings;
- Introduce sub categories for occurrences that involve Road Motor Vehicles to distinguish between the range of vehicles involved in occurrences.

1. INTRODUCTION

ITSRR has been requested by the RSRP to compile readily available level crossing occurrence data from each State and Territory for an exploratory analysis of level crossing safety including trends.

Given the broad terms of reference, it was also decided the report should consider data quality issues which influence governments' and industries ability to assess performance and understand risk. Hence, the report's discussion also contains suggestions on improvements to data quality including what additional data may be desirable to collect.

This has lead to the development of the following research questions for the study:

- What data do regulators hold for level crossing accidents and precursor (near miss) events?
- Can this regulator data be combined to create informative National data sets?
- What data quality issues are there with existing data? How can the situation be improved?
- What is existing data telling us, in terms of trends over time and comparison with level crossing performance overseas?
- What additional data are needed to inform governments and industry on safety performance and risks at level crossings?

2. METHODS

2.1. Data Request

ITSRR made a request to all States and Territories for data on level crossings occurrences and significant safety initiatives. The basis of the request was to strike a balance between obtaining data that was readily available (i.e. categorisation as per ON–S1 (RSRP, 2004) and the need for more informative breakdowns of data to inform risk analysis. The basis of the additional breakdowns (beyond the current version of ON-S1) requested was to ask for data similar to that provided by ITSRR to the NSW Level Crossing Strategy Council (LCSC). This data has been useful as it provides on near misses and equipment damage.

The request was extended to include some basic normalisation data to allow some comparison between Australian performance and overseas. The normalisation data requested was simply the number of active and passive level crossings on public roads in each State/Territory, at the start and end of the study period (i.e. 1995-96 and 2006–07 respectively). The purpose of requesting data on the number of crossings 12 years earlier was to gain a crude measure on the change in the number of level crossings over the period. The request was restricted to public roads on the basis that from an initial appraisal of data available it was clear that most jurisdictions did not have accurate data on the total number of crossings. This is largely due to difficulties in keep inventories of crossings in remote rural areas which can be quite informal and have highly variable usage.

2.2. Data Analysis

2.2.1. Data Quality

The data requested from each of the State and Territory regulators was annual fatality and occurrence counts for the period 1995-96 to 2006-07. Occurrence data were classified according to the available level crossing categories under the ON-S1 classification scheme (RSRP, 2004). Due to the coarseness of the ON–S1 precursor–related occurrence categories, all Regulators were asked to provide additional breakdowns of data into a more informative precursor–based categorisation used in NSW.

Some Regulators could not provide data for all years or all variables which limited the analyses that be could be undertaken.

Data that was outside the scope of the request (e.g. suspected suicide data, unprotected crossings, private crossings) were generally excluded from the analysis providing it was identified as such in the data returns.

While data quality is sound in terms of notification and classification of accidents (collisions, fatalities) a range of quality issues became apparent largely in relation to precursor data (e.g. criterion for defining near miss incidents). Data were analysed “as is” but there is potential for significant non-sampling error such that observed effects may be an artefact of different level crossing definitions and classification interpretations. Lessons learnt from this exercise could be addressed in future work.

2.2.2. Statistical Analysis

Data were provided in a standardised spreadsheet and imported to S-PLUS® 7.0 for analysis. Exploratory analysis was cursory and limited to calculation and comparison of summary statistics (for detection of gross errors / outliers) and histograms of variables to determine empirical frequency distributions as a basis for subsequent modelling. Cursory examination of autocorrelation functions for various time series suggested independence of annual time series – an important assumption of most standard statistical tests.

The empirical distributions of raw count data and associated rates were not consistent between variables or States. These ranged between near symmetry through to strong right skewness. The latter is typical of accident statistics and violates assumptions of classic modelling techniques (Ordinary Least Squares regression/ANOVA). In light of the range of distributions, a “one size fits all” statistical approach was not possible and more formal statistical modelling (build, diagnose, refit) on a case by case basis could not be achieved within the given time constraints.

In light of the above, the analysis remained largely exploratory and was based on “robust” statistical techniques i.e. less sensitive to violations of assumptions of common statistical models such as non–normality, presence of outliers. The median rather than the mean was used as a measure of central tendency (except where required for benchmarking).

For complete (12 year) series, the presence of temporal trend in time series data was tested using Kendall's Tau rank correlation test (see, for example, Sokal and Rolf, 1995). Kendall's Tau is a non-parametric test for monotonic trend, that is, a change in one overall direction. It does not distinguish the nature of the relationship between variables e.g. linear, curvilinear. Hence failure to detect "trend" does not necessarily indicate the absence of systematic change (e.g. increase followed by decrease). A two–tailed test was applied to determine whether there had been an increasing or decreasing trend over the 11 year period. A trend was considered significant if it, or a more extreme case, had a probability (p) of occurring by chance of less than or equal to 0.05.

To assess the nature of trend, temporal patterns in complete (12 year) series were explored using a locally weighted regression scatterplot smoother (LOESS) (see, for example, Cleveland 1994) as implemented in S–PLUS. LOESS is a non– parametric technique which iteratively fits curve to multiple points along the time series to track the central tendency of data. It is also resistant to outliers.

Comparisons of various incident rates were limited to recent years because associated level crossing count data are more reliable. When interpreting statistics such as incident rates, it is important to recognise that rates will exhibit year-to-year variation, even without changes in the underlying factors influencing level crossing safety. It is therefore necessary to quantify such chance variation in order to delineate variation beyond that due to chance alone. Non–parametric 95% confidence intervals for annual median rates were calculated for this purpose. They provide a measure of the range of values within which the true (population) median lies.

2.2.3. Analysis of Precursor Indicator Data Needs

In order to use precursor data effectively, models are required to relate rates of precursor events to estimates of the underlying risks of fatalities and injuries at level crossings.

An analysis of what additional precursor data that may be beneficial to gather was performed by sensitivity testing of a set of level crossing fault and event trees. Here inputs to the fault and event trees are raised and lowered to determine their relative influence on the overall result. Such a method indicates which precursor variables in the fault and event trees have the greatest bearing on risks, and as such should be given a priority over parameters that have less bearing on risks.

3. RESULTS

3.1. Level Crossings Inventory

3.1.1. State / Territory Summary

The number of public level crossings, as reported by each of the State and Territory Regulators is summarised in Table 1. Based on most recent data (2006–07), Victoria has the largest number of public level crossings in Australia (n = 1872). Approximately 30% of crossings in Australia are equipped with active warning devices. NSW and South Australia have a lowest proportion of active crossings (approx 20%) and Northern Territory has the highest (approx 50%).

Table 1: Reported Active and Passive Public Level Crossings by Jurisdiction
Pedestrian–only crossings excluded where supplied

	1995-96			2006–07			
	Active	Passive	***Total***	Active	Passive	***Total***	**Comment**
Victoria	758	1474	*2232*	761	1111	*1872*	
Queensland	na	na	*na*	534	1251	*1785*	
New South Wales	na	na	*na*	320	1139	*1459*	
Western Australia	na	na	*na*	471	783	*1254*	Return included private crossings. Public estimated from data in earlier return
South Australia	251	894	*1145*	253	892	*1145*	
Tasmania	146	163	*309*	120	250	*370*	
Northern Territory	4	6	*10*	28	30	*58*	

na. not available

3.1.2. Data Quality Issues

The request for level crossing normalisation data specified that counts were to comprise active or passive warning devices at public roads only. Upon receipt of initial returns and in follow up discussions it was apparent that there were variations in the definition / terminology used for level crossings. For example, a public road is understood to be a road freely accessible to the public, but in some cases, such as Sydney freight yard areas, there are roads that are not for public access, but are not restricted by access barriers either.

Another additional problem is the issue of disused lines. Such lines in NSW have been closed to rail traffic but have not been decommissioned and very occasionally have track maintenance vehicles on them. This raises a definition issue — should the crossings on such lines be part of the population? The current assumption is no, but this and the issue of public roads are areas were the application of better definitions would improve the quality of the data and subsequent analysis.

3.2. Level Crossing Fatalities

3.2.1. Time Series

In order to display the overall historical risks of level crossings, the total National annual number of fatalities at level crossings is presented as Figure 1. The data of Figure 1 includes road vehicle occupants, pedestrians, train crew and train passengers at crossings with both active and passive warnings. Suspected suicides are excluded in line with the convention adopted by most Rail Safety Regulators in presenting level crossing data. There was no significant temporal trend in the total annual fatalities over the period.

To account for the potential influence of changes in level crossing number on the temporal pattern of fatalities, the fatality rate (per 1000 crossings) is shown for both active and passive protection crossings in Figure 2. There was no significant temporal trend in the time series for either active or passive crossings.

This could also be examined with additional normaliser such as train traffic.

Nationally two states showed a significant decrease in the number of fatalities over the 12 year period.

3.2.2. Data Quality Issues

A potential source of error in level crossing incident data is the treatment of suicides. Suspected suicides are excluded from ON–S1 based summaries such as fatality and level crossing collisions despite difficulty in delineating “Suspected Suicides” from other occurrence types. The criteria and information used to support decisions in relation to suicide notification and classification varies between operators and between Regulators. This will therefore affect consistency in the number of “fatalities” and “collisions” reported between States. A more formal examination of the process for notifying and classifying suicide data would be valuable in understanding the magnitude of this error. However, the practicality of this approach would need further consideration (e.g. workload associated with review of relevant coroner reports).

The National time series of Figure 1 could only be started from 1998-99 as at least one state did not provide data prior to that time. The National fatality data, normalized for numbers of active and passive crossings, could only be started from 2002-03 as at least one state did not provide data prior to that time. The improvement in data consistency from 2002-03 could be related to the development leading up to and then the introduction of ON-S1 in 2004.

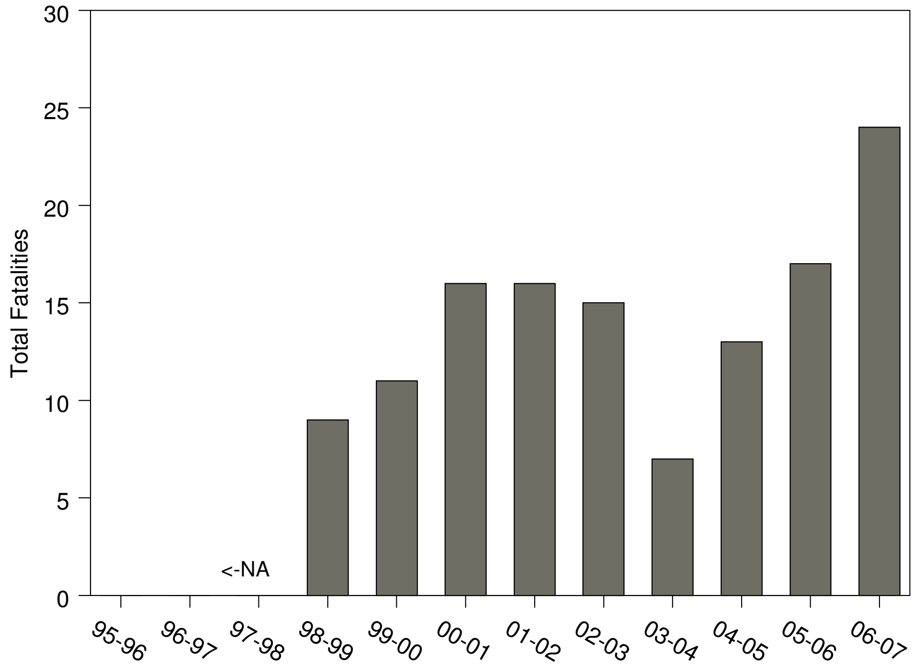

Figure 1: Annual Total Fatalities at Public Level Crossings in Australia 1995–96 to 2006–07.

Shows reported fatalities due to Train Colliding with Road Vehicle and Train Colliding with Person. Excludes unprotected crossings and incidents reported as suspected suicides. Data prior to 1998–99 is not available for all States.

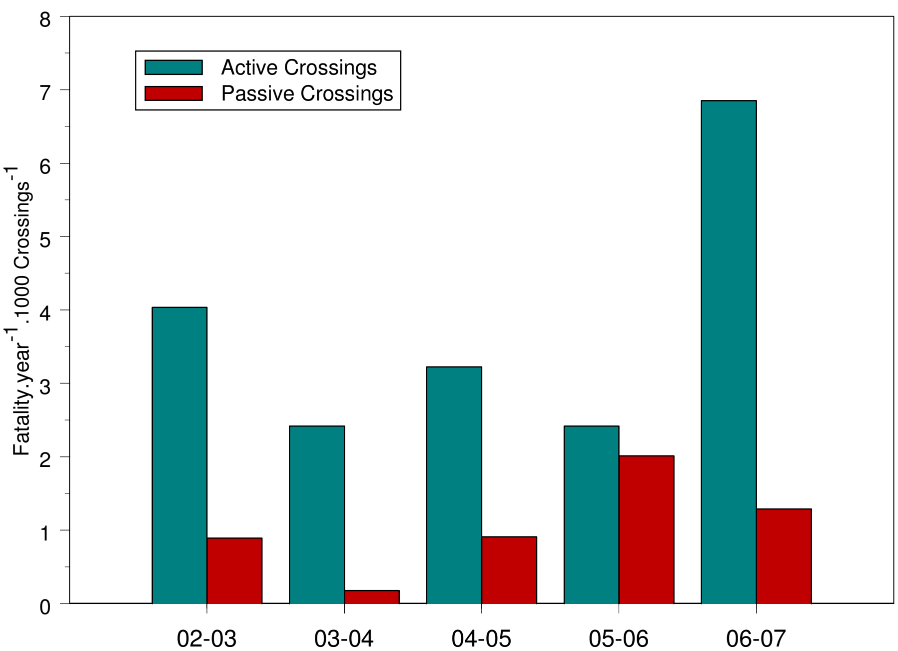

Figure 2: Annual Fatality Rate (per 1000 Public Crossing) by Protection Type.

Excludes unprotected crossings incidents reported as Suspected Suicide. Data prior to 2002–03 is not available for all States.

3.3. Level Crossing Collisions

3.3.1. Time Series

The annual national number of collisions between trains and road motor vehicles at active and passive crossings over a seven year period is shown in Figure 3. There was the suggestion of a decrease in the number of annual number of collisions between train and road vehicles over the 7 year period..

There was a significant decrease in the annual number of collisions between trains and road motor vehicle in two states. Analysis of trend in occurrences for the remaining States was hampered by incomplete data.

For the purpose of a comparative assessment with United Kingdom (UK)_data the ratio of fatalities per road vehicle collision for Australia was calculated. Using the data of Figure 3, the Australian average is 0.13 (annual ratio range 0.02 to 0.23) whereas the UK ratio is 0.16.

The variation of the number of collisions between trains and pedestrians at crossings with active and passive warning devices over time is presented in Figure 4. There was no evidence of a significant temporal trend in either the number of collisions or number of fatalities over time. A discussion of normalised rates based on recent data is considered in Section 3.4.

3.3.2. Data Quality Issues

As a collision between a train and RMV is so clearly manifest the data is considered not to suffer from definitional errors. However, the potential data quality issue in relation to suspected suicide noted previously is relevant to ON–S1 data definitions for collisions. Several states did not provide a full data series. If reasonable, such data should be sought to complete the data series.

The consequences of a train collision with a heavy motor vehicle can be quite different to collisions with lighter vehicles such as cars. Therefore a possible improvement to the ON-S1 categorisation is to allow for the distinction of heavy motor vehicles and so show their contribution to collision numbers.

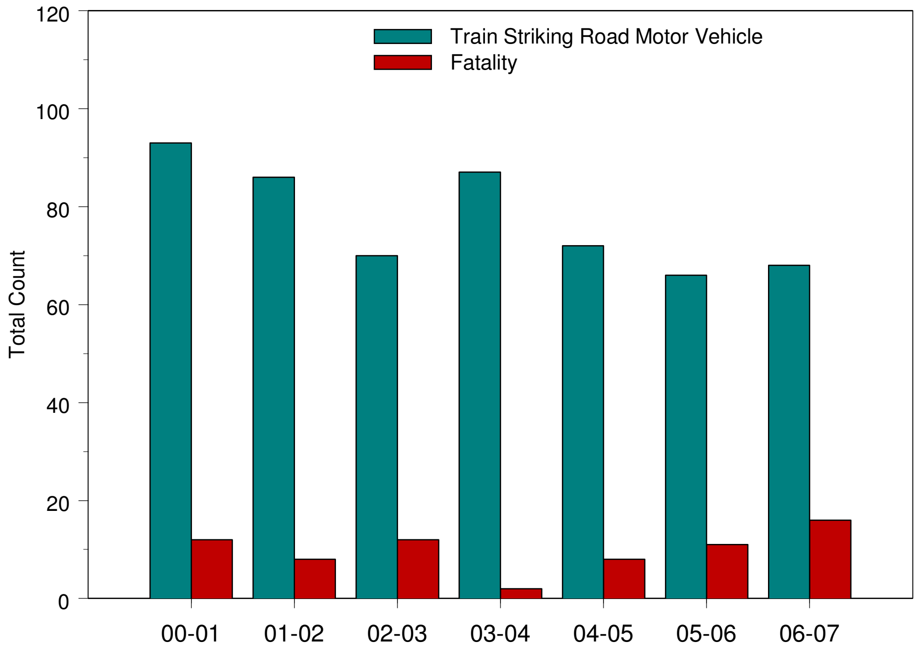

Figure 3. Train and Road Motor Vehicle Collisions at Public Level Crossings in Australia.
Includes active and passive crossings. Excludes incidents reported as Suspected Suicide. Data prior to 2000–01 is not available for all States.

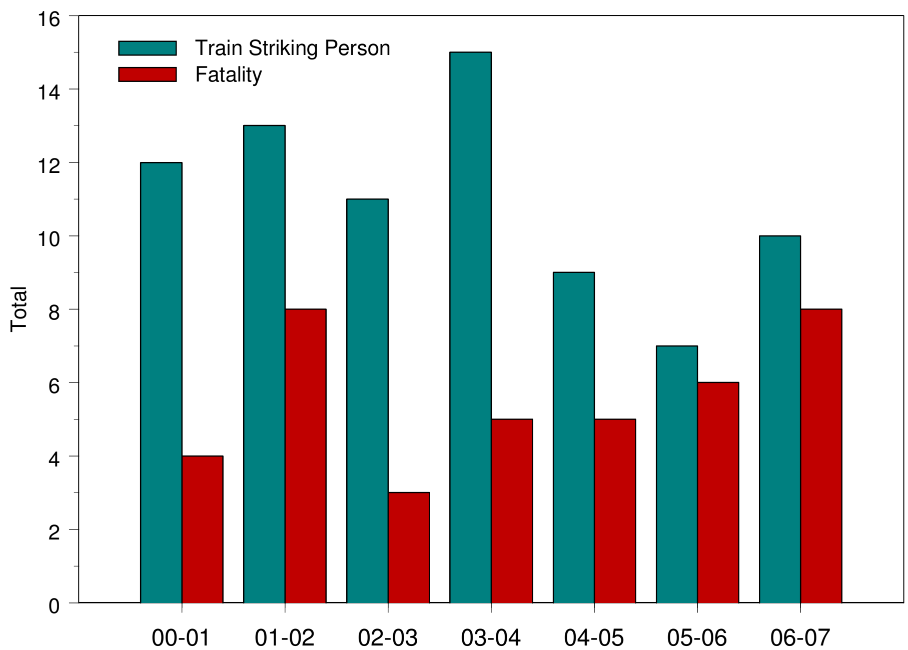

Figure 4. Train and Person Collisions at Public Level Crossings in Australia.
Includes active and passive crossings Excludes incidents reported as Suspected Suicide. Data prior to 2000–01 is not available for all States.

3.4. Comparison of Australian Performance

The UK Railway Safety and Standards Board (RSSB) has established some benchmarking data for level crossings in their recent safety performance report (RSSB, 2006). The benchmarks are presented as Table 2 which summarises the numbers of level crossing accidents in which a train strikes a level crossing user (per 1000 crossings) for a selection of European countries. The information is based on those events where any road vehicle is struck or a pedestrian receives a major or fatal injury at a level crossing.

Table 2: Collisions Between Trains and Road Users (Vehicles and Pedestrians) for Anonymised EU Countries.
Data sourced from RSSB (2006)

Country	Average Collisons per year (1999 to 2004)	Collisions per 1000 crossings per year (1999 to 2004)
Country A	80	27.0
Country B	165	26.8
Country C	51	22.0
Country D	21	14.3
Country E	327	13.1
Country F	66	8.8
Country G	167	8.6
Great Britain	34	4.1

The data available to this study shows over the period 2000–01 to 2006–07 there was a population of 56,260 crossing years and 621 train collisions with RMVs and pedestrians. The average number of collisions per year in Australian over the seven year period is 88.7 (interannual range 73 to 105) which is positioned slightly above the mid rank of the first column of data in Table 2. The average number of collisions per 1000 crossings over the seven year period is 11.0 (range 9.2 to 12.9). This puts Australia in the lower ranks of the second column of data of (Table 2) and therefore compares reasonably favourably with other European countries.

A further comparison can be made by looking in more detail at the different types of crossings involved. Data on UK collision rates per Automatic Half Barrier (AHB) crossing and Automatic Open Crossings (similar to Australian light and bell crossings) is provided by the RSSB (RSSB, 2004). The USA Federal Railroad Association (FRA) collects data on collisions at level crossings as well as the protection provided at such crossings. Raub (Raub, 2006), compares collision rates among different classes of warning devices in seven mid-western states over a ten year period (1994-2003).

This data is presented as Table 3 alongside relevant available data from Australia.

Table 3: Average Annual Collision Rates for the UK, USA and Australia

Country	Protection Class	Collisions with RMV per 1000 crossings
United Kingdom	Automatic Half Barrier (AHB)	18
	Automatic Open Crossing (Flashing Lights)	24
USA (7 states)	Gates (AHB)	28.2
	Flashing Lights	20.4
	Crossbucks (Similar to give way signs)	10
	Stop Signs	25.3
Australia (2 states)	Active (AHB & Flashing Lights)	16.5
	Automatic Half Barrier (AHB)	11.1
	Flashing Lights	19.7
	Passive (Stop signs & give way signs)	4.3

On a per crossing basis, Australia appears to be performing at a better level to the US and the UK, according to the results of Table 3. In particular passive crossings have a much lower rate of collisions per crossing than comparable crossings in the US. A possible explanation is that many Australian crossings, in particular those in rural areas, have lighter traffic than the US and UK. It is interesting to note how Australian and UK data shows, on a per crossing basis, that AHB crossings perform better than just flashing lights. The US data however does not support this on a per crossing basis, but when the Raub's data is considered on a per train movement basis, crossings with gates are 2.4 times safer than flashing lights.

As such information is so insightful on the relative performance of level crossing types it is recommended that ON-S1 is revised to separate passive crossing categories into stop signs and give way signs, as well as separate AHB active crossings from Flashing Lights and Bells. Collecting normaliser data such as average daily train traffic would be beneficial as well.

The interannual variation in national average RMV collisions per 1000 active crossings is shown as Figure 5. The average number of collisions per 1000 crossings over the 8 year period is 21.5 (interannual range 15.3 to 28.7). The annual average number of collisions has decreased significantly over the 8 year period. The average of the most recent year of data (2006–07, 15.3), while representing active crossings as a whole, compares favourably with the relevant data for active crossings types in Table 3.

The variation in the annual average RMV collisions per 1000 active crossings for each of the states is shown as Figure 6. It shows two states performing above the average of 21.5 and the rest roughly at average values or lower.

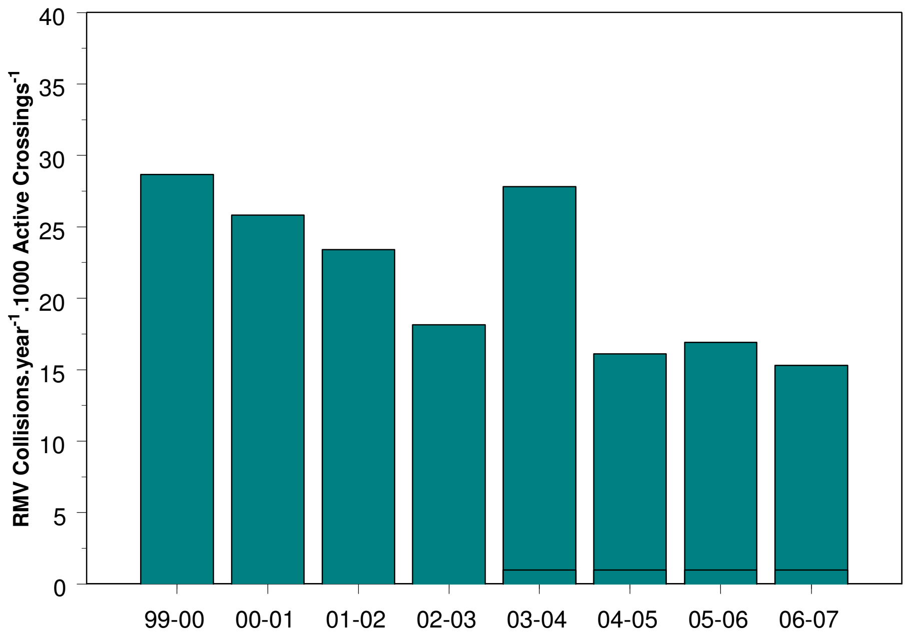

Figure 5. Annual Train and Road Vehicle Collision Rate (per 1000 Active Public Crossings) in Australia.
Excludes incidents reported as Suspected Suicide. Data prior to 1999–00 is not available for all States.

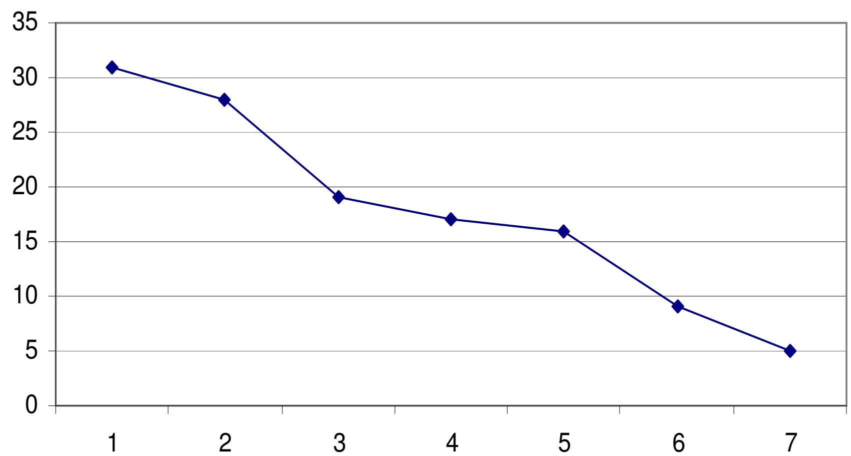

Figure 6: State Annual Average RMV collisions per 1000 Active Crossings

3.5. Level Crossing Precursor Occurrence Data

The UK Railway Group standard GN/GE 8658 (Railway Safety 2002) defines precursors as:

> *"A system failure, sub-system failure, component failure, human error or operational condition which could individually or in combination with other precursors (cause) result in the occurrence of a hazardous event eg broken rail, signal passed at danger (SPAD) or dragging brakes are precursors to the hazardous events derailment, collision and fire respectively."*

Precursors provide a forewarning of the risk of more serious accidents. For example good data on precursor events such as near misses or crossing failures may indicate a high risk crossing in advance of a serious accident. As precursors are the "near hits" for much more significant consequences but in themselves have little or no consequence they represent a "free lesson" on safety problems. So for the case of level crossings precursor data offers a valuable advance indicator of risk rather than having to become aware of risks through fatalities and injuries resulting from accidents.

Although not well captured in ON-S1 Railway Safety Regulators have still been classifying this important data to varying degrees. In some cases this is to provide data to State level crossing strategy councils. In order to try and compare this data nationally the categories of the data provided to the NSW level crossing strategy committee was used as the basis of the information request. The precursor data categories are:

- Level Crossing Failure / Defect
- Level Crossing Near Miss
- Level Crossing Boom Struck and Damaged
- Level Crossing Vandalisim
- Vehicle Colliding with Level Crossing Equipment other than Booms

All States and Territories managed to provide some data along the lines of these categories and each is discussed separately in the following sections of this report. As States could provide data along these lines this suggests that adopting a similar categorisation in ON-S1 would not be too much of an imposition.

3.5.1. Level Crossing Failure / Defect

In terms of informing on the risks of level crossings the current ON-S1 precursor category "Level Crossing Failure / Defects" is too general. Overall it does not distinguish the type of crossing involved, so defects in signage at passive crossings are combined with failures of automatic level crossings. Further, with regard to active level crossings, it does not distinguish between a dangerous failure of a crossing, where it fails to activate when a train approaches, and a less dangerous failure such as one light not flashing, or failing to deactivate. As such the counts in this category are essentially meaningless.

Suggestions as to how the new version of ON-S1 may be improved in this regard are as follows:

- Separate failures and defects of active level crossings from passive level crossings
- For active level crossings introduce a sub category of “crossing fails to activate when train approaches”
- For active level crossings introduce a sub category of “crossing fails to de-activate when train has past”
- For active level crossings introduce a sub category of “Element of crossing defective”

Again the ability of states to provide comparable data improves in the period leading up to the introduction of ON-S1.

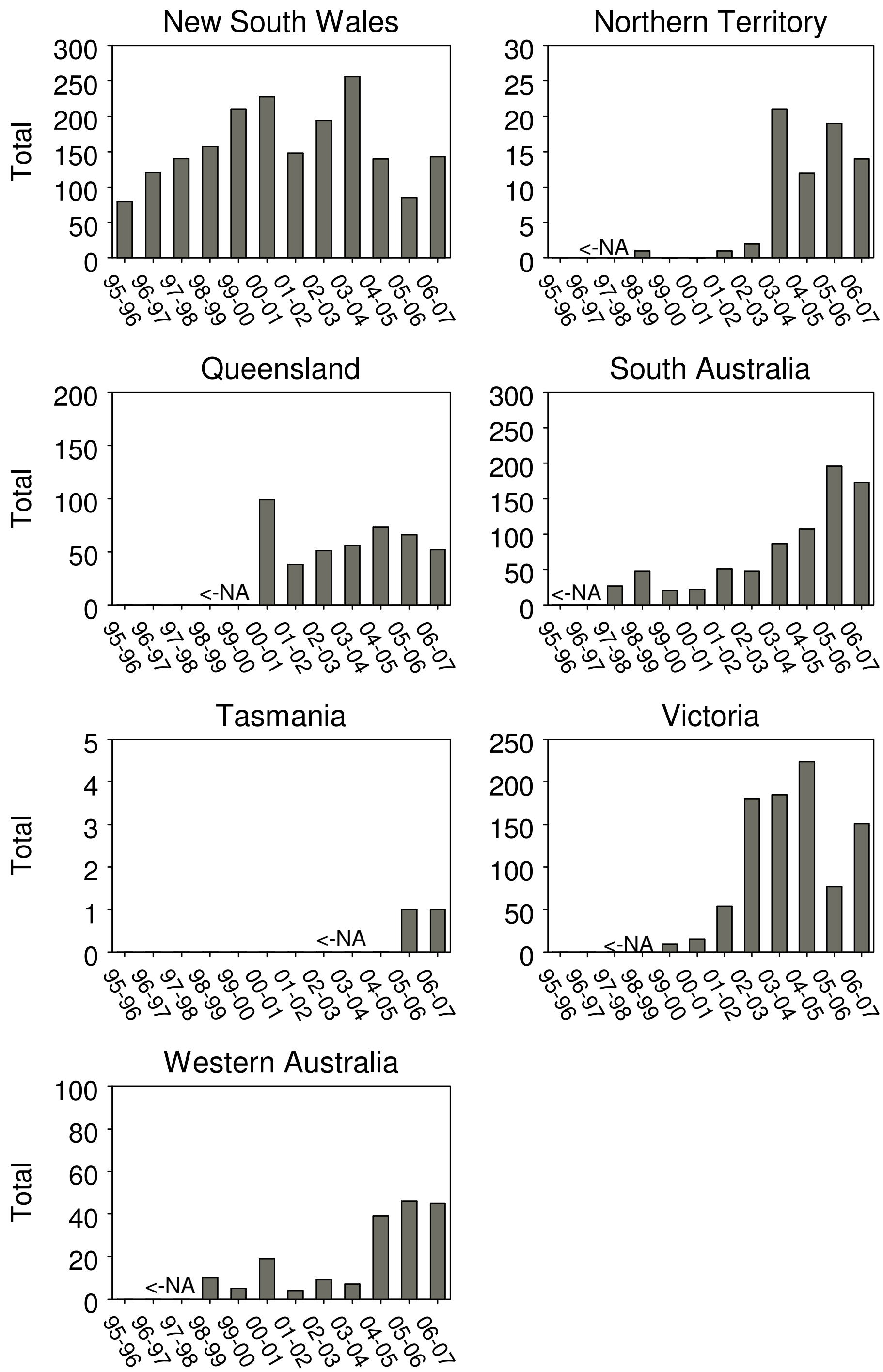

Figure 7. Public Level Crossings Equipment Failure / Defect. 1995-96 to 2006-07

Note scale of axes differ. NA = data not available

3.5.2. Near Miss

Near miss data for each of the States is presented as Figure 8. Historically, the data has been subject to definitional errors as differing definitions as to what constitutes a "near miss" are used in each jurisdiction. Therefore comparisons between states in terms of safety performance are not particularly valid.

Figure 8 suggests an increase in the number of reported near miss incidents over time for most States. This increase is statistically significant for all States with sufficient data to test. For many States the trend is characterised by a step change rather than gradual rise. For example, NSW, South Australia and Victoria. Victoria's counts rise markedly in 2002–03 and coincide with a directive in 2002 in relation to quality of occurrence reporting. The marked rise in near miss reporting in NSW in 2002–03 is due, in part, to commencement of reports from a large freight operator. For these reasons, rather than the rise indicating an increase in the underlying risk of level crossing accidents, it is more likely to be evidence of improving data reporting

An indication of the extent to which the reporting near miss data may improve can be gained by looking at the UK ratio of near misses to collisions at level crossings. The UK safety performance report for 2006 (RSSB 2006) gives an average number of 10.6 near misses per collision at level crossings.

The UK ratio was applied to Australian level crossing road vehicle collision data to estimate the expected near miss counts for the reported number of road vehicle collisions (Figure 9 (a)). Comparison of reported near miss incidents with those estimated from the UK ratio shows a convergence of the two curves over time. The level of reported near miss data in earlier years was markedly lower than expected counts based on the UK ratio consistent with the widely held view that historic near miss incidents were not fully or consistently reported within Australia. The gradual increase in reported near miss incidents over time within Australia will reflect improved capture rates due, in part, to gradual formalisation of the requirement to report near miss data nationally (e.g. listing within the national occurrence classification scheme ON-S1 imlplemented nationally in 2005).

The national pattern of Figure 9 (a) masks potentially important variation between individual states which is shown in Figure 9 (b). While a general increase was observed in nationally aggregated data, the level of agreement between observed and expected varies widely between States indicating consistentcy in capture and classification remain an issue. Further improvements in the quality of near miss data are expected as upcoming national model legislation and associated guidelines formalise both the criterion to define a "near miss" incident and the requirement to report defined near miss incidents as notifiable occurrences.

Near miss data for Western Australia was considered to be too inconsistent to be made available.

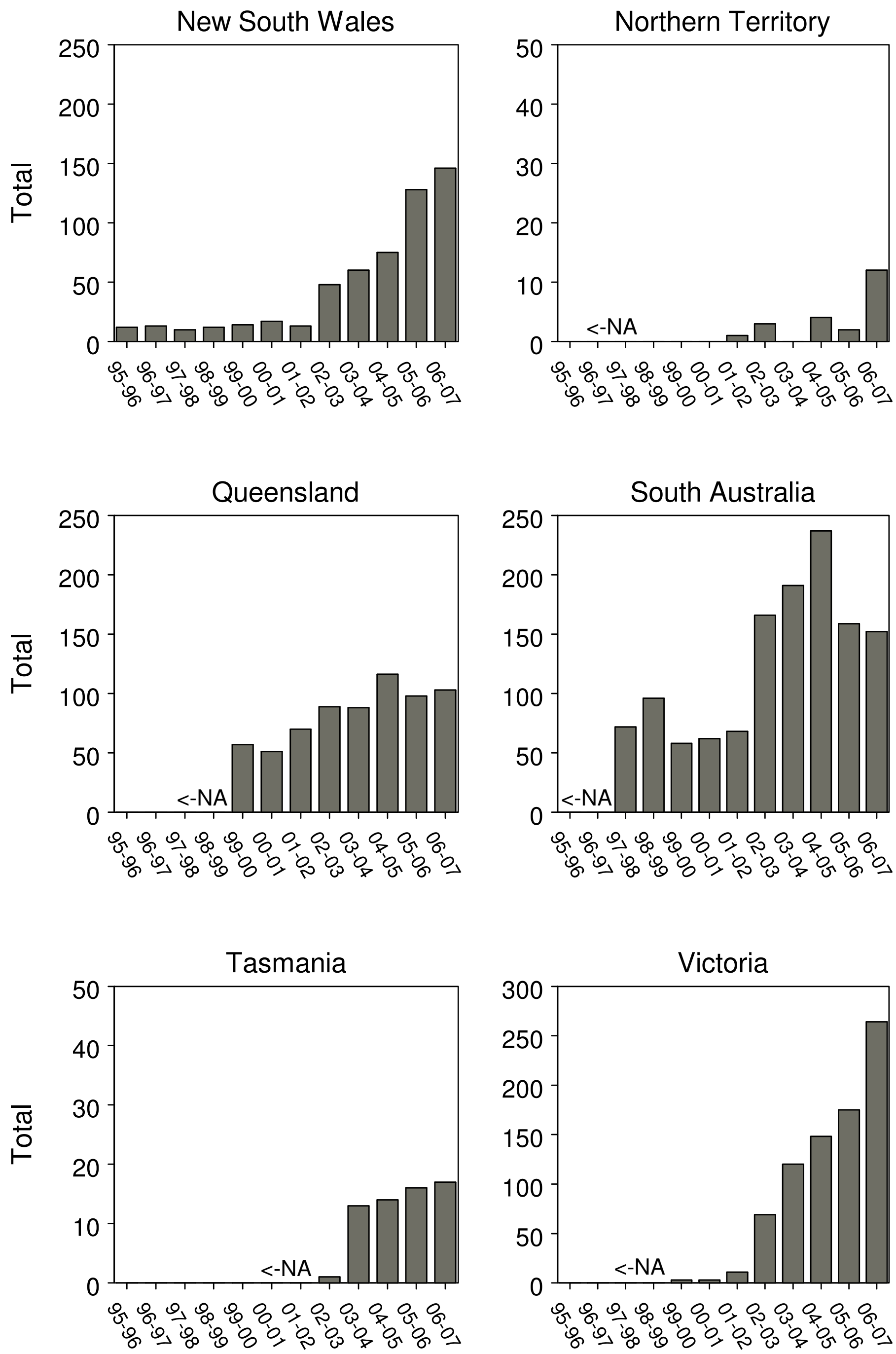

Figure 8. Near Miss at Public Level Crossings.
Data for Western Australia not available. Note scale of axes differ. ND = data not available

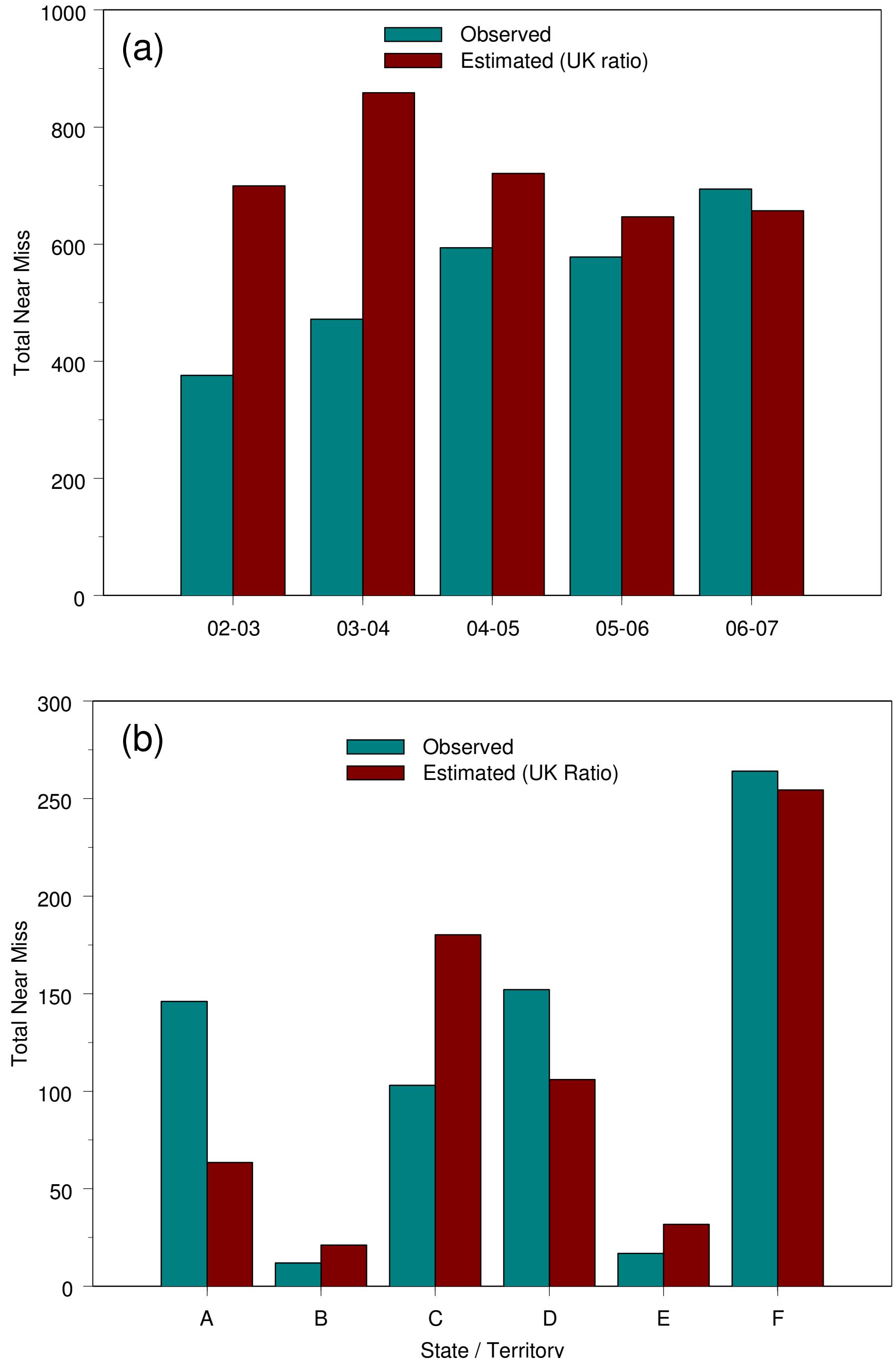

Figure 9. Near Misses Occurrences at Public Level Crossings in Australia
(a) National Data (2002–03 to 2006–07); (b) State/Terriroty Data (2006–07)
"Estimated" is based on application of UK ratio of near miss to road vehicle collisions to reported Road Vehicle collision data.. Excludes one State (data not available). Reported near miss may include near miss between Train and Person at level crossing whereas UK ratio is limited to RMV collision

3.5.3. Vandalism

Most States have made attempts to delineate those level crossing incidents associated with malicious acts such as vandalism. Data is presented as Figure 10. It needs to be recognised in this case, that it is difficult to distinguish intent behind observed damage and that different judgements may be made by data custodians in different states. Considering the number of crossings in Victoria and WA, it would be expected that they would have counts similar to NSW and Qld. Hence this could indicate an inconsistency in reporting or a level of under reporting.

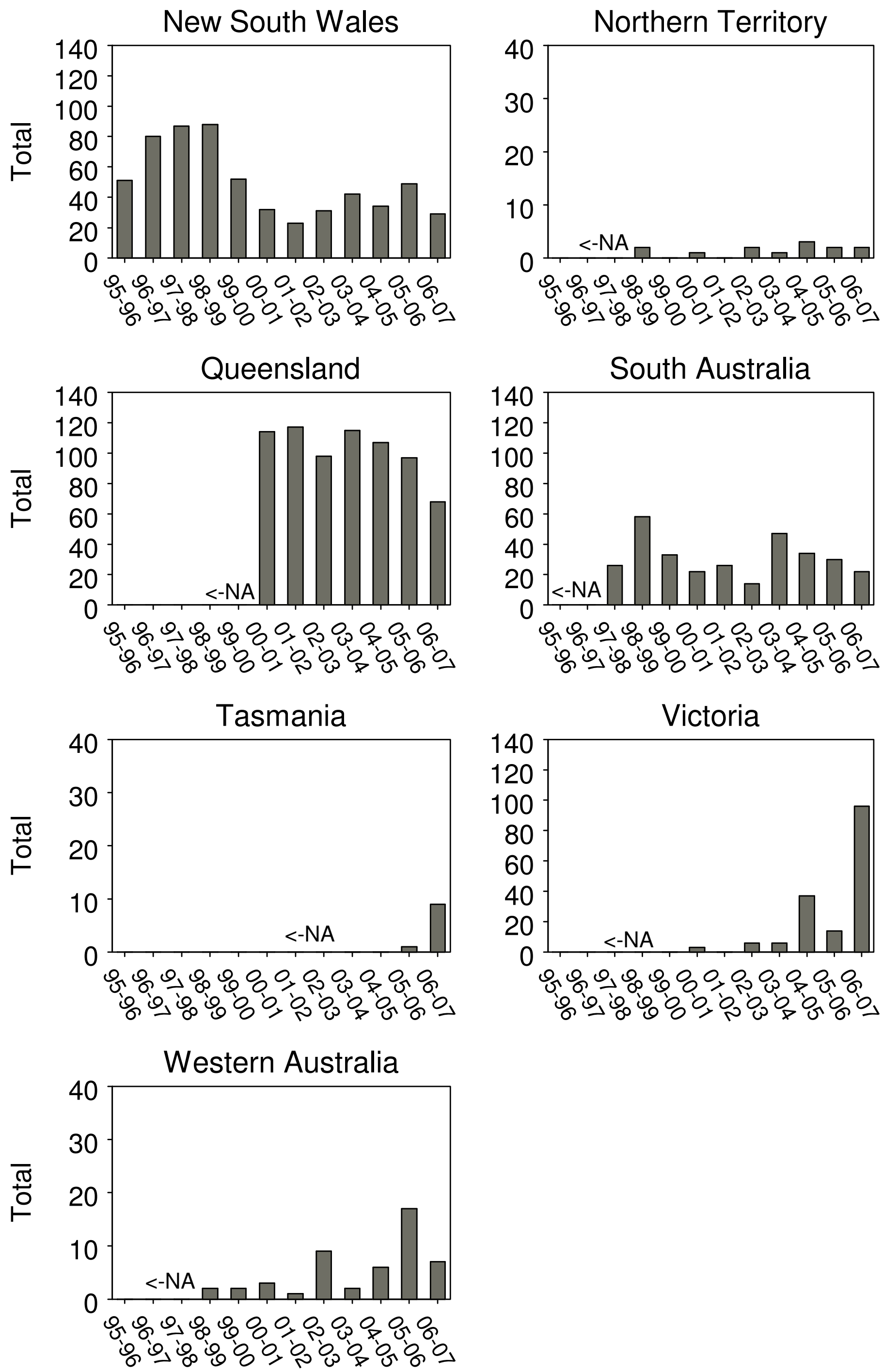

Figure 10. Vandalism Incidents at Public Level Crossings in Australia 1995–96 to 2006–07.

Note scale of axes differ. ND = data not available

3.5.4. Collision with Level Crossing Equipment (including Boom Strikes)

Unfortunately, due to limitations of occurrence notification records and associated gaps in data returns there was insufficient data to adequately summarise Level Crossing Boom Struck and Damaged and Vehicle Colliding with Level Crossing Equipment separately. The two categories were combined for those States with comparable data and data are presented as Figure 11.

The general number of road vehicle collisions with level crossing equipment does not provide any insight to road vehicle driver behaviour as perhaps boom strikes do, since boom strikes typically occur when the crossing is activated. Collisions with level crossing equipment can occur whether the crossing is operating or not and applies to all crossings rather than just AHB crossings. .

Collisions with Level Crossing equipment does give some idea of how much danger to road vehicle users does the crossing equipment as a roadside hazard present, and survivability of equipment in the field.

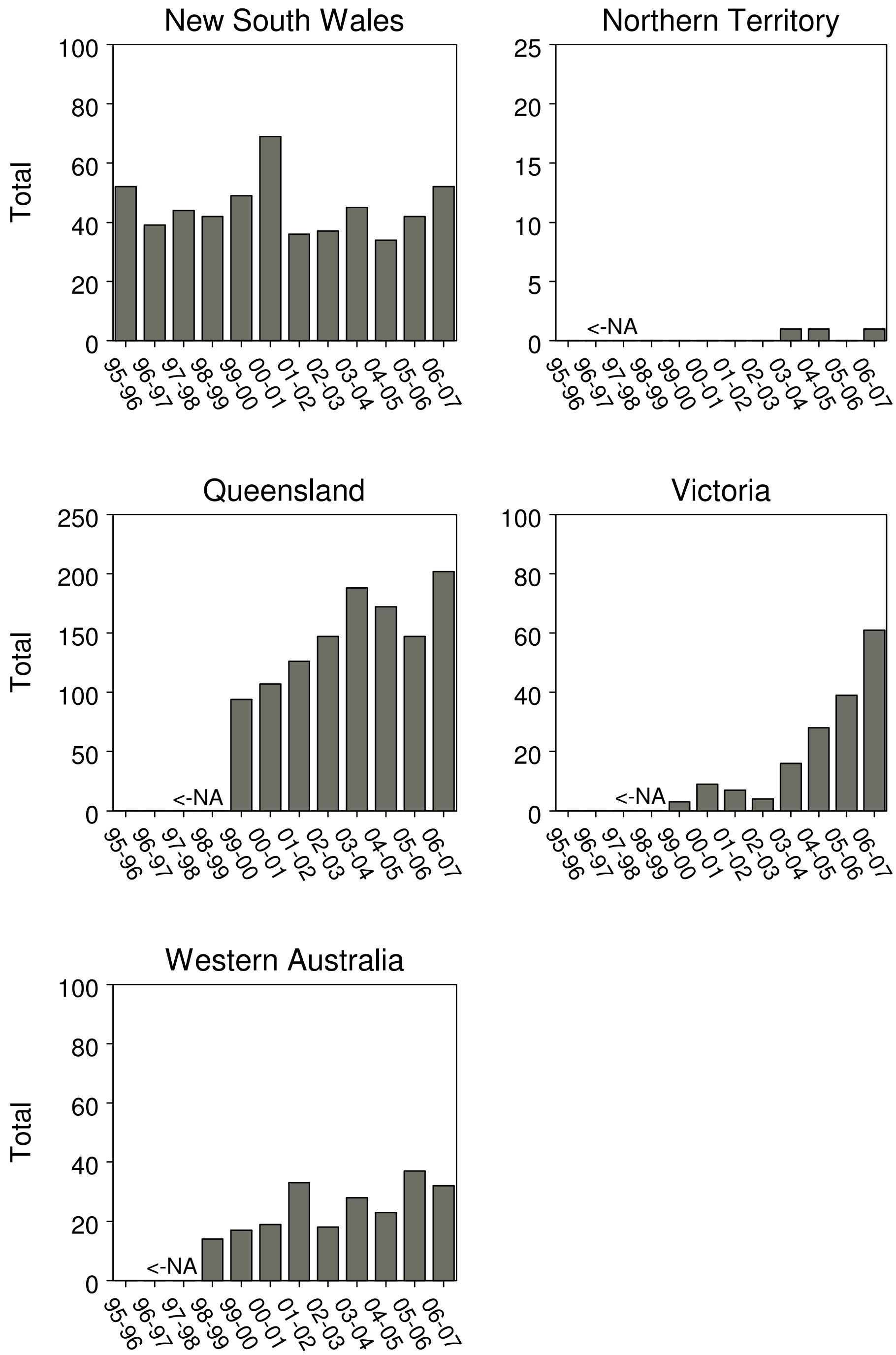

Figure 11. Road Vehicles Colliding with Level Crossing Equipment at Public Level Crossings in Australia.
Note scale of axes differ. ND = data not available

3.5.5. Analysis of Precursor Indicator Needs

ITSRR has developed a series of fault and event trees for level crossings which relate the rate of precursor or “near hit” events to the underlying risk of multiple casualty accidents. One of these fault and event tree models was examined to determine what the data needs to support the model are, and then consider if additional data should be collected through categorisation schemes such as ON–S1.

The fault and event tree models address a number of different types of crossings such as:

- Automatic Half Barrier (AHB) active crossings
- Light and Bell active crossings
- Crossings with passive warning devices
- Pedestrian crossings with active warning devices
- Pedestrian crossings with passive warning devices

The model selected for analysis was the AHB model. It has 51 separate inputs as well as a collection of “rule sets” for the determination of the consequences of accidents. The data used in the model draws from overseas models and is largely unvalidated for Australia, as the model is still under development by ITSRR. The model, however, was considered to be the best currently available for the intended purpose.

Using the current input variables the model provides a breakdown of contributors to road vehicle collisions at AHB level crossings, which is presented as Table 4.

Table 4: Contributors to Collisions with Road Vehicles at AHB crossings

Contributor Description	Percentage Contribution
1. Road user error / violation	67.4
2. Road vehicle becomes stranded	28.5
3. Car abandoned on level crossing	3.1
4. Equipment wrong side failure / vandalised	0.5
5. Error when manually operating crossings	0.4

The current version of ON–S1 OC-G1 does not provide categories for Road user errors / violations and Road vehicles becoming stranded but instead provides a more general category of “Near Misses”. Additionally the category “Level Crossing equipment defect/failure” is too general to be able to determine specific numbers of “equipment wrong side failures” (which are where the crossing fails to activate when a train is approaching).

Abandoned cars on crossings would be covered to some extent by the code “Collision with Road Vehicle” but will require sorting. Errors when manually operating crossings may be coded under the “Other” sub category for Level Crossings but again will be mixed with many other types of events.

While it may be desirable for data categorisations to break down near misses at level crossings to errors, violations, or strandings on the crossing, such distinctions may not be readily made by train drivers reporting to train controllers. (Train drivers reporting in this manner are the main source of near miss data). Therefore it is more practical to collect near miss occurrences plus boom strikes through the occurrence categorisation scheme and use other data to determine what fractions of near misses are errors, violations, strandings etc.

Looking at the contributors to risks suggested by the model highlights the significance of near miss data and raises the importance that “near miss” categories are well defined so that this influential aspect of data is collected in a consistent manner.

A sensitivity analysis was performed to determine which of the 52 input values the AHB crossing model is most sensitive to. The results are presented as Figure 12.

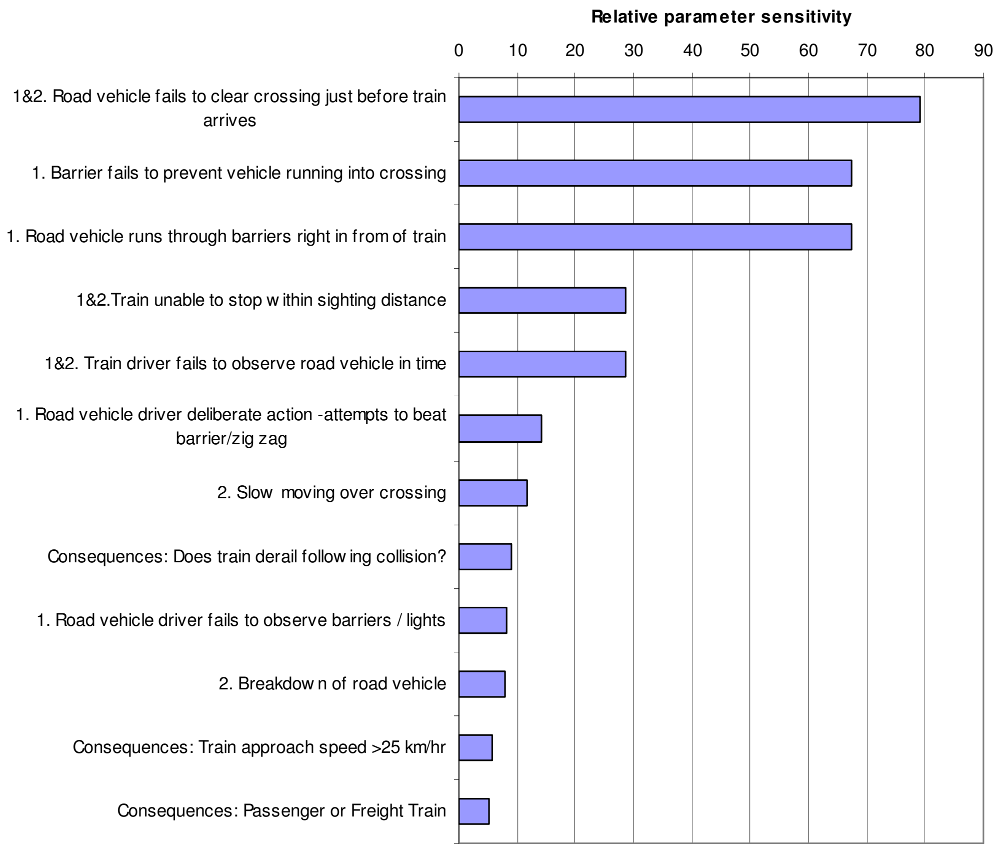

Figure 12: Sensitive Model Parameters

Notes: top twelve model parameters ranked on the basis of the effect on the overall result when individually increased by 10%.

The numbers shown next to the input parameters in Figure 12 relate to the contributor groups shown in Table 4. "Consequences" indicates where the parameter inputs to the split fractions in the event tree model. The results show the parameters the model is most sensitive to are associated with the inputs to the "Road user error/violation" contribution and the "Road vehicle becomes stranded" contribution both of which input to the rate of near misses.

As mentioned earlier it is probably impractical to ask railways to provide, via occurrence notifications, the relatively detailed information needed to support these specific sub categories of near misses. This is because as the information may not be immediately available to determine if the near miss was due to stranding or due to driver errors or violations (with the exception being boom strikes). However the sensitivity of the risk model of inputs that relate to near misses highlights the importance of collecting good quality near miss data.

Again the current ON–S1 OC-G1 has much improved sub categories for near misses so its implementation should improve the quality of data available for risk models. However, a recommendation is made under the discussion on boom strikes to include them as a separate category in OC-G1. Additionally, capture and coding of the "road vehicle type" (heavy vehicle, car etc.) involved in accidents and near miss events is also important.

4. CONCLUSIONS

Although State data categorisations have some consistency issues the study has produced a useful data set that can be improved through better data category definition and addressing apparent data quality issues. The data set allows normalised comparison of level crossing safety performance (“benchmarking”) and also provides data on precursor events (“near hits”). The precursor occurrence data itself provides some appreciation of the underlying risk, and there is scope to combine the data with risk models to provide a better indication of the underlying risk of level crossings.

4.1. Trends

The analysis was limited by a number of data quality issues. However, findings based on the available data used in this report indicate:

- Nationally, there is no evidence of an temporal trend in the the a rate of fatalities over time. However there is a statistically significant decrease in level crossing fatalities over time for two of the States with a relatively high number of level crossings;
- Nationally there is the suggestion of a decrease in annual number of of collisions between train and road vehicles over the most recent 7 years of data. This trend remains after adjusting for changes in the number of level crossings over time:
- There is a statistically significant decrease in the number of collisions with road vehicles over time for two with some of the largest numbers of level crossings in Australia;
- There is a statistically significant increase in the number of near miss incidents over time for all States with sufficient data to test. This is likely to represent improved reporting rather than an increase in underlying risk.

4.2. Benchmarking

Collisions and fatalities per crossing or 1000 crossings are available as benchmarks from railways in Europe, particularly the UK. While understanding the total number of crossings is a challenge in Australia, such benchmarks are a useful means of comparison. This study found that a pragmatic benchmark for current use is occurrences per 1000 crossings and so it is recommended that the population of crossings is collected more formally so as to be available going into the future. Another useful and reasonably accessible normaliser is the annual number of trains over crossings for each major crossing type.

National collision rates per crossing were found to compare reasonably favourably with US and European railways.

4.3. Data Quality

The following issues on data quality were determined in the study:

- Better definitions of the types of level crossings with respect to road accessibility need to be made (public and private crossings etc). Without such definitions it is difficult to determine exactly the number of crossings on publicly accessible roads and crossings in areas restricted to the public.
- States do have precursor data similar to that collected by NSW for level crossings but this data does have definitional inconsistencies between States.
- Data comparability improves in the period leading up to and following the introduction of ON-S1 in 2004.
- In order to be able to compare the performance of different types of active crossings collisions, casualties and near misses should be recorded under the two main types of active level crossings in Australia, lights and bells and automatic half barrier. This would be best achieved through a revision of the current ON–S1 OC-G1.
- Categories for near misses need to distinguish if the near miss is with a person or a road vehicle.
- A category to capture boom strikes should be introduced.
- Categories for collisions with road vehicles should distinguish the type of road vehicle involved.
- There is insufficient distinction between defects in elements of active level crossings and failures of the crossing to activate when a train approaches. Suggestions are made as to how ON-S1 OC-G1 can be improved in this regard.

4.4. Utility of data for risk models

The current way level crossing precursor occurrences are recorded and classified by ON–S1 are not sufficient to inform an understanding of the underlying risks of level crossings. The revised ON-S1 OC–G1 is a significant improvement in this area although improvements in sub category definitions for “level crossing equipment failures” can still be made.

The study found that near miss data has the most bearing on risk models. Such models require a further breakdown of near miss events into driver errors, violations and strandings etc, but this would likely prove impractical if introduced into an occurrence categorisation scheme such as OC–G1. Specialised studies would be required to collect such data. However, a separate category for boom strikes is recommended as well as capture of the type of vehicle involved (car, truck, etc).

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