



Department for Planning and Infrastructure  
Government of Western Australia

Office of Rail Safety

## **BENCHMARKING RAILWAY SAFETY DATA IN AUSTRALIA AND INTERNATIONALLY**

Written for the  
International Railway Safety Conference (I.R.S.C.) 2006  
Dublin, Ireland.

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## INTRODUCTION

- The conference theme is **Measuring Safety** – focusing on techniques for assessing and comparing risk in an increasingly globalised industry.
- Suggested sub-themes included:
  - Methods and techniques for measuring safety; and
  - Normalising data for comparative purposes
- This presentation looks at methods and some normalised data to highlight some difficulties not only of comparing data between Australian States but also between railway companies and other countries.

## ABSTRACT

Railway operators and safety regulators like to know how safely the railways are performing. Previously through the IRSC, New Zealand sponsored a process to trial international benchmarking of railway safety data (1999-2000). More recently IRSC has been briefed on establishment of the UIC database that may allow a degree of benchmarking between its members.

Benchmarking is a primary method for comparing safety performance but to be useful data needs to be reliably captured and recorded. Our experience shows this is difficult to achieve – so is benchmarking really possible or useful?

In 2001, taking a lead from the New Zealand / IRSC exercise, Australia established common national occurrence (accident/incident) definitions to facilitate national and potentially international benchmarking. It developed these definitions taking into account published definitions from a range of national and international sources including the IRSC study. All railway safety occurrences in the last 5 years have been categorised using the agreed definitions and now we are reviewing the data and definitions and trying to reach agreement on how best to compare data across state borders and what can be meaningfully published.

This presentation will discuss a range of issues and difficulties associated with recording data and with comparing safety performance.

## **METHODS AND TECHNIQUES TO ASSESS SAFETY PERFORMANCE**

There are a number of methods to help assess safety performance. Some require forms of qualitative assessment but most rely on accident and incident (occurrence) data. Two common means of assessment are trend analysis and benchmarking.

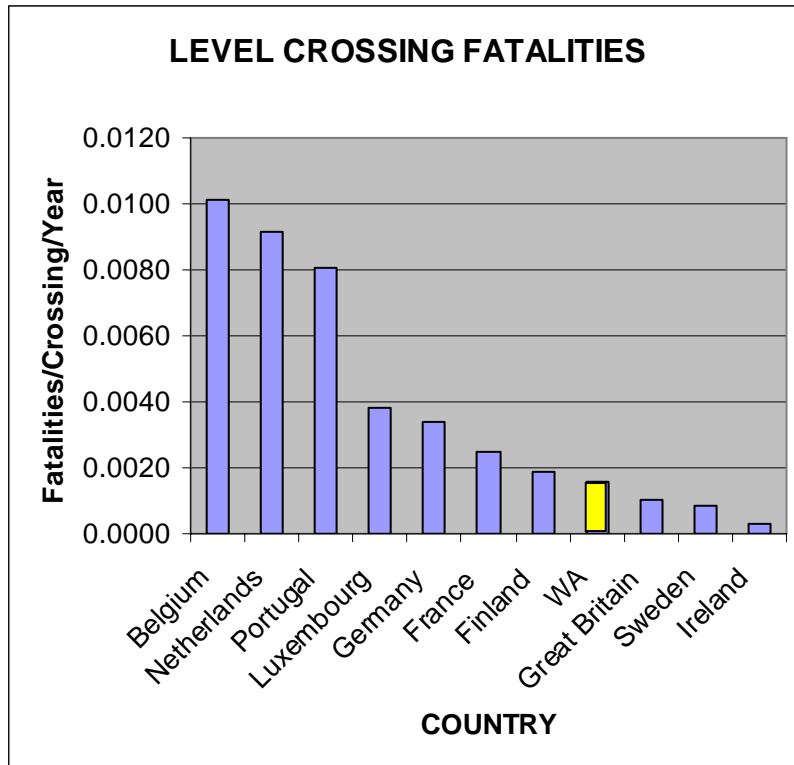
Trend analysis requires consistent capture of data over a period of time and the statistical analysis of trends. Analysis may indicate if safety is improving or not. It may even provide an indication of other factors at work such as seasonal variations driven for example by heat, cold or wet weather.

Benchmarking is a means of assessing how one thing or system is performing compared to another. Again statistical analysis may be able to help in advising if other factors are at play and to what extent. Benchmarking however is usually only able to give an indication of relative performance and great care needs to be taken not to read more into results than warranted. If benchmarking is to provide realistic indication of performance then the data must be identically based. This usually means that definitions for the parameters to be compared need to be carefully composed and then data collected strictly in accordance with the definition. The data is then normalised to allow direct comparison. If the data is not consistent with definitions the results can be dramatically distorted and give poor or misleading indications of performance. If the normaliser is inappropriate, or applied improperly, then biased results can be generated that affect comparisons.

To make it even harder, it is possible, even common, that consistent data may provide misleading indications. This is particularly true when a factor to be compared is made up of a number of sub-elements but the operating environments are different. In railway safety occurrence data many data categories are made up of multiple sub-categories. For example collisions can be with other trains, rolling stock, obstructions, animals, missiles, road vehicles, infrastructure and other things. Each of these things in a different environment may distort the total count and the normalised result. For example, collisions with obstructions may be prevalent in a particular system due to social behaviour in the area but non-existent in another system. Comparing collision data distorted by this element may then become problematic. Further examples of these problems will be provided later on.

In order to benchmark it is obviously necessary to have access to data from other places. This can be achieved through arrangements with others to share data. For example some metro/urban passenger train operators have agreed to exchange some information. Another source is by comparing published data (e.g. from the internet). For example in January 2004 the RSSB in UK published data for international comparison of road level crossing safety. It compared collision and road fatality data for a number of European countries and also Australia, Japan, USA and Great Britain. We were interested to see how we compared and superimposed our own results over the data provided. The following graph shows how Western Australian level crossings compared on fatalities.

We are grateful for some further information provided by RSSB in its report that ensures that we didn't get too excited about an apparently good result. It stated, "It is not known, for example, if the data refer to all crossings or a sub-set (e.g. just public crossings) in each country. It is also not known if the road death data just refer to vehicle occupants as these figures could possibly include pedestrian fatalities as well. (GB refers to both)." Clearly we can't be sure we are comparing apples with apples and our lesson is that we may use the comparison as an indicator, at best.



This sort of information is important advice in any benchmarking exercise as it alerts the user to take caution before drawing conclusions about its own performance. Such advice may result in either:

- The user making adjustments to local data to ensure it is more directly comparable; or
- Not trying to benchmark that particular data because of uncertainty about its true comparability; or
- Not assuming that the comparison is providing absolute confirmation that local performance is better or worse. At best benchmarking may only provide an indication.

### IRSC / NEW ZEALAND BENCHMARKING EXPERIENCE

At the International Rail Safety Conference in Canada in October 1999, Terry Atkinson of the Land Transport Safety Authority of New Zealand (NZ) volunteered to collate data from those delegates prepared to participate in an international benchmarking exercise.

In a follow up paper to the IRSC in London in 2000, UK, Terry reported on the exercise and provided a comparison of occurrence data in certain defined parameters of railway safety for the years 1997/98 and 99.

Our recent experience in Australia trying to get comparable data to allow benchmarking between Australian jurisdictions and companies has shown how difficult the task was that NZ pursued.

NZ provided IRSC delegates with a questionnaire requesting data for a range of occurrence categories for particular railways for the years 1997 to 2000. The questionnaire included a set of definitions for these data categories. Data requested included:

- Type of railway (e.g. heavy railway, urban metro, light rail, etc).

- Railway status (e.g. national, state, provincial, part national etc).
- Type of business (e.g. Government owned, private owned, infrastructure owner, vertically separated operator, etc).
- Business split (passenger/freight)
- Fatalities
- Serious Injuries
- Level crossing collisions
- Derailments
- Collisions
- Signals passed at danger (SPAD) and Warrant over-runs.
- Normalising data (e.g. track length, passenger train kilometres, freight train kilometres, freight tonne kilometres, passenger journeys, employee hours and population, etc).

In the questionnaire it was advised that:

- Respondents to the questionnaire would be provided with Tables indicating their performance position relating to all respondents for individual parameters.
- Collection of statistical information will be through the completion of this questionnaire.
- The difficulty of obtaining consistency of data due to different definitions and data capture categories is recognised and will influence the relevance of the results recorded.
- Respondents are asked to review and as far as possible adjust their data to adhere to use of the definitions and categories in this questionnaire.
- Where “significant” differences occur the definition used should be noted adjacent to each question.

This was all good advice and it remains particularly relevant, as our own experience has shown.

Results were presented in two categories in the form of “League Tables” without comment on performance. They were:

- Heavy rail operators
- Urban Metro and Transit operators

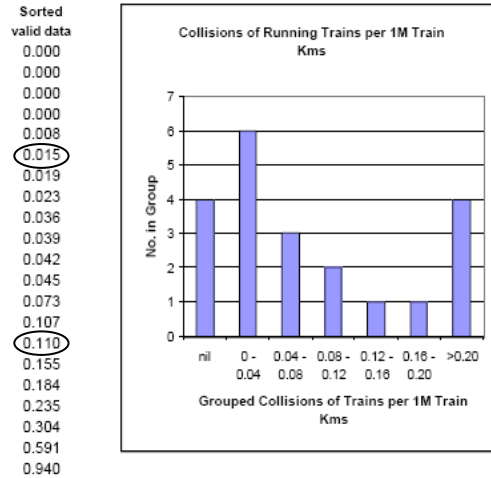
Participants were left to consider the comparisons and to reach their own conclusions relating to size/type/demographics of the railways seen to be reasonably comparable with their own circumstances.

The following NZ-IRSC graph for collisions of running trains examples the type of information provided. Similar graphs were provided for other data categories.

We found it was not possible to make any meaningful comparison or to draw any conclusions because we had no idea about what or who the other railway operators were or whether their operating environment was similar to any degree. In some measures we appeared to have a relatively low rate for one of our operators but not the other. But how were the particular operators comparing internationally? We could not compare heavy haul freight operations against other heavy haul freight operations because we didn’t know which data related to them. Nor could we compare our urban passenger operator against other urban passenger operators.

1999

Sample = 19



## NZ-IRSC study – Running Line Collisions

### AUSTRALIA'S EXPERIENCE DEVELOPING OCCURRENCE DEFINITIONS.

In 2001, inspired to some degree by the efforts of New Zealand at the IRSC we set out to standardise definitions for compulsory notification of occurrences across Australia. We developed a reporting framework that comprised occurrence 19 categories.

I promoted and received support from other jurisdictions of the need to develop the definitions and where possible to try to align them to overseas definitions to facilitate benchmarking.

To help in developing the definitions a large table identifying a list of occurrence types and sub-types was developed. In a number of columns alongside were added as many definitions as could be found from other countries like UK, USA, Canada, the New Zealand IRSC project and elsewhere. The European work that culminated in Regulations 91 and 1192 of 2003 was not developed at the time but I will add a few comments about the current EU definitions later on.

Examining these definitions we found that the principles underlying occurrence notification requirements in other countries varied considerably and that this would affect our ability to make direct comparisons of performance.

USA, for example, had a reporting threshold of \$6300 of damage for different types of accident categories - Collisions, derailments, fires, explosions, acts of God, and other events involving the operation of on-track equipment (standing or moving). Accidents with less damage may not be captured. This would mean that some USA data could show lower rates and may not provide readily comparable information in a benchmarking exercise. Also in USA injury is not separated into serious and minor injuries and this could lead to higher reporting.

A further aspect is that USA and South Africa seem to convert yard shunting work (yard switching) into mainline train distance rates. USA does this at a rate of 6 mph for the time actually engaged into train miles if actual mileage is not known. It is not known if this would

increase the size of the normalising factor (per million train miles) and further affect the normalised rate. Australia doesn't upsize train kilometres in this way meaning its calculated occurrence rates may be relatively higher. Similarly level crossing accidents in Australia include pedestrian crossings not at roadways while USA seems to only capture highway crossings. Also USA does not capture suicides, as determined by a coroner or other public authority or attempted suicides that could involve serious injuries.

The EU has recently developed regulations for reporting accidents that include some accident definitions. Safety statistics are now appearing on the European Rail Agency website. These definitions also show differences that would inhibit international benchmarking by Australia. E.g. 'seriously injured person is hospitalised for more than 24 hours whereas in Australia serious injury is simply 'admitted to hospital' with no time limit. Deaths and serious injuries seem to include only those caused by a rail vehicle in motion. It seems likely that road-rail inspection vehicles and some maintenance vehicles don't fit the definitions and therefore deaths and injuries caused by them having an accident may be excluded. Also it appears that the EU database mostly involves serious accidents on main lines rather than secondary lines as well. Like USA it is understood that the EU has a reporting threshold involving significant damage that is equivalent to. There serious accidents are defined as any accident causing at least one serious injury or damage over €150,000 (AUD250,000 and \$190,000US) or tracks blocked for more than 6 hours. Unlike Australia and UK the EU does not seem to define collision.

Australia's definitions are broadly similar to those used in UK but are not identical. For example the definition of serious injury in Australia is considerably different to that for a major injury in the UK. Also UK publications discuss a conversion or 'equivalence' concept that equates major and minor injuries into fatalities as follows:

- 10 major injuries = 1 fatality
- 200 minor injuries = 1 fatality

It is not clear if UK death rates include these adjustments or where the adjustment is applied. As with USA this sort of difference can result in difficulty comparing death and injury rates.

The next observation was that some occurrence types had several sub-categories. As mentioned before for collisions there are several identified sub-categories. If any country or railway does not record data for the same sub-categories then benchmarking apples with apples at category level is not directly possible.

Overall it is clear that definitions need to be clear and unambiguous. If not then people recording occurrence information into databases may have difficulty deciding which category and sub-category to record the event against. Because some categories have small numbers data need to be recorded reasonably accurately. Otherwise a normalised rate may be dramatically distorted by small changes in the number of occurrences and make benchmarking useless.

To further illustrate the points about some international definitions from different sources for a select range of occurrence types are provided at Appendix 1. Examination of these shows some varying philosophies. However there are also a great number of similarities. The challenge is to find where comparisons may be possible or plausible.

## **AUSTRALIAN OCCURRENCE REPORTING CATEGORIES**

Australia's agreed occurrence definitions were recorded in a standard called "Occurrence Notification Standard No.1" (ON-S1). It has the following occurrence categories:

1. Collision
2. Derailment
3. Level Crossing
4. Signal Passed at Danger

5. Proceed Authority Exceeded
6. Signal Irregularity
7. Slip, Trip & Fall
8. Loading Irregularity
9. Dangerous Goods
10. Safeworking Irregularity
11. Track, Civil Infrastructure Irregularity
12. Rollingstock Irregularity
13. Electrical Infrastructure Irregularity
14. Fire
15. Explosion
16. Alleged Assault
17. Suspected or Attempted Suicide
18. Alcohol or Drug Irregularity
19. Vandalism

Since 2001 it has been mandatory that accredited railways notify the regulator of the following:

- Details of any occurrence falling within the detailed definitions in ON-S1 categories;
- Any occurrence involving a death or serious injury is required to be notified; and
- Details of measures to allow normalising of the data.

Each category may have several sub-categories as exemplified here:

#### **1. Collision with**

1. Rollingstock
2. Person
- 3. Animals**
4. Infrastructure
- 5. Obstruction**
- 6. Missile**
7. Road Vehicle
- 8. Other**

#### **2. Derailment**

1. Running Line
2. Yard

#### **3. Level Crossing Occurrence**

1. Collision with Road Vehicle
2. Collision with Person
3. Equipment Failure / Defect
4. **Other**

#### **3. Signal Passed at Danger (SPAD)**

1. Driver Misjudged
2. Completely Missed while Running
3. Signal Restored as Train approached
4. Starting Against Signal
5. **Other**

Some other countries don't seem to capture all of these subcategory data meaning we would only be able to benchmark against some elements.

A feature of data categorisation in Australia is use of the "top event" principle. Standard ON – S1 requires that the occurrence categories be applied to the most serious the outcome (top event).

Occurrence reporting is based on “top event” reporting within the defined occurrences categories specified as notifiable occurrences within this standard. The method of determining the “top event” in a chain of events associated with any one occurrence or irregularity requires the identification of the most serious outcome within the chain of events that fits the definition of a category of occurrence within the standard. As a guide to the method of categorising occurrences some examples including the well-known UK Great Heck event is used.

The following table provides examples of how the ‘top event’ is determined. In Australia the Great Heck event would be recorded as a train collision with another train.

Description of Event	Possible Categories Relevant to Occurrence	“Top Event” Category
<i>Great Heck 28 February 2001:</i> A road vehicle and trailer ran down an embankment onto the rail reserve, collided with a train, train derailed, deflected at a set of points onto opposing main, collided with an opposing train, caused multiple fatalities and serious injuries.	2.2.8 Collision with road vehicle, 2.1.1 Running Line Derailment 2.2.1 Collision with train	<b>2.2.1 Collision with train (multiple fatalities and injuries)</b>
A signal fails to black out, driver fails to observe signal, proceeds into section and collides with another service.	2.6.2 Signal Failure –other, 2.4.2 SPAD – completely missed, 2.2.1 Collision with train.	<b>2.2.1 Collision with train</b>
Passenger falls from platform and is struck by train.	2.7.5 Slip on/from platform, 2.2.3 Collision with person.	<b>2.2.3 Collision with person.</b>

### Current Situation in Australia.

Currently we are reviewing data collected since ON-S1 commenced and testing:

- Where the definitions require any clarification;
- Whether any changes to categories or new categories are required; and
- What data can be compared (benchmarked) and published.

So far we have found that:

- Some results are being distorted by data in particular subcategories (e.g. those highlighted in red above). A key problem affecting comparability involves those caused by trespassers and vandals.
- Some railways are reporting occurrences that don’t fall within the above categories. The regulator database managers have treated this information in varying ways. Some have ignored the data while others have put the data into a best-fit category under the subcategory of ‘other’. This affects the total count for a category and can distort benchmarking. Others have placed such data in separate category called “miscellaneous”.
- Analysis of data collected within the subcategories labelled “other” and the “miscellaneous” category have shown it will be useful to add a small number new categories and subcategories to ON-S1. These include “Corridor Security” and “Communication System Failures” as well as subcategories for “Near Miss with Person” and “Near Miss with Road Vehicles” at level crossings).
- Similarly new trends in rail operation and technology have seen us propose adding other new categories for “Terrorism” and. “Train Warning and Enforcement System Irregularities.”
- A few definitions need to be adjusted to make them more clear to the user;

- Some regulators need to enhance their data collection and validation processes to improve data quality; and
- More work needs to be done to disaggregate some data to improve accuracy in normalising data and to better promote publication or exchange of data that facilitates meaningful benchmarking.

**SAMPLE BENCHMARKING OF 2005 RAIL SAFETY OCCURRENCE DATA.**

Let us now turn to illustrating some of the problems we have seen in data management and how it has impeded useful benchmarking. Four reporting categories are examined:

- Collision
- Derailment
- Level Crossing
- SPAD

Data used comprises some Australian results, some international data in these categories found on the Internet, and data provided in the NZ-IRSC report for 1999.

We see that results can be markedly different and will examine some of the many reasons that can help explain some of the differences. For convenience rates normalised per million train miles have been converted to million train kilometres (sorry to those still with feet!). 1 mile = 1.609 Km.

It should be noted that when we see a rate is lower than a rate from another place it does not mean that one railway or system is safer than the other. Often the reality is that the apparent difference is calling for further analysis of a number of issues such as the underlying definitions, the type of operations, social factors, etc.

To be able to benchmark the data needs to be captured on the same basis. For this reason, working with common definitions is critical. Otherwise we would need to adjust our raw data to be consistent with the other party’s definition before making the comparison. Obviously this can be quite tedious work.

One area where data comparison has proved nearly a waste of time has been in rates of death and serious injury. A key reason is the different definitions applied in different countries and reliability in capturing and recording the data.

The definitions for fatalities and serious injuries provide a good example. Areas where there are definition differences that could affect data levels follow:

**Fatalities:**

Australia	Dies, within 30 days from injuries sustained in that occurrence
NZ-IRSC	Injury-related death within thirty (30) days of the occurrence
UIC	Dies within 30 days as a result of an injury accident
UK	Dies within a year
USA	Dies within 365 days

**Serious Injury:**

Australia	Admitted to hospital
NZ-IRSC	Admitted to hospital for more than 48 hours
UIC	Admitted to hospital for more than 24 hours
UK	Admitted to hospital for more than 24 hours
USA	Requires medical treatment (not first aid) from a physician or licensed medical personnel. Does not include injury from assaults.

The concept of 'admitted to hospital' derives from the World Health Organisation's International Classification of Diseases (ICD-10) that is used in health systems globally to categorise injuries. However whether simply admitted or admitted for 24 or 48 hours or more are local differences. These differences affect our ability to benchmark key safety data. To make it more difficult a key problem we face in Australia is in complying with the definition for serious injury. It may be known that a person was taken to hospital after an incident but not whether the person was admitted to hospital. Injuries are assessed by the hospital that decides whether hospitalisation is required.

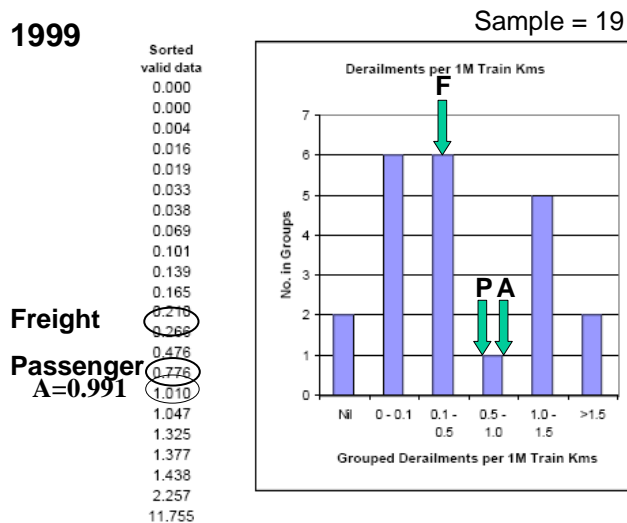
In one accident at Zanthus in Western Australia (August 1999), 47 people were injured (31 passengers and 16 on-train staff). Of these 21 (17 passengers and 4 staff) were taken to hospital by air ambulance. Of these 2 were admitted to hospital and one remained there for several weeks. One other member of train crew suffered a bruised arm (not taken to hospital) and was off work for 2 weeks. It is clear that the number of serious injuries would be recorded quite differently in the above-mentioned countries with a range from 22 serious injuries in USA, 2 in Australia and 1 in UK and the EU.

To further illustrate the points about some international definitions from different sources for a select range of occurrence types are provided at Appendix 1 in my paper. Examination of these shows some varying philosophies. However there are also a great number of similarities. The challenge is to find where comparisons may be possible or plausible.

I will now provide some further examples to highlight difficulties or risk with benchmarking.

#### Derailments per Million Train Kilometres.

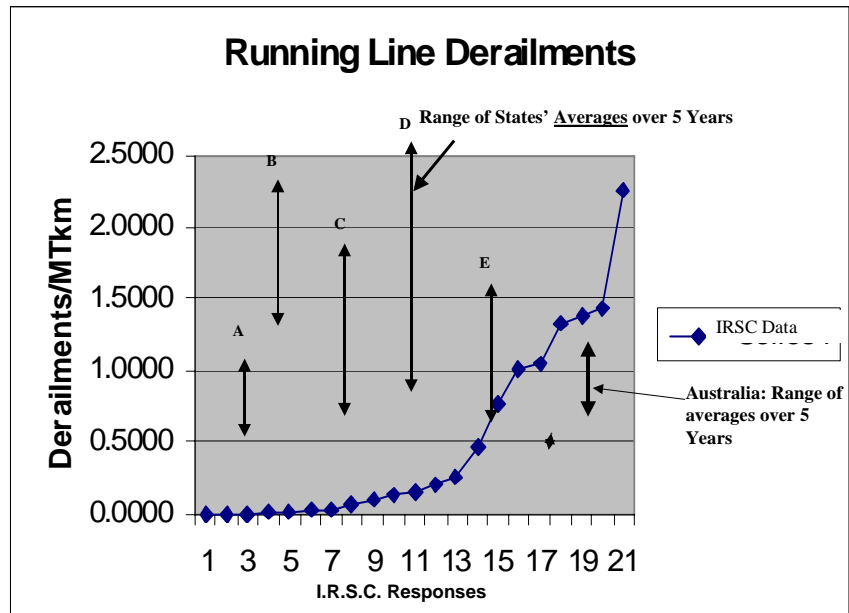
The IRSC data with WA results highlighted for 1999 was as follows:



P = WA passenger 1999; F = WA freight 1999; A = 2005 running line derailments Australian average.

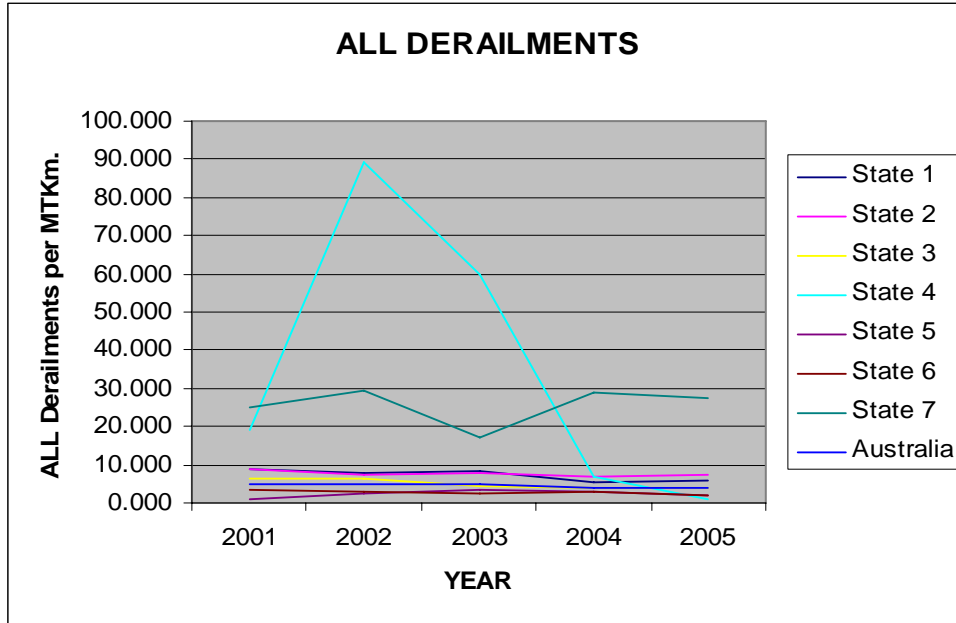
The NZ-IRSC data did not show what type of operations we were comparing data against and therefore it was not possible to assess whether safety performance was good, bad or reasonable.

The next graph shows the 1999 IRSC data range overlaid by a vertical line showing the range of annual average derailment rates for each State from 2001 to 2005 plus the range of Australian averages over that period. The NZ-IRSC data for 1999 derailments had a mean of 0.89 per million train kilometres. Australian average rates range from 0.82 to 1.33 between 2001 and 2005. However it can be seen that the various state averages were inside the range of results from the IRSC study. What cannot be seen in this data for Australia is that derailment rates for individual railway companies range from zero to over 100. Using an average is deceiving just as is comparing urban passenger train system rate (which would be expected to be very low) against the rate for a light rail or street tram system (which may be a lot higher).

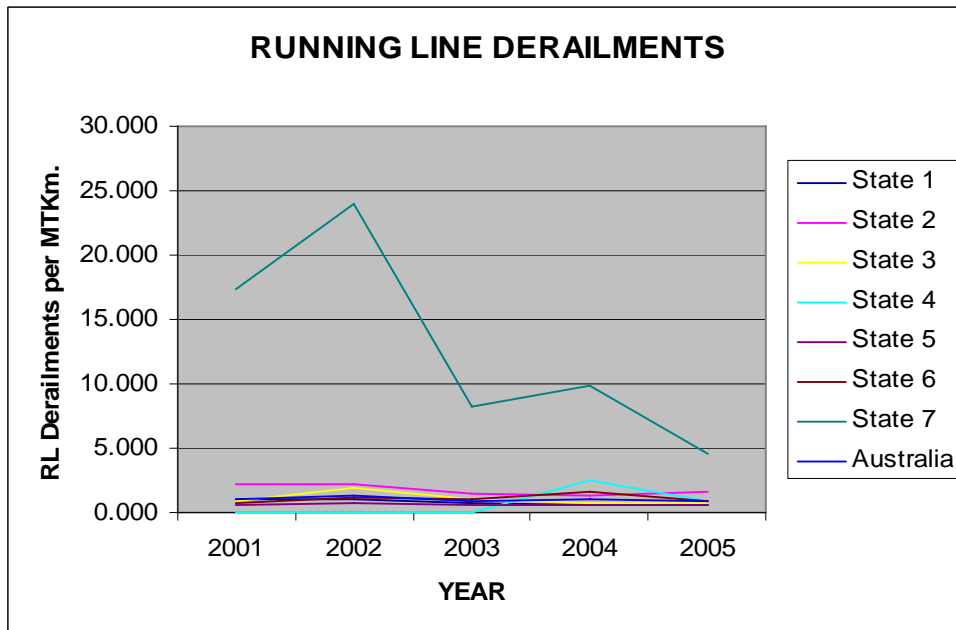


In Australia derailments are recorded separately as running line derailments or as yard derailments.

The following graph shows the range of derailment rates for each State in the last 5 years. Most are close but two States stand out with higher rates. Different working environment and industry structure (range, size and combination of railway types of activity) can explain most of this.



The next graph shows the subset of running line derailments. Note that only one State stands out now. The effect of removing yard derailments is obvious. Analysing at subcategory level can assist with identification of possible areas of interest for further assessment.



The following table provides further information focussed on Western Australia with some international comparisons.

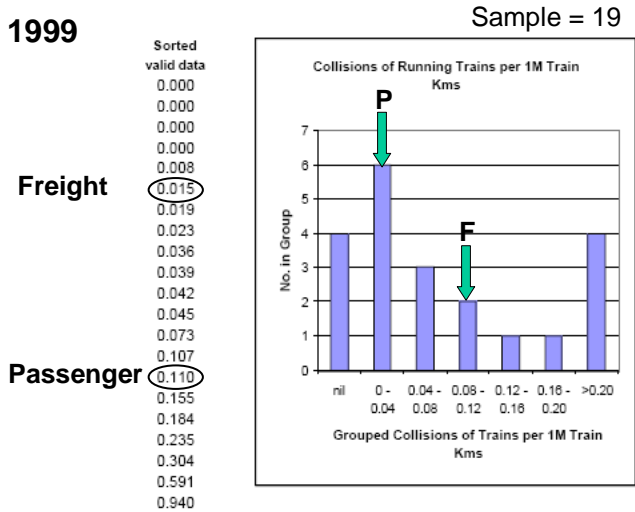
	<b>MAINLINE Derailments per MTKm.</b>	<b>YARD Derailments per MTKm.</b>	<b>Million Train Kilometres</b>
Australia	0.82	2.97	179.396
Western Australia – (total WA)	0.85	3.45	24.640
WA mainline operators only	0.61	3.38	24.574
Interstate: Perth to Kalgoorlie	0.46	2.75	4.359
Urban Passenger	0.00	0.69	7.668
Minor railways (WA)	90.3		0.664
NZ-IRSC	0.89		
UK (OOR)	0.08		858.990
EU (ERA)	0.19		3,725,514
USA (FRA)	1.77		1,273.290
Canada (TSB)	1.26		154.280

NOTES:

- Data for Australia does not include trams but data for total WA does. Data for WA mainline, interstate and urban does not.
- WA has a wide mix of railway systems with different operating standards.
- 30% of WA derailments involved freight trains and only 9% involved significant damage. The remainder involved light inspection vehicles or minor railways.
- During 2005 106 derailments were recorded in WA – 21 on the mainline and 85 in yards. Of the mainline derailments 11 involved inspection vehicles and 5 involved trams. Investigation shows they were caused by track and not train irregularities.
- Minor railways (including trams) in WA have 0.12% of track in the State, 2.7% of train miles but 29% of derailments. These trams operate at low speed and of low risk but distort the WA result considerably from year to year.
- Few derailments on the main line involve trains. Many involve high-rail (road-rail) inspection vehicles.
- Urban passenger system derailment rate is zero and has been for some years.
- Yard derailment rates are calculated using total mainline train kilometres as yard TKms are not collected or calculated. This is an inappropriate normaliser to use for yard derailments. It is of interest that in USA it appears that data includes adjustments for yard derailments (see earlier discussion).
- USA doesn't capture low damage occurrences. If the USA damage threshold were used in Australia its rates would be much lower.
- We really don't know what rail activity the EU data includes and excludes.
- Overall this data shows the importance of comparing data with similar definitions for railways that have similar operations. It also shows the need to use appropriate normalisers.
- Key questions include whether data for small tourist and heritage and light rail systems should be separated out and benchmarked separately from urban transit systems and long haul mainline system operations.

## Collisions per Million Train Kilometres.

The NZ-IRSC data for 1999 was as follows:

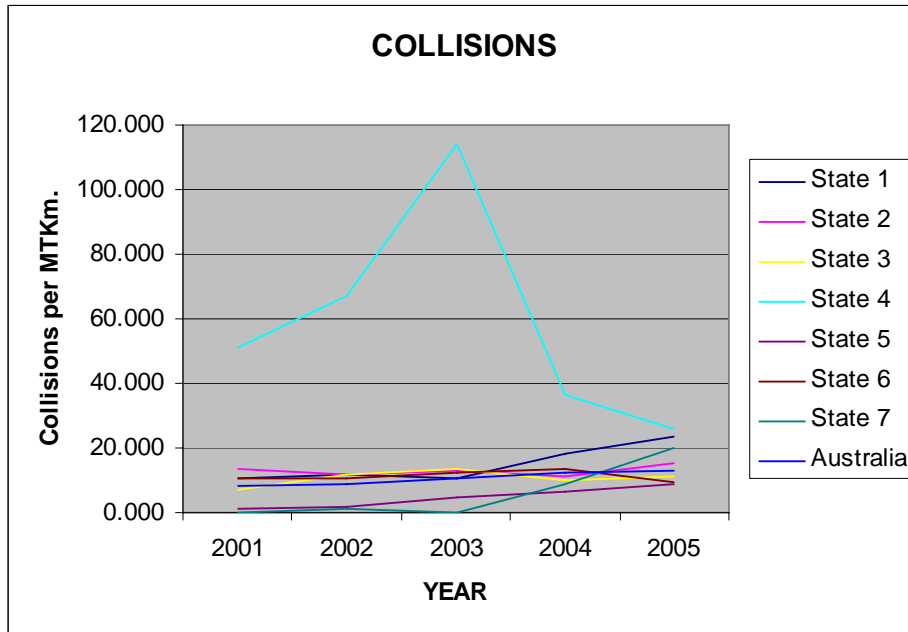


P = WA passenger 1999; F = WA freight 1999

Again the NZ-IRSC data did not show what type of operations we were comparing data against and therefore it was not possible to assess whether safety performance was good, bad or reasonable.

The mean rate for total collisions in the NZ-IRSC study was 0.42 with rates ranging from 0 to 2.86 per million train kilometres.

The following graph shows the range of collision data for each State in the last 5 years. Most are close but one stands out and a very different operating environment and industry structure explains most of this.



This table provides further information for 2005 focussed on Western Australia with some international comparisons.

	<b>Total Collisions / MTKm.</b>	<b>Running Line COLLISIONS per MTKm.</b>	<b>YARD (non main-track)</b>
Australia	13.13	N/A	N/A
Western Australia (WA)	10.96	N/A	N/A
WA mainline operators only	10.99	N/A	N/A
Interstate: Perth to Kalgoorlie	7.34	N/A	N/A
Urban Passenger	13.32	N/A	N/A
NZ-IRSC		0.42	
UK (train to train only)		0.01	
EU (ERA)		0.18	
USA		0.21	
Canada (main-track and other)	0.65	0.04	0.61

**NOTES:**

- At present Australia does not separate mainline and yard collisions making benchmarking difficult. Data is operator based. This limits benchmarking.
- Removing yard collisions dramatically reduces the collision rate.
- Australia and UK data doesn't include collisions at level crossings. However it does include collision sub categories of train with train, rollingstock, animals, obstructions, infrastructure, missiles, road vehicles (not at crossings), and other.
- It is not known what Canada's collision definition includes/excludes.
- Having so many collision subcategories can result in significant distortion of normalised data at category level and it can be argued that benchmarking should be limited to

mainline collisions by main network operators' trains with other trains, rollingstock and infrastructure.

- Local conditions have a marked effect on results. For example Perth urban passenger had 53 collisions of which 85% (28 with missiles and 17 with obstructions) were due to vandals. In contrast Pilbara Iron had a rate of 19.9 collisions per MTKm but 85 out of 86 collisions (99%) were with animals in remote unfenced areas and none caused by vandals.
- Overall this data shows the importance of comparing data with similar definitions for railways that have similar operating conditions.

The following data from Northern Territory (NT) for 2005 shows a similar result to Pilbara Iron. NT has a high rate of animal strikes. However other information is revealing. There was a major shift in the normalising factor with train kilometres increasing from 0.143 to 1.188 MTKm from 2004. This coincided with opening of a new northern railway corridor from Alice Springs to Darwin and introduction of new train services. The collision rate before 2004 was mostly with animals over a 281 km length of unfenced track south of Alice Springs. The new 1451 km of track north of Alice Springs is more than 90% fenced to keep animals out. The result is that the general operating environment on the new section is markedly different and even though most collisions are still with animals the rate has fallen dramatically. Overall animal strikes have increased in the southern section due to an overall increase in the number of trains. This highlights the need to understand more about why data trends change and why care needs to be taken before drawing conclusions about any benchmarking results.

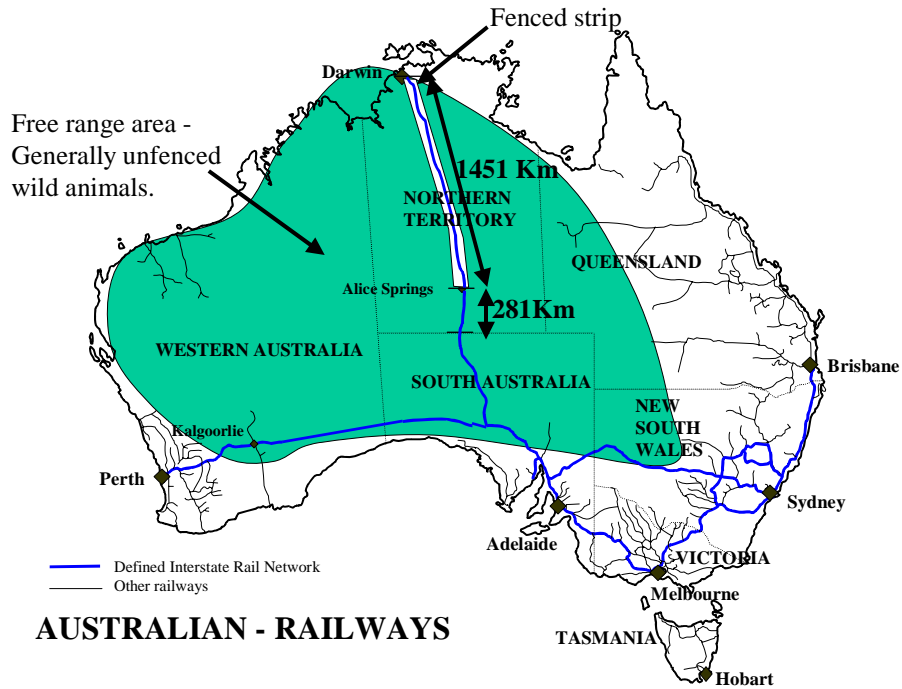
### Northern Territory Collisions – mostly with animals

	2001	2002	2003	2004	2005
<b>Track Km</b>	281	281	1,732	1,732	1,745
	← Unfenced →		← Mostly fenced →		
<b>Collisions</b>	8	12	21	43	29
<b>Million Train Km.</b>	0.1570	0.1790	0.1430	1.1880	1.1170
				← New trains →	
<b>Rate</b>	50.9554	67.0331	114.13	36.1941	25.9624

↑  
New track to Darwin opened

The following maps show shaded area where railways are generally unfenced and wild animals become a collision factor. In Western Australia one interstate freight company had a collision rate of 3.71 per MTKm in 2005. None of these were recorded west of Kalgoorlie and 12 were in the shaded area east of Kalgoorlie to the state border. Most animal collisions cause little if any damage.

Animals that roam freely provide an interesting side statistic for collisions in WA during 2005 as the 114 were killed in 2005 as follows: 94 beasts (cattle), 11 kangaroos, 3 camels, 3 horses and 3 sheep.



## WESTERN AUSTRALIA

Normaliser: - **track length**

Australia – 42,492 kilometres

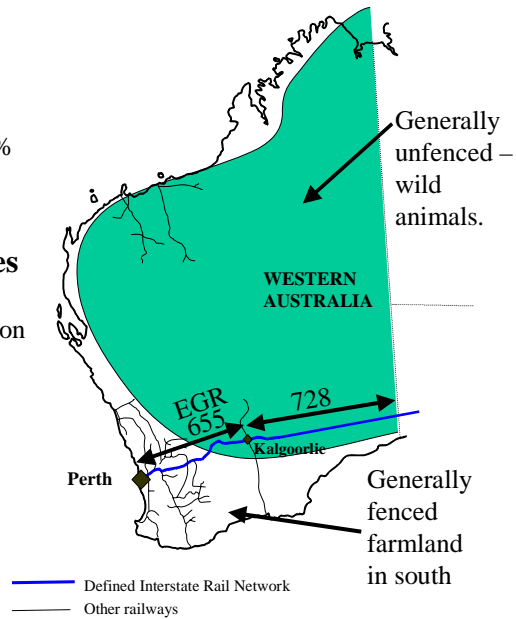
Western Australia – 7,901 (18.6% of Australian track)

Normaliser: - **train kilometres**

Australia – 179.396 million

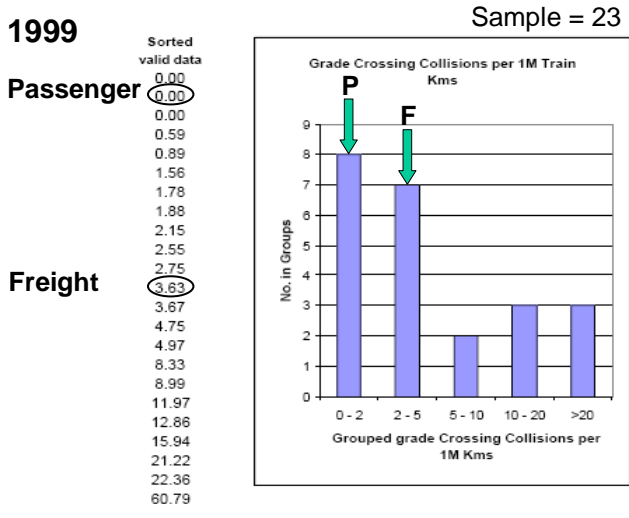
Western Australia – 24.611 million (13.7% of Australian travel)

WA figures do not include BHP operated railways in the North.



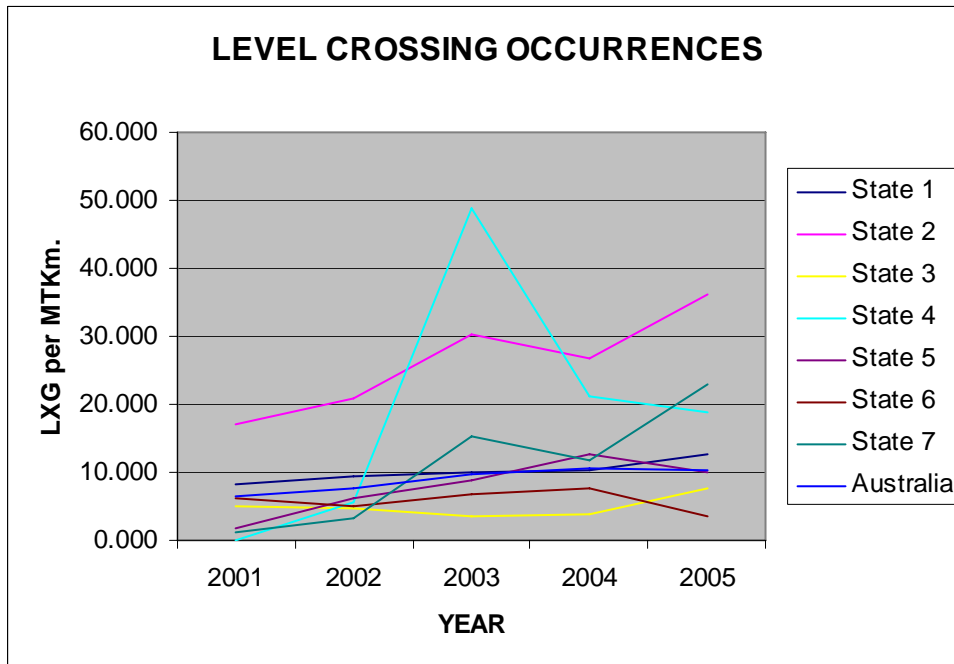
### Level Crossing Occurrences per Million Train Kilometres.

The NZ-IRSC data with WA results for 1999 was as follows:



P = WA passenger 1999; F = WA freight 1999

The following graph shows the range of level crossing data for each State in the last 5 years. These show more variation than with collision and derailment data.



In Australia Total Level crossing occurrence data is captured in 4 subcategories. The number of occurrences in each subcategory in WA in 2005 is shown here in brackets:

- Collision with road vehicle (6)
- Collision with person (0)
- Equipment failure / defect (69)
- Other (116)

Of the total 191 level crossing occurrences recorded in WA 116 were “Other” events and 106 of these were recorded near misses with road vehicles or pedestrians.

The last two subcategories comprise a very high portion of all level crossing occurrence data in Australia making benchmarking at category level with other countries senseless. Even comparing rates between States is problematic. For example some States have collected a lot of variable data under “Equipment failure/defect” that does not fit the definition. In Western Australia events at one location accounted for 27 of the equipment failure records and these should probably not been recorded. Even more variable data is collected under the “Other” subcategory. The extent of data capture for “near misses” varies considerably and is an unreliable factor that distorts normalised data considerably. The distortion is probably so significant that benchmarking or publishing the data at category level is not useful between States or with any other country. It would however be valuable to limit published data to the first two subcategories and to publish and benchmark it nationally and internationally.

For this report we have separated WA subcategory data to enable comparison of level crossing collision rates with available 2005 international data. The table below shows that collision rate (0.24 per MTKm) is a very small portion of overall total level crossing occurrence data rate (7.76 per MTKm).

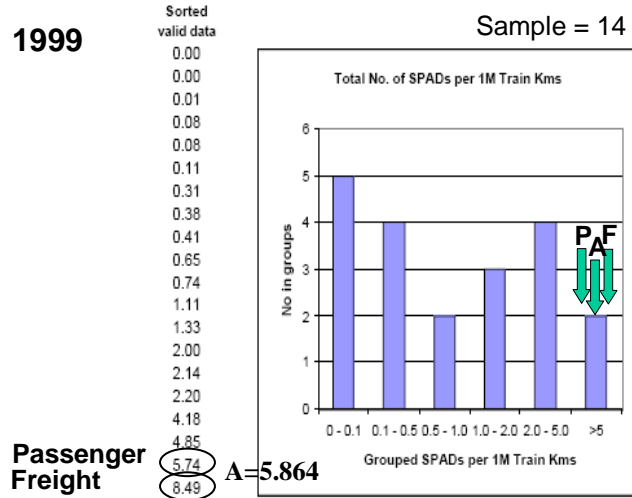
	<b>Total Level Crossing Occurrences</b>	<b>Collision with Road Vehicle or person</b>	<b>Million Train Kilometres</b>
Australia	10.41	N/A	179.40
Western Australia (WA)	7.76	0.24	24.64
			0.66
WA mainline operators only	N/A	0.24	24.57
Interstate: Perth to Kalgoorlie	3.44	0.46	4.36
Urban Passenger	16.43	0.26	7.67
NZ-IRSC		1.48	
UK		0.006	858.99
Canada		1.75	154.28

**NOTES:**

- Canadian and USA definitions include only train collisions with road vehicles and people at highway crossings. Australia includes collisions at pedestrian crossings that are not at a highway. Australia also includes equipment failures and other events such as near misses.
- Overall this data shows the importance of comparing data with similar definitions for railways that have similar operations.

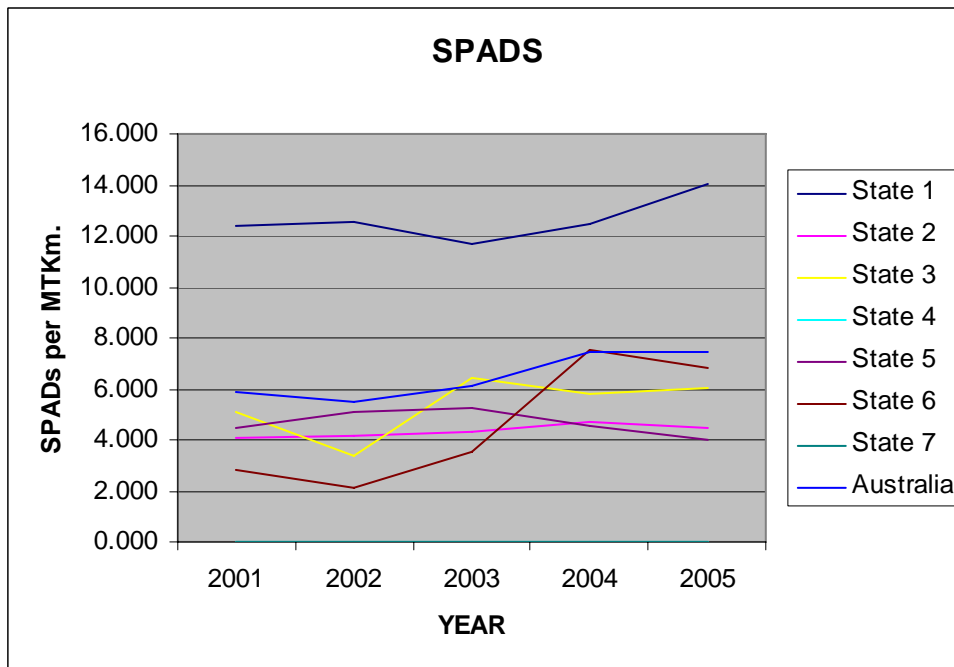
## SIGNALS PASSED AT DANGER (SPADS)

The NZ-IRSC data with WA results for 1999 was as follows:



P = WA passenger 1999; F = WA freight 1999; A = Australia rate 2005.

The following graph shows the range of SPAD data for each State in the last 5 years. These show more variation than seen in the earlier graphs for collision and derailment data.



In Australia SPAD occurrence data is captured in 5 subcategories. The number of occurrence for each subcategory in WA in 2005 is shown below in brackets:

- Misjudged (28)
- Completely Missed (4)
- Signal restored (91)
- Other (8)
- Starting Against Signal (11)

	SPADs / MTKm	Million Train Kilometres
Australia	7.41	179.396
Western Australia (WA)	5.76	24.640
WA Driver error	1.75	24.574
WA Minor railways	0.00	0.664
WA mainline operators only	5.78	24.574
Interstate: Perth to Kalgoorlie	16.29	4.359
Urban Passenger	6.78	7.668
NZ-IRSC	0.93	
UK Category A (Driver error)	0.76	858.990
UK Category B (technical SPADs)	4.47	
UK Network Rail	4.50	
USA	N/A	1,273.290
Canada (Movement authority exceeded)	0.58	154.280

NOTES:

- The NZ-IRSC rates range from 0 to 4.02 SPADs per MTKm. The 1999 mean was 0.93 per MTKm.
- The above Australian based data does not include where an authority is exceeded in non-signalled areas.
- There are 24 railway operators in WA but only 7 operate in signalled territory. The problem is that the total train kilometres of all 24 operators are used in the normaliser to calculate the State SPAD rate. This is clearly wrong. Also the Australian rate has the same problem. Consequently they are understated values.
- This incorrect method of normalising also leads to understating of SPAD rates for particular operators. For example one interstate operator had 19 SPADs in 2005. All occurred between Perth and Kalgoorlie (655 Km). From Kalgoorlie to the State border is a further 728 Km. It is obvious that using its total train kilometres to calculate a SPAD rate will understate its actual rate by more than half. i.e. 5.87 instead of 13.34. Fortunately 15 of its 19 SPADs involved signals restoring in the face of the train and its real rate of driver error misses is only 2.80.
- In WA about 27% of track is signalled and this carries 65% of train kilometres. If the normaliser was train kilometres on signalled track then the rate would be more correctly shown as 8.82 SPADs per MTKm. Of these 5.65 SPADs per MTKm are due to signals restoring in the face of an oncoming train.
- The following table allows comparison of SPAD performance on particular track sectors where equipment is different. It is apparent in 2005 that technical/equipment matters (subcategory 4.3 Signal Restored) are an issue on the Perth to Kalgoorlie line. By comparison performance on the Pilbara Iron railway is excellent.
- The driver error rate in the Perth network (27 SPADs) is a little higher than elsewhere but this system is also protected by automatic train protection (ATP). The Bunbury line rate looks high but subcategories 4.3 and 4.5 only comprise 2 SPADs each. This is a case where very small numbers can distort comparisons.

- Overall this data shows the importance of comparing data with similar definitions for railways that have similar operations. Also the importance of applying a normalising factor in the correct manner is highlighted.

TRACK WITH SIGNALS	Track Length	Approx TKm	4.1 Misjudged/MTKm	4.2 Missed / MTKm	4.3 Signal Restored / MTKm	4.4 Other / MTKm	4.5 Started / MTKm	Total All SPADs / MTKm	Total Driver Miss 4.1 + 4.2 + 4.5
Perth	385	7,668,184	2.22	0.00	2.61	0.65	1.30	6.78	3.52
Perth - Kalgoorlie	655	4,359,659	1.61	0.69	13.76	0.23	0.00	16.29	2.29
Perth to Bunbury	181	236,653	0.00	0.00	4.23	0.00	4.23	8.45	4.23
Pilbara	918	3,833,857	0.52	0.26	0.26	0.52	0.00	1.57	0.78
<b>TOTAL SIGNALLED</b>	<b>2,139</b>	<b>16,098,353</b>	<b>1.74</b>	<b>0.25</b>	<b>5.65</b>	<b>0.50</b>	<b>0.68</b>	<b>8.82</b>	<b>2.67</b>
% WA track signalled	27.0%	65.33%							

It is notable that the signal restored is so high but varies considerably according to the track segment. Further examination of causes shows that these technical SPADs rates are affected by other factors. For example different signalling equipment is located on the Perth to Kalgoorlie line than on other lines. The area has also been susceptible to power failures on the electricity grid and the equipment has not always provided adequate power backup when required.

The following table illustrates the value of further analysis of data. Here we observe SPAD data for each Australian State in 2000. Overall the rates between States are quite variable and the sub-category levels indicate the source of some of this variability. It would be a waste of time to try and benchmark a particular total State level rate with any of the other States or another country unless we had more information about the respective definitions and operating arrangements.

SPADS IN URBAN PASSENGER SYSTEMS IN 2000					
STATE	SPADS PER MILLION TRAIN KILOMETERS				
	Signal Misjudged	Signal Completely Missed	Signal Restored in Face	Other	TOTAL SPADs
A	2.14	0.00	0.00	2.14	4.27
B	1.20	0.30	0.75	0.00	2.25
C	3.36	0.86	3.91	0.08	8.20
D	0.85	0.51	0.05	0.41	1.81
E	0.50	0.69	4.51	0.13	5.83
<b>Average</b>	<b>1.29</b>	<b>0.55</b>	<b>1.57</b>	<b>0.39</b>	<b>3.79</b>

## **OTHER OCCURRENCE REPORTING CATEGORIES.**

This paper does not review the other 15 reporting categories in Australia. However it is known that the types of issues discussed above exist as issues in many of the other 15.

## **SAFETY PERFORMANCE – NORMALISING and TRENDS.**

All States and Territories have been collecting data based on the agreed national definitions in ON-S1 since 2000. In 2006 the State Regulators tabled all the collected data and been reviewing the results.

In WA we have undertaken more extensive data analysis to understand better what the data is able to tell us and to learn more about how to improve what we are doing.

This work has clearly proved that in order to compare safety performance data it is best normalised into common occurrence rates. This means bringing it into a form where the information is directly comparable. It should be like comparing “apples with apples”.

The most common method of normalising railway occurrences is by calculating the occurrence rate per million train kilometres (per million train miles for some countries). Care in selecting the right normaliser is important and this may vary depending on the nature or type of occurrence. Some other normalisers used in the NZ/IRSC study were mentioned previously. There needs to be a relationship between the normaliser selected and the data to be normalised. For example it would not be useful to normalise rail breaks with number of passenger journeys, as there is no relationship between them.

A normaliser may give different results for different types of rail operation. For example normalising SPADs per million train kilometres may not be useful when comparing high frequency urban passenger services with long haul rail operations where signalling is less frequent.

Normalisers also need to be used with care as they can change themselves. This is particularly true when the scope and arrangement of railway activities changes.

For all these reasons our experience in Australia shows it becomes dangerous to try and compare normalised data between countries or even States where the nature and scope of railway types are different. For example one State with predominantly urban passenger type railways cannot be compared with another where most activity comprises long-haul freight or heritage type or light railways (e.g. trams). The normalized rates may be naturally quite different.

Benchmarking normalised data is useful and likely to be more reliable in the following circumstances:

- Between similar types of railways (e.g. urban passenger)
- Between operators using the same network or type of network operation.

Trends in normalized data may also allow useful trend analysis and projections to help assess future safety risk.

Normalising data is not always necessary and simple trend analysis of raw data can be used by railway operator to assess how its own performance is progressing.

Trend analysis of raw data and of normalized data can be affected by abnormal situations. For example a spate of events or a change of operation can affects results.

Many occurrence categories may see very few events recorded. For example mainline collisions may be rare. So when one event occurs the result can jump and if two occur then the jump in rate can be very significant.

Over time experience can lead to review and adjustment to definitions to help ensure occurrence data is more easily logged in the data system. Definition changes can also affect trends.

For these reasons it is important to add notes to all published data to describe where changes in definitions, data, operation and so forth have occurred. Even then comparisons between any occurrence data may be at best only provide an indication of a degree of relative performance rather than an absolute measure of relative performance.

## **OPEN PUBLISHING OF RAIL SAFETY STATISTICS**

It is not possible to learn from others that may be better unless you know who they are and that they are willing to share information. The starting point and a key lesson from the NZ/IRSC experience is that railways in Australia who want to benchmark need to allow open publishing of data/sharing of information about their performance otherwise benchmarking is not really a feasible method.

In this regard we applaud the FRA in USA and to some extent the ORR in UK, which goes beyond publishing only country total data.

A visitor to the FRA website can download very detailed data that meets the user's needs but care is still required. For example one could interrogate the database and download information about how many accidents of a particular type a particular company had in a State or County between dates of your own choosing. This is very open publishing. The website also allows the user to download and study the accident definitions for reporting requirements. It is then that we find out about the damage reporting threshold that will reduce reporting levels and reduce normalised data results.

An examination of websites from other countries shows that data publication is generally less useful. For example TSB in Canada provided some information about collisions, derailments, employee passenger accidents, trespassers, fires, explosions and dangerous goods accidents. While million train miles are stated for the year it is possible to normalise the above categories but there are no definitions so we can't tell what we would be comparing. The ORR in UK, like its predecessors, publishes an Annual Report on Railway Safety. This contains more useful information but one has to look elsewhere to find the definitions in order to assess if benchmarking is likely to be a worthwhile exercise.

Those railway operators who demand comparative data from the regulator but don't want their own safety results published create a real problem. For example urban passenger operators want to compare their data with others but don't want their own data published or compared. Claims of confidentiality seem a poor excuse and illogical. It is in the public interest that safety performance is publicly available.

## **SUMMARY: ISSUES CONCERNING DATA BENCHMARKING**

Experience in Australia has shown that:

- Trend analysis of occurrence data can be useful where there are no underlying or significant shifts in operating environment and the data definitions in use. Trends give an indication of changing safety performance in particular measures for a particular railway or system but don't help much in making external comparisons.

- Normalising data can enhance trend analysis and make it more valuable. Normalised data can facilitate useful external benchmarking and is likely to be more reliable in the following circumstances:
  - Comparing performance between similar types of railways operation (e.g. urban passenger)
  - Comparing performance between operators using the same network or type of network operation.
- Benchmarking is not reliable without common definitions or counting rules. These need to be clear and unambiguous and applied rigorously.
- Definitions used in other countries contain differences (subtle at times) that can make comparative benchmarking a waste of time and give a false sense of relative performance level.
- Comparing local data with data from other States and countries is likely to provide an unreliable indication of relative safety because the underlying structure of railway operations will be different. For example a country with no freight and all urban passenger versus a country with a lot of long haul freight and little urban passenger will have very different overall rates. If one includes a high proportion of small tourist and heritage type or tram/light rail operations then the rates will likely be higher.
- Simply comparing occurrence rates in a benchmarking exercise is fraught with danger. Having a higher rate than some other railway does not mean you are less safe, you could actually be safer. Likewise having a lower rate. What is important is to ensure that the data is based on similar definitions and then you need to understand other factors for that railway system or collection of systems that may be driving the rates in a particular direction. Put simply it is important not to look at the rate but to understand why the rate is what it is.
- Normalisers need to be directly related to the data being normalised (e.g. SPADs normalised by train kilometres only travelled in signalled territory).
- Open publishing of data with definitions is required to facilitate useful benchmarking and is in the public interest.
- Identification of railways, networks and types of operation in published data is required to facilitate benchmarking and learning by others.
- The EU has made progress in defining accidents and is now better placed for benchmarking between EU countries and railway operators (undertakings).
- Australia appears to have a better developed range of definitions and is better placed to benchmark rail safety data between States and railway operations. However differences with definitions with overseas countries including those in the EU means international benchmarking will not be easy.

## **WHERE TO FROM HERE**

The key question now is can the IRSC do more to promote benchmarking based on common definitions on a global basis?

## DEFINITIONS

### GENERAL

#### **USA:**

##### **An accident/incident:**

Is the term used to describe the entire list of reportable events. These include: fatalities, injuries, and illnesses; collisions, derailments, and similar accidents involving the operation of on-track equipment causing reportable damage above an established threshold (\$6,600); and impacts between railroad on-track equipment and highway users at crossings.

A reportable rail-equipment train accident is one in which damage to equipment, track, and railroad structures is in excess of \$6600 that does not include loss of lading, clean up costs, societal costs, loss of main line, personal injury or death.

#### **AUSTRALIA:**

**Railway Occurrence:** Any accident or incident involving a train or rolling stock whether in motion or not, or other event on railway property affecting the safety of persons, property or railway operations.

Includes:

- Collision, derailment, fire, explosion, act of God, or other event; and
- Slips, trips and falls on trains or railway infrastructure.

Excludes: Occurrences in repair shops, not involving a train in motion.

**Train:** One, or more units of rolling stock coupled together, at least one of which is a locomotive or other self propelled unit that is designed to run on a railway.

Includes:

- Single locomotive in operation;
- Tram; and
- Track Maintenance Train: A special type of train that is designed and used for track inspection and maintenance work including:
  - Track machine
  - Hi-rail (road/rail vehicle) / inspection vehicle

Excludes:

- Ballast train (see Freight train).

#### **UIC:**

**"Train"** means one or more railway vehicles hauled by one or more locomotives or railcars, or one railcar travelling alone, running under a given number or specific designation from an initial point to a terminal fixed point. A light engine, i.e. a locomotive travelling on its own, is not considered to be a train. By "train" we mean not only trains that are used in revenue service, but also emergency units, trains that are used for maintenance of infrastructure, including motorised trucks, motorised wagons, etc.

**"Running Line"** Track which is used for train running traffic (passenger and freight). Therefore this does not cover secondary tracks that are used for example to park trains.

The Safety database deals with accidental events that have occurred on main lines. Nevertheless all the serious accidents and the following events that may occur on secondary tracks are taken in account

- Electrocutation by the overhead line or the third rail
- Accident involving dangerous goods with or without dangerous good release.

## **FATALITY AND SERIOUS PERSONAL INJURY**

### **NZ-IRSC:**

**Fatality:** includes.

**Serious Injury:** means an injury which:

- requires hospitalisation for more than 48 hours, commencing within seven (7) days of the occurrence or
- results in the fracture of any bone (except simple fractures of finger, toes or nose) or
- involves lacerations which cause severe haemorrhage, nerve, muscle or tendon damage or
- involves second or third degree burns or any burn affecting more than 5% of the body surface or
- involves verified exposure to infectious or hazardous substances or injurious radiation.

Injuries or industrial illnesses of a MINOR nature should NOT be included

### **AUSTRALIA:**

**Serious Injury:** A person admitted to hospital as the result of injuries sustained in a railway occurrence.

Excludes - Serious personal injury due to:

- natural causes (e.g. heart attack) on board a train or on railway property;
- substance abuse (e.g. drug or alcohol overdose) on board a train or on railway property;
- an occurrence in a repair shop, e.g., a person sustaining a serious personal injury while engaged in the maintenance of a stationary train in a repair shop;
- of a person travelling in a road vehicle involved in an accident on railway property where a train or other railway vehicle was not involved.

### **EU and UIC:**

**Fatality** means a person killed immediately or dying within 30 days as a result of a rail injury accident, excluding suicides.

**Person seriously injured** means any person injured who was hospitalised for more than 24 hours as a result of an accident, excluding attempted suicides.

### **UK:**

Major injury: involves any fracture (except to finger, thumb or toe); any amputation; dislocation of shoulder, hip, knee or spine; loss of sight; chemical or hot metal burn to the eye; penetrating injury to the eye, injury from electrical shock or electrical burn leading to unconsciousness or

requiring resuscitation or admittance to hospital for more than 24 hours; any other injury requiring resuscitation or admittance to hospital for more than 24 hours; loss of consciousness caused by asphyxia or exposure to harmful substance or biological agent; etc.

## **COLLISION:**

### **NZ- IRSC:**

An impact between two running rail vehicles, a running rail vehicle with an obstruction on the track (including excessive impact with track end buffer/bumping post) or shifted load/open wagon (car) door etc. collision with bridge or other structure

### **USA:**

An impact between on-track equipment consists while both are on rails and where one of the consists is operating under train movement rules or is subject to the protection afforded to trains. This definition includes instances where a portion of a consist occupying a siding is fouling the main line and is struck by an approaching train. It does not include impacts occurring while switching within yards, as in making up or breaking up trains, shifting or setting out cars, etc. Impacts of this type are to be classified as "Other."

The timetable, or schedule direction, should govern the classification of collisions when either one of the trains or the locomotives is at rest, or when its incidental movement temporarily differs from the schedule direction.

### **UK:**

#### **Any collision:**

- a) between trains or rail vehicles on a running line, including a collision:
  - i) with an open door or other projection from another train, for example a displaced load on a freight rail vehicle
  - ii) whilst the line is blocked, due to a previous accident or emergency
  - iii) occurring within a possession, including work sites within a possession
  - iv) occurring during a shunting operation
- b) in a siding that results in a running line being physically obstructed
- c) in a siding that is RCI.

### **AUSTRALIA:**

**Collision:** When a train or rolling stock strikes another train, rolling stock, obstruction, person or other object or is struck by another object.

Includes:

- Running line collisions that occur in the normal movement of a train on a running line;
- Yard collisions that occur in yards or sidings or on closed running lines.
- Any collision in a yard, siding or closed line that results in the running line being obstructed or interferes with the safe operation of a running line.

Excludes:

- Any collision (except train to train) that occurs at a level crossing (would be covered under the definition of "level crossing" occurrence).
- Suspected or attempted suicides.

**UIC:**

Crash of a railway vehicle into another railway vehicle or a crash of a railway vehicle into an obstacle: Obstacle includes:

- animals,
- fixed objects: e.g. buffers,
- objects on the track: trees, rocks, etc.,
- road vehicles: on open line and on level crossings.

**DERAILMENT****NZ- IRSC:**

An impact between two running rail vehicles, a running rail vehicle with an obstruction on the track (including excessive impact with track end buffer/bumping post) or shifted load/open wagon (car) door etc. collision with bridge or other structure

**USA:**

When on-track equipment leaves the rail for a reason other than a collision, explosion, highway-rail crossing impact, etc.

**UK:**

Any derailment

- a) of a train or rail vehicle on a running line, including a derailment that occurs:
  - i) whilst the line is blocked due to a previous accident or emergency
  - ii) occurring within a possession, including work sites within a possession
  - iii) occurring during a shunting operation
- b) in a siding that results in a running line being physically obstructed
- c) in a siding that is RCI.

**AUSTRALIA:**

Where one or more rolling stock wheels leave the rail or track during railway operations. Includes:

- Running line derailment; and
- Yard derailment

Running Line Derailment: Any derailment occurring in the movement of a train on a running line.

Includes:

- Track machine derailments if they are travelling on the line as a running train;
- Shunting derailments occurring on running lines within station limits
- Any derailment in a yard, siding or line temporarily closed for maintenance or other purposes that results in the running line being obstructed or interferes with the safe operation of a running line.

Excludes:

- Derailments of work trains/track machines occurring within closed section that does not interfere with the safe operation of a running line;

- Derailments that occur on a section of a running line which, at the time, was under absolute possession (meaning not available for normal train running), usually for the purposes of carrying out engineering works.
- Derailments of wagons on loop lines, equipped with derailleurs to protect the main line, which are temporarily being used for the stabling of rolling stock.

**IRSC:**

Occurs when one or more rail vehicle wheels leave the rail for any reason other than as a result of collision or when the wheels of any rail vehicle takes two lines.

Running train derailment: derailment of a train which has been signalled to depart to the main line and which has not yet arrived at its final destination, which causes death, serious injury or damage exceeding approximately US\$6,500 (excluding recovery costs).

OTHER DERAILMENT: all other derailments not classified as “running train derailment” on all lines including shunting (switching) yards.

**UIC:**

Effect resulting from *at least one axle* of a moving train running off the rails accidentally

**LEVEL CROSSING ACCIDENT**

**USA:**

A reportable highway-rail crossing crash is any highway user (car, pedestrian, bicycle, etc) hitting or being hit by on-track equipment at a highway-rail crossing (both public and private crossings). Sidewalks, pathways, shoulders and ditches associated with the crossing are considered to be part of the crossing site.

Highway-rail grade crossing: is a location where a public highway, road, street, or private roadway, including associated sidewalks and pathways crosses one or more railroad tracks at grade.

**AUSTRALIA:**

Level Crossing: A location where a public or private roadway, footpath, or both, crosses one or more railway tracks at grade.

Level Crossing Occurrence: Any collision of a train or rolling stock with either a road vehicle, person, level crossing safety equipment or gate, or any other occurrence that compromises safety, at a level crossing.

Includes:

- Cases of road vehicles causing damage to gates, barriers or other equipment at level crossings;
- Near miss incidents with road vehicle or person;
- Any case of a train running onto a level crossing when not authorised to do so is reportable;
- Any failure of equipment at a level crossing which could endanger users of the road or path crossing the railway. This includes ‘wrong-side’ failures of equipment (where equipment fails to a dangerous condition) whether or not any train or crossing user is involved at the time of failure;

- Incidents which occur during periods of unusual operation are to be included, e.g. when an automatic crossing is operated manually.
- Level crossing occurrences with Tramways where Trams operate over their exclusive right of way.

**Excludes:**

- Exclude suspected and attempted suicides from the count of level crossing fatalities and persons injured in level crossing occurrences. These are recorded as “suspected suicide”.
- Excludes infrastructure irregularities such as broken rails, welds and bonds that result in the unnecessary operation of crossing protection equipment. (These are reported in infrastructure irregularities).
- Roadways crossing tramways where tramways operate on roadways shared with road vehicles.

**IRSC:**

**LEVEL (Highway-Rail) CROSSING:** a location where a public or private road, including associated foot-way/s, crosses one or more railway tracks on the level (at grade).

**LEVEL CROSSING OCCURRENCE:** when a train or other rail service vehicle COLLIDES WITH or is struck by a road vehicle at a level crossing or when a person is struck by a train or other rail service vehicle at a road or pedestrian only level crossing.

**ACTIVELY PROTECTED CROSSING:** a level crossing provided with flashing lights, bells and/or gates or barriers in addition to warning signs and markings.

**PASSIVELY PROTECTED CROSSING:** a level crossing provided with road warning signs/markings only.

**UNPROTECTED CROSSING:** usually a field or farm crossing. No protection of any kind provided.

**EU:**

Any accident at level crossings involving at least one railway vehicle and one or more road vehicles, other users of the road such as pedestrians or other objects temporarily present at or near the track.

**UIC:**

“Railway line and road crossing each other on the same level arranged for the passage of road vehicles, pedestrians, cyclists or animals.”

Being regarded as components of a level crossing: roadways, ways for pedestrians, verges and ditches arranged in relation to the level crossings.

Level crossing accidents in the UIC database are recorded under another heading. They are accidents involving a rail vehicle and a road vehicle (collision with an obstacle) or accidents involving a rail vehicle and a pedestrian (individual hit by a train) that are located at a level crossing.

**SIGNAL PASSED AT DANGER**

**AUSTRALIA:**

Where a train passes without authority a signal displaying a stop indication or stop aspect.

Also referred to as SPAD – Signal passed at danger; or signal passed without authority.

Includes:

- When signals blacked out.

Excludes :

- Hand signal;
- Point indicator
- Stop boards;
- Radio signal;
- Proceed Authority exceedance.

**UK:**

When any part of a train has passed a stop signal at danger without authority or where an in-cab signalled movement authority has been exceeded without authority.

**NZ-IRSC:**

**SIGNAL PASSED AT DANGER (SPAD):** all instances of a rail vehicle over-running a red (danger) signal due to locomotive engineer (driver) error in misreading or failing to observe the red signal aspect.

**SIGNAL COMPLETELY MISSED:** all instances of a rail vehicle passing a red signal and continuing such a distance as to be in a position to cause a collision or derailment.

**MISJUDGEMENT:** all instances of red signal over-run at low speed caused by locomotive (driver) misjudgement of braking distance, insufficient to result in a significant risk of collision or derailment.

**REVERSION:** a clear signal which changes to red in the face of the locomotive engineer (driver) giving insufficient time for the rail vehicle to brake to a stop.

**UIC:**

“Any occasion where a train passes a signal at danger and runs beyond the danger point” (e.g. a train which runs beyond the fouling point of a set of points where routes converge or running beyond facing points).

(Wrong-side) signal failure

Any failure of the signalling system which results - in the lack of signal indication presentation or by the presentation of an aspect less restrictive than that which has been demanded, for example:

- a green light aspect presented instead of a indication at danger: signal warning to slow down, caution signal announcing a stop signal or a speed restriction signal;
- any signal less restrictive than a stop signal that is presented instead of a stop signal,
- the presentation failure of a distant signal announcing a stop signal or a speed restriction signal;
- at serious disturbances of the mechanical or electric installations, for example:
  - defect of closing of the barriers of a level crossing at the time of the passage of a train
  - malfunction of the electric interlocking, for example malfunction of a track circuit allowing the inopportune manoeuvre of a needle.

Each railway may use its own definition for a signalling failure until a common definition is adopted.