International benchmarking of rail safety indicators
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Information from various sources has been reviewed as part of the research for this report, as detailed in section 7, we thank all who have provided information which has allowed us to undertake this research and thus compile this report.

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Executive summary

The New Zealand Transport Agency ('the Transport Agency') commissioned Interfleet to undertake research on international benchmarking of rail safety indicators. The aim of the research was to identify a suite of implementable recommendations for the improvement of safety data collection and the identification of lead and lag indicators for use in the New Zealand rail environment, based on comparison with appropriate operations in the international rail industry. Safety indicators relating to rail accidents (lagging indicators) were considered in addition to precursors, which have been used as indicators or for data collection, ie leading indicators. In these instances, there is no 'loss', but there would be potential for loss on other occasions, and their measurement gives an indication of overall safety/risk management for the system. Other lead indicators, which are not incidents, could also be considered such as hazards identified, risk control improvements, safety audits undertaken/observations arising.

Following a review of the safety data gathered by various organisations in the international rail industry, it was agreed that data from the UK and Australia would be used for the initial benchmarking feasibility activity. The definitions of indicators used in these countries were reviewed alongside a comparison of local railway technology (particularly signalling systems), accident reporting systems and safety culture, and geography to identify indicators which the Transport Agency could use for benchmarking. Initially analysis was undertaken using the safety indicators and definitions presently used by the Transport Agency and cross referencing these to the safety indicators and definitions used in the UK and Australia. As the UK also prepares information for the European Railway Agency (ERA, which collects and publishes safety data across Europe) the review also considered safety indicators used by the ERA. A shortlist of proposed indicators was identified that concentrated on high risks and indicators where good comparisons could be made. Details of adjustments required to enable suitable benchmarking to be undertaken were also identified and a draft implementation plan with recommendations was developed.

The Transport Agency has a longer-term aim, which is to benchmark the safety performance of the New Zealand rail system against comparable rail systems internationally. However, the Transport Agency recognises that, for this to be achieved, there is initially a need to ensure that the data currently collected is suitable for comparison.

Benchmarking can be a very valuable tool if used in the correct manner. However, it is important to recognise that no two railways are exactly alike. There are many differences between railways in relation to such factors as size, operating procedures, rules, technology, reporting cultures, infrastructure and traffic density, all of which may impact on risks in different ways. There are also differences between types of rail operation within a country. For example, a train operator who operates over great distances across infrastructure with few signals will be likely to have a lower risk of a signal passed at danger (SPAD) than a train operator in a metropolitan area where signals are prevalent.

Thus care should be taken when comparing one railway with another; the fact that a figure on a particular indicator is higher or lower than on another railway does not necessarily reflect the relative effectiveness of how risk is managed.

One reason for benchmarking is to monitor data on key risks to confirm that trends are continuing to improve. Another reason is to compare what controls are being used by benchmarking partners to mitigate risks and to review how effective these controls are in reducing risks; for instance it is possible to review the effectiveness of technology, such as automatic train protection (ATP), in preventing SPADs.

If seeking to benchmark against others, a key starting point should be to understand the initial differences in the figures, before drawing conclusions on the comparison (ie better or worse than the comparator),

through examination of the various factors which affect the figures such as the different operating environments.

However, other non-operational factors may also have an effect, such as consistency of definitions and normalisers used within the monitoring processes. An example of this is lost time injury frequency rates, where the USA tends to use 200,000 hours worked as its normaliser whereas the equivalent Australian figures use 1,000,000 hours worked; at first sight, this makes the Australian figures appear five times worse.

Once the differences are understood and recognised, it is possible to explore other reasons for higher or lower figures. This is assisted by discussions with the other organisations.

When considering SPADS, the presence of ATP or any technology for interceding after a signal has been passed at danger or improving driver situational awareness before a signal to prevent a SPAD will obviously have a significant impact. For this reason, when benchmarking SPAD data, sensible comparisons can only be made if similar technology is used, and then comparison of all other control measures and mitigating factors should be considered to ensure that a fair comparison is made.

The key reasons for an organisation to consider benchmarking should therefore be to measure whether continuous improvements are being achieved, and to explore what others are doing that may also be considered to better control the organisation's own risks.

The Transport Agency may also wish to consider whether it would support the involvement of rail transport operators in the International Suburban Benchmarking Group. This group is made up of many international suburban railways that have agreed to not only provide data but also to research and comment on the differences in data and results and do 'deep dive' on specific risk topics such as safety culture and SPADs so that members of the group can understand their performance against others and why differences exist.

Abstract

The aim of this research topic was to identify a suite of implementable recommendations for the improvement of data collection and for the identification of lead and lag indicators for use in the New Zealand rail environment, based on comparison with appropriate operations in the international rail industry. A draft implementation plan for use by the rail industry is included in this report.

1 Introduction

1.1 Background

The Transport Agency commissioned Interfleet to undertake research on international benchmarking of rail safety indicators. The aim of the research was to identify a suite of implementable recommendations for the improvement of data collection and for the identification of lead and lag indicators for use in the New Zealand rail environment, based on comparison with appropriate operations in the international rail industry. The work was divided into two phases.

Phase 1 was to identify five to eight comparable international rail systems from which a shortlist of at least two operations suitable for benchmarking could be selected.

Phase 1 is covered by letter report 'Proposals for benchmarking opportunities', which is included in appendix A.

The two countries chosen in phase 1 were the UK and Australia.

The scope of phase 2 was to look at the rail safety indicators used in New Zealand and the shortlisted operations to identify indicators against which it would be appropriate for the Transport Agency to benchmark. Comparisons were made of the definitions used for the benchmarked indicators. The method of data collection was investigated as were related factors which might affect the indicator (such as environmental or different operating practices). Finally, how the data would be used was determined.

From this work, a list of possible safety indicators was compiled and an implementation plan drafted proposing improvements in data collection and the provision of comparison data for use by the general public and rail industry.

1.2 New Zealand safety-related information

In New Zealand, all rail vehicle operators or access providers to railway lines must hold a licence under the Railways Act 2005. These licence holders are required to operate under a safety case which mandates the monitoring, recording and reporting of key safety performance factors and measures, including (but not limited to) accidents and incidents. In addition, all operators who run trains on KiwiRail infrastructure are required to comply with the National Rail System Standards (NRSS), of which NRSS 5 (Occurrence Management) details the reporting process for safety occurrences, defining the process to follow and a means of classification of incidents.

However, not all incidents are reported via the NRSS 5 process. As privacy legislation within New Zealand does not give rail participants access to medical information from hospitals and police, the Ministry of Transport (MoT) has an agreement with the police to receive additional occurrences that are not reported through the NRSS 5 process. An example of this is information on fatalities at level crossing, which is published by the MoT.

In addition to the occurrence reports, licence holders provide the Transport Agency with an annual safety performance report which contains summaries and trends of incidents to date.

The Transport Agency collects safety-related information from all licence holders including passenger, freight, and heritage operators and access providers. None of the information collected by the Transport Agency is published, except for a small subset which is published annually by the MoT and as such, one aim of this study was to consider what information should be published. It was suggested that trends only

should be published as there are dangers in publishing comparisons of railway data, as discussed in section 4.1, as no two railways are exactly alike and data can therefore be taken out of context.

The system of collection, publishing and use of rail safety data is less mature in New Zealand than in Australia or Europe (including the UK). It is understood that the New Zealand rail industry is also working in partnership with Australian rail safety organisations in the development of rail safety initiatives. This partnership may give the industry access to additional Australian rail safety data and safety management techniques.

It is recognised that the Transport Agency has a longer-term aim to be able to benchmark the safety performance of the New Zealand rail system against comparable rail systems internationally. However, it recognises that for this to be achieved there is a need to ensure that the data currently collected is suitable for comparison.

1.3 UK safety-related information

In the UK, rail safety-related information is collected via the Safety Management Information System (SMIS). *Railway group standard GE/RT8047* 'Reporting of safety-related information' (RSSB 2013b) mandates the requirements for the reporting of safety-related information using SMIS so that reliable safety data is collected, analysed and made available for use by rail industry parties in the management of risk. It should also be noted that certain accidents must also be reported via Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995 (RIDDOR). The Rail Safety and Standards Board (RSSB) undertakes analysis of this data and publishes information, which includes:

- annual reports detailing fatality figures and rail safety statistics
- the risk profile bulletin (RSSB 2014c), which is a detailed assessment of areas of risk on the UK rail network; from this, train operators and infrastructure managers can compare their respective safety figures against the current level of industry risk for a range of events. This enables objectives to be set to mitigate high risks or reduce risks that are higher than currently anticipated and accepted by the industry
- documents providing guidance to managing risk in the rail environment.

It should be noted that UK safety data, which also includes information sourced from rail operators' annual safety reports, is also provided to the European Railway Agency (ERA) which compiles information on European rail safety for the European Union. Information is published annually by the ERA in the format of a report containing tables which compare sets of data against specified headings across all European countries.

1.4 Australian safety-related information

In Australia, the supply of certain safety-related information is mandated through legislative provisions. All rail transport operators (RTOs) are required to supply reports relating to categorised 'notifiable occurrences' to the rail safety regulator in accordance with Regulation 57 of the Rail Safety National Law Regulations 2012[1]. RTOs include both rail infrastructure managers and rolling stock operators.

The majority of the Australian rail system falls within the jurisdiction of the Office of the National Rail Safety Regulator (ONRSR). This is a recently formed body, which started operations in January 2013 and

[1] www5.austlii.edu.au/au/legis/nsw/consol_reg/rsnlnr2012425/

has assumed the regulatory role from the previous state-based regulators. Each participating Australian state has enacted legislation which enables the adoption of the provisions of the Rail Safety National Law. This law is enacted as a schedule to the Rail Safety National Law (South Australia) Act 2012. The provisions of the Rail Safety National Law National Regulations 2012 are also adopted through this mechanism.

At the time of issue of this report the national legislation has not been adopted in Queensland and Western Australia, although Western Australia is expected to adopt it shortly, and so the regulation of rail operations, including the requirement to report certain incidents, continues to be administered by the respective state-based regulators. Despite there being gaps in geographical coverage, the ONRSR does provide regulation for the majority of rail operations in Australia and, given this, the information provided in this report is based on that lying within its jurisdiction. It should be noted that as ONRSR is a relatively new organisation, the accuracy of data and consistency of railway reporting is still under development.

Regulation 57 lists occurrences that must be reported by RTOs to the ONRSR. The ONRSR has published Occurrence Notification Standard (ON-S1), and Occurrence Classification Guideline (OC-G1)[2], which detail the content and form in which this occurrence information is to be reported in order to meet the regulatory requirement.

Throughout Australia there are a number of different networks and track gauges managed by different rail infrastructure managers and there are many rolling stock operators, including those which operate passenger, freight, infrastructure maintenance vehicles and heritage rolling stock. Each RTO is required to report occurrences affecting its operation, and as such it is possible to segregate and analyse occurrences by individual operator or type of operation. It should also be noted that more than one organisation may report the same occurrence.

In addition to reporting notifiable occurrences, RTOs are required, as detailed in Regulation 56 of the Rail Safety National Law Regulations 2012, to provide periodic returns to the ONRSR which include information on the number of track kilometres managed, the number of kilometres travelled by train type, and the number of passenger journeys made. This is used to normalise occurrence data to allow comparisons to be made.

Certain information collected by the ONRSR is presented in its annual safety report publication. The 2013 to 2014 report (ONRSR 2014b) was only the second such report to be published and as such it is not clear if the same normalised information will be reported year on year. The ONRSR has not indicated, as yet, if it will make publically available set key safety performance indicators relating to notifiable occurrences. However, the details of all notifiable occurrence reports are entered into a database and it is possible to analyse this data and to provide the results, as required, to the RTOs.

Each RTO is required, by Section 103 of the Rail Safety National Law, to submit its own safety performance report to the ONRSR. The ONRSR (2014a) has published its *Safety performance reporting guideline* which provides guidance to RTOs on the expected contents, and this includes notifiable occurrence classifications which may be suitable for the RTOs to measure against. Taking note of the guideline, RTOs are required to define and report on their own key safety performance indicators.

The Australian rail industry has been considering the issue of benchmarking and what to benchmark. Work has been undertaken through the Australasian Railway Association (ARA) to determine which key performance indicators would be useful and in what way, and then to agree on the detail of these and their definitions. The Rail Industry Safety and Standards Board (RISSB) (2014) has published its *Safety data*

[2] At the time of writing ON-S1 and OC-G1 are under review by ONRSR and an update to the standards is expected in due course.

guideline (version 1) which is intended to 'provide a safety data management resource for the Australasian rail industry'. Its purpose is 'to provide guidance on how to establish a consistent, efficient and effective approach to the collection, analysis and use of safety data in managing risk for Operators and the Rail Industry as a whole, according to good practice'. Once agreed it is intended that the ARA will expand the work to the wider industry and regulators.

Further information can be obtained about this work if required. The Transport Agency may wish to consider participation when the ARA expands the work to regulators.

2 Method

2.1 Phase 1

The aim of the first phase of this assignment, as described in appendix A, was to identify five to eight comparable systems from which a shortlist of at least two operations suitable for benchmarking could be selected.

Information provided by the Transport Agency and a variety of information available on the internet regarding the train operations in New Zealand were reviewed. Interfleet offices around the world were contacted and information available on the internet was reviewed to identify:

- which train operators publish safety data suitable for the Transport Agency to benchmark against
- which countries have railway infrastructure (particularly signalling systems and track complexity) similar to New Zealand
- which organisations could be contacted, should more information be required about the data collected.

New Zealand rail operations were broken down into the following areas:

- freight (which is understood to be mainly long distance carrying coal, logs, stone, steel and container traffic etc)
- long-distance passenger services:
  - Auckland – Wellington
  - Christchurch – Picton
  - Christchurch – Greymouth
- regional passenger services:
  - Wellington – Palmerston North (Capital Connection)
  - Wellington – Masterton (Wairarapa)
- suburban:
  - Auckland suburban
  - Wellington suburban.

A table was provided which summarised key data to assist in the comparison of rail operations in the different countries considered for benchmarking. For European countries this data was taken from *Rail safety performance in the European Union* (ERA 2014); comparable data was also sourced for the other countries. As signals passed at danger (SPAD) was a key hazard and would be focused on in the next phase, consideration was given to the percentage fitment of automatic train protection (ATP). It should also be noted there are other forms of train protection in place in some countries in addition to ATP which impact on the risk of passing a signal at danger. For example, the UK has a large number of critical junctions fitted with train protection and warning systems (TPWS), and in Queensland Rail, although there is no ATP in the city network, an automatic warning system provides a warning of a restricted signal to the driver and is therefore a secondary protection method.

The UK and Australia were selected for benchmarking.

2.2 Phase 2

The second phase of this research work identified the safety-related indicators used in New Zealand, Australian and UK rail operations. Two spreadsheets were populated to compare the present incident reporting categories and indicators used in each country with the aim of identifying similarities and their definitions and to establish if there was justification in defining a safety indicator in each area. As UK safety data is provided to the ERA for publishing alongside European rail safety data, the ERA safety indicators were also considered.

The information provided in appendices B and C comprises occurrence categories and a list of possible primary indicators extracted from the spreadsheets. These were reviewed and high-risk areas and indicators with good comparable data were identified, from which the list in section 3.3 of proposed fully defined indicators, suitable for benchmarking, was compiled. A specific purpose of this exercise was to be able to suggest an approach for manipulating data into a comparable indicator and therefore it focused on:

- how and when the data is gathered
- who gathers the data
- who manipulates/consolidates the data
- who receives the output
- who acts upon the output.

2.3 Implementation plan

After reviewing accident and incident reporting undertaken in the UK, New Zealand and Australia, the data collected was compared and a number of key indicators were identified. These were proposed as possible indicators for use by the Transport Agency to compare against data available in Australia or UK (or Europe). It may be necessary to manipulate the New Zealand or overseas data to provide useful comparisons and section 3.3 outlines recommendations for doing this. The draft implementation plan identifies:

- which indicators should be used
- how they are defined
- if the data should be manipulated
- how the data should be made available to the rail industry and the general public
- other lessons learnt which would be useful information to the New Zealand rail industry in collecting safety data and using the safety data to improve rail safety.

2.4 Constraints

In comparing data the following constraints were identified:

- The New Zealand indicators were not clearly defined thus making it difficult to establish the exact data which would be reported under a particular indicator.
- Based on Interfleet's interpretation of the definitions, there appears to be some overlap between a number of the New Zealand indicators.

- There are differences between the rail infrastructures (such as signalling systems), physical environment, incident reporting culture, operation densities which may hinder exact comparisons. As discussed in section 3.1 no two railway systems are exactly the same, thus these differences must be evaluated when comparing data to understand the influence they may have on the risk in the area under consideration and thus to the data being compared.

The above constraints need to be considered as part of determining the validity of any benchmarking undertaken.

3 Discussion

3.1 General

Although the Transport Agency has a comprehensive set of incident reporting categories, there has not always been good correlation between these and the categories used in Australia and the UK. This is more than likely due to the approach taken in developing NRSS 5. This resulted in the consolidation of certain categories to increase the user friendliness of the reporting process and minimise the number of categories, which due to the size of the New Zealand rail industry, would have little to no occurrences reported within the category.

Incident reporting categories which would be suitable for use in the benchmarking exercise were identified and the definitions used by the proposed benchmarking partner (UK or Australia) were provided. The indicators proposed for introduction by the Transport Agency in section 3.3 include references to definitions to give clarity to the data to be collected to ensure it is comparable with that collected in the UK or Australia, whichever is envisaged as the preferred benchmarking partner. It should also be noted that much data is available for European railways, thus definitions for incident reporting categories have been provided that would additionally enable benchmarking between New Zealand and European countries other than the UK, should this be desirable.

Benchmarking can be a very valuable tool if used in the correct manner. However it is important to recognise that no two railways are exactly alike. There are many differences between railways in relation to size, operating procedures, rules, technology, reporting cultures, infrastructure and traffic density, all of which may impact on risks in different ways. There are also differences between types of rail operation within a country, For example a train operator that operates over great distances across infrastructure that has few signals will be likely to have a lower risk of a SPAD than a train operator in a metropolitan area where signals are prevalent.

Thus care should be taken when comparing one railway with another; the fact that a figure on a particular indicator is higher or lower than on another railway does not necessarily reflect the relative effectiveness of how risk is managed.

Thus one reason for benchmarking is to monitor data on keys risks to confirm that trends are continuing to improve. Another reason for benchmarking is to compare what controls are being used by benchmarking partners to mitigate risks and to review how effective these controls are in reducing risks; for instance it is possible to review the effectiveness of technology, such as ATP, in preventing SPADs.

If seeking to benchmark against others, a key starting point should be to understand the initial differences in the figures, before drawing conclusions on the comparison (ie better or worse than the comparator), through examination of the various factors that affect the figures such as the different operating environments.

However, other non-operational factors may also have an effect, such as consistency of definitions and normalisers used within the monitoring processes. An example of this is lost time injury frequency rates, where the USA tends to use 200,000 hours worked as its normaliser whereas the equivalent Australian figures use 1,000,000 hours worked. At first sight, this makes the Australian figures appear five times worse.

Once the differences are understood and recognised, it is possible to explore other reasons for higher or lower figures; this is assisted by discussions with the other organisations.

When considering SPADS the presence of ATP or any technology for preventing the passing of a signal at danger will obviously have a significant impact, thus when benchmarking SPAD data, sensible comparisons can only be made if similar technology is used, and then comparison of all other control measures and mitigating factors should be considered to ensure a fair comparison can be made.

The key reasons for an organisation to consider benchmarking should therefore be to measure whether continuous improvements are being achieved, and to explore what others are doing that may also be considered to better control the organisation's own risks.

The Transport Agency may also wish to consider the benefits of involvement of RTOs in the International Suburban Benchmarking Group.[3] This group is made up of many international suburban railways that have agreed to not only provide data but also to research and comment on the differences in data and results and do 'deep dives' on specific risk topics, such as safety culture and SPADs, so members of the group can understand their performance against others and why differences exist. This would have benefits for setting performance targets, identifying cost savings and achieving best practice industry outcomes. The industry may need to better define these benefits and understand implications around commercial confidentiality and resourcing to progress this further.

3.2 Details of safety performance data

3.2.1 European data

The European Union (2004) *Railway safety directive (2004/49/EC*) includes the requirement for EU member states to ensure that safety is generally maintained and, where reasonably practicable, continuously improved. The ERA is mandated to develop common safety targets (CSTs) and national reference values (NRVs) to monitor the performance of member states. The NRVs are designed to reflect observed baseline levels of safety in each member state. The ERA monitors each member state's performance against its NRVs to determine whether levels of safety are at least being maintained in each of the defined safety performance categories. These categories are defined as the common safety indicators (CSIs), with the national safety authorities submitting performance against each to the ERA as part of their annual safety reports.

In its monitoring role for European rail safety data, the ERA collects and collates data from the annual reports, and publishes the data in separate annual reports, which are generally available on the internet. ERA reports *Railway safety performance in the European Union* are available on the ERA website for 2012, 2013 and 2014. They include historical data going back to 1980; however, detailed data is available only for more recent years (the 2014 report covers 2010, 2011 and 2012). This provides a range of comparable data for a large number of rail operations in European countries. Data is also published regarding train km, passenger train km, freight train km etc, thus enabling the normalisation of data. Information is also provided regarding railway infrastructure such as the percentage fitment of ATP to give some indication of the comparability of key safety features between networks. As stated in section 3.1, there are various forms of operating methods and technology which are used around the world to prevent or mitigate the risk of passing a signal at danger. Differences in operating methods and technology can have a significant effect on the data regarding SPADs (as can many other factors such as environment and reporting regimes), thus full consideration should be given to any differences, particularly in technology when comparing data on SPADs.

[3] It is understood that at the time of writing both KiwiRail and Transdev have jointly sponsored a paper to the National Rail System Standards Executive to consider membership of the International Suburban Benchmarking Group.

This information is used by the member states and their rail operating organisations to show their rail safety is equal to, or better than, their agreed target. Each member state is responsible for implementing action plans to enable targets to be achieved.

Full definitions for the CSIs used in the ERA reports are given in *Commission directive 2009/149/EC* (European Union 2009), amending the original indicators from the *Railway safety directive 2004/49/EC*.

3.2.2 UK data

Although reference is generally made to the UK in this report, the main data considered, as managed through the RSSB, relates specifically to Great Britain (GB), and therefore does not include Northern Ireland. However, data reported to and published through the ERA, which is also considered, covers the whole of the UK.

The primary objective of the RSSB is to facilitate GB's railway industry work to achieve continuous improvement in the health and safety performance, and thus to facilitate the reduction of risk to passengers, employees and the affected public. A number of regulatory measures have been implemented to ensure certain standards of safety are achieved. Over the years a wide variety of groups, forums and arrangements have been established both nationally and regionally between train operators, freight operators, Network Rail (which manages the rail infrastructure), infrastructure contractors and RSSB to help understand system safety risk, review performance and sponsor improvement actions. These meetings all play a part in delivering the legal 'duty of cooperation' obligation on train operators and infrastructure managers, which is enshrined in law through the Railways and Other Guided Transport Systems (Safety) Regulations (ROGS) 2006 (UK).

The System Safety Risk Group, which reports to the RSSB Board, has been established to understand system safety risk and identify areas for improvement.

In the UK there are regulatory and industry-mandated requirements to report certain types of accidents and incidents.

RIDDOR, which was introduced in 1995, requires all companies to report certain workplace-related accidents to the Health and Safety Executive. Such reporting focuses on, but is not entirely limited to, incidents resulting in lost working time and applies to the rail industry alongside all other UK industry. (It is worth noting that Australian railways also have separate reporting requirements to the respective Work Health & Safety authorities in each state.) The rail industry established SMIS as its own reporting system in 1997. This is an industry-wide database for the collection and interrogation of railway safety data, designed to capture all elements of a safety-related event. RIDDOR helped to define the scope of events that were reported into SMIS; however, the scope of SMIS was widened to collect all physical injuries and cases of psychological, non RIDDOR-reportable train accidents and a number of precursor events.

The UK's Railway Group Standards are mandated on train operators and infrastructure managers through their licence agreements. *Railway group standard GE/RT8047* requires certain railway incidents and accidents to be reported via SMIS, and details what is required to be input and by whom. In 2013/14, close to 79,000 incidents were reported into SMIS.

A rail industry close call system has also been developed, which is managed by RSSB. It is an online, web-based system to allow organisations to record and manage events or situations considered to be close calls (ie potential to cause injury or damage). The enhanced system went live on 29 October 2012.

The RSSB produces the Safety Risk Model (SRM), which consists of a series of fault tree and event tree models representing 131 hazardous events that collectively define the overall level of risk on the railway.

It provides a structured representation of the causes and consequences of potential accidents arising from railway operations and maintenance. The hazardous events are divided into three categories:

1 Train accidents (accidents directly occurring onboard trains)

2 Movement accidents (occurring as a result of the movement of trains, but with loss being incurred outside a train)

3 Non movement accidents (which would happen regardless of whether trains or not trains were present).

The hazardous events are modelled into precursor events, each of which is separately modelled, allowing its significance and risk contribution to be identified. Individual issues can then be managed at precursor level.

The SRM has been designed to take account of both high-frequency, low-consequence events (occurring routinely, and for which there is a significant quantity of recorded data) and low-frequency, high-consequence events (occurring rarely, and for which there is little recorded data). The results for each hazardous event are presented in terms of the frequency of occurrence (number of events per year) and the risk (number of fatalities and weighted injuries per year). The weightings equate injuries of differing degrees with a fatality, which allows all of the risk on the railway to be totalled and contrasted in comparable units.

The SRM has been developed and published to support RSSB members. The primary objectives of the SRM are to provide:

- an estimate of the extent of the current risk on the railway
- risk information and risk profiles relating to the railway.

This information is used for risk assessments, appraisals and to inform decision making throughout the railway industry.

The RSSB publishes data in annual reports, which are available on the internet. These reports also include historical data to illustrate trends. For instance, the *Annual safety performance report 2013/2014: A reference guide to safety trends on GB railways* (RSSB 2014a) includes trends in fatalities going back 50 years in addition to detailed data for 2009 to 2014. This annual report also includes detailed information describing the different types of level crossings in use in GB, these representing a high proportion of the overall network risk. The RSSB also uses the data in SMIS to provide risk information for a large variety of accident/incident scenarios. SRM information is used by train operating companies to identify the likely level of risk attributable to them, and that they face in their operations, in a range of accident/incident scenarios. The RSSB publishes guidance in undertaking risk assessment (refer to RSSB 2009). Train operating companies also use the information to identify any area where their accident/incident rate is higher than that predicted from the RSSB risk information. The train operating company can then identify key performance indicators which aim to inform the control of these high risks or the reduction of the risks where the accident/incident rate is higher than predicted.

3.2.3 Australian data

The requirement placed on RTOs to report 'notifiable occurrences' is prescribed by legislation. The data is collected and analysed by the ONRSR and other state regulators who use the information to inform regulatory activity. This includes benchmarking against the performance of other jurisdictions, setting priorities for regulatory activity and oversight of RTOs, and communicating emerging issues back to industry. The ONRSR owns and manages a database into which the data is fed. Reporting of notifiable

occurrences in accordance with the OC-G1 guideline allows classification of the data from which reports and trending information can be output. The ONRSR has not indicated that it has formally set key safety performance indicators relating to notifiable occurrences, or of their precursors.

Historically, prior to the formation of the ONRSR, each state regulator collected notifiable occurrence data from the RTOs, analysed it and reported this on a state-by-state basis. There were many similarities between the data classifications collected by each state, but also some differences. The ONRSR is currently converting this historical data to align it with the current reporting requirements, and entering it into its database. Once this work is complete, there should be records of occurrences going back a number of years which will be consistent with current reporting and this should be available for interrogation. Throughout this period, the regulatory requirement to report certain incident occurrences has existed, and so although there may have been some under reporting, it can generally be assumed that, for accident occurrences, the data will be complete enough to make meaningful comparisons.

Every RTO is required to collect its own incident data, at least to satisfy regulatory requirements, but many, dependent on the size and complexity of their operation, will need to define safety indicators for the purposes of internal review as part of identifying and prioritising actions aimed at mitigating rail safety risk.

The Australian rail industry body, the RISSB, in collaboration with the ONRSR, has recently embarked on a project to promote the development of the Australasian Rail Risk Model (ARRM). The development of the ARRM is likely to consider the approach used to produce and maintain the SRM managed by the RSSB in the UK, as well as calling upon Australian and New Zealand initiatives. It is understood that the Transport Agency is party to the development activities.

The intention of the model is that it be developed to support mainline rail operations, allowing risk-based decisions to be made. This includes enabling informed investment prioritisation decisions to be taken by government bodies where these decisions have the potential to affect rail safety outcomes.

The creation of the risk model will require a number of inputs, with incident data being an important element. Consistency of classification of this data, forwarded for input to the model will be important, and the OC-G1 guideline may be a likely starting point.

The OC-G1 guideline can be expected to undergo review and future reporting classifications may change. A particular area which is currently being worked on is that of SPAD occurrence classification, with the Transport Agency having representation on the Australasian Railway Association (ARA) Working Group. The group was set up to develop a common classification system for SPADs across Australia and New Zealand to allow for the sharing of consistent information between RTOs. The motivation for this was in part inspired by the current OC-G1 classifications not being seen as particularly useful. Given the desire from the ONRSR, the RISSB and industry representatives to develop the ARRM, it could be expected that, for efficiency and consistency of reporting, agreement would need to be reached on new SPAD classifications. It could then be expected that OC-G1 would be updated to support regulatory reporting of notifiable occurrences and for input to the ARRM. This is work in progress. Work undertaken by the ARA and the RISSB in this area is discussed in section 1.4 of this report.

The data which the ONRSR collects, analyses and then publishes or provides to RTOs collectively or individually, is not necessarily the full suite of information which it has available. However, this information may be of interest to the Transport Agency for the purposes of benchmarking. Dependent on the relationship between the Transport Agency and the ONRSR, it may be possible to request and seek permission to use this information to generate safety indicators of interest.

3.2.4 New Zealand data

The Transport Agency is the primary regulator of safety on the New Zealand rail network. It ensures rail operators operate in a way that secures the safety of rail passengers, rail workers and the public when in, or in the vicinity of, the rail corridor. The Transport Agency supports and undertakes regular reviews of safety performance. Past reviews have helped the rail sector to better target and resolve safety risks.

As outlined in section 1.2, NRSS 5 forms the basis for occurrence reporting in New Zealand and specifies all occurrences that are required to be reported to the Transport Agency. NRSS 5 was developed out of a review of the ONRSR Occurrence Notification Standard (ON-S1) and Occurrence Classification Guideline (OC-G1).

NRSS 5 uses a safe systems approach to safety reporting and in order to simplify the reporting process and make it easier to use by licence holders, it aims to minimise the number of reporting categories to allow for creation of more meaningful numbers. Given the size of the New Zealand rail network, a broad array of reporting categories would result in very low numbers of occurrences or none at all in specific incident reporting categories.

In contrast to the ON-S1, NRSS 5 classifies occurrences at the macro system level of the rail system. Within the context of NRSS 5 these areas are termed the 'operating process' and occurrences categories are allocated to each of these areas.

The operating processes listed in NRSS 5 are as follows:

- level crossing (LX)
- mainline operations (MO)
- terminal operations (TO)
- infrastructure maintenance (IM)
- freight operations (FO)
- passenger operations (PO)
- controlled network security (CN).

For each of these operating processes a number of occurrence categories (termed 'primary effects' in the context of NRSS 5) are identified which apply to any given process. These are outlined in table 2 of the NRSS 5 which is reproduced below as table 3.1.

Please note that at the time of writing the SPAD classifications in table 3.1 are being reviewed and will be updated in due course (refer to the notes section at the end of the table for more details).

Table 3.1 Reproduction of table 2 of NRSS 5

	OPERATING PROCESS						
	LX	MO	TO	IM	FO	PO	CN
Anti Social Behaviour (NOS)						ASB	
Assault - by passenger (physical)						APP	
Assault - by passenger (verbal)						APV	
Assault - on passenger						AOP	
Collision Heavy Road Vehicle	CHV		CHV		CHV		CHV
Collision Illegal Obstruction	CIO		CIO		CIO		CIO
Collision Light Road Vehicle	CLV		CLV		CLV		CLV

	OPERATING PROCESS						
	LX	MO	TO	IM	FO	PO	CN
Collision Maintenance Providers Personnel / Equipment / RV / Road Vehicle		CMP	CMP	CMP			
Collision with Rail Personnel		CRP	CRP		CRP		
Collision with Rail Vehicle		CRV	CRV		CRV		
Collision with equipment		CWE	CWE		CWE		
Collision Person	CPN		CPN				CPN
Collision Slip							CSL
Collision Structure			CST	CST	CST		
Collision Trespasser			CTP				CTP
Collision Trespassing Stock			CSK				CSK
Container Doors Open					CDO		
Damage by Heavy Road vehicle	DHV		DHV		DHV		DHV
Damage by Light Road vehicle	DRV		DRV		DRV		DRV
Derailment	DRM	DRM	DRM	DRM	DRM		
DG Placards and Papers					DGP		
DG Segregation					DGS		
Electrical Hazards (excluding OHLE)		ELH##	ELH##	ELH##	ELH##	ELH##	
Fire/smoke/fumes – Equipment Related		FEQ	FEQ	FEQ		FEQ	
Fire/smoke/fumes - Trackside		FTS	FTS	FTS			FTS
Fire/smoke/fumes - Building			FBD	FBD			FBD
Flooding			FLD				FLD
Handbrakes dragging		HBD	HBD	HBD			
Illegal Obstruction Other							IOO
Illegal RV's on rail track			IRV				IRV
Infrastructure Safety Critical Component Failure NOS				ISC			
Injury / Death Passenger Alighting						IAG	
Injury / Death Passenger Boarding						IBG	
Injury / Death Passenger/Public on Platform						IPM	
Injury / death passenger when on board						IOB	
Leak / Spill (DG)				LKDG	LKDG		
Leak / Spill (not DG)		LKEN	LKEN	LKEN	LKEN		
Line Speed Exceeded		LSE	LSE	LSE			
Load Lost Overboard					LLO		
Loading Irregularity				LIR%	LIR%		
Near Collision Heavy Road Vehicle	NCHV		NCHV				NCHV
Near Collision Light Road Vehicle	NCLV		NCLV				NCLV
Near Collision Illegal Obstruction	NCIO		NCIO				NCIO
Near Collision Maintenance Providers Personnel / Equipment / RV / Road Vehicle				NCMP			
Near Collision Operators Personnel / Equipment / RV		NCOP	NCOP				
Near Collision Person	NCPN		NCPN				NCPN
Near Collision Trespasser			NCTP				NCTP

	OPERATING PROCESS						
	LX	MO	TO	IM	FO	PO	CN
Overgauge Load					OGL		
Overhead Traction Fault				OHT			
Out of Balance Wagon / Container					OOB		
Overweight Wagon / Container					OWT		
Passenger Door faults						PDF	
Rail Personnel Injury / Death (includes electrical accidents)	RPI	RPI	RPI	RPI	RPI	RPI	RPI
RV Runaway		RVR	RVR	RVR			
RV Safety Critical Component Failure		RVS	RVS	RVS	RVS		
Safe Working Irregularity		SWI	SWI	SWI	SWI	SWI#	
Signal Reverted - no SPAD				NSPAD			
Slip / Subsidence			SLS				SLS
SPAD A (++)		SPADA	SPADA	SPADA			
SPAD B (++)				SPADB			
SPAD C (++)		SPADC	SPADC	SPADC			
SPAD D (++)		SPADD	SPADD	SPADD			
Stone / Missile Throwing							STW
Strops & Chains					SCS		
Track Defect				TDF			
Train Parting		TPG	TPG	TPG		TPG	
Track Occupancy Occurrence				TOO			
Trespassing – Person on corridor			TPN			TPN	TPN
Trespassing – Person on vehicle						TPV	
Trespassing – Stock			TSK				TSK
Twistlocks					TLS		
Vandalism (Theft)	VTT		VTT	VTT	VTT	VTT	VTT
Vandalism (Damage)	VDE		VDE	VDE	VDE	VDE	VDE
Vandalism (Tagging)	VTG		VTG	VTG	VTG	VTG	VTG
Wagon Doors Open					WDO		
Wrong Side Failure – Signalling (no other effect)	WSFS			WSFS			

NOTE:

** SPAD clarification - any SPAD that involves passing a signal, noticeboard or fouling point board protecting entry onto the Controlled Network is to be classified MO

Covers specifically passenger trains, i.e. stopping with doors off platform

NOS – Not Otherwise Specified

Electrical hazards (excluding traction overhead) – including rail vehicles, generators, other rail equipment, signals power and reefer container shore power supply...

% Includes shifted and insecure loads. Note that IM only applies at an infrastructure worksite or on a work train. If an infrastructure load is in transit on a freight train then CO applies.

(++) Note that these SPAD classifications are currently under review and updated classifications consisting of A1, A1, A3, A4, B1, B2, B3, B4 will be included in an update to NRSS 5.

All occurrences on the NRS are reportable to the access provider, KiwiRail. Data specified as notifiable is electronically provided each business day to the Transport Agency. Notifiable occurrence data is then

stored in a central database owned and managed by the Transport Agency. In addition to the data specified in NRSS 5, the Transport Agency collects normalising data from licence holders. Internally, the Transport Agency tracks a subset of all reported indicators, mainly in relation to fatalities, serious injuries and collisions. Fatalities and serious injuries are usually broken down by event.

3.2.5 Limitations of NRSS 5 for benchmarking purposes

As stated previously, great care should be taken to ensure that the benchmarking is comparing the same types of data; if there are differences in how the measure is put together this could result in invalid comparisons. In order to avoid this it is critical that the occurrences being measured are well defined. In the case of NRSS 5 this is a key area that is currently missing. While the primary effects as stated are fairly self explanatory, it is not clear to the reader exactly what is included or excluded in each case. For example how are suicides included within the fatalities, if at all? It is Interfleet's opinion that NRSS 5 could benefit from the inclusion of detailed definitions for each of the categories and would aid in the validation of the benchmarking opportunities outlined below.

3.3 Proposed indicators

Tables 3.2 to 3.6 give details of proposed indicators from UK data also published by ERA, from GB and from Australia, which could be used by the Transport Agency in benchmarking activities

The broad range of indicators would enable the Transport Agency to select a small number of indicators which are most appropriate for its aspirations for improving safety on the rail system and which have good correlation with the occurrence reporting categories for which the Transport Agency currently collects data. This work can then be expanded over time with the introduction of more indicators.

For each international indicator proposed in this section, we have noted a possible approach which could be used by the Transport Agency to manipulate the data within the relevant NRSS 5 occurrence categories to enable a valid comparison against the proposed international indicator. It should, however, be noted that these approaches are based on incomplete information, in particular it is Interfleet's opinion that NRSS 5 does not adequately specify the data that is collected and as a result the NRSS 5 categories are open to interpretation. Therefore the approaches outlined below are based on Interfleet's own interpretation of the reporting categories in NRSS 5 and before any benchmarking is undertaken the Transport Agency may wish to undertake an exercise to understand and detail how it should manipulate the data to make it comparable to that collected/published by others.

As stated previously, care must always be taken when comparing data from other rail operations as none are exactly the same and thus differences in operation which may affect the data must be evaluated. However, it is always useful to measure internal trends which, it is hoped, should show improving safety of the rail operation in each area. Reference is also made to work undertaken by the ARA as discussed in section 1.4, which the Transport Agency may wish to consider or participate in.

Please note that the definition for each international indicator is referenced in table 3.2 but the actual definitions are contained in appendix D.

3.3.1 Indicators selected from UK data also published by ERA

Benchmarking against UK categories which are also published by ERA gives the Transport Agency the opportunity to also benchmark against other EU countries. The following initial indicators in table 3.2 are selected from UK data which is also published by ERA (thus EU definitions are used).

Table 3.2 Fatalities[4]

Indicator	Definition ID (appx 4)	Why benchmark and what to benchmark against	Applicable NRSS 5 primary effect categories	Possible approach for benchmarking
Fatalities – total	1	Most railway operations provide data regarding fatalities as this is a headline figure which is also used to compare the safety of various forms of transport. Care should be taken as suicides (or suspected suicides) will skew fatality figures. EU data reports suicides separately from accident fatalities.	• Injury/death passenger alighting (IAG) • Injury/death passenger boarding (IBG) • Injury/death passenger/ public on platform (IPM) • Injury/death passenger when onboard (IOB) • Rail personnel injury/ death (RPI)	NRSS 5 currently requires the reporting of fatalities[5] but they are combined with injuries and are measured across multiple categories. The Transport Agency could benchmark against this UK indicator using the following approach: • Ensure NRSS 5 definition for 'fatalities' is broadly comparable with the EU definition. • Aggregate occurrences from the identified primary effects categories across all operating processes. • Rationalise the NRSS 5 indicators by removing any incidents resulting in injury only, to ensure valid comparison or alternatively create new indicators splitting out Injuries and fatalities into separate categories (It is noted that the Transport Agency rail incidents database already has 'separate flags' for injury and death making the data searchable). • Remove any incidents from the primary effects that are suicides[6]. It is currently not clear from NRSS 5 how suicides are coded.

[4] It should be noted that Australia does produce fatality figures (as do many countries) however care should be taken to ensure the same definitions are used. In the EU data, suicides are reported separately from accident fatalities. (The ERA states that suicides constitute 70% of all fatalities within the railway system.) The full EU definition defines 'deaths (killed persons)' as any person killed immediately or dying within 30 days as a result of an accident, **excluding suicides**.

[5] Note that privacy legislation in New Zealand prevents the access provider from gaining fatality information when a fatality does not occur at the scene.

Indicator	Definition ID (appx 4)	Why benchmark and what to benchmark against	Applicable NRSS 5 primary effect categories	Possible approach for benchmarking
Fatalities – passenger	2	Most railway operations provide data regarding fatalities as this is a headline figure which is also used to compare the safety of various forms of transport.	• Injury/death passenger alighting (IAG) • Injury/death passenger boarding (IBG) • Injury/death passenger/ public on platform (IPM) • Injury/death passenger when onboard (IOB)	NRSS 5 currently requires the reporting of passenger fatalities[7] but they are combined with injuries and are measured using multiple categories. This UK indicator could be used for benchmarking taking the following approach: • Ensure NRSS 5 definition for 'fatalities' is broadly comparable with the EU definition. • Aggregate occurrences from the identified primary effects categories across all operating processes. • Rationalise the NRSS 5 indicators by removing any occurrences resulting in injury only or alternatively create new indicators splitting out Injuries and fatalities into separate categories, to ensure valid comparison (It is noted that the Transport Agency rail incidents database already has 'separate flags' for injury and death making the data searchable). • Normalise the data using either train km (as used by the ERA), number of passenger km, or number of passenger train km.

[6] Note it is not always possible to determine which fatalities are suicides as coroners are only beginning to notify suicides and then in most cases restricting any use of this information.

[7] Note that privacy legislation in New Zealand prevents the access provider from gaining fatality information when a fatality does not occur at the scene.

Indicator	Definition ID (appx 4)	Why benchmark and what to benchmark against	Applicable NRSS 5 primary effect categories	Possible approach for benchmarking
Fatalities – employees	3	Most railway operations and employers provide data regarding fatalities as this is a headline figure. Employers need to show they have aimed to ensure the safety of their employees.	• Rail personnel injury/ death (RPI)	NRSS 5 currently requires the reporting of employee fatalities but they are combined with injuries and are measured using multiple categories. This UK indicator could be used for benchmarking taking the following approach: • Ensure NRSS 5 definition for 'fatalities' is broadly comparable with the EU definition. • Aggregate occurrences from all operating processes. • Rationalise the NRSS 5 indicators by removing any occurrences resulting in injury only or alternatively create new primary effects splitting out Injuries and fatalities into separate categories, to ensure valid comparison (It is noted that the Transport Agency rail incidents database already has 'separate flags' for injury and death making the data searchable). • Normalise the data using train km.
Fatalities – level crossing users		Most railway operations provide data regarding fatalities as this is a headline figure. Level crossing safety is a major issue. Care should be taken as suicides (or suspected suicides) will skew fatality figures. EU data reports suicides separately from accident fatalities.	None	Privacy legislation prevents the access provider from gaining fatality information when a fatality does not occur at the scene. NRSS 5 therefore is unable to mandate the reporting of fatalities at level crossings. This information is provided to the MoT by the police, who then publish the data. Further investigation is required to understand the definition associated with the MoT data before a benchmarking comparison can be undertaken.

Table 3.3 contains the indicators for UK dangerous good accidents.

Table 3.3 UK dangerous goods accidents[8]

Indicator	Definition ID (appx 4)	Why benchmark and what to benchmark against	Applicable NRSS 5 primary effect categories	Possible approach for benchmarking
Number of accidents involving at least one rail vehicle transporting dangerous goods in which dangerous goods are NOT released.	4	The ERA publishes data related to dangerous goods accidents in its safety reports which cover all European counties. The 2014 report covers data for 2010; 2011 and 2012. Aside from the safety impact there is also an environmental impact of dangerous goods accidents.	• Collision heavy road vehicle (CHV) • Collision illegal obstruction (CIO) • Collision light road vehicle (CLV) • Collision with rail vehicle (CRV) • Collision with equipment (CWE) • Collision structure (CST)	NRSS requires specific reporting of dangerous goods control failures (placard/papers/segregation) but does not directly require the reporting of incidents involving dangerous goods which do not result in their release. However an approximate comparison could be arrived at using the following approach: • Aggregate the applicable occurrences from the freight operations processes only. • Rationalise the NRSS 5 indicators by removing any occurrences from these categories that were not transporting dangerous goods and any collisions that result in the release of dangerous goods. It is expected that this would need to be included in the actual occurrence report. • Normalise the data. When comparing dangerous goods accident data the ERA normalises using tonne kilometre. • Compare 'dangerous goods' as defined by ERA with the definition in New Zealand to understand any differences.
Number of accidents involving at least one rail vehicle transporting dangerous goods in which dangerous goods ARE released.	5	The ERA publishes data related to dangerous goods accidents in its safety reports which cover all European counties. The 2014 report covers data for 2010; 2011 and 2012. Aside from the safety impact there is also an environmental impact of dangerous goods accidents.	• Leak/spill dangerous goods (LKDG)	NRSS 5 currently requires the reporting of incidents that result in the release of dangerous goods. The Transport Agency could benchmark against this UK indicator using the following approach: • Normalise the data. When comparing dangerous goods accident data the ERA normalises using tonne kilometre. • Ensure 'dangerous goods' as defined by ERA is comparable with the definition in New Zealand to understand any differences. **Note** this indicator is included for completeness, however due to the small numbers expected in this category it would not constitute a good initial indicator for benchmarking.

[8] UK dangerous goods accidents as published by ERA (hence EU definition)

Indicator	Definition ID (appx 4)	Why benchmark and what to benchmark against	Applicable NRSS 5 primary effect categories	Possible approach for benchmarking
Total number of accidents involving at least one railway vehicle transporting dangerous goods	6	The ERA publishes data related to dangerous goods accidents in its safety reports which cover all European counties. The 2014 report covers data for 2010; 2011 and 2012. Aside from the safety impact there are also additional environmental impacts, reputational impacts and monetary sanctions associated with dangerous goods accidents.	• Collision heavy road vehicle (CHV) • Collision illegal obstruction (CIO) • Collision light road vehicle (CLV) • Collision with rail vehicle (CRV) • Collision with equipment (CWE) • Collision structure (CST) • Leak/spill dangerous goods (LKDG)	NRSS 5 does not currently have a reporting category for the total number of incidents involving dangerous goods. However an approximate comparison could be arrived at using the following approach: • Aggregate occurrence categories identified from the freight operations processes only. • Rationalise the NRSS 5 indicators by removing any occurrences from these categories that were not transporting dangerous goods. • Include the occurrences from the NRSS 5 leak/spill dangerous goods category. • Normalise the data. When comparing dangerous goods accident data the ERA normalises using tonne kilometre. • Compare ‘dangerous goods’ as defined by ERA with the definition in New Zealand to understand any differences.

It is important to measure data on precursors as we wish to prevent accidents. The benefit of measuring these lead indicators /precursors is that they do not typically result in loss, but they can be used to predict where an accident or incident could occur. Table 3.4 contains the precursors to accidents for the UK. ERA data is available for a wide range of countries

Table 3.4 UK precursors to accidents[9]

Indicator	Definition ID (appx 4)	Why benchmark and what to benchmark against	Applicable NRSS 5 primary effect categories	Possible approach for benchmarking
Broken rails	7	Broken rails could lead to derailment. Benchmark against ERA data.	• Track defect (TDF)	Broken rails are currently grouped together within the TDF primary effect category. In order to allow comparison the Transport Agency could take the following approach: • Rationalise the NRSS 5 indicators by removing any occurrence from the category that do not comply with the EU definition. This may or may not be possible depending on the level of detail included in the occurrence report. • Normalise the data using infrastructure km (broken rails/km). • In addition consideration should also be given to the climate of the country benchmarking against.
Trackbuckles	8	Trackbuckles could lead to derailment. Benchmark against ERA data.	• Track defect (TDF)	Trackbuckles are currently grouped together within the TDF primary effect category. In order to allow comparison the Transport Agency could take the following approach: • Rationalise the NRSS 5 indicators by removing any occurrence from the category that do not comply with the EU definition. This may or may not be possible depending on the level of detail included in the occurrence report. • Normalise the data using infrastructure km (trackbuckles/km). • In addition consideration should also be given to the climate of the country benchmarking against.

[9] UK precursors to accidents, data published by ERA (hence EU definitions). See appendix D.

Indicator	Definition ID (appx 4)	Why benchmark and what to benchmark against	Applicable NRSS 5 primary effect categories	Possible approach for benchmarking
Wrong-side signalling failures	9	Wrong-side signalling failures could lead to SPADs. Benchmark against ERA data	• Wrong-side failure – signalling (no other effect) (WSFS)	NRSS 5 does have a category for WSFS and there appears to be good correlation between the EU definition and the NRSS 5 category. In order to compare the Transport Agency could take the following approach: • Aggregate the occurrence categories identified across all applicable Operating processes. • Normalise the data using infrastructure km (wrong-side signalling failures/km). • Ensure similar definition used for wrong side signalling failures in NRSS 5. • Give consideration also to climatic conditions and the variation in infrastructure and signalling systems and the level of risk.
Signals passed at danger	10	Signals passed at danger could lead to collision between rail vehicles. Benchmark against ERA or GB data (both have the same definition)	• SPAD A (SPADA) • SPAD B (SPADB) • SPAD C (SPADC) • SPAD D (SPADD)	NRSS 5 currently requires the reporting of SPAD and there appears to be good correlation between the EU definition and the NRSS 5 category based on the definitions in the semi-permanent bulletin no. 452. In order to compare the Transport Agency could take the following approach: • Aggregate the occurrence categories identified across all applicable Operating processes, with the exception of SPAD C and SPAD D as the exact definitions for these categories are unknown. • Give consideration also to operating environments, climatic conditions and the variation in infrastructure and signalling systems and the level of risk. • Normalise the data using infrastructure km (SPAD/km). Alternatively use train km. • In addition, give consideration to the validity of data capture methods and reporting, the climate and the variations in infrastructure and signalling systems of the country benchmarking against.

Indicator	Definition ID (appx 4)	Why benchmark and what to benchmark against	Applicable NRSS 5 primary effect categories	Possible approach for benchmarking
Broken wheels	11	Broken wheels could lead to derailment. Benchmark against ERA data	• RV safety critical component failure	NRSS 5 does not currently require the explicit reporting of broken wheels but all rail vehicle safety critical component failures are grouped together within the RV safety critical component failure primary effect category. In order to allow comparison the Transport Agency could take the following approach: • Rationalise the NRSS 5 indicators by removing any occurrences from the category that do not comply with the EU definition. This may or may not be possible depending on the level of detail included in the occurrence report. • Normalise the data using train km (broken wheels/train km). • In addition, give consideration to the climate of the country benchmarking against.
Broken axles	12	Broken axles could lead to derailment. Benchmark against ERA data.	• RV safety critical component failure	NRSS 5 does not currently require the explicit reporting of broken axles but all rail vehicle safety critical component failures are grouped together within the RV safety critical component failure primary effect category. In order to allow comparison the Transport Agency could take the following approach: • Rationalise the NRSS 5 indicators by removing any occurrences from the category that do not comply with the EU definition. This may or may not be possible depending on the level of detail included in the occurrence report. • In addition, give consideration to the climate of the country benchmarking against. • Normalise the data using train km (broken axles/train km).

3.3.2 Indicators selected from GB experience

The following indicators in table 3.5 are selected from GB experience. It is important to collect relevant data on precursors to reduce risk and prevent accidents. Much data is collected in GB which is used to identify risk in many areas.

Table 3.5 Indicators from GB experience[10]

Indicator	Definition ID (appx 4)	Why benchmark and what to benchmark against	Applicable NRSS 5 primary effect categories	Actions required by the Transport Agency
Collisions	13	Collisions could lead to fatality. Benchmark against GB data.	• Collision heavy road vehicle (CHV) • Collision illegal obstruction (CIO) • Collision light road vehicle (CLV) • Collision maintenance providers personnel/equipment/RV/road vehicle (CMP) • Collision with rail vehicle (CRV) • Collision with equipment (CWE) • Collision structure (CST) • Collision slip (CSL)	NRSS 5 currently requires the reporting of collisions across a number of primary effect categories In order to compare, the Transport Agency could take the following approach: • Aggregate the occurrence categories identified across all applicable operating processes. • Normalise the data using train km (collisions/train km). • Ensure similar definition used for collision.
Derailments	14	Derailments could lead to fatality. Benchmark against GB data.	• Derailment (DRM)	NRSS 5 requires the reporting of derailments and there appears to be good correlation between the UK definition and the NRSS 5 category. In order to compare the Transport Agency could take the following approach: • Aggregate the occurrence categories identified across all applicable operating processes. • Normalise the data using train km (derailments/train km). • Ensure similar definition used for derailment in NRSS 5. • In addition, give consideration to the climate and the variations in infrastructure and signalling systems of the country benchmarking against.

[10] Definitions taken from GE/RT8047. See appendix D for full definitions.

Indicator	Definition ID (appx 4)	Why benchmark and what to benchmark against	Applicable NRSS 5 primary effect categories	Actions required by the Transport Agency
Level crossings – failures of equipment	15	Fatalities on level crossings are a major risk area thus possible precursors to these accidents should be considered. However it is recognised that there may not be good correlation between UK and New Zealand data due to the cultural and technological differences. Benchmark against GB data.	• Wrong side failure – signalling (no other effect)	Failure of equipment at level crossings is not currently directly required to be reporting by NRSS 5; however, the wrong side failure – signalling (no other effect) primary effect could be used to approximate. In order to allow comparison the Transport Agency could take the following approach: • Use only the occurrences from the level crossing operating procedure. • Ensure similar definition used for this failure; recognise the differences in equipment and their use. • Normalise the data using train km (failures/train km). • It should also be noted there are differences in level crossings equipment and their use between the UK and New Zealand.
Level crossings – misuse of equipment and near misses with persons, road vehicles etc	16	Fatalities on level crossings are a major risk area thus possible precursors to these accidents should be considered. However, it is recognised that there may not be good correlation between UK and New Zealand data due to the cultural and technological differences. Benchmark against GB data.	• Near collision heavy road vehicle (NCHV) • Near collision light road vehicle (NCLV) • Near collision illegal obstruction (NCIO) • Near collision person (NCPN) • Vandalism (damage)	Level crossing near misses are currently reported as near collision. Misuse of equipment is reported as vandalism (damage) In order to allow comparison the Transport Agency could take the following approach: • For each of the primary effect categories, use only the occurrences from the level crossing operating procedure. • Ensure similar definition used for this failure; recognise the differences in equipment and their use and normalise data as suggested. • Normalise the data using train km (failures/train km). • It should also be noted there are differences in level crossings equipment and their use between UK and New Zealand. • Further work would be required to understand how misuse of level crossing equipment is captured in New Zealand and understand the impact on the comparison.

Indicator	Definition ID (appx 4)	Why benchmark and what to benchmark against	Applicable NRSS 5 primary effect categories	Actions required by the Transport Agency
Near misses with persons, road vehicles etc.	17	Fatalities on rail infrastructure a major concern thus possible precursors to these accidents should be considered. Benchmark against GB data.	• Near collision heavy road vehicle (NCHV) • Near collision light road vehicle (NCLV) • Near collision illegal obstruction (NCIO) • Near collision maintenance providers personnel/equipment/RV/road vehicle (NCMP) • Near collision operators personnel/ equipment/RV (NCOP) • Near collision person (NCPN) • Near collision trespasser (NCTP)	NRSS 5 currently requires the reporting of near misses across a number of primary effect categories. In order to compare, the Transport Agency could take the following approach: • Aggregate the occurrence categories identified across all applicable operating processes. • Ensure similar definition used for collision. • Ensure similar definition used for this failure. • Ensure that the primary effects identified also include emergency brake applications within the NRSS 5 definition. • Recognise the cultural differences. • Normalise the data using train km (failures/train km).

3.3.3 Indicators selected from Australian experience

The following table 3.6 shows the indicators selected from Australian experience.

Table 3.6 Indicators from the Australian experience[11]

Indicator	Definition ID (appx 4)	Why benchmark and what to benchmark against	Applicable NRSS 5 primary effect categories	Actions required by the Transport Agency
Collision with rail personnel	18	Collisions with rail personnel are of concern. Although reporting does not classify occurrences of rail personnel being struck specifically, the details of any particular incident will highlight whether the person involved was a rail worker.	• Collision with rail personnel (CRP)	NRSS 5 has a reporting category for collisions with rail personnel. In order to compare, the Transport Agency could take the following approach: • Aggregate the occurrence categories identified across all applicable operating processes. • Ensure that the NRSS 5 definition for collision with rail personnel is comparable. • Consider normalisation by the estimated size of the exposed population and by total number only.
Collisions between trains and with rolling stock (running line)	19	Collisions involving one or more rail vehicles could lead to one or more fatalities.	• Collision with rail vehicle (CRV)	NRSS 5 has a category for collisions with rail vehicle which appears to be broadly comparable to the Australian indicator. In order to compare, the Transport Agency could take the following approach: • Aggregate the occurrence categories identified across all applicable operating processes. • Ensure that the NRSS 5 definition for collision with rail personnel is comparable with the OC-G1 definition, particularly with regards to the inclusions and exclusions stated. • Normalise the data using train km.

[11] Definitions taken from (OC-G1). See appendix D for full definitions.

Indicator	Definition ID (appx 4)	Why benchmark and what to benchmark against	Applicable NRSS 5 primary effect categories	Actions required by the Transport Agency
Derailment (running line)	20	Derailment of rail vehicles, together with subsequent events could lead to multiple fatalities.	• Derailment (DRM)	NRSS 5 has a category for derailments. In order to compare the Transport Agency could take the following approach: • Aggregate the occurrence categories identified across all applicable Operating processes. • Normalise the data using train km. • Ensure similar definition used for derailment in NRSS 5. • Consider reporting passenger and freight train derailments separately.
Level crossing occurrence – collision with road vehicle	21	Level crossings are known to be high risk locations and as such all incidents occurring at these locations are classified as level crossing occurrences such that the risk associated with operations at, and through, this infrastructure can be monitored and understood holistically.	• Near collision heavy road vehicle (NCHV) • Near collision light road vehicle (NCLV)	Level crossing collisions with road vehicle is not currently directly required to be reported under NRSS 5, however a number of primary effect near collision categories could be used to approximate. In order to allow comparison the Transport Agency could take the following approach: • For each of the primary effect categories, use only the occurrences from the level crossing operating procedure. • Normalise the data using train km (failures/train km). • Consider capturing the level of protection provided at the level crossings at which the incidents occur.
Level crossing occurrence – collision with person	22	Level crossings are known to be high risk locations and as such all incidents occurring at these locations are classified as level crossing occurrences such that the risk associated with operations at, and through, this infrastructure can be monitored and understood holistically.	• Collision person	Level crossing collisions with person is required to be reported by NRSS 5. In order to allow comparison the Transport Agency could take the following approach: • For each of the primary effect categories, use only the occurrences from the level crossing operating procedure. • Normalise the data using train km (failures/train km). • Consider capturing the level of protection provided at the level crossings at which the incidents occur.

Indicator	Definition ID (appx 4)	Why benchmark and what to benchmark against	Applicable NRSS 5 primary effect categories	Actions required by the Transport Agency
Level crossing occurrence – equipment failure / defect	23	Level crossings are known to be high risk locations and as such all incidents occurring at these locations are classified as level crossing occurrences such that the risk associated with operations at, and through, this infrastructure can be monitored and understood holistically.	• Wrong side failure – signalling (no other effect)	Failure of equipment at level crossings is not explicitly required to be reported by NRSS 5; however, the wrong side failure – signalling (no other effect) primary effect could be used to approximate. In order to allow comparison the Transport Agency could take the following approach: • Use only the occurrences from the 'level crossing' operating process. • Ensure similar definition used for this failure; recognise the differences in equipment and their use. • Normalise the data using train km (failures/train km). • Consider capturing the level of protection provided at the level crossings at which the incidents occur.
Load irregularity	24	'Load irregularity' is a precursor event of a safety incident which could result in injury and/or damage. Certain Australian rail freight operations have similarities with New Zealand operation in that there is transportation of similar commodities over long distance routes predominately operated by freight trains.	• Loading irregularity (LIR)	NRSS 5 currently requires the reporting of loading irregularity; however, it is not clear from NRSS 5 whether the definitions for loading irregularity are compatible with the Australian definition. In order to allow comparison the Transport Agency could take the following approach: • Check that the definition is compatible or adopt a similar/ same definition for load irregularity. • Normalise the data using freight train km.

Indicator	Definition ID (appx 4)	Why benchmark and what to benchmark against	Applicable NRSS 5 primary effect categories	Actions required by the Transport Agency
SPAD	25	SPAD events are captured as they provide an indication of the risk exposure to the potentially high consequence events of collision and derailment.	• SPAD A (SPADA) • SPAD B (SPADB) • SPAD C (SPADC) • SPAD D (SPADD)	NRSS 5 requires the reporting of signals passed at danger (SPAD) and there appears to be good correlation between the Australian definition and the NRSS 5 category based on the definitions in the semi-permanent bulletin no. 452. In order to compare the Transport Agency could take the following approach: • Aggregate the occurrence categories identified across all applicable Operating processes, with the exception of SPAD C and SPAD D as the exact definitions for these categories are unknown. • Consideration should also be given to operating environments, climatic conditions and the variation in infrastructure and signalling systems and the level of risk. • Normalise the data using infrastructure km (SPAD/km), alternatively use train km. Note: The ARA SPAD Working Group is currently reviewing SPAD classifications which may result in a change to reporting through a revised OC-G1 guideline.
Track irregularity	26	Track defects are precursors to potential derailment occurrences and as such are regarded as high risk.	• Track defect (TDF)	NRSS 5 currently requires the reporting of track defect occurrences; however it is not clear if the definition in NRSS 5 is broadly comparable with the Australian definition. In order to compare the Transport Agency could undertake the following approach: • Check the definitions are comparable or adopt a similar/ same definition for track irregularity. • Give consideration to climate differences between Australia and New Zealand which may affect overall exposure to these events. • Normalise the data using track km.

4 Conclusions

Although the Transport Agency has a comprehensive set of incident reporting categories, it was not always possible to determine if there was a correlation between the incident reporting categories used by the Transport Agency and the chosen comparator countries, namely Australia and UK.

A broad-ranging set of safety indicators from Europe, UK, and Australia were identified, which, with some further work, would enable the Transport Agency to undertake meaningful benchmarking activities using the data it currently collects. To assist in the collection of suitable data, clearly defined comparison indicators, aligned with those used by the ERA, and the UK and Australian rail authorities, have been provided.

It is essential that the Transport Agency ensures all companies providing accident and incident data have a clear understanding of the definitions of the reporting categories so that all occurrences are correctly categorised and the data collected is not only comparable with the data provided by benchmarking partners, but also between participants in the New Zealand rail industry.

Differences affecting the nature of operations in different countries should be taken into consideration when comparing data. Such differences include:

- size
- operating procedures
- operating rules
- technology
- reporting cultures.

The table in section 3.3 of this report provides suggestions on how the data could be normalised to take account of these differences in the target benchmarking countries.

Although consideration has only been given in this report to benchmarking with the UK, Australia and Europe it would be possible for the Transport Agency to benchmark against data from other rail authorities in future. For this to be successful, the Transport Agency would need to gain a clear understanding of the definition used for each incident reporting category to ensure it was comparable.

Benchmarking can be a very valuable tool if used appropriately. However it must be recognised that no two railways are exactly alike. There are many differences between railways in such things as size, operating procedures, rules, technology, reporting cultures, infrastructure and traffic density which impact on risks in different ways.

Thus care should be taken when comparing one railway with another; the fact that a figure on a particular indicator is higher or lower on one railway than on another does not necessarily mean the risk is managed better or worse.

In conclusion the real reasons for benchmarking should be to measure whether you are continuing to improve and to explore what others are doing to better control your own risks.

As discussed in section 3.1 the Transport Agency may also wish to consider the benefits of the involvement of RTOs in the International Suburban Benchmarking Group

5 Recommendations

The ultimate aim of this research topic was to provide the Transport Agency with a recommended approach and strategy for benchmarking against suitably comparable rail operations. From the initial phase of work, UK and Australian rail operations were chosen as suitable rail operations against which benchmarking could be started. Indicators identified in section 3.3 have been proposed as suitable for benchmarking against European, UK, and/or Australian rail operations.

5.1 Draft implementation plan

The implementation plan below is a suggestion for the roll out of the proposed safety indicators:

- The rail industry clearly defines the incident categories that are to be used to ensure robust data is collected. This could be done through an update to NRSS 5 to include formal definitions for all 'primary effects' in table 2 (reproduced as table 3.1 in this report).
- The rail industry reviews the proposed benchmarking identified in section 3.3 alongside the proposed approach and updated NRSS 5 definitions to validate that the data collected by the Transport Agency is suitable for the comparison and the approach recommended is valid.
- The Transport Agency makes a final selection of the indicators and benchmarking partners in section 3.3, considering any feedback from the industry review above.
- Good promotion is required to encourage robust reporting of accident and incident data (it should be recognised that improvements in accident/incident reporting can lead to an apparent increase in accident trends, which may have been under reported previously). The UK mandates the reporting of a comprehensive range of accident and incident information through a central system (SMIS) which thus provides comprehensive data for safety analysis and risk identification. The Transport Agency may wish to follow this example.
- The Transport Agency considers undertaking an exercise to understand and detail how it should manipulate the data for the selected indicators to make it comparable to that collected/published by the chosen benchmarking partners. There are many factors which could skew data such as differences in technology used, physical differences in infrastructure or geography, differences in safety cultural and thus to reporting information, and differences in rail operating procedures.
- Once sufficient data has been collected, benchmarking activities can be undertaken, noting the adjustments and considerations which may be required, as identified in section 3.3.
- Appropriate data can be shared with rail industry partners and the general public.
- The Transport Agency continues to work with Australian railway authorities to develop processes for the understanding of risk profiles which are similar to those used in the UK. This information would be of particular use to rail industry partners to identify key areas of risk which require additional focus.
- Fatality figures (although thankfully small) could be published for the general public to show how safety on New Zealand railways compares with the rest of the world and other forms of transport, as is published by ERA. Importantly, public trespasser fatalities and suicides need to be highlighted as societal issues which impact on the sustainability of the railway and the mental health of rail personnel. They are not deaths resulting from rail operations that operators have control over and need to be separately classified to afford them specific focus by society at large (not included as rail deaths).

- As level crossing safety is a particular area of concern (as in many countries), data on level crossing accidents and incidents could be published for the general public to encourage the safe use of level crossings.

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Appendix A: Letter report 'Proposals for benchmarking opportunities'

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Proposals for Benchmarking Opportunities

1. Introduction

The information provided in this letter summarises the first phase of the work Interfleet is undertaking for NZTA (New Zealand Transport Agency) on research topic ART 14/47. The aim of this research topic is to identify a suite of implementable recommendations for the improvement of data collection and identification of lead and lag indicators in the New Zealand rail environment, based on comparison with appropriate operations in the international rail industry. The aim of this first phase was to identify five to eight comparable systems from which the Steering Group can identify a short list of at least two operations which could be used to undertake useful benchmarking activities.

The information provided by NZTA and a variety of information available on the internet regarding the train operations in New Zealand was reviewed. Interfleet offices around the world were contacted and information available on the internet was reviewed to identify:

- which train operators publish safety data which could be suitable for NZTA to benchmark against;
- which countries have railway infrastructure (particularly signalling systems and track complexity) which is similar to New Zealand;
- which organisations could be contacted, should more information be required about the data collected.

The New Zealand rail operations could be broken down into the following areas:

- Freight (which is understood to be mainly long distance carrying coal; logs; stone; steel and container traffic etc)
- Long distance passenger services

- Auckland - Wellington
- Christchurch – Picton
- Christchurch – Greymouth

- Regional passenger services
  - Wellington – Palmerston North (Capital Connection)
  - Wellington – Mastertown (Wairarapa)
- Suburban
  - Auckland Suburban
  - Wellington Suburban

Consideration should be given to whether NZTA should identify benchmarking partners for the whole rail system or whether different benchmarking partners should be identified against different areas of operation, particularly in the areas of freight operation and suburban passenger operation.

Safety data is issued by organisations for the countries mentioned in this letter which could be used in benchmarking activities by NZTA.

The attached table provides a summary of key data to assist the Steering Group in comparing the rail operations in the countries given. For European countries this data was taken from 'Rail Safety Performance in the European Union 2014' published by the European Rail Agency (ERA); comparable data was then sourced for the other countries. As Signals Passed at Danger (SPAD) information is a key hazard and area for examination in the next phase, consideration was given to the percentage fitment of ATP (Automatic Train Protection). The ERA defines this as a system that enforces obedience to signals and speed restrictions by speed supervision, including automatic stop at signals. Systems where track signaling information is substituted and/or supplemented by cab signaling are included in the ERA data.

2. Possible Benchmarking Opportunities

2.1 Opportunities

Interfleet's exercise has given detailed consideration to the countries below. High level information is given of the advantages and disadvantages of using each of these countries as benchmarking partners, either for the whole rail system or selected areas of the rail system. Further details of the characteristics of each country's network are given in the attached spreadsheet.

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2.1.1 European countries

Sweden

The railway operations and environment are similar to New Zealand although on a slightly larger scale.

Good data is published and available through ERA. Interfleet has offices in Sweden and Interfleet has also worked closely with ERA should we wish to investigate data further.

There is a high level of ATP (81%) in operation which does not compare well with New Zealand.

Norway

The railway operations and environment are similar to New Zealand although on a slightly larger scale.

Good data is published and available through ERA. Interfleet has an office in Norway and Interfleet has also worked closely with the ERA should we wish to investigate data further.

There is a high level of ATP (74%) in operation which does not compare well with New Zealand.

UK

The railway operations and environment is similar to New Zealand. Various train operators within UK could be used such as: ScotRail; MerseyRail; Northern; Transpennine Express and Northern Ireland as they provide passenger services which would provide a good comparison to the passenger services in New Zealand, however these individual operators do not operate freight services, which are separately undertaken by a number of freight operating companies.

Good data is published and available through ERA and RSSB (Rail Safety and Standards Board). Interfleet has a number of offices in the UK, including its headquarters. Interfleet has worked closely with ERA and RSSB should we wish to investigate data further. The RSSB publishes comprehensive data covering a wide variety of hazards.

The UK only has 4% of track with ATP in operation which is comparable with the New Zealand rail system.

Republic of Ireland

The railway operations and physical environment in Republic of Ireland is similar to New Zealand, particularly the less mountainous areas.

Good data is published and available through ERA. Interfleet have worked closely with ERA and railway organisations in the Republic of Ireland should we wish to investigate data further.

There is only a little ATP in operation, on local Dublin services, thus comparable with the rail system in New Zealand.

Other European countries

There are also a number of other European countries with similar railway operations and environment to New Zealand.

Good data is published and available through ERA for these European countries. Interfleet have worked closely with ERA should we wish to investigate data further. Countries with no or little operational ATP are shown as these are more comparable with the rail system in New Zealand.

Suggestions are:

Greece (0% ATP).

Belgium (9% ATP);

Bulgaria (11% ATP);

Slovakia (21% ATP);

Poland (0% ATP);

Czech Republic (0% ATP);

Estonia (23% ATP);

2.1.2 Rest of the World

Australia

There are close relationships between Australia and New Zealand in relation to rail operations, legislation, and standards. Interfleet also has a number of offices in Australia who have undertaken some work on safety data interrogation and with which we are therefore familiar.

Although the distances travelled in Australia are considerably longer and the freight carried is much greater, the physical environment is similar, as is the track complexity, with only small pockets of ATP in operation. Thus the rail system in general is comparable with that of New Zealand although much larger. Perth may be a good urban operation to consider using as a comparison to the New Zealand urban operations. It may also be possible to consider rail operations in certain states. The Defined Interstate Rail Network (DIRN) managed by ARTC may offer something of a comparison to KiwiRail.

South Africa

The railway operations and environment are similar to New Zealand although on a much larger scale. The track complexity and lack of ATP in South Africa is similar to New Zealand.

Good publically available data is available for South African rail operations and Interfleet have an office in South Africa who have contacts through which further information can be sought.

USA

Although data is available, the scale of train operations in USA has been considered and found to be significantly larger than New Zealand; furthermore the predominance of freight operations and less significance of passenger operations does not provide a good match to New Zealand.

However Interfleet does have offices in USA through which additional information could be requested if this was to be selected.

Canada

The railway operations and environment is similar to New Zealand although on a bigger scale.

Railway safety performance data is collected by the Transportation Safety Board of Canada (TSB) and the Rail Association of Canada (RAC). The TSB maintains a database of safety performance statistics on federally-regulated railways, and the RAC collects similar statistics on provincially-regulated operations. Interfleet has offices in Canada through which it should be possible to request further information if required.

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2.2 Recommendations for Benchmarking

It is suggested that the following countries, which Interfleet has used its judgement to put into an order of preference, should be given the greatest consideration, with the aim of selecting two countries to be used in the next phase of the exercise:

- European countries such as Republic of Ireland or Greece – good data is available for all European countries, thus if NZTA collected comparable data it could benchmark against a range of European countries, it was felt that the Republic of Ireland and Greece had similar infrastructure to New Zealand.
- UK – due to the good provision of data available from RSSB and ERA. Interfleet has worked closely with these organisations and regularly works with the data published by them. As only little ATP is fitted the rail infrastructure, particularly at urban and regional level, compares well. Reasonable comparison could therefore be made with a number of UK passenger train operators, although there is not such a good comparison with freight operations.
- South Africa – Good data is available. Interfleet has an office in South Africa who are working with the local rail organisations. Although a larger network, the rail infrastructure is comparable with New Zealand.
- Australia - Good data is available. Interfleet has offices in Australia who are working with the local rail organisations. It is understood that working relationships already exist between NZTA and the Australian rail organisations. Although a larger network, the rail infrastructure is comparable with New Zealand. Perth may be a good urban operation to consider using as a comparison to the New Zealand urban operations

3. Next Stage

In the next stage of the review the hazards against which benchmarking should be considered will be identified, however primary consideration will be given to:

- Signals Passed at Danger (SPADs) – A comparison needs to be made of the definitions used by each train operator of types of 'SPAD' and the technology in place to prevent and record SPADs in New Zealand and the comparison train operators.
- Collisions and near collisions with obstacles and vehicles, it is noted that Level Crossing safety is a concern in New Zealand thus it would be a key area to monitor with the aim of improving safety.
- Collisions and near collisions with people on the infrastructure is an area of concern in New Zealand and thus should be an area of focus, however suicides may skew this data so clarity is required as to how this data is defined and collected.
- It is noted that there is some concern about tunnel safety in New Zealand due to a number of incidents with train ventilation and maintenance staff using combustion engines in long tunnels, which have no ventilation; it would be good to give a focus to this hazard, however this may not be an area that is given focus in data collection by other train operators.
- Key data published by the ERA includes: fatalities and serious injuries (passengers, employees, level crossing users); collisions of trains; derailment of trains; fires in rolling stock; and accidents involving vehicles carrying dangerous goods.

- Consideration could be given to certain precursors, data in the following areas being published by the ERA: broken rails; track buckles; wrong side signal failures; broken wheels; and broken axles.

Following agreement with the Steering Group, Interfleet will review the data collected by the short listed rail operations to understand how data for the principal safety performance indicators for the comparator systems is gathered and manipulated. Interfleet will then identify the strengths and weaknesses of individual leading and lagging indicators. From this, recommendations will be made identifying appropriate lead and lag indicators. In addition suggestions will be made to facilitate the improvement of data collection in the New Zealand rail environment to allow appropriate benchmarking activities to be undertaken.

Yours sincerely

Jayne Brown

JAYNE BROWN
Associate Consultant

Enc. Spreadsheet showing benchmarking opportunities, 1 page.

Appendix B: Possible primary indicators from UK analysis

Table B.1 Possible primary indicators from UK analysis

Indicator	UK definition	Comparison	Appreciation for New Zealand operating environment	Recommendation
Collision heavy road vehicle	Part of 'road vehicles, aircraft, etc on the line, or damaging equipment at level crossings'.	Possible to make comparison.	Major risk	Possible primary indicator
Collision illegal obstruction	Part of 'train striking obstructions or being struck by objects'.	Possible to make comparison.	Major risk	Possible primary indicator
Collision light road vehicle	Part of 'road vehicles, aircraft, etc on the line, or damaging equipment at level crossings'.	Possible to make comparison.	Major risk	Possible primary indicator
Collision maintenance providers/personnel /equipment/RV/road vehicle	Part of a number of UK event categories.	Not easy to make direct comparison as no direct correlation to UK data.	Major risk	Possible primary indicator
Collision with rail personnel	Different categories used in UK – 'operational incidents'; 'level crossings – misuse and near misses with persons' etc; 'near misses with persons' etc; table B 'Accidents resulting in death or injury to people'.	Although the Transport Agency definition does not correlate to UK definitions, 'number of fatalities per year' is a major UK indicator and thus it would be possible to use this as an indicator.	'Staff fatalities' is a major indicator in all countries.	'Staff fatalities' should be a primary indicator.
Collision with rail vehicle	Good correlation to UK 'collisions', although UK definition also includes all rail vehicles and collision with open door etc.	Should be easy to make a good comparison to UK, but need to confirm the Transport Agency definition.	Collisions between rail vehicles could be a major risk although should not include the wide range of the UK definition.	'Collisions between trains or rail vehicles' should be a primary indicator.

Indicator	UK definition	Comparison	Appreciation for New Zealand operating environment	Recommendation
Collision person	Different categories used in UK – 'operational incidents'; 'level crossings – misuse and near misses with persons etc'; 'near misses with persons etc'; table B 'Accidents resulting in death or injury to people'.	Although the Transport Agency definition does not correlate to UK definitions 'number of fatalities per year' is a major UK indicator and thus it would be possible to use this as an indicator.	'Passenger/general public fatalities' is a major indicator in all countries.	'Passenger/general public fatalities' should be a primary indicator.
Collision slip	No correlation with UK definition, closest is 'failures of permanent way or works'.	It is important to ensure the rail infrastructure is maintained to an acceptable standard, thus an indicator measuring the failures of the permanent way would be useful although environmental differences in the UK would not be a good comparison. Maybe use Australian indicator?	Environmental differences in the UK would not make this a good comparison. Australia may be a better comparison.	Consider using information from Australia to compare rail infrastructure failures such as land slips.
Collision trespasser	Different categories used in UK – 'operational incidents'; 'level crossings – misuse and near misses with persons etc'; 'near misses with persons etc'; table B 'Accidents resulting in death or injury to people'.	Although the Transport Agency definition does not correlate to UK definitions, 'number of fatalities', including suicides per year' is a major UK indicator and thus it would be possible to use this as an indicator.	'General public fatalities' is a major indicator in all countries. Work is being undertaken in UK to reduce number of suicides. Not sure of the Transport Agency attitude to suicide. It should be noted that this has been a topic of research in Australia; refer to http://phoenixaustralia.org/	'Passenger/ general public fatalities' should be a primary indicator – not sure if this should include trespassers and suicides.
Collision trespassing stock	Closest UK indicator – 'animals struck by trains'.	In looking at the category titles it appears to give good correlation.	The railway environment and the control of stock is different between the UK and New Zealand. In the UK 'stock' is usually cows, sheep or horses normally held in relatively small well fenced fields. The UK definition also includes large wild animals such as deer.	Due to the derailment risk and the attitude of the general public to trespass on the rail line this would be a useful indicator for New Zealand to measure although it may be better to compare with data from Australia.

Indicator	UK definition	Comparison	Appreciation for New Zealand operating environment	Recommendation
Derailment	UK also has an event category 'derailment'. Need to confirm that a similar definition is used in New Zealand.	Clear UK definition which should give good comparison with New Zealand data. This is also a significant risk in the rail environment.	Differences between the UK and New Zealand rail environment should not affect the derailment risk, thus a comparison could easily be made.	Possible primary indicator
Dangerous goods placards and papers	UK event category is 'dangerous goods incidents and irregularities'.	The UK event category includes a number of New Zealand categories; however, there should be good correspondence if the New Zealand categories could be included in the UK definition.	It is envisaged there could be similarities between the dangerous goods carried in both countries. Further research is required to establish amount and mileage differences.	Possible primary indicator
Dangerous goods segregation	UK event category is 'dangerous goods incidents and irregularities'.	The UK event category includes a number of New Zealand categories; however, there should be good correspondence if the New Zealand categories could be included in the UK definition.	It is envisaged there could be similarities between the dangerous goods carried in both countries. Further research is required to establish amount and mileage differences.	Possible primary indicator
Fire/smoke/fumes – equipment related	There are a number of UK event categories which could relate to this event such as: 'breathing apparatus malfunction'; 'electrical short circuit'; or 'fires affecting permanent way, works or signalling equipment'.	If the Transport Agency event definition could be adjusted to cover fires as in the UK it might lead to a useful indicator for bench marking.	Due to the differences in the physical geography and railway infrastructure between UK and New Zealand this may not be a useful comparison; however, it may be possible to make a suitable comparison with Australian railway.	Consider adjusting Transport Agency definition to cover fires and look at possibility of comparing with Australia.
Fire/smoke/fumes – trackside	Closest UK event category appears to be 'fires affecting permanent way, works or signalling equipment'.	If the Transport Agency event definition could be adjusted to cover fires as in UK it might lead to a useful indicator for bench marking.	Due to the differences in the physical geography and railway infrastructure between UK and New Zealand this may not be a useful comparison; however, it may be possible to make a suitable comparison with Australian railway.	Consider adjusting the Transport Agency definition to cover fires and look at possibility of comparing with Australia.

Indicator	UK definition	Comparison	Appreciation for New Zealand operating environment	Recommendation
Fire/smoke/fumes – building	Closest UK event category appears to be 'fires affecting permanent way, works or signalling equipment'.	If the Transport Agency event definition could be adjusted to cover fires as in UK it might lead to a useful indicator for bench marking.	Due to the differences in the physical geography and railway infrastructure between UK and New Zealand this may not be a useful comparison; however, it may be possible to make a suitable comparison with Australian railway.	Consider adjusting the Transport Agency definition to cover fires and look at possibility of comparing with Australia.
Flooding	UK event category is 'flooding of the permanent way'. Need to understand the Transport Agency definition to confirm similarity.	Appears to be a good comparison between UK and the Transport Agency events; however, need to investigate full Transport Agency definition.	It should be possible to compare flooding risk in UK and Australia with the Transport Agency	Although this is a lower risk event it would appear to be easy to make a comparison. This event category would give an indication of how well the railway infrastructure is maintained and could also be used to show how environmental factors, going forward, are affecting rail infrastructure globally.
Handbrakes dragging	Closest UK definition: 'failures or defects in axles, wheels, tyres and other equipment on trains or rail vehicles'	The Transport Agency event category appears to be a subset of the UK definition; however, as a high risk category consideration should be given by the Transport Agency to expand their definition to that of the UK so this could be used as a primary indicator.	There appears to be sufficient similarity between the vehicles operated and the speed of operation in UK (and Australia) to make a good comparison. The risks in the UK of a serious accident following the failure of an axle etc may be greater due to the density of vehicles on the infrastructure.	Consider adjusting the Transport Agency definition to UK definition of 'failures or defects in axles, wheels, tyres and other equipment on trains or rail vehicles' as this is a high-risk event and should be a primary indicator.
Infrastructure safety critical component failure	No correlation with UK definitions. The closest are 'signalling system incidents' and 'failures of track/train control systems'.	Further information is required to understand the types of systems used in New Zealand and thus to establish if the two rail systems are comparable with regards to signalling and train control systems.	Need to understand definition of 'equipment' to understand risk	Should be considered as a primary indicator but there needs to be an understanding of the systems used and how comparable they are to UK and Australia before deciding if this should be a primary indicator.

Indicator	UK definition	Comparison	Appreciation for New Zealand operating environment	Recommendation
Injury/death passenger alighting	No direct correlation with UK events, closest 'personal accidents'.	'Personal accidents' under UK definition covers a number of New Zealand events. However, it should be noted that the UK definition includes infrastructure manager (IM)/railway undertaking (RU) employee or contractor's employee while travelling by road vehicle between sites of work.	It would be good to record and compare accidents to employees and passengers as we have a duty of care to employees, passengers and members of the public; however, further investigation is required to establish if comparable data is available in the UK or Australia.	Accidents to passenger, employees and the general public should be measured; however, further investigation is required to establish if comparable data is available in the UK or Australia.
Injury/death passenger boarding	No direct correlation with UK events, closest 'personal accidents'.	'Personal accidents' under UK definition covers a number of New Zealand events. However, it should be noted that the UK definition includes IM/RU employee or contractor's employee while travelling by road vehicle between sites of work.	It would be good to record and compare accidents to employees and passengers as we have a duty of care to these people; however, further investigation is required to establish if comparable data is available in the UK or Australia.	Accidents to passenger, employees and the general public should be measured; however, further investigation is required to establish if comparable data is available in the UK or Australia.
Injury/death passenger/public on platform	No direct correlation with UK events, closest 'personal accidents'.	'Personal accidents' under UK definition covers a number of New Zealand events. However, it should be noted that the UK definition includes IM/RU employee or contractor's employee while travelling by road vehicle between sites of work.	It would be good to record and compare accidents to employees and passengers as we have a duty of care to these people; however, further investigation is required to establish if comparable data is available in the UK or Australia.	Accidents to passenger, employees and the general public should be measured; however, further investigation is required to establish if comparable data is available in the UK or Australia.
Injury/death passenger when on board	No direct correlation with UK events, closest 'personal accidents'.	'Personal accidents' under UK definition covers a number of New Zealand events. However, it should be noted that the UK definition includes IM/RU employee or contractor's employee while travelling by road vehicle between sites of work.	It would be good to record and compare accidents to employees and passengers as we have a duty of care to these people; however, further investigation is required to establish if comparable data is available in the UK or Australia.	Accidents to passenger, employees and the general public should be measured; however, further investigation is required to establish if comparable data is available in the UK or Australia.

Indicator	UK definition	Comparison	Appreciation for New Zealand operating environment	Recommendation
Leak/spill (dangerous goods)	No direct correlation with UK. A number of possible events used in UK: 'dangerous goods incidents and irregularities'; 'environmental events' or 'failure of pipelines'.	In the UK there is a legal responsibility to prevent environmental damage, thus it is important to record and compare this information; however, further work is required to identify suitable indicators which could be used to compare information from New Zealand with UK and Australia.	Further information is required to understand the New Zealand attitude and legislation to prevent environmental damage.	It is important to reduce the risk of environmental damage, thus it would be advantageous to record information regarding spills etc; however, further work is required to identify comparable data in the UK and Australia.
Leak/spill (not dangerous goods)	No direct correlation with UK. A number of possible events used in UK: 'dangerous goods incidents and irregularities'; 'environmental events' or 'failure of pipelines'.	In the UK there is a legal responsibility to prevent environmental damage, thus it is important to record and compare this information; however, further work is required to identify suitable indicators which could be used to compare information from New Zealand with UK and Australia.	Further information is required to understand the New Zealand attitude and legislation to prevent environmental damage.	It is important to reduce the risk of environmental damage, thus it would be advantageous to record information regarding spills etc; however, further work is required to identify comparable data in the UK and Australia.
Line speed exceeded	Comparable data with UK – 'excessive speed of trains or rail vehicles'	It is not known how excessive speed is established in New Zealand, thus further work is required to establish if data available is comparable as excessive speed may be under-reported in New Zealand and UK depending on the checking or supervisory processes used.	As the density of rail vehicles on the infrastructure is less in New Zealand and the population density is lower than in the UK the risk of excessive speed is lower, it may also be difficult to identify excessive speed in remote areas.	It is essential that operating instructions are complied with, speed limits is one operating requirement which can be measured and could be used as a measure to establish the attitude to working within the operating instructions; however, due to the differences in physical environment it may not be possible to make a comparison with UK data. It may be possible to use Australian data.

Indicator	UK definition	Comparison	Appreciation for New Zealand operating environment	Recommendation
Load lost overboard	A number of New Zealand events could be compared with the UK event 'displaced and insecure loads on, or excessive or improper loading on, trains or rail vehicles'.	Further information is required regarding the goods carried on the New Zealand Railway and how they are conveyed before it is possible to confirm that UK data is comparable to New Zealand data in this area.	Further information is required regarding the goods carried on the New Zealand Railway and how they are conveyed before it is possible to confirm that UK data is comparable to New Zealand data in this area.	It is important to ensure that freight is carried safely and an indicator should be used in this area; however, without further information regarding the type of freight and how it is conveyed it is not possible to compare the data available in the UK or Australia with that from New Zealand.
Loading irregularity	A number of New Zealand events could be compared with the UK event 'displaced and insecure loads on, or excessive or improper loading on, trains or rail vehicles'.	Further information is required regarding the goods carried on the New Zealand Railway and how they are conveyed before it is possible to confirm that UK data is comparable to New Zealand data in this area.	Further information is required regarding the goods carried on the New Zealand Railway and how they are conveyed before it is possible to confirm that UK data is comparable to New Zealand data in this area.	It is important to ensure that freight is carried safely and an indicator should be used in this area; however, without further information regarding the type of freight and how it is conveyed it is not possible to compare the data available in the UK or Australia with that from New Zealand.
Near collision heavy road vehicle	No correlation with UK definitions, closest is 'near misses with persons, road vehicles etc'.	There are a number of Transport Agency events, such as this which would be included in the UK event. Near misses should be recorded as they give an indication of the risk of collision.	An understanding is required of the New Zealand infrastructure and the attitude of the general public to access to the rail infrastructure, particularly trespass and level crossing use.	Near misses with persons, road vehicles etc should be a primary indicator; however; it may be necessary to adjust the Transport Agency definition.
Near collision light road vehicle	No correlation with UK definitions, closest is 'near misses with persons, road vehicles etc'	There are a number of Transport Agency events, such as this which would be included in the UK event. Near misses should be recorded as they give an indication of the risk of collision.	An understanding is required of the New Zealand infrastructure and the attitude of the general public to access to the rail infrastructure, particularly trespass and level crossing use.	Near misses with persons, road vehicles etc should be a primary indicator; however, it may be necessary to adjust the Transport Agency definition.

Indicator	UK definition	Comparison	Appreciation for New Zealand operating environment	Recommendation
Near collision illegal obstruction	No correlation with UK definitions, closest is 'near misses with persons, road vehicles etc'	There are a number of Transport Agency events, such as this, which would be included in the UK event. Near misses should be recorded as they give an indication of the risk of collision.	An understanding is required of the New Zealand infrastructure and the attitude of the general public to access to the rail infrastructure, particularly trespass and level crossing use.	Near misses with persons, road vehicles etc should be a primary indicator; however, it may be necessary to adjust the Transport Agency definition.
Near collision maintenance providers personnel/ equipment/RV/road vehicle	No correlation with UK definitions, closest is 'near misses with persons, road vehicles etc'	There are a number of Transport Agency events, such as this, which would be included in the UK event. Near misses should be recorded as they give an indication of the risk of collision.	An understanding is required of the New Zealand infrastructure and the attitude of the general public to access to the rail infrastructure, particularly trespass and level crossing use.	Near misses with persons, road vehicles etc should be a primary indicator; however, it may be necessary to adjust the Transport Agency definition.
Near collision operators personnel/equipment/ RV	No correlation with UK definitions, closest is 'near misses with persons, road vehicles etc'	There are a number of Transport Agency events, such as this, which would be included in the UK event. Near misses should be recorded as they give an indication of the risk of collision.	An understanding is required of the New Zealand infrastructure and the attitude of the general public to access to the rail infrastructure, particularly trespass and level crossing use.	Near misses with persons, road vehicles etc should be a primary indicator; however, it may be necessary to adjust the Transport Agency definition.
Near collision person	No correlation with UK definitions, closest is 'near misses with persons, road vehicles etc'	There are a number of Transport Agency events, such as this, which would be included in the UK event. Near misses should be recorded as they give an indication of the risk of collision.	An understanding is required of the New Zealand infrastructure and the attitude of the general public to access to the rail infrastructure, particularly trespass and level crossing use.	Near misses with persons, road vehicles etc should be a primary indicator; however, it may be necessary to adjust the Transport Agency definition.
Near collision trespasser	No correlation with UK definitions, closest is 'near misses with persons, road vehicles etc'	There are a number of Transport Agency events, such as this, which would be included in the UK event. Near misses should be recorded as they give an indication of the risk of collision.	An understanding is required of the New Zealand infrastructure and the attitude of the general public to access to the rail infrastructure, particularly trespass and level crossing use.	Near misses with persons, road vehicles etc should be a primary indicator; however, it may be necessary to adjust the Transport Agency definition.

Indicator	UK definition	Comparison	Appreciation for New Zealand operating environment	Recommendation
Overgauge load	A number of New Zealand events could be compared with the UK event 'displaced and insecure loads on, or excessive or improper loading on, trains or rail vehicles'.	Further information is required regarding the goods carried in New Zealand and how they are conveyed before it is possible to confirm that UK data is comparable to New Zealand data in this area.	Further information is required regarding the goods carried in New Zealand and how they are conveyed before it is possible to confirm that UK data is comparable to New Zealand data in this area.	It is important to ensure that freight is carried safely and an indicator should be used in this area; however, without further information regarding the type of freight and how it is conveyed it is not possible to compare the data available in the UK or Australia with that from New Zealand.
Out of balance wagon /container	A number of New Zealand events could be compared with the UK event 'displaced and insecure loads on, or excessive or improper loading on, trains or rail vehicles'.	Further information is required regarding the goods carried in New Zealand and how they are conveyed before it is possible to confirm that UK data is comparable to New Zealand data in this area.	Further information is required regarding the goods carried in New Zealand and how they are conveyed before it is possible to confirm that UK data is comparable to New Zealand data in this area.	It is important to ensure that freight is carried safely and an indicator should be used in this area; however, without further information regarding the type of freight and how it is conveyed it is not possible to compare the data available in the UK or Australia with that from New Zealand.
Overweight wagon/ container	A number of New Zealand events could be compared with the UK event 'displaced and insecure loads on, or excessive or improper loading on, trains or rail vehicles'.	Further information is required regarding the goods carried in New Zealand and how they are conveyed before it is possible to confirm that UK data is comparable to New Zealand data in this area.	Further information is required regarding the goods carried in New Zealand and how they are conveyed before it is possible to confirm that UK data is comparable to New Zealand data in this area.	It is important to ensure that freight is carried safely and an indicator should be used in this area; however, without further information regarding the type of freight and how it is conveyed it is not possible to compare the data available in the UK or Australia with that from New Zealand.

Indicator	UK definition	Comparison	Appreciation for New Zealand operating environment	Recommendation
Rail personnel injury/ death (includes electrical accidents)	In SMIS all accidents are recorded against primary events given in table A of GE/RT8047; however, any other accidents resulting in death or injury to people must also be reported, in this case the nearest event (given in table B) is 'workforce accidents - all physical injuries or incidents of shock occurring on the mainline railway'.	Clear data is available for fatalities, including workforce fatalities in the UK. The UK also publishes data on workforce fatalities by sector to ensure risks in all industries are recognised and controlled. An understanding is, however, required for the definition of 'injury' used in the UK and New Zealand to ensure the data is comparable. Equivalent fatality figures are also published in the UK which may be a useful for comparison.	A clear understanding is required for the definition of 'injury' to ensure that UK and New Zealand data is comparable. Also attitudes to reporting accidents involving injury in New Zealand need to be considered to ensure there is no under reporting.	Possible primary indicator
RV (component failure	No correlation with UK definitions, closest are 'signalling system incidents'; 'failures or defects in axles, wheels, tyres and other equipment on trains or rail vehicles' and failures of track/train control systems'.	Further information is required to understand the types of systems used in New Zealand and thus to establish if the rail vehicles on the two rail systems are comparable with regards to signalling and train control systems.	Need to understand definition of 'equipment' to understand risk.	Should be considered as a primary indicator but there should be an understanding of the systems used and how comparable they are to UK and Australia before deciding if this should be a primary indicator.
Signal reverted – no SPAD	It is believed that this is a sub-set of the UK event 'signalling system incidents'; however, more information is required to understand the New Zealand signalling systems to understand possible failure mechanisms and thus to understand if they are comparable with UK.	Further information is required to understand the types of systems used in New Zealand and thus to establish if the two rail systems are comparable with regards to signalling and train control systems.	Further understanding of New Zealand signalling systems and possible failure mechanisms required.	Signalling system incidents should be considered a primary indicator, but an understanding of the systems used and how comparable they are to UK and Australia is needed before deciding if this should be a primary indicator.

Indicator	UK definition	Comparison	Appreciation for New Zealand operating environment	Recommendation
Slip/subsidence	This is a sub set of the UK event 'failures of permanent way or works'	It is important to ensure the rail infrastructure is maintained to an acceptable standard, thus an indicator measuring the failures of the permanent way would be useful although environmental differences in the UK would not be a good comparison. Maybe use Australia as an indicator?	Environmental differences in the UK would not make this a good comparison; however, Australia may be a better comparison	Consider using information from Australia to compare rail infrastructure failures such as land slips.
SPAD A	Need to understand New Zealand categories for SPAD. All UK SPADs reported under category 'signals passed at danger (SPAD)'; however, GO/RT3119 defines how SPADs are investigated.	To ensure a good comparison can be made the differences between the signalling and train control systems between New Zealand and UK (and Australia) must be fully understood as various systems are available to control and prevent passing signals at danger.	Due to differences in operating environment in New Zealand the possibility of under reporting in New Zealand must also be considered.	SPADs should be considered as a primary indicator but an understanding of the signalling systems used; driver monitoring devices used; the attitudes to reporting SPADs and various additional human factors is required to understand how comparable SPAD data is to UK and Australia data.
SPAD B	Need to understand New Zealand categories for SPAD. All UK SPADs reported under category 'dignals passed at danger (SPAD)'; however, GO/RT3119 defines how SPADs are investigated.	To ensure a good comparison can be made the differences between the signalling and train control systems between New Zealand and UK (and Australia) must be fully understood.	Due to differences in operating environment in New Zealand the possibility of under reporting in New Zealand must also be considered.	SPADs should be considered as a primary indicator but an understanding of the signalling systems used; driver monitoring devices used; the attitudes to reporting SPADs; and various additional human factors is required to understand how comparable SPAD data is to UK and Australia data.

Indicator	UK definition	Comparison	Appreciation for New Zealand operating environment	Recommendation
SPAD C	Need to understand New Zealand categories for SPAD. All UK SPADs reported under category 'signals passed at danger (SPAD)'; however, GO/RT3119 defines how SPADs are investigated.	To ensure a good comparison can be made the differences between the signalling and train control systems between New Zealand and UK (and Australia) must be fully understood.	Due to differences in operating environment in New Zealand the possibility of under reporting in New Zealand must also be considered.	SPADs should be considered as a primary indicator but an understanding of the signalling systems used; driver monitoring devices used; the attitudes to reporting SPADs; and various additional human factors is required to understand how comparable SPAD data is to UK and Australia data.
SPAD D	Need to understand New Zealand categories for SPAD. All UK SPADs reported under category 'signals passed at danger (SPAD)'; however, GO/RT3119 defines how SPADs are investigated..	To ensure a good comparison can be made the differences between the signalling and train control systems between New Zealand and UK (and Australia) must be fully understood.	Due to differences in operating environment in New Zealand the possibility of under reporting in New Zealand must also be considered	SPADs should be considered as a primary indicator but an understanding of the signalling systems used; driver monitoring devices used; the attitudes to reporting SPADs; and various additional human factors is required to understand how comparable SPAD data is to UK and Australia data.
Track defect	Covered by UK events 'track buckles' and 'track faults and broken rails'.	It is important to ensure the rail infrastructure is maintained to an acceptable standard, thus an indicator measuring track defects would be useful although environmental differences in the UK would not be a good comparison. Maybe use Australia as an indicator?	Environmental differences in the UK would not make this a good comparison; however, Australia may be a better comparison	Consider using information from Australia to compare track defects.

Indicator	UK definition	Comparison	Appreciation for New Zealand operating environment	Recommendation
Train parting	UK event 'train divisions'	No good comparison with UK event	Risk from train divisions in New Zealand may be less due to less density of rail vehicles on rail infrastructure. Further information required of New Zealand rail operating procedures.	Consider using as a primary indicator, however further investigation is required to ensure data is comparable with UK due to different operating conditions.
Trespassing – person on corridor	No correlation with UK definitions, closest is 'near misses with persons, road vehicles etc'	There are a number of Transport Agency events, such as this, which would be included in the UK event. Near misses should be recorded as they give an indication of the risk of collision.	An understanding is required of the New Zealand infrastructure and the attitude of the general public to access to the rail infrastructure, particularly trespass and level crossing use.	Near misses with persons, road vehicles etc should be a primary indicator; however, it may be necessary to adjust the Transport Agency definition.
Trespassing – person on vehicle	No correlation with UK definitions, closest is 'near misses with persons, road vehicles etc'	There are a number of Transport Agency events, such as this, which would be included in the UK event. Near misses should be recorded as they give an indication of the risk of collision.	An understanding is required of the New Zealand infrastructure and the attitude of the general public to access to the rail infrastructure, particularly trespass and level crossing use.	Near misses with persons, road vehicles etc should be a primary indicator; however, it may be necessary to adjust the Transport Agency definition.
Wrong side failure – signalling (no other effect)	It is believed that this is a sub-set of the UK event 'signalling system incidents'; however, more information is required to understand the New Zealand signalling systems to understand possible failure mechanisms and thus to understand if they are comparable with UK.	Further information is required to understand the types of systems used in New Zealand and thus to establish if the two rail systems are comparable with regards to signalling and train control systems.	Further understanding of New Zealand signalling systems and possible failure mechanisms required.	Signalling system incidents should be considered as a primary indicator but an understanding is required of the systems used and how comparable they are to UK and Australia before deciding if this should be a primary indicator.

Appendix C: Possible primary indicators from Australian analysis

Table C.1 Possible indicators from Australian analysis

Indicator	Australian definition	Comparison	Appreciation for New Zealand operating environment	Recommendation
Collision with rail vehicle	All collisions between rail vehicles are recorded for the purposes of regulatory reporting. 'Collision' sub-classifications differentiate between running line and yard collisions. Collisions on a running line not available for normal train running (eg under engineering possession) are excluded from the running line occurrence count. Collision sub-classifications include 'collision between trains' and 'collision with rolling stock'. 'Collision between trains' includes all types of rail vehicles including road-rail vehicles and track machines. 'Collision with rolling stock' includes collisions which are other than with trains whose safety integrity is intact and include such things as collisions with open doors and protruding loads.	Possible	Australian networks are fitted with a mix of enforcement and intervention technologies to prevent and/or mitigate the likelihood of collision between rail vehicles. This includes ATP, mechanical train stops at signals to limit signal over-run, and TPWS. Many locations, however, are signalled with no intervention or enforcement mechanism provided. Rail traffic density varies with metropolitan systems in the major cities running services with tight headways and complex junctions. Longer distance passenger and freight routes are more typically characterised by bi-directional operation and passing loops. Metropolitan networks have portions that include mixed passenger and freight operations.	Primary indicator Consider as part of 'collision – running line – between trains'.

Indicator	Australian definition	Comparison	Appreciation for New Zealand operating environment	Recommendation
Collision with light road vehicle	Regulatory reporting captures all occurrences of collisions between rolling stock and road vehicles at level crossings. Sub-classifications include road vehicles described as 'light passenger', 'dangerous goods', 'motorcycle', 'heavy freight vehicle', 'bicycle', 'bus', and 'other'. Additionally, sub-classifications note the level crossing treatment and include 'active – lights only', 'active – lights and booms', 'passive – stop signs', 'passive – give way signs' and 'none'. Separately, collisions with road vehicles not at level crossings are classified as 'collisions', with sub-classifications differentiating between running line and yard collisions. Collisions on a running line not available for normal train running (eg under engineering possession) are excluded from the running line occurrence count. Sub-classifications include road vehicles described as 'light passenger', 'dangerous goods', 'motorcycle', 'heavy freight vehicle', 'bicycle', 'bus' and 'other'.	Possible Clarity needs to be provided around the inclusion or exclusion of certain occurrences particularly related to occurrences at, or not at, level crossings.	The rail networks in Australia collectively include thousands of level crossings in urban, rural, and remote locations. Treatment types, in terms of level crossing protection vary between provision of full boom barriers with lights and bells, to crossings with no protection fitted. Treatment decisions are based on various factors including density of rail and road traffic and location. A limited number of level crossings are fitted with CCTV as a deterrent to misuse by road users. Consideration of factors including rail and road traffic volumes and populations of level crossings incorporating various treatments may need to be considered when seeking to make a comparison with New Zealand.	Primary indicator Consider as part of 'collision – running line – with road vehicle not at a level crossing' and 'Level crossing collision – with road vehicle'.

Indicator	Australian definition	Comparison	Appreciation for New Zealand operating environment	Recommendation
Collision with rail personnel	All collisions between rolling stock and people are recorded. Collisions are separately classified as to whether they occur at level crossings or elsewhere. There is no distinction as to the category of person struck other than cases of suspected suicide are reported and addressed as a separate 'occurrence type'. However, categories of person are defined and reported as 'person type' as distinct from 'occurrence type' when reporting occurrences. Person types include railway staff, contractors, volunteers, passengers, public, and trespassers. 'Collision' sub-classifications differentiate between running line and yard collisions. Collisions on a running line not available for normal train running (eg under engineering possession) are excluded from the running line occurrence count.	Possible Although collisions with rail personnel are not required to be reported as a specific category this is considered to be a high risk area such that ONRSR public reporting is likely to include reporting of this measure whenever incidents occur. Typically reporting is likely to be in the context of reporting total safe working incidents where near misses and safe working breaches etc can also be analysed and included to give an overall trending of risk exposure.	Various infrastructure maintenance strategies exist on the different Australian rail networks, but the potential for vehicles, plant and people to be on track at times when the rail corridor remains open to running line traffic does exist. Incidents have been known to occur. There may be differences between Australia and New Zealand as to rules and procedures adopted to allow for the safe undertaking of track maintenance, indication of track occupancy and consequent protection (eg track circuits), and of traffic density, which could affect rates of exposure and which may need to be understood before a comparison could be made.	Primary indicator Consider as part of 'collision – running line – with person'.

Indicator	Australian definition	Comparison	Appreciation for New Zealand operating environment	Recommendation
Collision with person	All collisions between rolling stock and people are recorded. Collisions are separately classified as to whether they occur at level crossings ('level crossing occurrence') or elsewhere ('collision'). Sub-classifications note the level crossing treatment and include 'active – lights only', 'active – lights and booms', 'passive – stop signs', 'passive – give way signs' and 'none'. There is no distinction as to the category of person struck other than cases of suspected suicide are reported and addressed as a separate 'occurrence type'. However, categories of person are defined and reported as 'person type' as distinct from 'occurrence type' when reporting occurrences. Person types include railway staff, contractors, volunteers, passengers, public, and trespassers. 'Collision' sub-classifications differentiate between running line and yard collisions. Collisions on a running line not available for normal train running (eg under engineering possession) are excluded from the running line occurrence count.	Possible For the purposes of comparison, the similarity of the Transport Agency definition to Australian definitions of recording by 'occurrence type' and 'person type' need to be understood.	The rail networks in Australia collectively include thousands of level crossings in urban, rural, and remote locations. Treatment types, in terms of level crossing protection vary between provision of full boom barriers with lights and bells and pedestrian cribs, to crossings with no protection fitted. Treatment decisions are based on various factors including density of rail, road, and foot traffic and location. A limited number of level crossings are fitted with CCTV as a deterrent to misuse by road users. Consideration of factors including rail and road traffic volumes and populations of level crossings incorporating various treatments may need to be considered when seeking to make a comparison with New Zealand.	Primary indicator Consider as part of 'collision – running line – with person' and 'level crossing collision – with person'.

Indicator	Australian definition	Comparison	Appreciation for New Zealand operating environment	Recommendation
Collision with trespasser	All collisions between rolling stock and people are recorded. Collisions are separately classified as to whether they occur at level crossings ('level crossing occurrence') or elsewhere ('collision'). There is no distinction as to the category of person struck other than cases of suspected suicide are reported and addressed as a separate 'occurrence type'. However, categories of person are defined and reported as 'person type' as distinct from 'occurrence type' when reporting occurrences. Person types include railway staff, contractors, volunteers, passengers, public and trespassers. 'Collision' sub-classifications differentiate between running line and yard collisions. Collisions on a running line not available for normal train running (eg under engineering possession) are excluded from the running line occurrence count.	Possible For the purposes of comparison, the similarity of the Transport Agency definition to Australian definitions of recording by 'occurrence type' and 'person type' need to be understood.	The rail networks in Australia collectively include thousands of level crossings in urban, rural, and remote locations. Treatment types, in terms of level crossing protection vary between provision of full boom barriers with lights and bells and pedestrian cribs, to crossings with no protection fitted. Treatment decisions are based on various factors including density of rail, road, and foot traffic and location. A limited number of level crossings are fitted with CCTV as a deterrent to misuse by road users. Consideration of factors including rail and road traffic volumes and populations of level crossings incorporating various treatments may need to be considered when seeking to make a comparison with New Zealand. Away from level crossings, reasons and opportunities for trespass potentially exist on the Australian networks which are likely to be comparable in New Zealand.	Primary indicator Consider as part of 'collision – running line - with person'

Indicator	Australian definition	Comparison	Appreciation for New Zealand operating environment	Recommendation
Container doors open	Regulatory reporting captures occurrences of load irregularity – door open' as a specific sub-classification giving a record of the total number of occurrences occurring within the ONRSR jurisdiction.	Possible Definitions and data collection would appear readily comparable.	Containerised freight trains are a feature of medium and long distance operations in Australia including from ports to terminals.	Primary indicator Consider as part of 'load irregularity'
Derailment	All derailments of rail vehicles are recorded for the purposes of regulatory reporting with an occurrence of one or more rail wheels leaving the track during operations considered a derailment. Differentiation is made between running line and yard derailments, however, derailments occurring on non-running lines which foul running lines are considered 'running line derailments'. Derailments on a running line not available for normal train running (eg under engineering possession) are excluded from the running line occurrence count. Derailments on loop lines equipped with roll out protection (derailers) are not classified 'running line derailments'.	Possible	Causes of derailment are expected to be common between New Zealand and Australia.	Primary indicator Consider as part of 'derailment'.

Indicator	Australian definition	Comparison	Appreciation for New Zealand operating environment	Recommendation
Load lost overboard	Regulatory reporting captures only those occurrences that have the potential to endanger the safety of railway operations, persons, or cause damage. The 'load shift' classification includes occurrences of loads that move, spill, or fall on or from a train. Loads which move to become 'out of gauge' are excluded from the classification and are reported separately. 'Load shift' is reported as a sub-classification of 'loading irregularity' against Australian regulatory reporting.	Possible	Comparability of load types to be understood before making any comparison between Australian and New Zealand operations.	Primary indicator Consider as part of 'load irregularity'
Loading irregularity	Regulatory reporting includes sub-classifications of 'door open', 'out of gauge', 'load shift', 'uneven distribution of load' and 'loose fastening'. Only those occurrences that have the potential to endanger the safety of railway operations, persons, or cause damage are captured.	Possible	Comparability of load types to be understood before making any comparison between Australian and New Zealand operations.	Primary indicator Consider as part of 'load irregularity'

Indicator	Australian definition	Comparison	Appreciation for New Zealand operating environment	Recommendation
Over gauge load	For the purposes of regulatory reporting, 'out of gauge' is reported as a sub-classifications of 'loading irregularity'. Only those occurrences that have the potential to endanger the safety of railway operations, persons, or cause damage are captured.	Possible	Comparability of load types to be understood before making any comparison between Australian and New Zealand operations.	Primary indicator Consider as part of 'load irregularity'
Out of balance wagon/container	For the purposes of regulatory reporting, 'uneven distribution of load' is reported as a sub-classifications of 'loading irregularity'. Only those occurrences that have the potential to endanger the safety of railway operations, persons, or cause damage are captured.	Possible	Comparability of load types and intermodal freight operations to be understood before making any comparison between Australian and New Zealand operations.	Primary indicator Consider as part of 'load irregularity'
Over weight wagon/container	For the purposes of regulatory reporting overloading is captured as 'other load irregularity' and is reported as a sub-classification of 'loading irregularity'. Only those occurrences that have the potential to endanger the safety of railway operations, persons, or cause damage are captured.	Possible	Comparability of load types and intermodal freight operations to be understood before making any comparison between Australian and New Zealand operations.	Primary indicator Consider as part of 'load irregularity'

Indicator	Australian definition	Comparison	Appreciation for New Zealand operating environment	Recommendation
Rail personnel injury/death (includes electrical accidents)	Occurrences resulting in death or serious injury are captured through regulatory reporting requirements regardless of the cause. Occurrences are classified dependent on the nature of the cause and reported against the relevant occurrence classification.	Possible Definitions of death and serious injury need to be understood for purposes of direct comparison.	Deaths and serious injuries associated with rail operations remain a risk within all jurisdictions	Total number of fatalities to be reported as a primary indicator
Signal reverted – no SPAD	Regulatory reporting of 'signal restored as train approached' includes those occurrences when the train was unable to stop and passed the signal concerned. Passing of hand signals and stop boards are excluded from the definition.	Possible The scope and meaning of the definition of the Transport Agency classification needs to be understood in order to determine if a direct comparison can be made	Trains passing signals may or may not be automatically logged dependent on location in Australia. An understanding would need to be gained as to the likely under reporting of such an occurrence in Australia and New Zealand to allow a direct comparison to be made.	Primary indicator Consider as part of 'SPAD'

Indicator	Australian definition	Comparison	Appreciation for New Zealand operating environment	Recommendation
SPAD A	Regulatory reporting of SPADs includes sub-classifications of 'driver error – completely missed', 'driver error – misjudged', 'driver error – start against signal', 'signal restored as train approached', 'other type of SPAD'. The classification excludes 'failure to comply with hand signal', 'proceed authority exceeded', and locations with stop boards and limit boards.	Possible The Transport Agency definition of SPAD A to D needs to be clarified to understand if a comparison can be made with the Australian definitions.	In Australia a working group is currently looking at how SPAD events should be best categorised. Initial recommendations appear to suggest that classifications that are closely aligned to those used in the UK should be considered for adoption. Australian networks are fitted with a mix of enforcement and intervention technologies to prevent and/or mitigate the consequence off potential or actual SPAD events. This includes ATP, mechanical train stops at signals to limit signal over-run, but only for rolling stock fitted with trip cocks and TPWS both for advanced speed proving and enforcement of braking, and for enforcement at the point of SPAD. In addition, at many locations signals are not provided with any form of intervention or enforcement mechanism.	Primary indicator Consider as part of 'SPAD'

Indicator	Australian definition	Comparison	Appreciation for New Zealand operating environment	Recommendation
SPAD B	Regulatory reporting of SPADs includes sub-classifications of 'driver error – completely missed', 'driver error – misjudged', 'driver error – start against signal', 'signal restored as train approached', 'other type of SPAD'. The classification excludes 'failure to comply with hand signal', 'proceed authority exceeded', and locations with stop boards and limit boards.	Possible The Transport Agency definition of SPAD A to D needs to be clarified to understand if a comparison can be made with the Australian definitions.	In Australia a working group is currently looking at how SPAD events should be best categorised. Initial recommendations appear to suggest that classifications that are closely aligned to those used in the UK should be considered for adoption. Australian networks are fitted with a mix of enforcement and intervention technologies to prevent and/or mitigate the consequence off potential or actual SPAD events. This includes ATP, mechanical train stops at signals to limit signal over-run, but only for rolling stock fitted with trip cocks, and TPWS both for advanced speed proving and enforcement of braking, and for enforcement at the point of SPAD. In addition, at many locations signals are not provided with any form of intervention or enforcement mechanism.	Primary indicator Consider as part of 'SPAD'

Indicator	Australian definition	Comparison	Appreciation for New Zealand operating environment	Recommendation
SPAD C	Regulatory reporting of SPADs includes sub-classifications of 'driver error – completely missed', 'driver error – misjudged', 'driver error – start against signal', 'signal restored as train approached', 'other type of SPAD'. The classification excludes 'failure to comply with hand signal', 'proceed authority exceeded', and locations with stop boards and limit boards.	Possible The Transport Agency definition of SPAD A to D needs to be clarified to understand if a comparison can be made with the Australian definitions.	In Australia a working group is currently looking at how SPAD events should be best categorised. Initial recommendations appear to suggest that classifications closely aligned to those used in the UK should be considered for adoption. Australian networks are fitted with a mix of enforcement and intervention technologies to prevent and/or mitigate the consequence off potential or actual SPAD events. This includes ATP, mechanical train stops at signals to limit signal over-run, but only for rolling stock fitted with trip cocks, and TPWS both for advanced speed proving and enforcement of braking, and for enforcement at the point of SPAD. In addition, at many locations signals are not provided with any form of intervention or enforcement mechanism.	Primary indicator Consider as part of 'SPAD'

Indicator	Australian definition	Comparison	Appreciation for New Zealand operating environment	Recommendation
SPAD D	Regulatory reporting of SPADs includes sub-classifications of 'driver error – completely missed', 'driver error – misjudged', 'driver error – start against signal', 'signal restored as train approached', 'other type of SPAD'. The classification excludes 'failure to comply with hand signal', 'proceed authority exceeded', and locations with stop boards and limit boards.	Possible The Transport Agency definition of SPAD A to D needs to be clarified to understand if a comparison can be made with the Australian definitions.	In Australia a working group is currently looking at how SPAD events should be best categorised. Initial recommendations appear to suggest that classifications closely aligned to those used in the UK should be considered for adoption. Australian networks are fitted with a mix of enforcement and intervention technologies to prevent and/or mitigate the consequence off potential or actual SPAD events. This includes ATP, mechanical train stops at signals to limit signal over-run, but only for rolling stock fitted with trip cocks, and TPWS both for advanced speed proving and enforcement of braking, and for enforcement at the point of SPAD. In addition, at many locations signals are not provided with any form of intervention or enforcement mechanism.	Primary indicator Consider as part of 'SPAD'

Indicator	Australian definition	Comparison	Appreciation for New Zealand operating environment	Recommendation
Track defect	Regulatory reporting includes sub-classifications of defect including 'break', 'misalignment', 'spread', and 'points'. Track misalignment or spread found during normal maintenance activity is excluded.	Possible The scope of the definition of the Transport Agency classification needs to be understood in order to determine if a direct comparison can be made	Track in Australia includes a variety of constructions including concrete slab, concrete sleeper, wooden sleeper, continuously welded, and jointed. Extremes of temperature provide challenges in managing rail stress, particularly track buckles due to high rail temperatures. Environmental differences and asset construction may need to be considered when making comparisons between Australia and New Zealand.	Primary indicator Consider as part of 'track defect' including broken rails and track misalignments.
Twistlocks	Regulatory reporting includes sub-classifications of 'door open', 'out of gauge', 'load shift', 'uneven distribution of load', and 'loose fastening'. 'Twistlocks' do not have a specific sub-classification, but may be classified as 'loose fastening'.	Possible The scope of the definition of the Transport Agency classification needs to be understood in order to determine if a direct comparison can be made	Twistlocks, including automatic twistlocks, are used as a securing mechanism for container freight.	Primary indicator Consider as part of 'load irregularity'.
Wagon doors open	Regulatory reporting includes the sub-classification of 'door open' as part of 'load irregularity'. The classification excludes occurrences where load is lost this being separately captured against the sub-classification 'load shift'. Only those occurrences that have the potential to endanger the safety of railway operations, persons, or cause damage are captured.	Possible The scope of the definition of the Transport Agency classification needs to be understood in order to determine if a direct comparison can be made.	Comparability of wagon types to be understood before making any comparison between Australian and New Zealand operations.	Primary indicator Consider as part of 'load irregularity'.

Appendix D: Definitions of indicators selected for benchmarking

Table D.1 details the definitions for each of the indicators selected for benchmarking.

Table D.1 Definitions of indicators selected

No.	Indicator	Country	Full definition
1	Fatalities – total	EU (ERA definition)	EU defines 'deaths (killed person)' as any person killed immediately or dying within 30 days as a result of an accident, excluding suicides.
2	Fatalities – passenger	EU (ERA definition)	EU defines 'passenger' as any person, excluding members of the train crew, who makes a trip by rail. For accident statistics, passengers trying to embark/disembark onto/from a moving train are included.
3	Fatalities – employees	EU (ERA definition)	EU defines 'employees (staff of contractors and self-employed contractors are included)' as any person whose employment is in connection with a railway and is at work at the time of the accident. It includes the crew of the train and persons handling rolling stock and infrastructure installations.
4	Number of accidents involving at least one rail vehicle transporting dangerous goods in which dangerous goods are NOT released.	EU (ERA definition)	EU defines 'accident involving the transport of dangerous goods' as any accident or incident that is subject to reporting in accordance with RID/ADR section 1.8.5. (ie loading, filling, carriage, or unloading of dangerous goods). 'Dangerous goods' means those substances and articles the carriage of which is prohibited by RID (regulations concerning the International Carriage of Dangerous Goods by Rail, as adopted under Directive 2008/68/EC), or authorised only under the conditions prescribed therein.
5	Number of accidents involving at least one rail vehicle transporting dangerous goods in which dangerous goods ARE released.	EU (ERA definition)	EU defines 'accident involving the transport of dangerous goods' as any accident or incident that is subject to reporting in accordance with RID/ADR section 1.8.5. (ie loading, filling, carriage, or unloading of dangerous goods). 'Dangerous goods' means those substances and articles the carriage of which is prohibited by RID 2015 (regulations concerning the International Carriage of Dangerous Goods by Rail, as adopted under Directive 2008/68/EC), or authorised only under the conditions prescribed therein.
6	Total number of accidents involving at least one railway vehicle transporting dangerous goods	EU (ERA definition)	EU defines 'accident involving the transport of dangerous goods' as any accident or incident that is subject to reporting in accordance with RID/ADR section 1.8.5 (ie loading, filling, carriage, or unloading of dangerous goods). 'Dangerous goods' means those substances and articles the carriage of which is prohibited by RID (regulations concerning the International Carriage of Dangerous Goods by Rail, as adopted under Directive 2008/68/EC), or authorised only under the conditions prescribed therein.

No.	Indicator	Country	Full definition
7	Broken rails	EU (ERA definition	EU defines 'broken rails' as any rail which is separated in two or more pieces, or any rail from which a piece of metal becomes detached, causing a gap of more than 50mm in length and more than 10mm in depth on the running surface.
8	Trackbuckles	EU (ERA definition	EU defines 'track buckles' as faults related to the continuum and the geometry of track, requiring track obstruction or immediate reduction of permitted speed to maintain safety.
9	Wrong-side signalling failures	EU (ERA definition	EU defines 'wrong side signalling failure' as any failure of a signalling system (either to infrastructure or to rolling stock), resulting in signalling information less restrictive than that demanded.
10	Signals passed at danger (SPAD)	EU (ERA definition	EU defines 'SPAD' as any occasion when any part of a train proceeds beyond its authorised movement. Unauthorised movement means to pass: • a trackside colour light signal or semaphore at danger, order to STOP, where an automatic train control system (ATCS) or ATP system is not operational • the end of a safety-related movement authority provided in an ATCS or ATP system • a point communicated by verbal or written authorisation laid down in regulations • stop boards (buffer stops are not included) or hand signals. Cases in which vehicles without any traction unit attached or a train that is unattended run away past a signal at danger are not included. Cases in which, for any reason, the signal is not turned to danger in time to allow the driver to stop the train before the signal are not included.
11	Broken wheels	EU (ERA definition	EU defines 'broken wheels and broken axles' as a break affecting the essential parts of the wheel or the axle and creating a risk of accident (derailment or collision).
12	Broken axles	EU (ERA definition	EU defines 'broken wheels and broken axles' as a break affecting the essential parts of the wheel or the axle and creating a risk of accident (derailment or collision).
13	Collisions	GB definition	Any collision • Between trains or rail vehicles on a running line including a collision: - with an open door or other projection from another train, for example a displaced load on a freight rail vehicle - while the line is blocked, due to previous accident or emergency - occurring within a possession, including work sites within a possession - occurring during a shunting operation. • In a siding that results in a running line being physically obstructed. • In a siding that is NRMI.

No.	Indicator	Country	Full definition
14	Derailments	GB definition	Any derailment: • Of a train or rail vehicles on a running line including a derailment that occurs: - while the line is blocked, due to previous accident or emergency - occurring within a possession, including work sites within a possession - occurring during a shunting operation. • In a siding that results in a running line being physically obstructed. • In a siding that is NRMI.
15	Level crossings – failures of equipment	GB definition	Any failure of equipment at a level crossing that could endanger users, and where the level crossing is on a running line or a siding that is NRMI
16	Level crossings – misuse of equipment and near misses with persons, road vehicles etc	GB definition	Any case: • Of a near miss between a train and a person, road vehicle, etc at a level crossing • Of an emergency brake application of the train or rail vehicle being made, to avoid striking a person, road vehicle etc at a level crossing • Involving the misuse of level crossing equipment.
17	Near misses with persons, road vehicles etc	GB definition	Any case of: • A near miss between a train and a person, road vehicle, crane, low flying aircraft etc on or near a running line. • An emergency brake application of the train or rail vehicle being made, to avoid striking a person, road vehicle, crane, aircraft etc on or near a running line.
18	Collision with rail personnel	Australia definitions (taken from OC-G1)	When a train or rolling stock strikes a person. 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.
19	Collisions between trains and with rolling stock (running line)	Australia definitions (Taken from OC-G1)	Train includes any type of train (including road rail vehicles on track and track machines) Rolling stock which at the time was not part of a train. Includes: • Collision between train and rolling stock. • Collision with open rolling stock door. • Collision with load protruding from rolling stock.

No.	Indicator	Country	Full definition
			When a train or rolling stock strikes or is struck by another train or rolling stock. Includes: • Running line collisions that occur in the normal movement of a train on a running line. • The collision of a train which has been authorised to depart and has commenced its journey to operate on a main line. • Track machine collisions if they are travelling on the line as a running train. • Shunting collisions occurring on running lines within station limits. • Any collision in a yard or siding that results in the running line being obstructed or interferes with the safe operation of a running line. • A collision on a portion of track closed for maintenance or other purposes that results in obstruction of a non–closed running line or interferes with the safe operation of a non–closed running line. Excludes: • Collisions of work trains/track machines occurring within a portion of track closed for maintenance or other purposes that does not interfere with the safe operation of another non-closed running line. • Collisions 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. • Collisions of rolling stock on loop lines, equipped with roll out protection (eg derailers) to protect the main line, which are temporarily being used for the stabling of rolling stock • Collisions on balloon loops during the loading and unloading process not involving a train that has been authorised to depart and has commenced its journey to operate on a running line.
20	Derailment (running line)	Australia definitions (taken from OC-G1)	Where one or more rolling stock wheels leave the rail or track during railway operations. Any derailment that affects the safe operation of a running line: Includes: • The derailment of a train which has been authorised to depart and has commenced its journey to operate on a running line. • Track machine derailments if they are travelling on the line as a running train. • Shunting derailments occurring on running lines within station limits. • A derailment in a yard or siding that results in the running line being obstructed or interferes with the safe operation of a running line. • A derailment on a portion of track closed for maintenance or other purposes that results in obstruction of a non–closed running line or interferes with the safe operation of a non–closed running line.

No.	Indicator	Country	Full definition
			Excludes: • A derailment on a portion of track closed for maintenance or other purposes where there is no possibility that the safe operation of any non-closed running line is affected. • Derailments of rolling stock on loop lines, equipped with roll out protection (eg derailers) to protect the main line, which are temporarily being used for the stabling of rolling stock. • Derailments on balloon loops during the loading and unloading process not involving a train that has been authorised to depart and has commenced its journey to operate on a running line.
21	Level crossing occurrence – collision with road vehicle	Australia definitions (Taken from OC-G1)	A collision of a train or rolling stock with a road vehicle. Includes: • Any case of a train running onto a level crossing when not authorised to do so. • Incidents which occur during periods of unusual operation are to be included, eg when an automatic crossing is operated manually • Level crossing occurrences with tramways where trams operate over their exclusive right of way.
22	Level crossing occurrence – collision with person	Australia definitions (Taken from OC-G1)	A collision of a train or rolling stock with a person. Includes: • Incidents which occur during periods of unusual operation are to be included, eg when an automatic crossing is operated manually.
23	Level crossing occurrence – equipment failure/ defect	Australia definitions (Taken from OC-G1)	An occurrence that endangers or has the potential to endanger the safety of a railway operations or level crossing operations. Includes: • 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; or • Incidents which occur during periods of unusual operation are to be included, eg when an automatic crossing is operated manually. Note: Where the occurrence is caused by infrastructure irregularities such as broken rails, welds and bonds that result in the unnecessary operation of crossing protection equipment this is reported separately.
24	Load irregularity	Australia definitions (Taken from	Any situation where the load endangers or has the potential to endanger the safety of railway operations, persons and/or premises or causes damage.

No.	Indicator	Country	Full definition
		OC-G1)	Excludes: • Dangerous goods not loaded in accordance with the Australian Dangerous Goods Code. **Door open** Any door, hatch or gate that is incorrectly secured and could result in the loss of load or a collision. Includes: • Open container doors. Excludes: • Where loss of load has occurred. **Out of gauge** Any load that is placed, or any load that shifts, to become wider, higher or longer than the approved dimensions for the lines over which it operates. Excludes: • Any out of gauge load that has formal approval and special conditions for the transport of that load provided it remains compliant with that approval. **Load shift** Any load that moves, spills or falls on or from a train. Excludes: • Load that moves out of gauge **Uneven distribution of load** Any uneven distribution of load on rolling stock or in the consist of trains. **Loose load fastening** Any fastening irregularity on rolling stock or in the consist of trains. Includes: • Chains, ropes, tarpaulins etc dragging, or hanging dangerously. Excludes: • Unlocked twist locks. • Load shifts. • Uneven distribution of loads.

No.	Indicator	Country	Full definition
			Other load irregularity Any load irregularity that is not classifiable under one of the above subcategories. Includes: • Overloading that causes coupling misalignment.
25	SPAD	Australia definitions (Taken from OC-G1)	Where a train passes without authority a signal displaying a stop indication or stop aspect, referred to as a SPAD or a signal passed without authority. Includes: • When signals blacked out. Excludes: • Failure to comply with hand signal. • Proceed authority exceeded. • At locations such as stop boards, limit boards. **Driver misjudged** Where the driver has attempted to stop the train but failed to stop the train before passing the signal. Excludes: • SPADS associated with a rolling stock irregularity (eg brake). **Completely missed while running** Where no attempt has been made to bring a train to a stand before the stop signal and the train has proceeded into the next section or block without the necessary authority. The driver has not realised that the train has passed a stop signal until a more serious event results; the driver is stopped by train control over the radio or at the next signal or stopped by other external intervention. **Starting against signal** Where a stationary train starts and proceeds beyond a signal at danger without authority. The driver may or may not realise that the train has run past the signal. **Signal restored as train approached** Where a proceed signal changes to stop in the face of the driver giving insufficient time for the train to brake to a stop prior to passing the signal at danger. Includes: • Where signal equipment fails.

No.	Indicator	Country	Full definition
			• Where the controller changes the signal to stop. **Other SPAD** Any SPAD that is not classifiable under one of the above subcategories. Includes: • SPADS associated with a rolling stock irregularity. • SPADS involving runaway rolling stock.
26	Track irregularity	Australia definitions (taken from OC-G1)	Any irregularity in the track that endangers, or has the potential to endanger, the safety of railway operations, persons and/or premises. **Broken rail** A fracture of the rail in a running line including a broken joint or weld, or detachment of a piece from the rail which necessitates an immediate stoppage of traffic or the immediate imposition of a speed restriction lower than that currently in force. Includes: • Complete breaks, broken joints, internal/external defects, etc. • Broken rails detected during normal maintenance inspections. **Misaligned track** A horizontal or vertical misalignment of a running line which results in an immediate stoppage of traffic or the immediate imposition of a speed restriction lower than that already in force. Includes: • Heat buckles. • Vertical misalignments (eg due to formation failures). Excludes: • Misaligned track detected during maintenance activities. **Spread track** Any spread of rail track, in a running line, beyond approved gauge tolerances that results in an immediate stoppage of traffic or other restrictions. Excludes: • Spread track detected during maintenance activities. **Points irregularity** Any failure of a set of points.

No.	Indicator	Country	Full definition
			Includes: • Misalignment of points. • Broken or damaged points blade or components such as spreader bars and brackets. • Damage caused by trailing or run throughs. Excludes: • Irregularities detected and corrected during regular maintenance programmes. • Malfunction of points motors and point detection circuits. • Failures of control systems and equipment. Failure of points signalling operating and locking equipment and train detection equipment.

Appendix E: Glossary

ARA	Australasian Railway Association
ARRM	Australasian Rail Risk Model
ATP	automatic train protection
CCS	close call system
CSI	common safety indicator
CST	common safety target
ERA	European Railway Agency
HSE	Health and Safety Executive (UK)
IM	infrastructure manager
MoT	Ministry of Transport
NRMI	Network Rail Managed Infrastructure
NRSS	National Rail System Standards
NRV	national reference value
ONRSR	Office of the National Rail Safety Regulator (Australia)
RID	regulations concerning the International Carriage of Dangerous Goods by Rail, as referenced within Directive 2008/68/EC on the inland transport of dangerous goods
RIDDOR	Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995 (UK)
RIM	rail infrastructure manager
RISSB	Rail Industry Safety and Standards Board (Australia)
ROGS	The Railways and Other Guided Transport Systems (Safety) Regulations 2006 (UK)
RSO	rolling stock operator
RSSB	Rail Safety and Standards Board (UK)
RTO	rail transport operator
RU	railway undertaking
SMIS	Safety Management Information System: a computer database containing details of events reported by, and on behalf of UK infrastructure managers and railway undertakings
SPAD	signal passed at danger
SRM	Safety Risk Model
TPWS	train protection and warning system