OFFICE OF THE national rail safety regulator

annual safety report

2012 to 2013

Working together for rail safety

Office of the National Rail Safety Regulator

Disclaimer

The data contained in this report will be subject to review on an annual basis as additional or more detailed information becomes available. This review may in some instances result in occurrences being re-classified so the data published in this report may vary in future reports.

Image Acknowledgements

Scott Sloan – Cover
Page 7 – Department of Planning, Transport and Infrastructure South Australia
Pages 42, 52 and 53 – Transport for NSW

CONTENTS

ABBREVIATIONS

ARTC	Australian Rail Track Corporation
ATSB	Australian Transport Safety Bureau
CRN	Country Regional Network
DIRN	Defined Interstate Rail Network
GWA	Genesee & Wyoming Australia
ITSR	Independent Transport Safety Regulator (NSW)
JHR	John Holland Rail
MRA	Metropolitan Rail Area
NCIS	National Coronial Information System
NRSR	National Rail Safety Regulator
ONRSR	Office of the National Rail Safety Regulator
OTSI	Office of Transport Safety Investigations (NSW)
RSNL	Rail Safety National Law
RISSB	Rail Industry Safety and Standards Board (Australia)
RSSB	Rail Safety and Standards Board (UK)
SPAD	Signal Passed at Danger (without authority)

FOREWORD

The Office of the National Rail Safety Regulator (ONRSR) commenced operations on 20 January 2013. The ONRSR was created as part of the national rail reform agenda to establish a single national rail safety regulator. During the period covered by this report the ONRSR and its predecessor jurisdiction-based regulators had legal responsibilities in South Australia, New South Wales, Tasmania and Northern Territory. The remaining states and territory are committed, through an Inter-Governmental Agreement, to pass and commence law to give the ONRSR a truly national focus.

The aim of the ONRSR is to enhance and promote the safety of Australian railways through effective risk-based regulation. The ONRSR Corporate Plan 2013 to 2016 sets out the full goals of the ONRSR; one of which is to report annually to its stakeholders, which includes Ministers, the rail industry and the public, on rail safety performance using the data that rail operators are legally required to report to the ONRSR.

This is the first ONRSR annual report on railway safety and is prepared at a time when industry and the ONRSR are adjusting to the implications and change in responsibilities resulting from the new Rail Safety National Law. This report represents a small but significant step towards the ONRSR's absolute commitment to a regulatory approach that is inclusive of, and proportionate to a consideration of, quantitative safety risk. All parties under the co-regulatory framework of the new law, recognise it will take a number of years to establish the framework, collect data and undertake the analysis necessary to underpin this approach. There is general recognition that this will support rational and justifiable decisions on safety improvement and be of considerable economic and operational benefit in the harmonisation of the Australian rail industry.

The ONRSR has consulted with senior safety managers in the rail industry on the overall approach and structure of this report and is grateful for their input.

Before looking in detail at rail safety performance in the ONRSR's area of operation, it is worth reflecting on some of the significant and tragic train accidents across the world over the last calendar year including derailments in Santiago de Compostela, Spain resulting in 79 deaths; and Paris, France resulting in seven deaths. Whilst the full analysis of these accidents is awaited, it is fair to say that these types of events are reasonably preventable. To do so requires knowledge of the pre-existing weaknesses in systems and practices, and this is where intelligent analysis of safety data can be a powerful tool.

The ONRSR will use the data in this and subsequent reports to guide its regulatory activities and it is hoped and expected that industry will also make similar use of this report.

The ONRSR welcomes feedback on the content and approach set out in this report – please contact the ONRSR on (08) 8406 1500 or via email at contact@onrsr.com.au.

Rob Andrews
National Rail Safety Regulator

EXECUTIVE SUMMARY

This first Annual Safety Report examines the safety performance of the Australian rail industry for those jurisdictions currently regulated by the Office of the National Rail Safety Regulator (ONRSR) – namely South Australia, New South Wales, Tasmania, and the Northern Territory. The foundation of this report is data drawn from rail safety occurrences reported by rail transport operators to the ONRSR and its predecessors.

For the period 1 July 2012 to 30 June 2013 there were 28 rail fatalities notified:

- 26 fatalities involving acts of suspected suicide or trespass. In each of these cases the person was struck by a train
- one passenger fatality as a result of a train strike at a railway station
- one public fatality as a result of a train strike at a pedestrian level crossing.

There were no fatalities to the workforce in the 2012–13 year and the last workforce fatality was in 2010–11.

There was a total of 530 injuries requiring ambulance attention in 2012–13. The majority of injuries were associated with passenger slips, trips and falls at stations. Workforce injuries accounted for 5% of these injuries.

Rail safety is complex, and thankfully, major rail accidents do not occur frequently. Measuring the safety performance of industry solely by recording such events is insufficient. Performance needs to be measured in other ways. Rail transport operators have reported over 33,000 occurrences in the last year which have been categorised against the national rail safety classification framework. The vast majority of these occurrences did not result in harm but can provide early warning on safety performance. This report provides targeted analyses of these occurrences and instead of reporting simply by their incident category – which has been done by other bodies in the past – they have been analysed from the perspective of their potential contribution to railway safety risk.

In the absence of a national quantitative safety risk model for the Australian rail industry, the report uses a mature rail safety risk model from the United Kingdom (UK) to assist in identifying the hazardous events that affect the Australian rail industry. Hazardous events are incidents that have the potential to be the direct cause of safety harm and this report focuses on those considered most significant in their contribution to Australian railway safety risk, including;

- derailments
- collisions between trains
- level crossing accidents
- workforce strikes
- structural collapses
- lineside, station and train fires
- buffer stop collisions.

The report examines available precursors for passenger train derailments and collisions, including:

- broken rails
- track obstructions
- signals passed at danger and other forms of authority exceedance
- runaways.

Alignment between the existing national data capture framework, key precursor indicators and hazardous events is weak in some areas. Significant variability in the quality of available historic data has been found, together with an often broad range of incident classification which is not conducive to detailed risk-based analysis. Some cleansing of data has been undertaken to assist the analysis in this report.

The ONRSR will reflect on the insights that this report provides and highlights:

- too many near miss incidents with trains entering areas of track occupied by workers. The ONRSR forward regulatory plan includes assessment of track worker safety and safe-working breaches. It will be focussing in particular on adherence to acceptable safety critical communications practices, including those between train controllers and work crews.
- a number of near miss incidents with vehicles at level crossings. The ONRSR is developing a level crossing strategy which will, as a minimum, include the monitoring of rail transport operators' safety management systems, engage with local authorities, and support research into low-cost level crossing protection strategies.
- a number of preventable road/rail vehicle incidents in the last few years. The ONRSR will continue its collaborative work with industry on this over the coming months, following up with audits and inspections to check for improved performance.
- a number of significant projects are currently underway delivering major rail assets. Through our accreditation activities and safety improvement initiatives, the ONRSR will look at the engineering management approach of these projects, with an emphasis on delivery of safety and particularly, human factors considerations in design.
- fires on trains and in stations, particularly safety in underground commuter railways, is already a focus area for the ONRSR. It will be examining rail transport operator management of this risk both in terms of prevention and emergency preparedness.
- the rate of train derailment, especially freight trains, is high when compared with mainline railways in the UK. The ONRSR will be considering what reasonable measures can be taken to reduce the direct safety risk of derailment and the consequences of fouling adjacent lines.

The ONRSR is committed to encouraging and assisting the industry to develop a national safety risk model supported by a safety incident database. Examination of the (sometimes) poor quality and utility of historic rail safety data in preparation of this report has added justification to this intent. The ONRSR will work with industry to develop a clear strategy for developing this risk model and an industry-led database to capture better and higher utility data to meet the needs of industry and regulator alike.

The ONRSR encourages the rail industry to examine the detail of this report and the priorities identified, to challenge its existing performance and to seek opportunities for improvement.

1.0 INTRODUCTION

1.1 Office of the National Rail Safety Regulator

ONRSR'S FUNCTION

The Office of the National Rail Safety Regulator (ONRSR) began operations on 20 January 2013. The functions of the ONRSR are legislated in the Rail Safety National Law (RSNL) and described fully in the ONRSR's Statement of Intent.[1] In summary they are to:

- improve rail safety for the Australian community
- decrease the regulatory burden on industry
- provide seamless national safety regulation
- enforce regulatory compliance.

The establishment of the ONRSR represents the successful delivery of the December 2009 Intergovernmental Agreement (IGA) between the Commonwealth and all states and territories to establish a national rail safety regulator.

ONRSR'S ROLE

The ONRSR performs the functions and responsibilities conferred upon it by the RSNL. It delivers these functions under a co-regulatory framework, in which responsibility for regulation and safety is shared between the ONRSR and industry.

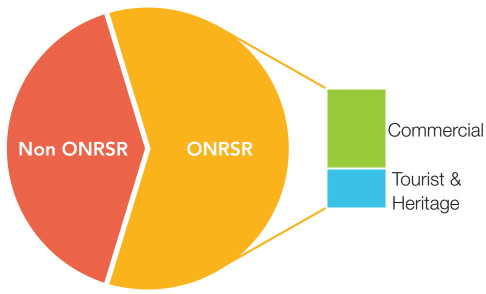
The principle of shared responsibility is clearly delineated from specific duties defined under the RSNL. In particular, section 52 of the RSNL states a rail transport operator must ensure, so far as is reasonably practicable, the safety of railway operations. This duty is consistent with the principles of safety risk management generally — those responsible for safety risks must ensure measures are in place to protect people from the harm that may arise from those risks.

ONRSR'S COVERAGE

As of 30 June 2013 the ONRSR has responsibility for rail safety regulation in the jurisdictions of South Australia, New South Wales, Tasmania and the Northern Territory. In terms of Australia's rail service, these jurisdictions collectively account for approximately 35% of all train kilometres (km) travelled, and 40% of track length nationally.

The scope of the ONRSR's regulatory responsibility as of 30 June 2013 is shown in Figure 1 below. There were 174 accredited rail transport operators within Australia, of which 106 (61%) were wholly or partly administered by the ONRSR. Of these, approximately 65% were commercial operators and the remainder tourist and heritage operators.

Figure 1: Proportion of rail transport operators in Australia accredited by the ONRSR



In addition to accredited railways, the ONRSR has registered 97 rail infrastructure managers of private sidings. They are exempt from the requirement to be accredited, however, they must be registered or hold an exemption from registration. They operate under the same safety duties that apply to accredited rail transport operators.

1. Office of the National Rail Safety Regulator, *Statement of Intent*, as endorsed by the Standing Council on Transport and Infrastructure, May 2013

1.2 The National Rail Safety Regulator in practice

The RSNL defines the specific functions of the ONRSR but does not describe the way in which the ONRSR will deliver them. The ONRSR's aim, as defined in its Corporate Plan[2] and Regulatory Approach[3], is *to enhance and promote safety through effective risk-based regulation*. The framework, data collection systems and analytical techniques necessary to underpin this approach will take several years to develop. The way in which the ONRSR intends to incorporate risk into its decision making is summarised below.

RISK CONTEXT

Risk is defined formally[4] as the effect of uncertainty on objectives. In practical terms, it is the combination of the consequences of an event and the likelihood of its occurrence. Consequences can be expressed in various ways such as financial or environmental loss. The RSNL's provisions in relation to management of risk refer specifically to safety risk, the consequences of which can be injuries and fatalities.

Under the RSNL, rail transport operators are responsible for managing safety risks associated with their railway operations. Consistent with a risk-based approach to regulation, the ONRSR also requires sound knowledge of risks to prioritise its activities and to evaluate the adequacy of operators' management of risk.

SCOPE OF RISKS

The full breadth of matters the ONRSR must consider in developing its national risk picture is framed in terms of:

i. the types or groups of individuals whose safety is potentially endangered by railway operations, and

ii. the specific types of hazards to which this population may be exposed.

People: Section 4 of the RSNL defines safety *as the safety of people, including rail safety workers, passengers, other users of railways, users of rail or road crossings and the general public.*

The ONRSR considers the safety of a wide range of individuals. These include people interacting directly with railways such as rail safety workers and passengers, as well as those who gain no direct benefit from railways but may be at risk from rail activities, for example, people on adjacent property.

Hazards: a hazard is a source of potential harm.[5] It is sometimes described as an intrinsic property or attribute of something that can cause harm. Examples of hazards include the energy associated with a moving train and the gap between a train and platform that must be traversed when boarding or alighting.

The hazards of interest to the ONRSR are those which threaten the target population of individuals (above) and they vary widely in their nature and origins.

Some hazards are unique to railways such as those related to the movement of rolling stock, while some are common across industries such as electrical hazards. Hazards also include occupational hazards such as manual handling, as well as those experienced by the general public in everyday life, for example, using a staircase. Rail-related hazards are not confined to railway premises and include external threats such as those originating from adjoining property, as well as hazards originating within the railway but potentially moving beyond its boundaries.

2. Office of the National Rail Safety Regulator, *Corporate Plan 2013 to 2016*, ONRSR, Adelaide, June 2013
3. Office of the National Rail Safety Regulator, *ONRSR Regulatory Approach*, ONRSR, Adelaide, July 2013
4. Standards Australia, Standards New Zealand, *AS/NZS ISO 31000:2009. Risk management–Principles and guidelines*, SA, SNZ, Sydney, Wellington, November 2009
5. International Organisation for Standardisation, *Guide 73: Risk Management – Vocabulary*, First Edition, ISO, Geneva, 2009

ANALYSING RAIL SAFETY RISKS

The hazards affecting the rail industry are many and varied — the risk registers of individual rail operators can extend to several hundred individual hazards. Regulatory resources are finite, therefore the ONRSR requires an objective basis for prioritising and optimising its regulatory effort. A key principle of the ONRSR's general approach to decision making is that regulatory effort is proportional to risk. That is, the amount of regulatory resource assigned to a given issue will depend on the issue's contribution to total railway safety risk. This requires an analysis and estimation of risk.

Risk analysis is a process involving estimation of the consequences of an event, and the likelihood of its occurrence. Contemporary methods of risk analysis include those that make robust, quantified estimates of safety risk. Unfortunately, there is currently no system in place in Australia to analyse rail safety risks in such a way at a national scale. While rail transport operators do analyse risks associated with their own operations, they use various methods, do not always consider risks beyond their scope of operations, and generally do not utilise the larger volumes of data that exist for similar operations elsewhere.

The ONRSR is committed to working with the Australian rail industry to build its capability to analyse and prioritise risks at a national level. Historical accident and injury data can be used to estimate likelihoods and consequences for risks associated with frequent incidents such as falls because these occur at a relatively constant rate. However, estimation of risk associated with rare and potentially high consequence events requires more sophisticated techniques such as accident modelling, particularly for those events which may not have been observed in Australia or have yielded consequences below their full potential.

DECISION MAKING IN PRACTICE

A key principle of the ONRSR's regulatory approach is to align effort to risk. In practice, the proportionality criterion described is moderated according to several factors:

- **Uncertainty:** where the level of risk is unknown or uncertain, and available information suggests consequences are potentially catastrophic, the ONRSR will determine an appropriate strategy to improve its knowledge. For example, further analysis to understand the risk and its treatment within safety management systems of rail transport operators.
- **Voluntary exposure:** accident data shows suicide and trespass are the largest contributors to loss of life on railways. The ONRSR expects industry to do all that is reasonably practicable to reduce such occurrences but recognises the balance of responsibility lies with the individuals who voluntarily expose themselves to danger.
- **Complementary law:** regulation of rail safety is currently undertaken through two main sets of law — Workplace Health and Safety legislation and the RSNL. The ONRSR has entered into agreements with workplace safety authorities around Australia[6] to avoid duplicated effort and ensure the most efficient and effective use of available resources and expertise to regulate and reduce workplace-related safety risks.
- **Coordination:** for risks associated with external hazards such as road user behaviour at level crossings, the ONRSR has limited power to directly influence some of the important contributory factors to accident risk. In such cases, the ONRSR regulatory approach involves coordination with, and support to, other bodies to achieve effective outcomes.

6. Heads of Workplace Safety Authorities, Office of the National Rail Safety Regulator, *Memorandum of Understanding between the ONRSR and the Workplace Safety Authorities*, May 2013

1.3 Role of this report

CONTEXT

Consistent with the ONRSR's risk-based approach to regulation, the focus of this report is on the identification and analysis of key safety risks relevant to the Australian rail industry. Consequently, the analysis moves away from simply reporting incident categories defined in the national occurrence classification guideline (OC-G1, 2013).[7] However, some of the information needed for a risk-based approach does not currently exist, and initially, the ONRSR is reliant on a mix of Australian information and information from other sources.

Over the longer term, the ONRSR recognises that industry, as the primary originators of rail safety data and owners of safety risk, should ultimately lead and manage the collection of information and the national analysis of railway risks. The ONRSR has carriage of the National Data Strategy and is working with the Rail Industry Safety and Standards Board (RISSB) on its endeavours to develop a Safety Information System for Australasian Rail (the SISAR project) comprising a national safety risk model and database.

SCOPE AND METHODS

A summary of scope and methods is provided in Appendix B. The general approach is outlined below:

Geographic coverage: except where explicitly stated, all descriptions and statistics in this report apply only to those railways within the current ONRSR's area of operation — South Australia, New South Wales, Tasmania and the Northern Territory.

Data sources: the information presented in this report is based primarily on occurrence notifications — the initial written advice of a rail safety incident that a rail transport operator submits to the ONRSR in accordance with section 121 of the RSNL. The scope of incidents defined as "notifiable occurrences" under the RSNL is summarised in Appendix D.

Definitions: some of the statistical summaries in this report are based on incident classes defined within the national occurrence classification guideline (OC-G1, 2013). However, some statistics are based on other incident categorisation including some developed specifically for this report to support a more meaningful risk-based analysis of critical events.

Reporting period: the ONRSR commenced operation on 20 January 2013. However, the last available summary of safety data for the ONRSR's area of operation was the safety statistics bulletin produced by the Australian Transport Safety Bureau (ATSB)[8] for the reporting period to the end of June 2012. For this reason, a minimum reporting period of 1 July 2012 to 30 June 2013 applies to this report. A longer period of data is considered where appropriate and available for analysis.

7. Office of the National Rail Safety Regulator, *Classifying Notifiable Occurrences. Guideline for the Top Event Classification of Notifiable Occurrences: Occurrence Classification Guideline (OC-G1)*, Version 1.1, ONRSR, Adelaide, March 2013
8. Australian Transport Safety Bureau (ATSB), *Australian Rail Safety Occurrence Data, 1 July 2002 to 30 June 2012*, ATSB Transport Safety Report, RR-2012-00, ATSB, Canberra, 2012

2.0 INDUSTRY OVERVIEW

Australian railways are diverse. This is due in part to the historical development of separate state and territory based railways, resulting in differences in track, rolling stock and operating systems. It also reflects a practical need to tailor railways to specific industries, demographics and geography as well as differences in regional infrastructure and technology.

Railways are generally described in terms of their *above rail* and *below rail* assets:

- *above rail:* rolling stock such as locomotives, freight wagons and passenger carriages
- *below rail:* comprising infrastructure such as track, tunnels, signalling.

The accreditation provisions of the RSNL also define rail transport operator roles in the same way. Rail infrastructure managers have effective control and management of the below rail infrastructure such as track while rolling stock operators manage the operation of trains. Rail transport operators may be accredited to perform one or both of these roles.

2.1 Below rail

URBAN PASSENGER NETWORKS

Five of Australia's eight capital cities have urban passenger networks. Two of these — Adelaide and Sydney — are currently within the ONRSR's jurisdiction and collectively represent approximately 40% of the urban passenger journeys nationally.

Table 1 summarises the urban passenger networks of Adelaide and Sydney. Both cities have heavy and light rail networks and Sydney has a small monorail network.[9] All networks are owned and operated by the respective state governments with the exception of the Sydney light rail and monorail networks which are leased to, and operated by, a private operator.

Table 1: Key features of the urban passenger networks

Networks as at 30 June 2013. Annual journeys for Sydney's heavy passenger network include some services to surrounding non-metropolitan regional areas. All figures rounded. Patronage and track figures from periodic returns.

CITY (POP'N)[1]	RAIL TYPE	TRACTION SUPPLY	GAUGE	TRACK KM (ROUTE KM)	STATIONS STOPS	PASSENGER JOURNEYS (MILLION)	FREIGHT INTERACTION
Adelaide (1.2 million)	Heavy	Diesel	Broad	251 (125)	84	9.9	25% route km shared (infrequent services)[3]
	Light	Electric	Standard	32 (16)	29	2.7	None
Sydney (4.4 million)	Heavy	Electric	Standard	1,790 (940)	262	306	46% route km shared (frequent services)[3]
	Light	Electric	Standard	15 (7.5)	14	4.2	None
	Monorail[2]	Electric	NA	4 (4)	8	1.8	None

1. Greater metropolitan area (Australian Bureau of Statistics, 2011 Census QuickStats, accessed 14 October 2013)
2. Sydney's monorail ceased operation on 30 June 2013 and surrendered is accreditation in July 2013
3. Bureau of Infrastructure, Transport and Regional Economics (BITRE), *Understanding Australia's Urban Railways*, Research Report 131, BITRE, Canberra, July 2012 (metropolitan area only)

The heavy rail networks carry the majority of rail passengers for both cities (79% and 98% for Adelaide and Sydney respectively). However, Sydney's heavy rail network (referred to as the Metropolitan Rail Area (MRA)) carries 30 times more passengers than that of Adelaide.

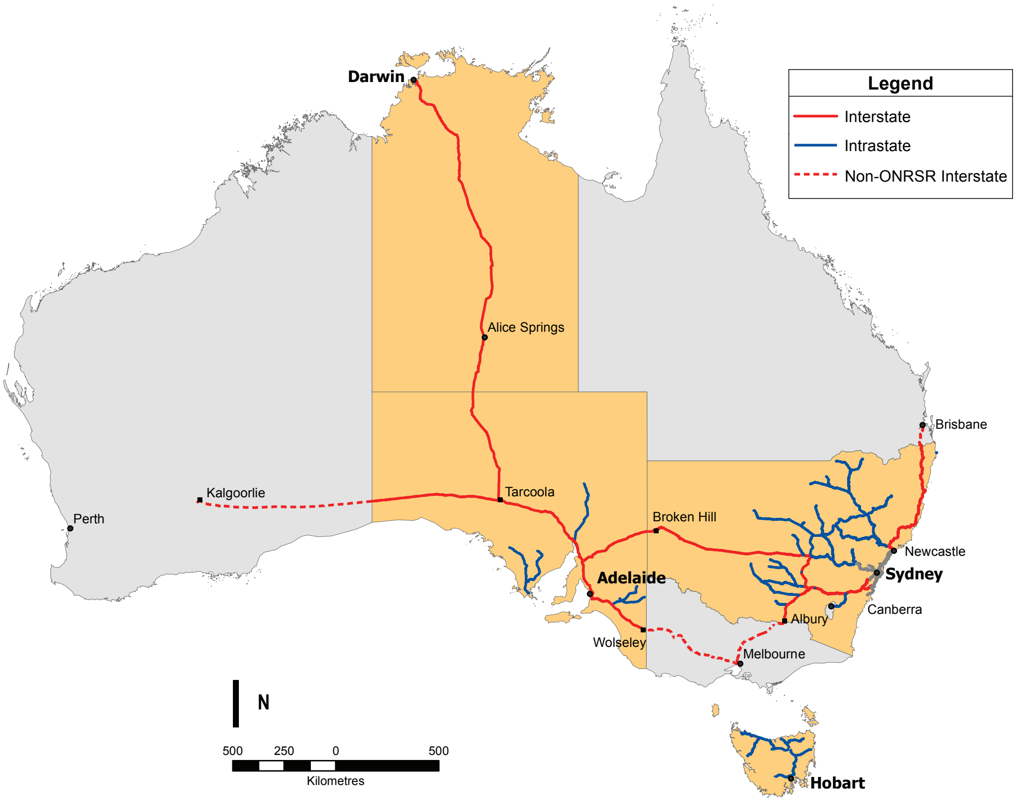
Another key difference between the networks of the two cities is the interaction with freight train operations. The main north-south and east-west axes of Sydney's MRA share track with both intra and interstate freight traffic. This increases the complexity of railway operations due to the different running patterns (i.e. slow long freight versus fast frequent stopping passenger services). In contrast, the majority of freight traffic through Adelaide runs on separate track to passenger services. A relatively small amount of freight traffic shares the broad gauge metropolitan rail network between Dry Creek and Gawler.

9. Ceased operation at the end of the 2012–13 financial year

INTERSTATE FREIGHT NETWORKS

The Defined Interstate Rail Network (DIRN) is the standard gauge line linking Brisbane in Queensland to Perth[10] in Western Australia, as well as the cities of Sydney, Melbourne, Adelaide and Darwin (Figure 2). The primary use of the DIRN is for interstate freight transport, but it also carries longer distance interstate and intrastate passenger services.

Figure 2: Major inter and intrastate freight networks in the ONRSR's area of operation
Sources: Railways (excluding NSW) and cities DeLorme Publishing Company, USA, 2011; NSW Railways: Rail Centreline Copyright RailCorp 2007.



Two operators manage separate sections of the DIRN within the ONRSR's area of operation. These operators are responsible for selling access, capital investment, operation and maintenance of the network.

Australian Rail Track Corporation (ARTC) is the primary manager of the DIRN. In NSW the DIRN consists of approximately 2,900 km of track managed by ARTC under a long term lease from the NSW Government. It runs between the Queensland border and connects with the MRA at Islington Junction, north of Sydney. It also joins with the MRA at Macarthur south of Sydney and runs south to Albury on the NSW / Victorian border and west to Adelaide via Cootamundra, Parkes and Broken Hill.

10. The ARTC-managed section of the DIRN in Western Australia connects at Kalgoorlie with a private standard gauge line running to Perth

In South Australia, ARTC owns and manages almost 2,000 km of the DIRN including the main east-west corridors between Melbourne, Sydney and Perth. Unlike Sydney, where the interstate freight traffic transits through the MRA, the section of DIRN running through Adelaide is a dedicated freight line, albeit in a shared corridor with the Adelaide broad gauge passenger network between Belair and Salisbury.

Genesee & Wyoming Australia (GWA) owns and manages the 2,200 km section of the DIRN between Darwin in the Northern Territory and Tarcoola in South Australia at the junction of the ARTC-managed east-west corridor. The GWA-managed line is used primarily for freight traffic between Darwin and other state capitals, supplemented by Northern Territory mineral traffic. It is also used for the long distance Ghan passenger service.

INTRASTATE FREIGHT NETWORKS

The major intrastate networks within the ONRSR's area of operation are shown in Figure 2.

NSW Country Regional Network (CRN) comprises approximately 2,800 km of track. It is owned by the NSW Government and since January 2012 has been managed by John Holland Rail (JHR). The network is used primarily for bulk commodities such as grain but carries other freight and long distance passenger services.

NSW Hunter network is managed by ARTC under a lease from the NSW Government. It is used primarily for transport of coal to the Newcastle ports with 130 million tonnes carried in 2011–12.[11] It also carries intermodal freight as well as commuter and long distance passenger services. In July 2011 the network expanded to incorporate existing rail lines servicing coal mines in the Gunnedah Basin, bringing its total track length to approximately 1,100 km.

NSW regional network comprises approximately 500 km of track between Parkes and Werris Creek. This is also managed by ARTC as part of the above-mentioned lease. This provides a secondary route for interstate traffic from Melbourne to Brisbane as an interface with CRN grain lines.

South Australian intrastate network consists of several networks including:

- 500 km (approximately) of narrow gauge line on the Eyre Peninsula. This line is owned and managed by GWA and its primary use is for transport of grain to Port Lincoln
- 300 km (approximately) of standard gauge line in the Murray / Mallee region managed by GWA
- 250 km (approximately) of private standard gauge line running between the Leigh Creek coal field to the Port Augusta power station
- 100 km (approximately) of narrow and standard gauge lines owned and managed by OneSteel Manufacturing associated with the iron ore mining and steel manufacturing operations in Whyalla.

Tasmanian Rail Network is a single line narrow gauge railway. It has been owned and managed by the state owned Tasmanian Railway Pty Ltd (TasRail) since December 2009. The network consists of 630 km of operational track. The main line runs between Hobart in the south, via Western Junction to Bells Bay in the north and Burnie in the north-west. From Burnie it runs south-west to Melba Flats on the west coast. The line is used solely for intermodal and bulk freight services operated by TasRail.

11. Australian Rail Track Corporation, *2012 Annual Report*, ARTC, Adelaide, September 2012

TOURIST AND HERITAGE NETWORKS

The ONRSR has accredited 37 tourist and heritage operators. Just five of these run their services on mainline networks on a regular basis (all five on mainline networks in NSW). The remaining 32 maintain their own networks that are physically or operationally separate to mainline networks. This is a diverse sector that operates on various track gauges, ranging from 610 mm through to broad gauge railways. The combined total length of isolated track of this sector is in the order of 370 km.

OTHER NETWORKS

Dedicated metropolitan freight lines are relatively small in terms of their collective track length but serve a critical role in the effective management of the freight and passenger tasks in metropolitan areas.

Adelaide's dedicated freight lines consist of approximately 60 km of line including:

- the shared corridor for the DIRN and the Adelaide passenger network running between Belair and Salisbury
- the dual gauge line forming part of the ARTC interstate network running from Dry Creek to Outer Harbor.

Sydney's dedicated freight lines came under ARTC management in 2012–13. They consist of:

- Southern Sydney Freight Line (SSFL): the final stage of this line opened in January 2013. It is a 36 km dedicated freight line that forms part of the link between the DIRN at Macarthur and the Metropolitan Freight Network (below)
- Metropolitan Freight Network: ARTC commenced operations of this network in August 2012. It connects with the SSFL and provides dedicated freight path to major terminals including Port Botany which handles the majority of import/export containerised freight in NSW.

2.2 Above rail

Of the 106 rail transport operators accredited by the ONRSR, 96 are accredited for rolling stock operations. The two primary above rail tasks are urban passenger services and commercial freight operation. Tourist and heritage services and specialist rolling stock operations associated with infrastructure construction and maintenance are also included.

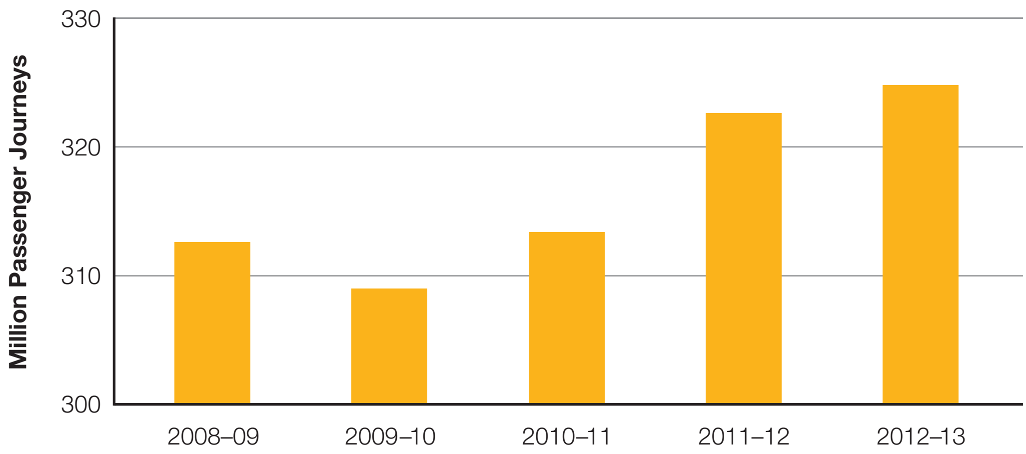
URBAN PASSENGER OPERATORS

Annual passenger journeys for urban passenger operators within the ONRSR's area of operation are summarised in Figure 3. The urban passenger task is dominated by CityRail in Sydney[12], which accounted for approximately 94% of passenger journeys in 2012–13. CityRail's fleet consists of 1,816 carriages[13]. Trains run primarily as electrically powered double deck carriages with some services extending to regional centres beyond Sydney's MRA.

The other major passenger operator is Adelaide Metro's heavy rail urban services which accounted for 3% of all journeys in 2012–13. Adelaide Metro's diesel fleet currently consists of 99 single deck carriages normally operating in one, two and three car consists.

12. CityRail ceased operation in June 2013. From July 2013 CityRail's passenger services on the greater Sydney suburban area are operated by Sydney Trains, and CityRail's intercity passenger services are operated by NSW Trains along with other regional and interstate services.
13. Bureau of Transport Statistics. *Compendium of Sydney Rail Travel Statistics*, 8th Edition v1.1, Sydney, November 2012

Figure 3: Annual passenger journeys for urban passenger operators, 2008–09 to 2012–13
Based on monthly periodic activity data supplied by rail transport operators.



OTHER COMMERCIAL PASSENGER OPERATORS

There are two primary long distance passenger operators. Great Southern Rail operates four interstate tourist services — The Ghan, Indian Pacific, The Overland and The Southern Spirit. These services cover significant distances in a single journey, as much as 4,352 km for the Indian Pacific. The other major operator is NSW CountryLink[14] which operates long distance passenger services to major regional centres in NSW as well as interstate services to Melbourne, Canberra and Brisbane.

The remaining passenger operators tend to be part of specialised railways in which above and below rail assets are managed by one entity. The vast majority of these are tourist and heritage operators, considered later in this section. An exception is Perisher Blue, which operates its 'Skitube' rail system in the NSW ski fields. The Perisher Skitube is one of only a few 'rack' railways in Australia, utilising a toothed rack rail to enable operation on its steep gradients.

FREIGHT OPERATORS

The freight task consists of two primary divisions — bulk freight (such as coal, grain and minerals) and non-bulk or intermodal freight, which is primarily transported as containerised freight.

Pacific National is the largest freight operator. It is accredited for operation in all the ONRSR jurisdictions except Tasmania. It is one of Australia's largest coal haulage operators, carrying approximately 95 million tonnes of coal annually[15], in NSW's Hunter Valley network, on the CRN west of Sydney and in SA, on the line from Leigh Creek coal fields to the Port Augusta power station. It also carries bulk freight such as grain as well as intermodal freight.

The second largest freight operator in terms of train distance travelled is Genesee and Wyoming Inc. (GWA), which operates primarily in South Australia and the Northern Territory. GWA's primary tasks are the hauling of intermodal freight and bulk freight on the Adelaide to Darwin line and freight trains on the SA intrastate networks. GWA carries intermodal and bulk products, with the latter averaging 3 million tonnes annually.[16]

The only freight operator within Tasmania is the state–owned TasRail. TasRail is both the sole operator and accredited rail infrastructure manager of the heavy rail freight network in Tasmania.

14. CountryLink ceased operation in June 2013. From July 2013 CountryLink's regional and interstate passenger services will be operated by NSW Trains
15. Pacific National, <www.pacificnational.com.au>, viewed 5 November 2013
16. Genesee and Wyoming Inc., <www.gwrr.com.au>, viewed 5 November 2013

TOURIST AND HERITAGE OPERATORS

The tourist and heritage sector operates a wide range of rolling stock with focus on historical passenger rolling stock being hauled by varied traction types from the steam and early diesel locomotive eras. Operations range from short duration trips on loops through to scenic half day and full day tours over many kilometres.

The largest operator in terms of passenger train distances travelled in 2012–13 is the Steam Ranger Heritage Railway in South Australia. This operator runs passenger services on 77 km of track using a variety of rolling stock including diesel railcars and passenger cars hauled by steam and diesel locomotives.

The largest passenger operator for NSW is the NSW Rail Transport Museum. This operator is based at Thirlmere, south of Sydney, and runs services from Thirlmere to the MRA, CRN and DIRN.

The largest operator in Tasmania is the West Coast Wilderness Railway. This operator runs heritage rolling stock on approximately 35 km of narrow gauge track between Queenstown and Regatta Point. The railway uses the 'Abt' rack system that enables steam locomotives to traverse the steep grades on sections of the railway.

OPERATORS OF INFRASTRUCTURE MAINTENANCE ROLLING STOCK

Infrastructure maintenance rolling stock consist of a vast array of specialised rolling stock used primarily for maintenance and construction of rail infrastructure. There are two main types:

- *Road/rail vehicles* are vehicles capable of running on both road and rail. Often these are standard road vehicles that have a pair of flanged rail wheels on the front and rear. There is a vast assortment of these vehicles operating in Australia including excavators, tippers and utilities.
- *On track infrastructure maintenance vehicles* are rail-bound vehicles manufactured to meet specific maintenance and construction-related tasks including track laying, sleeper renewal and ballast cleaning. They are far fewer in number than road/rail vehicles.

Historically, infrastructure maintenance vehicle activity has been difficult to quantify. This is due in part to the challenges in developing appropriate measures for this sector, which is heterogeneous in terms of vehicle type, ownership, maintenance and operation.

Based on data reported to date and noting that many of the vehicles are not equipped to accurately record data, the combined distance travelled by these vehicles is in the order of 2 million train km per year.

This figure includes several different forms of operation — relatively high speed travel of road/rail vehicles as part of routine track inspections/patrols; travel of various forms of vehicles to and from fixed work-sites; and, relatively slow speed movements within fixed work-sites associated with construction and maintenance tasks.

2.3 Industry outlook 2013–14

Growth in the use of rail has been accompanied by significant developments and reforms in railways within Australia. The major changes within the ONRSR's area of operation are summarised in the table below.

2004	Alice Springs to Darwin standard gauge railway completed ARTC starts 60 year lease of NSW interstate & Hunter networks
2008	Sydney's Epping to Chatswood rail line completed on the metropolitan rail network
2009	Tasmanian Government purchases Pacific National's Tasmanian rail assets
2010	GWA purchases the 2,200 km Tarcoola to Darwin railway
2011	ARTC expands Hunter Valley lease in NSW to incorporate Gunnedah basin collieries
2012	JHR takes over operation of the NSW Country Regional Network ARTC takes over operation of Sydney's Metropolitan Freight Network
2013	ARTC opens $1 bn Southern Sydney Freight Line linking the DIRN with Sydney's Metropolitan Freight Network

The Australian rail industry has grown significantly over the last decade across passenger and freight sectors. In 2011–12 urban heavy rail passenger services supported 601.1 million journeys in the whole of Australia, an increase of 7.6 million over the previous year. The annual freight task increased by 29.2 billion net tonne-kilometres to 290.6 net tonne-kilometres in 2011–12. This recent growth follows a decade of sustained growth with 84% more freight transported in 2011–12 compared with 2002–03.[17]

Australia's railways continue to grow and several major capital works programs are currently underway. The following works are due for completion in the 2014 calendar year.

NEW SOUTH WALES

- Sydney light rail extension. A 5.6 kilometre extension including nine new stops and procurement of additional rolling stock. Services are expected to commence early 2014.
- $172 million Port Botany upgrade as part of the Metropolitan Freight Network. Stage 1 of the project involved a reconfiguration of Botany Yard and was completed in April 2012. The final stage of the upgrade (expansion of Enfield rail yard) is due for completion in 2014.
- Two consortia short-listed for the North West Rail Link operations, trains and systems contract. The contract is to be awarded in 2014 and the successful proponent will be the single entity responsible for providing passenger rail services and operating and maintaining the rail infrastructure.

SOUTH AUSTRALIA

- The Rail Revitalisation program consists of a series of projects in South Australia to upgrade the passenger rail network. The program involves electrification of the Seaford and Tonsley lines, procurement of new electric multiple unit rolling stock, station upgrades, level crossing upgrades and a number of other enhancements. Work continues into 2014.

TASMANIA

- $206 million capital works program for below rail maintenance and renewal of the freight network in 2013–14.
- $6 million funding of a major capital improvement program on West Coast Wilderness Railway.

17. Australasian Railway Association, *Australian Rail Industry Report 2012*, prepared by Apelbaum Consulting Group, Canberra, September 2013

3.0 ANALYSIS OF RAILWAY SAFETY IN 2012–13

3.1 Risk overview

An effective risk-based approach to regulation must consider not only accident history but also the underlying level of risk associated with rare but serious accidents that could occur. Historical notifiable occurrence data is of some use in estimating accident potential particularly for frequent events that have a repeatable pattern of behaviour and a limited range of potential consequences. Such data is of limited use in understanding all the ways that serious accidents could occur and the nature and scale of their potential consequences.

A predictive capability is therefore necessary to build knowledge on all risks relevant to rail, and optimise regulatory activity between observed harm and underlying risk. This capability may be developed in various ways and will generally require a research phase, to understand all cause and consequence scenarios and use of expert opinion, incident data and statistical techniques to build a representative mathematical model of risk. Such an approach has been used in Australia in the case of the Australian Level Crossing Assessment Model (ALCAM) for level crossing accidents. However, the capability to estimate all relevant risks at a national scale does not currently exist within Australia, and a priority for the ONRSR and the rail industry is the development of a national-scale quantitative risk model for Australia's railways.

SAFETY RISKS RELEVANT TO AUSTRALIAN RAILWAYS

In the absence of a risk model for Australian railways, the ONRSR has utilised existing sources of risk information to help understand risks deserving priority scrutiny on Australian railways. This report uses outputs from the United Kingdom's (UK) Safety Risk Model, which is a quantitative model of safety risks on UK mainline railways. The model is developed and maintained by the UK Rail Safety and Standards Board (RSSB) and used by UK operators and regulators. It is founded on an extensive body of research and a process of continual improvement and is already used as a reference by a number of railways in Australia. In this report it is assumed that the range of hazardous events defined in the model encompasses most of those relevant to railway operations in Australia.

The UK risk model consists of a series of mathematical models of 121 hazardous events — each defined as an incident that has the potential to be the direct cause of safety harm. It uses historical incident data, expert judgement, as well as cause and consequence modelling to predict the national level of risk. It considers both high frequency/low consequence events (such as falls) and rare catastrophic events that have never occurred but are possible. Outputs from the model are regularly communicated in summary form by the RSSB in its regular Risk Profile Report.[18]

The modelled risk for each hazardous event is summarised in the UK risk report as two parts – the estimated average frequency of each hazardous event; and the estimated average consequence of that event. Consequence takes account of both potential fatal and non-fatal injury[19] and is expressed in Fatalities and Weighted Injuries (FWI), where 1 fatality is considered equivalent to 10 major injuries, 200 minor (reportable) injuries[20] or 1,000 non-reportable injuries. Examples are shown in Table 2.

18. Rail Safety and Standards Board, *Safety Risk Model: Risk Profile Report Version 7.5. Issue 1.1*, RSSB, UK, March 2013
19. The estimate of consequence also includes trauma
20. "Reportable" injuries are defined in Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (UK), 1995.

Overall risk for the UK railway system is calculated as the sum of the estimated risk for each of the individual hazardous events. Because the UK risk model considers accident potential, the annual risk estimate will often differ from the observed levels of harm (based on incident reports) in any given year.

Table 2: Examples of estimated average risk for UK railways from the UK risk model
Source is Risk Profile Report Version 7.5. Refer Appendix B.

HAZARDOUS EVENT (HE) CODE[1]	HE DESCRIPTION	AVERAGE FREQUENCY (EVENTS/YEAR)	AVERAGE CONSEQUENCE (FWI/EVENT)	MODELLED RISK (FWI/YEAR)
HET-21	Train crushed by structural collapse or large object (not at station)	0.0006	13.31	0.008
HET-12	Derailment of passenger train	7.110	0.273	1.941
HEM-14B	Passenger slip, trip or fall (stairs)	1,120	0.0091	10.22

1. As referenced in the Safety Risk Model

For the purpose of this report, the 121 primary hazardous events of the UK risk model have been aggregated into 21 summary groups.

Table 3 presents a summary of risks for 20 of these categories. It excludes risk associated with Suicide, which alone accounts for approximately 62% of the total safety risk on the UK network. This is comparable to local data which shows that suicide accounts for approximately 65% of all fatalities in the ONRSR's area of operation over recent years.

The coarse-level summary of the UK risk model as presented in Table 3 masks a level of sophistication and rigour in the model, as well as a number of limitations in its application to this report. The key points in this regard are:

- **Scale:** the safety risk estimate for UK railways as a whole (139.2 FWI, Table 3) is likely to be significantly higher than that for Australian railways because of the larger passenger rail task in the UK (490 million passenger train km, 2011–12[21]) compared to Australia (110 million passenger train km, 2011–12[22]). However, the relative contributions of specific rail tasks to overall risk will vary. For example, freight operations in Australia are larger than that for the UK.
- **Scope:** the UK risk model only covers mainline railway operations on rail infrastructure managed by Network Rail. It does not consider all forms of operation relevant to Australian railways such as incidents in yards and sidings adjoining mainline networks, tourist and heritage operators which pose risks of a different nature to mainline railways in relation to age of asset, interfaces, etc. or services operated on non-Network Rail infrastructure, such as the London Underground.
- **Breadth:** the UK risk model considers a broader range of risks than those represented in Australia's national occurrence classification scheme. While some of the additional risks are on the margins of "railway operations" as defined in Australia, others are relevant to rail-related fatality in Australia. For example, track workers killed from crush-type accidents or electrocution.

Table 3: Summary of estimated risk for UK mainline railways, excluding suicide[23]
Source is Risk Profile Report Version 7.5. Refer Appendix B.

HAZARDOUS EVENT GROUP	MODELLED RISK (FWI / YEAR)	CONTRIBUTION (%)
Slip, trip, fall	46.5	33.4
Train strike person – member of public	32.5	23.4
Miscellaneous hazardous events	16.8	12.1
Assault – passenger, workforce, member of public	11.6	8.3
Electric shock	9.1	6.6
Train strike person – at level crossing	6.8	4.9
Train strike person – passenger	3.3	2.4
Level crossing collision – passenger train and road vehicle	3.0	2.1
Train strike person – workforce	2.2	1.5
Derailment – passenger train	1.9	1.4
Collision between trains – involving passenger train	1.2	0.8
Collision between train and object (excluding buffer stop)	0.6	0.4
Explosion	0.6	0.4
Derailment – other than freight train	0.6	0.4
Level crossing collision – other than passenger train	0.5	0.3
Struck/crush by structural collapse or large object	0.4	0.3
Toxic release/exposure	0.3	0.2
Fire	0.2	0.1
Collision between trains – not involving passenger train	0.1	0.1
Collision between train and buffer stop	0.1	0.1
Grand Total	**139.2**	**100**

21. Mainline passenger operators, 2011–12 (Network Rail, *Annual Return 2012*, Network Rail, London, August 2012)
22. Approximate figure for comparable scope of operations to the UK figure
23. Excludes the direct risk associated with suicide (224.2 FWI). Secondary risk associated with suicide (e.g. staff trauma) is included in the total but not shown as an individual category

- **Complexity:** the 20 groups depicted in Table 3 are a coarse summation of a detailed and complex model. The risk model's 121 hazardous events are further subcategorised into almost 400 sub-events. A given event may also have one or multiple precursors. For example, *Derailment – passenger train* has 56 precursors each of which is quantified in terms of its contribution to derailment risk, such as over-speeding leading to passenger train derailment (0.82% of derailment risk).
- **Relevance:** some of the key factors influencing risk in the UK are not relevant to Australian railways, for example, electrocution risk via a third rail.
- **Accuracy:** the expansive and detailed categorisation of events in the UK risk model allows for more insightful analysis than that possible under an OC-G1–type categorisation. For example, the definition of *Train Collision* in Australia includes events in which a train is struck by an out of gauge item on a train passing on an adjacent line. This type of event is very different in its nature and risk to collisions between trains and in the UK risk model is defined uniquely and grouped logically with events of a similar nature (train striking object).

Despite these differences, the summary of Table 3 is beneficial in highlighting the likely high level contribution of various events to safety risk in Australia on a large and diverse mainline railway.

The majority of risk on UK railways is concentrated within a small number of incident types. Approximately 70% of the total estimated UK safety risk (excluding suicide) is from three hazardous event groups — *Slip, Trip, Fall* (33.4% of risk); *Train strike – member of the public* (23.4%); and *Miscellaneous hazardous events* (12.1%). The latter consists of a range of incidents typically associated with minor injuries to individuals and is not considered further.

Slip trip and fall incidents are very frequent (several thousand incidents a year in both the UK and Australia) and typically low consequence — a minor injury. The majority of UK risk (68%) is associated with passengers. The other major contributor to this risk is workforce falls (18%). This is an occupational issue and the ONRSR works with relevant workplace safety authorities to monitor such risks as described previously (Section 1.2). This risk, while significant, is not considered further in this report.

Train strike – member of the public risk in the UK consists almost entirely of acts of trespass. While its contribution is of a similar order of magnitude to *Slip trip and fall*, the risk differs markedly in its nature, being far less frequent (less than 50 per year in both the UK and Australia) but with each occurrence typically resulting in a fatal injury. The ONRSR will routinely monitor this risk and expects industry to do all that is reasonably practicable to reduce such occurrences but recognises that in most cases the balance of responsibility lies with the individuals who voluntarily expose themselves to danger. This significant risk is not considered further in this report.

Assault on rail premises contributes approximately 8.3% of risk on UK railways. Like falls, described above, this risk is generally a high frequency/low consequence type event. Approximately 70% of this risk is associated with non-fatal injuries to passengers. The ONRSR recognises that railway passengers are entitled to travel free of personal security threats and that police authorities work closely with service providers to minimise this type of risk. This significant risk is not considered further in this report.

Train strike – passenger risk consists of people being struck at the platform edge and falling from a platform and subsequently being struck by a train. The consequence of such events is typically a fatality or serious injury and this is a relevant hazard on the urban passenger networks of Australia's railways. Passenger behaviour is a significant factor in many of these incidents (for example, intoxication, standing too close to the platform edge). However, some factors are within operators' control such as station design – with short or curved platforms increasing the risk.

The ONRSR monitors this risk, paying particular attention to those factors within the direct control of rail transport operators, including use of appropriate design to improve safety at the train platform interface. This risk is not considered further in this report.

Train strike – workforce risk is modelled in the UK based on worker role, with track workers considered separately to other members of the workforce. Both risks are relevant to Australian railways. ONRSR notes that the UK risk model does not consider risks in sidings and yards to non-track workers such as security guards, train crew and rolling stock maintainers. Also, in relation to track worker strikes, the systems for protection of workers on track vary between states and territories and it is unlikely the UK risk model categorisation adequately represents the nature of this risk in an Australian context. This is explored further in Section 3.2 of this report.

The three level crossing-related event groups of Table 3 collectively contribute approximately 7.1% of the UK risk. Approximately two thirds of level crossing risk in the UK is associated with strikes, and in such cases the greatest threat is to the individual level crossing user. The nature of risk changes for collisions involving road vehicles, the greater mass of which threatens passengers and train crew. The chance of multiple fatalities is greatest for passenger trains because each collision exposes a large number of people (passengers and train crew) to potential harm. This group of risks is explored further in Section 3.2 of this report.

There are several risk groups in Table 3 associated directly with rail system hazards for which rail transport operators have effective control and a primary responsibility to manage. These are *Derailment, Collision between trains* and *Collision between train and object* (including buffer stops). These groups collectively account for approximately 3% of the UK risk but vary in the nature of risk posed. Collisions between trains involving a passenger train pose a multi-fatality risk whereas collision with obstruction is predominately a non-fatal risk.[24] However, the latter remains a focus as a significant contributor to derailment (approximately 40% of passenger train derailment risk). Such accidents have occurred in Australia though the consequences have not always reflected their full potential. These risks are a primary focus for the ONRSR and are explored further in Section 3.2 of this report.

24. Because of the way UK risk model apportions risk between hazards the multi-fatality risk is associated with escalation to derailment

Fire, Explosion, Electric shock and Toxic release / exposure collectively account for approximately 7.3% of the estimated UK risk. These hazards are not unique to rail operations and exist amongst various heavy industries. The relative importance of some of the risks as presented in Table 3 may differ to that in Australia. For example, 85% of the UK electric shock risk is associated with a hazard not present on Australian railways (a live third rail). Conversely, some hazards of relevance are associated with sidings and maintenance facilities. These facilities are outside the scope of the UK risk model and their relative importance may be greater than estimated by the model.

Notwithstanding the above, each of the above four risks has the potential to cause multiple fatalities in a single incident and remain relevant to Australian railways. The ONRSR's regulatory approach is dependent on the nature of the risk and complementary law. Outside of trespassers, rail workers are generally the primary exposed group and the ONRSR coordinates its activities with relevant workplace safety authorities as described previously. Dangerous goods are a key contributor to risk associated with *Toxic release / exposure* and *Explosion*. The ONRSR's approach to regulation in this case is to support the nominated state-based competent authorities responsible for oversight of compliance with the Dangerous Goods Code. *Fire* is considered a priority and is considered in Section 3.2 of this report.

Struck/crush by structural collapse or large object is largely presented as a workforce risk in the UK. The ONRSR's approach to this aspect of risk is as per other occupational-type occurrences. However, a small proportion of risk is associated with trains being crushed. This risk exemplifies the challenge of risk–based regulation. The average frequency of these types of events in the UK is estimated at less than one event every 100 years, yet the estimated average consequence of such an event is the highest of all events in the model, (for example, structural collapse not at station, 13.3 fatalities and weighted injuries per event). For this reason this risk is considered further in Section 3.2 of this report.

3.2 Australian railway safety performance 2012–13

The summary statistics presented in this section focus upon rail safety within the ONRSR's area of operation for 2012–13 financial year, with emphasis on the groups of hazardous events of greatest regulatory priority as highlighted in Section 3.1. In some cases, summaries are based on the occurrence categories and related definitions of the national occurrence classification guideline (OC-G1, 2013). However, where these do not align directly with hazardous event definitions, alternative summaries are provided. Separately, Appendix A provides summary statistics for notified occurrences generally.

3.2.1 FATALITY AND INJURY

There were 28 notified fatalities in 2012–13. In summary:

- 26 fatalities involving acts of suspected suicide or trespass. In each of these cases the person was struck by a train
- one passenger fatality due to a strike at a station platform on Sydney's MRA (Table 4)
- one public fatality due to a strike at a pedestrian level crossing in South Australia (Table 4)
- no workforce fatalities were notified in 2012–13.

Approximately 530 people received non-fatal injuries in 2012–13.[25] Three quarters of cases involved falls, while another 12% were due to assault. The majority of notified injuries (85%) involved passengers on the urban rail networks of Sydney and Adelaide. Approximately 5% of notified injuries involved members of the workforce but the ONRSR recognises a significant proportion of workplace type injuries may not be notified, particularly those arising from hazards common to many workplaces such as manual handling and use of power tools.

Table 4: Railway fatalities, July 2012 to June 2013
Excludes fatalities associated with trespass, suicide/suspected suicide and ill-health.

DATE	LOCATION	CATEGORY	DESCRIPTION
25 November 2012	Coledale, NSW	Train collision – running line – with person	Intercity passenger train struck a male hanging his legs over the edge of the platform. The person later died from their injuries in hospital.
17 December 2012	Ovingham, SA	Level crossing collision – with person	Passenger train struck person walking bike through pedestrian maze. The person later died from their injuries in hospital.

The pattern of rail-related fatalities over the past five years is summarised in Figure 4:

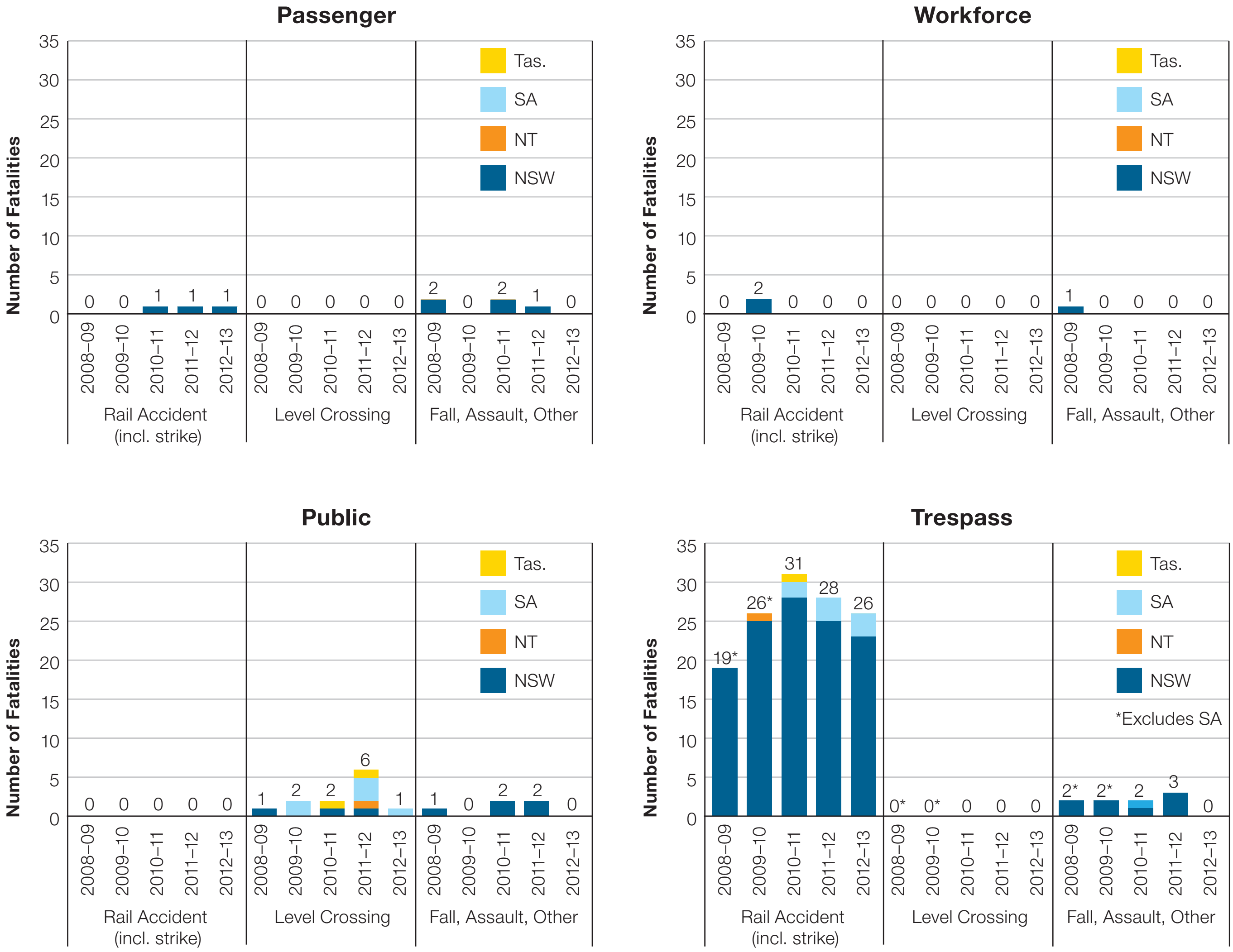
- a total of eight passenger fatalities were recorded in the period. All were single fatality incidents in NSW. Three incidents involved strikes at stations and all occurred within several hours of midnight. Three were associated with assault and two were due to falls on rail premises.

25. Refer to Appendix B for an explanation of injury related definitions

- three members of the workforce were fatally injured in the period. All were single fatality incidents to track workers but with the potential for multiple fatalities. The two most recent fatalities (2009-10) involved trains entering a work-site with workers on track. The remaining fatality (2008-09) involved a *crush*–type event. These risks are considered further in Section 3.2.2.
- 17 public fatalities (excluding trespass incidents) were recorded in the period. Level crossing collisions and strikes accounted for 12 (70%) of these fatalities and level crossing risk is considered further in Section 3.2.2. The remaining public fatalities in the period involved road vehicle accidents that affected the safety of rail operations, for example, one incident resulted in a semi-trailer obstructing track.
- trespass-related incidents account for the majority of fatalities in any given year. The average number of trespass-related fatalities over the most recent three years of complete data is 30. A previous analysis of these types of incidents for NSW, based on coronial findings, shows approximately three quarters of all trespass fatalities are associated with suicide.

Figure 4: Rail-related fatalities, 2008–09 to 2012–13

Trespass includes *suspected suicide*. Some level crossing fatalities may involve acts of trespass but are assigned to *Public* on the basis that members of the public may legitimately access level crossings. Data excludes health-related fatalities not affecting the safety of railway operations.



FATALITIES IN CONTEXT

Notified fatalities are summarised in Table 5 alongside data for the UK and the United States (US). The ONRSR-based data in Table 5 is a subset of fatalities summarised previously (Table 4 and Figure 4). The specific scope of occurrences has been matched to the UK and US incident definitions. It includes passenger, workforce and public fatalities but excludes occurrences classed as *suspected suicide* under the national occurrence classification guideline.

The UK statistics in particular are suitable for comparison because of the similarity of UK railway operations to Australia and its comparatively high safety performance amongst the 27 states of the European Union[26]. UK data and supporting documentation was sourced from RSSB and was reviewed to ensure the validity of comparison to Australian data. The US data was sourced from the Federal Railroad Administration but is less robust in this regard because of definitional uncertainties.

The ONRSR-based average fatality rate over the three year period (0.16 fatalities per million train km) is well below that for the United States (0.62 per million train km). A review of the US figures by individual incident types suggests the average rate reflects a significantly higher proportion of trespass and level crossing-related fatalities compared to the ONRSR's area of operation.

The ONRSR-based average rate is higher than that for the UK over the three year period (0.10 fatalities per million train km). However, the observed difference is comparable to the degree of statistical uncertainty associated with the three year sample of data.

Table 5: Railway fatality rate – ONRSR, United Kingdom and United States
Fatalities involving passengers, workforce and public (excluding suicide/ suspected suicide).

		2010–11	2011–12	2012–13	3 YEAR
ONRSR (SA, NSW, Tas, NT)	Fatalities	14	19	5	38
	Train km (million)	76.3	79.1	79.3	234.7
	Rate	**0.18**	**0.24**	**0.06**	**0.16**
United Kingdom[1]	Fatalities[1]	45	65	55	165
	Train km (million)[2]	516.3	536.2	536.3	1,589
	Rate	**0.09**	**0.12**	**0.10**	**0.10**
USA[3]	Fatalities	725	689	766	2180
	Train km (million)	1,144	1,180	1,197	3,521
	Rate	**0.63**	**0.58**	**0.64**	**0.62**

1. Source: Rail Safety and Standards Board, *Safety Risk Model: Risk Profile Report Version 7.5*, Issue 1.1, RSSB, UK, March 2013
2. Source: Network Rail, *Annual Return 2013*, Network Rail, London, August 2013
3. Source: Federal Railroad Administration Office of Safety Analysis: online database query (accessed 18 September 2013) <http://safetydata.fra.dot.gov/>

26. European Railway Agency, *Intermediate report on the development of railway safety in the European Union*, ERA Safety Unit, Lille, May 2013

3.2.2 TRAIN ACCIDENTS AND OTHER HAZARDOUS EVENTS

PASSENGER TRAIN DERAILMENT

Passenger train derailment risk is characterised by infrequent events that are potentially catastrophic, due to the exposure of multiple passengers to potential harm. The ONRSR needs to consider this risk across a broad range of passenger operations, including isolated commercial operators, tourist and heritage railways, as well as mainline urban, intercity and long distance passengers operations.

All running line passenger train derailments for the 2012–13 year are described in Table 6. In summary:

- two derailments of passenger trains on mainline railways in 2012–13. No injuries were reported for either incident
- one derailment of a passenger train on an isolated tourist and heritage railway in South Australia. No injuries were reported for this occurrence.

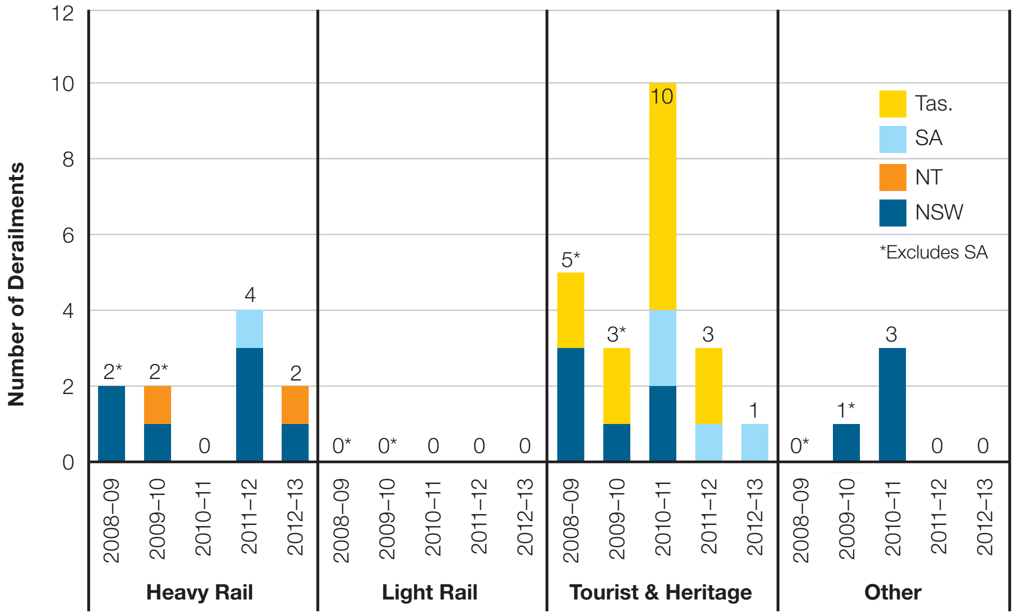
Table 6: Passenger train running line derailments, July 2012 to June 2013
All passenger train operators including heavy rail, light rail and tourist and heritage operators.

DATE	LOCATION	CATEGORY	DESCRIPTION
29 August 2012	St Marys, NSW	Heavy rail	Passenger train derailed one carriage after striking a piece of equipment that had fallen from the locomotive of a previous freight service. Passengers were escorted from the train. No injuries reported.
30 January 2013	Katherine, NT	Heavy rail	Long distance passenger train ('The Ghan') en-route from Darwin to Adelaide derailed while traversing points. A crew car and luggage van derailed and the train blocked the mainline. No injuries reported.
29 June 2013	Moonta Mines Railway, SA	Tourist and Heritage (narrow gauge)	Locomotive and two carriages derailed at low speed when rails spread due to broken weld. Estimated speed at time of derailment was less than 10 km/ h. No injuries reported.

Derailments involving heavy rail passenger trains are of primary concern because of the higher running speeds and passenger volumes compared to other services. It has been more than 10 years since the last multi-passenger fatality train derailment in Australia (Waterfall accident, NSW, January 2003). However, these types of derailments still constitute a significant risk.

Figure 5 summarises derailment data for ONRSR's area over the past five years. While data is incomplete for early years, it allows a qualitative summary of the nature of risk realised in recent years. There have been at least ten derailments involving heavy rail commuter services over the past five years. All but two (including the Katherine derailment; Table 6) involved commuter trains on urban or intercity networks. Three of the remaining eight cases involved a train passing a signal at danger without authority (SPAD), three involved a derailment following a collision with an object on the line, and two occurred while trains were traversing points.

Figure 5: Passenger Train Running Line Derailment, 2008–09 to 2012–13
Includes derailments in yards affecting safety of running lines. Excludes derailment following collision with train and derailment associated with level crossing collision. *Tourist & Heritage* includes operators on mainline networks. *Other* includes empty passenger trains.



A comparison of mainline passenger train derailments against comparable UK data is shown in Table 7. The ONRSR figures for the past three years represent a subset of derailments summarised previously — essentially the *Heavy Rail* derailments of Figure 5 together with the small number of tourist and heritage operators running trains on mainlines.

The average ONRSR rate over the three years with complete data (0.042 per million train km, Table 7) is higher than the UK (0.011 per million train km). However, the observed difference is comparable to the level of statistical uncertainty associated with a three year sample of data.

Table 7: Passenger train derailment rate – ONRSR and United Kingdom
In service passenger trains on or affecting safety of running lines. Excludes derailments on isolated networks and derailments following collision with train or level crossing collision. No relevant operations in Tasmania

		2010–11	2011–12	2012–13	3 YEAR
ONRSR (NSW, NT, SA)	Derailments	0	4	2	6
	Train km (million)	47.4	48.8	48.0	144.2
	Rate	**0.000**	**0.082**	**0.042**	**0.042**
United Kingdom	Derailments[1]	7	2	7	16
	Train km (million)[2]	475.1	492.3	492.5	1459.9
	Rate	**0.015**	**0.004**	**0.014**	**0.011**

1. Source: Rail Safety and Standards Board, *Safety Risk Model: Risk Profile Report Version 7.5*, Issue 1.1, RSSB, UK, March 2013
2. Source: Network Rail, *Annual Return 2013*, Network Rail, London, August 2013

Reliable estimates of the level of risk associated with derailments for passenger services other than heavy rail are not available. The historical derailment data of Figure 5 shows a relatively large number of passenger train derailments associated with tourist and heritage operations compared to heavy rail services. Whilst the incidents are frequent, a review of the circumstances of individual incidents shows these derailments generally occur at lower running speeds and involve smaller passenger loads compared with heavy rail services. Notwithstanding this, tourist and heritage operations are considered alongside those of heavy rail passenger services in an analysis of derailment precursors in Section 3.3 of this report.

FREIGHT TRAIN DERAILMENT

The UK model of derailment risk (Table 3; Section 3.1) suggests the risk of passenger train derailment is several times greater than non-passenger trains. This difference reflects, in part, the much greater overall distances travelled by passenger trains compared to freight in the UK. In contrast, distances travelled by passenger and freight trains in Australia are of a similar order of magnitude.

There were 35 derailments involving freight-related rolling stock on or affecting the safe operation of running lines in 2012–13. In summary:

- 33 derailments of freight trains. No injuries were reported for any of these occurrences. The derailments that are the subject of investigation are summarised in Table 8
- one incident involving a runaway of a wagon from a siding. The wagon ran down a gradient, passed a signal at danger and derailed on catch points protecting a running line that carries passenger services
- one derailment of a light locomotive. The locomotive passed a signal at danger and derailed at catch-points protecting a freight-only line.

The five year history of freight train related derailments is presented in Figure 6 according to the type of rolling stock involved. It is clear from this figure that the nature of freight train derailment risk is very different to that described previously for passenger trains. Freight train derailment is characterised by relatively frequent but comparatively low consequence events. For the three most recent years with complete data in Figure 6 almost 120 derailments were notified. None were fatal and one injury was reported.

The rate of freight train derailment for the past three years is summarised alongside comparable UK data in Table 9. There is a statistically significant difference in the average derailment rate between the ONRSR and UK data. The ONRSR rate (1.27 derailments per million train km) is far greater, being nearly an order of magnitude higher than that for the UK (0.14 per million train km).

Table 8: Freight train running line derailments, July 2012 to June 2013

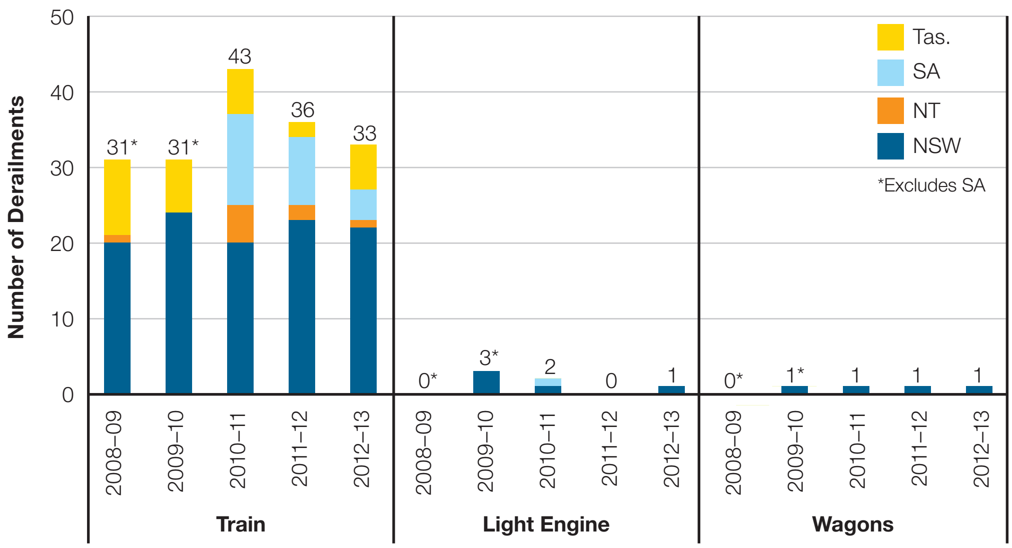
Selected occurrences only – those subject to "no blame" investigation by ATSB/OTSI or compliance investigation by ONRSR/ITSR.

DATE	LOCATION	TRAIN TYPE	DESCRIPTION
5 September 2012[3]	Bengalla, NSW	Bulk – coal	Train derailed one wagon due to fractured axle, damaging several thousand sleepers, three level crossings and signalling equipment. No injuries reported.
23 September 2012[3]	Sefton Park, NSW	Intermodal	Train derailed two wagons whilst crossing from suburban passenger line to goods line. Passenger services suspended. No injuries reported.
28 November 2012[2,3]	Boggabri, NSW	Bulk – coal	Train derailed last six wagons travelling over bridge. Five wagons fell from bridge to open ground below. Extensive damage to bridge and line closed for approximately three weeks. No injuries reported.
3 January 2013[2]	Rennie, NSW	Bulk – grain	Train derailed 10 wagons causing extensive damage to track and leading to small grass fire. No injuries reported.
17 January 2013[1]	Yunta, SA	Intermodal	Train enroute from Perth to Sydney derailed 19 wagons with many on their side. Significant track damage but no injuries reported.
17 February 2013[1]	Port Augusta, SA	Bulk – ore	Train departing junction at low speed derailed five wagons over points. Significant damage to track but no injuries reported.
9 April 2013[1]	Lowdina, Tasmania	Intermodal	Train derailed several wagons, travelling in derailed state for 2.5km. Dangerous goods involved. No injuries reported. ATSB determined cause of the derailment was a rail twist.

1. Subject of investigation by the ATSB
2. Subject of investigation by OTSI
3. Subject of compliance investigation by ONRSR (commenced by ITSR)

Figure 6: Freight Train Running Line Derailment, 2008–09 to 2012–13

Includes derailments in/associated with sidings but affecting the safe operation of running lines. *Wagons* typically comprise single or multiple wagons running away from a siding (not associated with locomotive movement).



The difference in average derailment rates between ONRSR and the UK reflects, in part, the extremely diverse nature of freight operations in Australia compared to the UK. Australia's freight operations include remote, industry-specific networks associated with high traffic coal and ore operations, cross continent intermodal freight on the DIRN, seasonal traffic on grain lines as well as intermodal and bulk freight on shared passenger lines. The nature of derailment risk will vary significantly between each of these operations. Derailment risk is expected to be significantly higher for lines shared with passenger services.

Table 9: Freight train derailment rate – ONRSR and United Kingdom

In-service freight trains and wagons on or affecting safety of running lines. Excludes light locomotives.
Excludes derailments following collision with train.

		2010–11	2011–12	2012–13	3 YEAR
ONRSR (SA, NSW, TAS and NT)	Derailments	44	36	34	114
	Train km (million)	28.8	30.2	31.2	90.1
	Rate	**1.53**	**1.19**	**1.09**	**1.27**
United Kingdom[1]	Derailments[1]	2	7	6	15
	Train km (million)[2]	35.0	37.3	37.2	109.5
	Rate	**0.06**	**0.19**	**0.16**	**0.14**

1. Source: Rail Safety and Standards Board, *Safety Risk Model: Risk Profile Report Version 7.5*, Issue 1.1, RSSB, UK, March 2013
2. Source: Network Rail, *Annual Return 2013*, Network Rail, London, August 2013

The ONRSR's regulatory program recognises the diversity of risk according to the nature of operation, and considers this in the development of its regulatory program. With regard to freight train derailments, the ONRSR is concerned with the seemingly high number of freight train derailments and through its regulatory work plan will ensure rail transport operators appropriately manage this risk.

The ONRSR will also encourage new approaches to managing key sources of risk. For example, investigation findings show that infrastructure quality is a key factor influencing freight train derailment risk. Infrastructure Australia has recently concluded a pilot study[27] with local governments to produce asset condition reports for roads. Such information has helped identify priorities for improvement to asset safety as well as freight efficiency. A similar scheme could potentially benefit rail by providing a consistent basis for prioritising network safety and infrastructure investment.

DERAILMENTS NOT INVOLVING PASSENGER AND FREIGHT TRAINS

While outputs from the UK risk model are helpful in identifying major sources of risk associated with passenger and freight operations, it is less useful in relation to the nature and level of risk associated with ancillary rolling stock operations, such as those involving road/rail vehicles and on-track infrastructure maintenance vehicles. Estimating safety performance of these types of trains from observed data is not straightforward because incidents are defined inconsistently with regard to the task at the time of the incident (inspection, maintenance, transfer), track configuration (single versus multiple lines), status of lines and the specific type of safe-working system in place at the time of the occurrence.

Notwithstanding the above, there were of the order of 50 derailments in 2012–13 across all types of operation (track patrol, sidings, working in possessions). The vast majority of incidents involved road/rail vehicles. Many of these incidents had limited potential for serious harm because they occurred at low speed, on lines closed to normal traffic or on non-commissioned lines during

27. Infrastructure Australia, *National Road Asset Reporting Pilot*, report prepared by Juturna Consulting Pty Ltd, March 2013

construction. However, some incidents involved higher speeds or vehicles carrying multiple crew, or gave rise to secondary risks such as obstructing adjacent running lines or damaging track. Several examples of derailments involving road/rail vehicles are presented in Table 10 to indicate the relevance and nature of this risk. Like freight train derailment, these incidents, remain a focus for the ONRSR.

Table 10: Road/rail vehicle derailments, July 2012 to June 2013

Selected occurrences only – examples of potentially higher risk incidents within OC-G1 (2013) categories of *derailment running line* and *derailment yard*

DATE	LOCATION	DESCRIPTION
15 September 2012	Newbridge, NSW	Road/rail vehicle with two people on board derailed during track inspection with vehicle coming to a stop 1.5 m from track. No injuries reported.
6 November 2012	Heybridge, Tasmania	Road/rail vehicle with one person on board derailed and rolled over while the vehicle was tipping material during maintenance. No injuries reported.
26 November 2012	Sandgate, NSW	Four wheel drive road/rail vehicle on track patrol derailed over incorrectly set points. No injuries reported but road/rail vehicle damaged.
3 January 2013	Bengerang, NSW	Track inspector reported derailing road/rail vehicle at approximately 20–30 km/h while travelling over private level crossing. No injuries reported.
11 April 2013	Spencer Junction, SA	Track inspector reported derailing road/rail vehicle whilst travelling on a bend. No injuries reported but vehicle unable to be moved due to damage sustained.
2 June 2013	Lowdina, Tasmania	Excavator derailed then re-railed by its operator. Track inspection not carried out before train running after the derailment. No injuries reported.
11 June 2013	McLeay, SA	Four wheel drive road/rail vehicle derailed during track inspection. Speed of derailment estimated at 60–65 km/h. No injuries reported.

COLLISIONS BETWEEN TRAINS

The UK risk model splits the risk associated with collisions between trains into multiple event categories according to a number of different criteria including the types of trains involved, the train at fault and the immediate cause. However, the major determinant of risk is the involvement of a passenger train — the earlier summary of the UK risk model (Table 3; Section 3.1) estimates collisions involving at least one passenger train collectively account for almost 90% of all train collision risk.

All running line collisions notified in 2012–13 are described in Table 11. In summary:

- no collisions involving passenger trains of any form in 2012–13
- four collisions between infrastructure maintenance rolling stock. One accident on an isolated tourist and heritage railway in Tasmania resulted in a serious injury to a road/rail vehicle driver
- one collision between a freight train and an assisting locomotive.

Table 11: Collisions between trains on running lines, July 2012 to June 2013
Collisions on or affecting the safe operation of running lines.

DATE	LOCATION	TRAINS	DESCRIPTION
5 July 2012	Goodwood, SA	Road/rail vehicles	Second of two road/rail vehicles travelling in convoy collided with leading vehicle which was being taken off rails at the time. Minor injuries reported.
21 August 2012	Brewongle, NSW	On-track infrastructure maintenance vehicles	Collision between two on-track infrastructure maintenance vehicles en-route to a work-site after one of the vehicles suffered a mechanical failure and came to a stand. No injuries reported.
23 August 2012	Nundah, NSW	Freight train and light locomotive	Light locomotives called to assist loaded freight train collided with the rear wagon of the freight train and derailed. Extensive damage to rear wagon of freight train. No injuries reported.
4 March 2013	Georges Plain, NSW	Road/rail vehicle and on-track infrastructure maintenance vehicle	Road/rail vehicle entered work-site and collided with an on-track infrastructure maintenance vehicle. Significant damage to road/rail vehicle. No injuries reported.
4 June 2013[1]	Rinadeena, Tasmania	Road/rail vehicles	Empty road/rail vehicle ran away down steep grade and collided with another stationary road/rail vehicle containing two track workers. Driver of second vehicle trapped and seriously injured.

1. Subject of investigation by the ATSB

Collisions between trains on running lines constitute a single incident class within Australia's national occurrence classification guideline. However, as noted above, this one class of accident represents a range of scenarios, each with its own nature and potential range of consequences. Factors such as the type(s) of trains involved (for example, passenger versus road/rail vehicle), line speed and method of train control (for example, signal-based authority versus train orders) significantly influence the level of risk.

The five year history of collisions between trains is summarised in Figure 7 with an emphasis on the criterion of passenger train involvement.

Figure 7: Running Line Collisions between Trains, 2008–09 to 2012–13

Excludes train striking / being struck by out of gauge items on train on adjacent line (e.g. container doors, protruding load). Includes collision leading to derailment. Passenger trains includes in-service, tourist and heritage, light and heavy rail. Trains other than passenger trains include freight trains, light locomotives and infrastructure maintenance rolling stock.

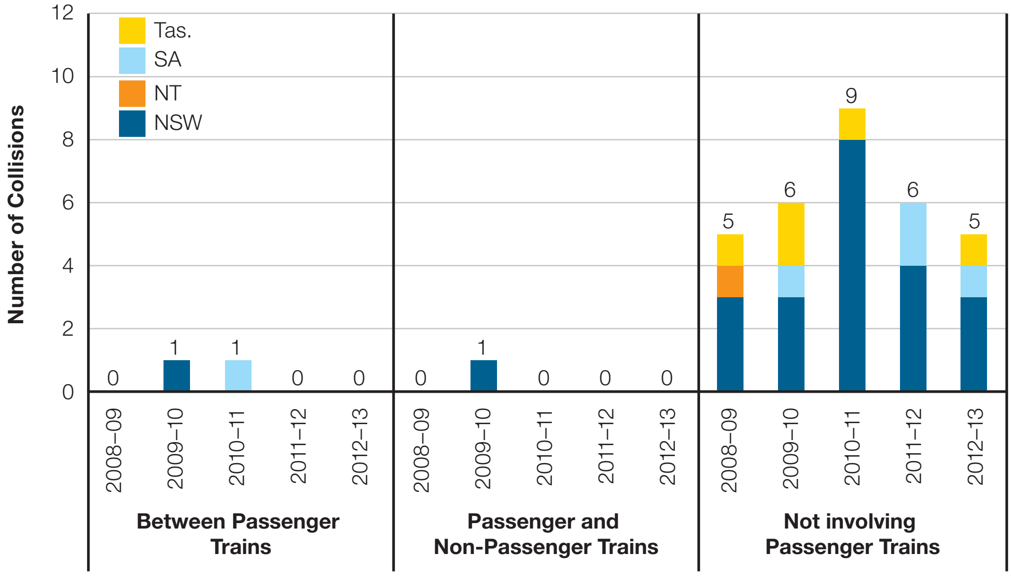


Figure 7 shows that collisions involving passenger trains are relatively infrequent occurrences, with just three notified in the past five years. However, the potential severity of such incidents remains high due to the exposure of a large number of passengers to potential harm. One of the two collisions between passenger trains in the five year period involved the Sydney monorail which ceased operating on the 30th June 2013. The remaining two were the subject of ATSB investigations:

i. Newbridge, NSW, May 2010: an intercity passenger train carrying 71 passengers collided with a stationary on-track excavator. The train was travelling at just under 69 km/h at the time of the collision and the operator of the track machine was fatally injured. The ATSB found[28] that both individual actions and systemic issues led to the incorrect conclusion by those involved in establishing the work-site that the passenger train had already passed the work-site location. This incident was the subject of a compliance investigation by ITSR and resulted in a successful prosecution of ARTC.

ii. Adelaide, South Australia, February 2011: collision between two suburban passenger trains at Adelaide railway station. One train, carrying 17 passengers and travelling at approximately 24 km/h, struck another train carrying 22 passengers which was virtually at stop. There were no injuries as a result of the collision but both trains sustained minor damage. The ATSB found[29] the second train had passed a signal at stop without authority.

The recent history of running line collisions between trains as presented in Figure 7 highlights the relevance of passenger train collision risk to Australian railways. However, it does not necessarily reflect the level of risk, nor provide a basis for understanding the many ways in which these accidents can happen. The two passenger train collisions summarised above represent two of the immediate causes of collisions – a conflict in the issuing of authorities for train movement and the exceedance of a valid authority. The major contributors to passenger train collision risk are considered more fully in Section 3.3 of this report.

28. Australian Transport Safety Bureau, *Collision between an XPT passenger train and track-mounted excavator near Newbridge, NSW, 5 May 2010*, Rail Occurrence Investigation, RO-2010-004, Final, ACT, April 2012

29. Australian Transport Safety Bureau, *Collision between suburban passenger trains G231 and 215A in Adelaide Yard, South Australia, 24 February 2011*, Rail Occurrence Investigation, RO-2011-002, Final, ACT, 2011

The estimated collision risk for train collisions not involving passenger trains in the UK is an order of magnitude lower than that involving passenger trains. This will reflect, in part, the relative differences in movements between the two in the UK, i.e. 492.5 million passenger train km in 2012–13 against 37.2 million freight train km (Table 7 and Table 9 respectively). Based on the recent fatality and accident history as summarised in Table 11 and Figure 6, collisions involving track maintenance rolling stock (in particular, road/rail vehicles) also appear to be significant contributors to risk in Australia.

The ONRSR views all collisions between trains as avoidable and the integrity of train authority systems as paramount to maintaining operational safety. It expects rail transport operators to take a risk-based approach to the management of these events that includes attention to the identification and management of collision precursors.

LEVEL CROSSING ACCIDENTS

Level crossings are the primary means by which members of the public may legitimately traverse the rail corridor and therefore present a unique set of safety risks. Collisions at level crossings between trains and road vehicles accounted for approximately 30% of rail fatalities (excluding suicide) in Australia between 2005 and 2009.[30]

There are at least 25,000 level crossings in Australia[31]. Over half of these are private or maintenance road crossings, equipped mainly with passive warnings devices such as stop or give way signs. Slightly more than 5% are pedestrian crossings. Of the remaining crossings, those across public roads, one third are actively controlled i.e. use equipment such as flashing lights or boom gates to manage road traffic movement.

There were eight level crossing collisions between trains and road vehicles in 2012–13 (Table 12) comprising:

- six collisions between freight trains and light passenger road vehicles. One incident in Tasmania resulted in a minor injury to the occupant of the road vehicle
- one collision between a passenger train and a light passenger vehicle on an isolated tourist and heritage railway. The train was not carrying passengers at the time of the collision
- one collision between a track recording train and a light passenger vehicle.

In addition to the collisions reported in Table 12, there was a collision between an intercity passenger train and road vehicle in NSW in May 2013 notified as a *suspected suicide*.[32] No injuries to train passengers or crew were reported but the sole occupant of the road vehicle was pronounced deceased at the scene.

There was one fatal strike at a pedestrian maze in South Australia. Another three fatal strikes at level crossings in 2012–13 were notified as *suspected suicide*.

30. Excluding incidents involving *suspected suicide*; Independent Transport Safety Regulator (ITSR), *Level crossing accidents in Australia*, ITSR, Sydney, August 2011
31. Rail Industry Safety and Standards Board, *Level Crossing Stocktake*, RISSB, Canberra, May 2009
32. Under Australia's current national occurrence notification and classification framework a fatal occurrence may be classed as *suspected suicide* based on the circumstances described in the initial occurrence report. A formal determination of suicide is based on a coronial determination

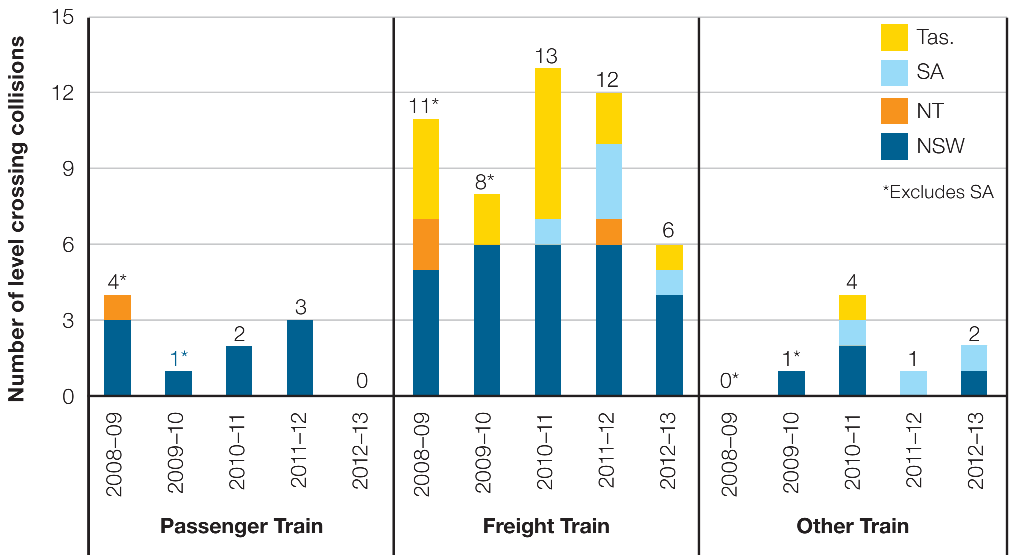
Table 12: Level crossing collisions between train and road vehicle, July 2012 to June 2013
No incidents were reported for Northern Territory in the period.

DATE	LOCATION	CONTROL TYPE	TRAIN TYPE	ROAD VEHICLE TYPE	REPORTED INJURY
3 November 2012	Beelbangera, NSW	Stop signs	Freight	Light passenger	none
10 February 2013	Two Wells, SA	Booms	Freight	Light passenger	none
3 March 2013	Molong, NSW	Stop signs	Freight	Light passenger	none
5 April 2013	Moonah, Tasmania	Lights	Freight	Light passenger	1 x minor
2 May 2013	Koolkhan, NSW	Lights	Freight	Light passenger	none
4 May 2013	Goolwa, SA[1]	Stop signs	TH passenger	Light passenger	1 x minor
21 May 2013	Moree, NSW	Stop signs	Track maintenance[2]	Light passenger	none
30 June, 2013	Henty, NSW	Lights	Freight	Light passenger	none

1. Isolated tourist and heritage operator. Train was not carrying passengers at time of the occurrence
2. Locomotive hauling track recording car

Notified level crossing collisions over the past five years are summarised in Figure 8. There were eight collisions in 2012–13 which was the lowest of the past five years. Whilst this is not statistically significant in light of the variability in the record, separate data suggests the average number of collisions has fallen over the past decade, from a median of 23 per year in the first half of the decade to 16 per year for the five years to 2012–13.

Figure 8: Level crossing collision between train and road vehicles, 2008–09 to 2012–13
Excludes occurrences involving suicide or suspected suicide; *Other* includes isolated tourist and heritage operators.



There were no fatal level crossing collisions notified in 2012–13[33]. However, a broader review of level crossing-related occurrences shows there were over 250 occurrences involving near-misses between trains and road vehicles in 2012–13. Freight trains account for the majority of near miss incidents over the period, with most of these incidents involving light passenger road vehicles. In such incidents, the primary risk is to road vehicle occupants because of the greater mass of freight trains compared to that of road vehicles. These collisions can also result in injuries and trauma to train crew.

The balance of fatality risk shifts towards train occupants for collisions involving passenger trains and/or heavy road freight vehicles. Separate national data[34] shows the rate of fatality per collision involving heavy road vehicles is double that of collisions involving light passenger vehicles such as cars. The greatest risk of multi-fatality accidents at level crossings is associated with collisions between passenger trains and heavy vehicles. The June 2007 collision between a semi-trailer and passenger train at Kerang in Victoria led to 11 fatalities and more than 20 people being injured.[35] Table 13 presents a subset of these types of occurrences and shows that the potential for catastrophic accidents remains.

Table 13: Level crossing near-miss between train and road vehicle, July 2012 to June 2013
Selected occurrences only – examples of potential higher severity occurrences involving passenger trains, heavy road vehicles or other serious events.

DATE	LOCATION	CONTROL TYPE	TRAIN TYPE	DESCRIPTION
4 July 2012	Melinga, NSW	Stop signs	Non-urban passenger	Train travelling at approximately 100 km/h applied emergency brakes and missed van by approximately 1 m.
13 July 2012	Emerald Hill, NSW	Give way signs	Freight	Freight train travelling at 95 km/h missed truck by approximately 20 m.
2 October 2012	Direk, SA	Lights and booms	Non-urban passenger	Train travelling at approximately 100 km/h missed road vehicle by approximately 100 m.
7 November 2012	Bellata, NSW	Stop signs	Non-urban passenger	Train travelling at approximately 80 km/h applied emergency brakes and missed road train by approximately 50 m.
16 November 2012	Rappville, NSW	Stop signs	Non-urban passenger	Train travelling at approximately 115 km/h applied emergency brakes and missed truck by less than 50 m.
16 January 2013	Aberdeen, NSW	Lights	Non-urban passenger	Train travelling at approximately 110 km/h applied emergency brakes and missed car by less than 1 m.
29 April 2013	Mindarie, SA	Give way signs	Freight	Driver of freight train reported school bus with children on board failed to stop. Train crew blew horn and missed bus by 50 m.
17 May 2013	Granton, Tasmania	Lights	Freight	Train control advised of near miss between freight train and B-double.

33. Excluding the previously discussed suspected suicide incident
34. Independent Transport Safety Regulator (ITSR). *Level crossing accidents in Australia*, ITSR, Sydney, August 2011
35. The Coroners Court of Victoria delivered its findings on this accident in October 2013 <www.coronerscourt.vic.gov.au>

Level crossing risk is characterised by a third party threat from road user behaviour and poses a significant multi-fatality risk to rail users, particularly in relation to passenger trains.

A subset of risks at level crossings arises from rail operations. Examples include hazards associated with level crossing design, equipment failures such as wrong side failures in level crossing controls, and secondary risks arising when normal systems of working are suspended, for example, during track work or movement of specialised pieces of rolling stock. The ONRSR is currently undertaking a compliance investigation into an incident at Gerogery (NSW) in August 2012, involving a near miss between an on-track infrastructure maintenance vehicle and a motorist. The level crossing warning equipment was deactivated at the time of the incident.

The ONRSR considers level crossing safety a priority and will work to improve safety by:

- providing technical support, data analysis and occurrence reporting to state and territory-based agencies and committees developing level crossing safety strategies and action plans
- working with research organisations in relation to alternative low cost level crossing warning technologies[36]
- working with Transport Safety Victoria on the recommendations made by the Kerang Coronial Investigation.

WORKFORCE STRIKES

There are many scenarios in which rail workers interact with trains, making workforce strikes a particularly complex area of risk. The UK risk model makes a primary distinction on the basis of worker role, with infrastructure workers considered separately to others such as train crew and station staff. The two main scenarios are:

(i) single fatality events associated with a train striking an individual working on or about rolling stock, such as a shunter, station attendant or security guard. These events are associated with irregularities in a range of rules governing the safe operation of trains and protection of people on/about track.

(ii) multi fatality events associated with trains entering work-sites and striking track workers. The multi fatality potential arises because track work typically involves teams of workers on track at one time. The risk relates to a set of rules and systems designed specifically to ensure the safety of work-sites and track workers, commonly referred to as “work-site protection”.

Approximately 85% of the UK risk for workforce strike (Table 3; Section 3.1) is associated with the second of the above two scenarios. The two most recent examples[37] of this type of accident are Singleton, NSW (July 2007) when a coal train struck and killed two track workers; and Sydney (April 2010) when a train struck and killed a track worker, with four other members of the work team taking evasive action to avoid being struck.

Various methods of work-site protection are prescribed in the network rules. These range from low levels of protection (for example, where lookouts warn workers of approaching trains), through to exclusive ‘possessions’ where the protection arrangements are advertised in advance and no trains (other than work trains) are permitted to enter the work-site.

36. Projects R2.121 Low cost risk and legal evaluation for a safety argument supporting low-cost level crossing warning devices; and R3.122 Affordable level crossings – Stage 2 <http://www.railcrc.net.au>

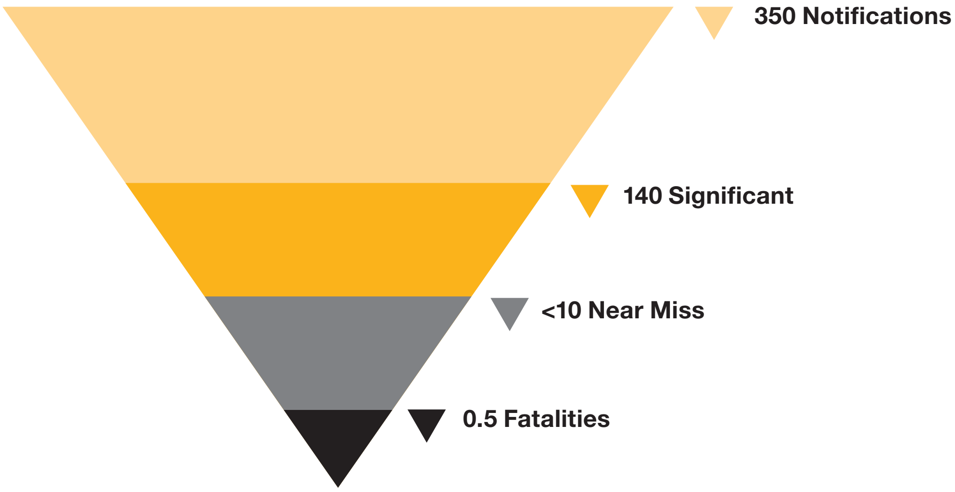
37. A more recent fatal work-site protection incident (Newbridge, NSW, May 2010) involved a train hitting a road/rail vehicle and is therefore classed as a *collision between train* rather than a *strike*

Hundreds of work-site protection incidents are notified each year, representing a broad range of circumstances in terms of the specific protection method employed, the purpose of protection, the nature of the irregularity and hence the potential for harm.

Only a subset of these incidents represents a situation which had or could have escalated to a catastrophic event. The exact number of these incidents is difficult to determine readily because of the broad nature of existing incident classes available for statistical summary and the limited description often available in an initial notification.

The figure below summarises the nature of this issue for a set of notifications received in any given year.

Figure 9: Annual breakdown of work-site protection occurrences*



* approximate figures only

There were of the order of 350 notified occurrences relating to breaches of work-site protection safe-working rules in 2012–13. These reflect an extremely diverse range of events, from relatively minor breaches such as failing to remove equipment (e.g. flags) at the end of track work, through to serious events such as trains entering a work-site without authority.

Based on an initial review of the circumstances of each of the incidents in 2012–13, approximately 40% represented a situation where safe separation between trains and work-sites was not adequately ensured. These include situations such as protection applied in a different location to where work was actually taking place; work being undertaken without any protection being established at all; work continuing after an authority had been withdrawn; and irregularities in timing where track workers have been given authority to commence work whilst a scheduled train service was still in the section.

Only a small number of incidents in any given year escalate to the point where the only remaining defence against injury or fatality is emergency action on behalf of the individual(s) involved, such as workers moving out of the path of an oncoming train. The number of these incidents is particularly hard to estimate from the typically brief descriptions provided in incident reports but it is estimated to be in the order of 10 occurrences per year. Fatal incidents in recent years due to a worksite protection failure have resulted in approximately one fatality every two years on average. A sample of such incidents in 2012–13 is presented in Table 14.

Table 14: Potentially high risk work-site protection occurrences, July 2012 to June 2013
Selected occurrences only – examples of occurrences that have escalated to/close to a near miss.

DATE	LOCATION	DESCRIPTION
17 July 2012[1,2]	Summit Tank, NSW	Driver of freight train approaching viaduct spotted three workers directly ahead. Driver blew horn and applied brakes and workers quickly moved off viaduct with the train approximately 5 m from them.
15 August 2012	Ashfield, NSW	Driver of passenger train reported near miss with a rail worker who was part of a graffiti inspection team. Train approached within 100m of worker when he moved clear.
7 October 2012[2]	Warrabrook, NSW	Driver of passenger service noticed dump truck at work-site fouling the line. The driver applied train brakes to avoid a collision, stopping the train approximately 50 m short of the dump truck.
30 January 2013[1,3]	Hurlstone Park, NSW	Freight train passed two signals at stop without authority and entered a work-site. Track worker saw approaching train and quickly moved to a safe position.
13 June 2013[1,3]	Blackheath, NSW	Two minutes after completing track work, track workers observed train passing site and calculated train was within section when work was underway.

1. Subject of investigation by ATSB/OTSI
2. Subject of compliance investigation by ITSR
3. Subject of compliance investigation by ONRSR

Recognising the relatively high level of this risk as supported by the recent history of fatal accidents and the continued occurrence of near miss incidents, track worker safety is a key priority for the ONRSR. The ONRSR will proactively work with rail transport operators to review the management of track worker safety. It also routinely monitors work-site protection performance through incident analysis and compliance activity and responds to serious incidents when they occur.

STRUCK/CRUSH BY STRUCTURAL COLLAPSE OR LARGE OBJECT

Struck/crush from structural collapse as summarised in Table 3 (Section 3.1) is a combination of three hazardous events. The risk is narrowly defined, being limited to harm associated with the direct crushing force of large objects and collapse of structures. It excludes a specific set of risks related to structural failure, for example, failure of a track supporting structure and landslips. These are considered primarily as precursor events in the estimation of train derailment risk in Section 3.3.

Over 90% of the UK-based structural collapse risk is associated with individual workers being crushed. This type of incident is relevant to Australian railways — in 2009 at Farley in NSW a track worker was killed and four others seriously injured when struck by a load falling from a crane at a construction site. However, this type of risk is regulated under Workplace Health and Safety law[38], and ONRSR has a MOU with the Heads of Workplace Safety Authorities for coordinated regulation in such cases.

A small proportion of UK-based risk is associated with trains being crushed. These events are rare (average frequency in the UK estimated at less than one every 100 years), yet the estimated average consequence per event is the highest of any event in the model (for example, train crushed by structural collapse not at station, 13.3 fatalities and weighted injuries per event). This profile aligns generally with the accident history in Australia. Over 35 years ago, 83 people were killed when an urban passenger service derailed, struck and was then crushed by an overline road bridge in Granville, Sydney.[39]

The risk of structural collapse in ONRSR's area of operation is associated with specific points of the network. Examples include underground lines and stations on sections of Sydney's MRA including the Epping to Chatswood rail line, the airport line and the underground rail network of the central business district. On above ground sections of the network, the threat is posed by a variety of lineside structures including overline bridges, car parks and commercial/residential development adjacent to the rail corridor. An emerging issue is an increase in high density residential and commercial development in the airspace over rail premises — examples include Hurstville and North Sydney on the MRA and the Convention Centre in Adelaide.

The ONRSR's approach to regulation of this risk recognises that routine analysis and monitoring of notifiable occurrences provides little insight or defence. By its nature, this type of event typically manifests as sudden, catastrophic failure at an interval far greater than the available historical incident record. Moreover, due to the economic, social and safety critical nature of much of this infrastructure, precursor conditions rarely escalate to a threshold that constitutes a notifiable event, i.e. presenting an immediate or tangible threat to the safety of railway operations.

For these reasons, the ONRSR's regulatory approach is to include this specific risk in the scoping of its compliance activity for relevant operators. This includes inspections to monitor rail transport operators' management of safety and overall condition of higher risk structures, taking into consideration a range of factors such as the age of the asset and proximity to high volume passenger rail traffic. In the case of new developments, the ONRSR's focus is seeking assurance of appropriate preventative safety controls at the design stage.

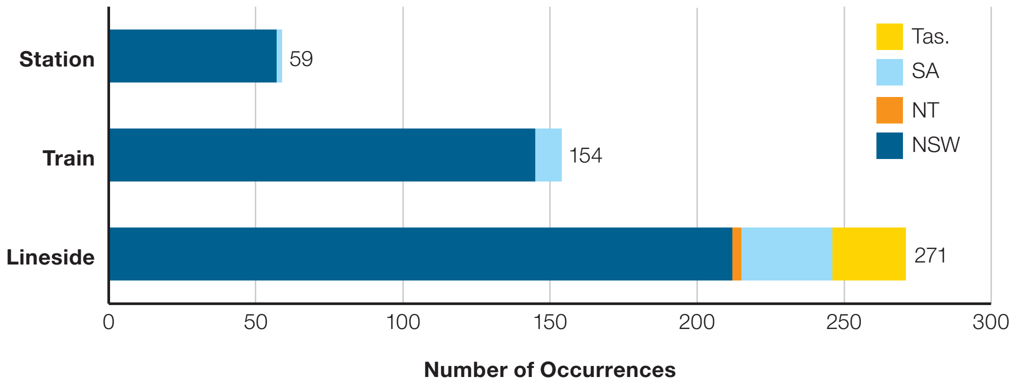
38. The incident at Farley in NSW resulted in several prosecutions under NSW Occupational Health and Safety laws
39. Noting that in the UK risk model this event would formally be assigned to the initiating event — a derailment

LINESIDE, STATION AND TRAIN FIRES

A total of 484 fires were notified in 2012–13 (Figure 10). In summary:

- one serious injury was notified when in NSW a rail worker received serious burns when a can of gas ignited in a signalling cable pit
- several minor injuries were notified, all of which were sustained by train guards when attempting to extinguish fires on passenger trains on Sydney's MRA
- lineside fires were the most frequently notified class of fire, consisting primarily of grass and rubbish fires
- the majority of station fires were at above-ground stations and involved small bin or rubbish fires. Most were the result of arson or careless acts (e.g. discarded cigarettes)
- approximately 80% of the 154 notified train fires were on passenger trains. Almost all remaining train fires involved locomotive faults on freight trains.

Figure 10: Notified fires, July 2012 to June 2013



Approximately 60% of the fire risk on the UK rail network is associated with passenger trains, by virtue of large numbers of people exposed in such situations. There were more than 121 passenger train fires notified in 2012–13 and most were associated with arson on passenger trains.

The longer term pattern of passenger train fires for the Adelaide and Sydney heavy rail urban networks is summarised in Figure 11. The majority of these incidents are associated with arson and data shows a statistically significant decreasing trend in the number of on-train fires.

Despite this marked reduction in one of the major contributors to fire risk over time, potentially high risk incidents still occur, both on trains and in other potentially harmful situations. Some examples of these are summarised in Table 15.

Figure 11: Passenger train fires, September 2009 to June 2013
Monthly total occurrences. OC-G1 class *Fire On Train*. NSW and SA data only.

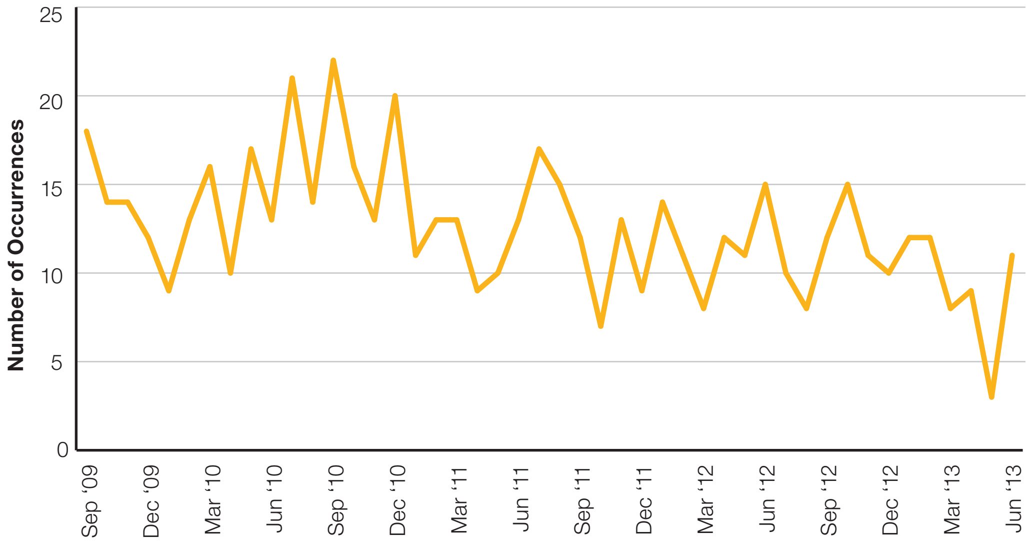


Table 15: Significant fires notified in the period, 2008–09 to 2012–13
Selected occurrences only — examples in which multiple people were exposed to potential harm.

DATE	LOCATION	SITUATION	DESCRIPTION
1 July 2008	Holsworthy, NSW (MRA)	Train fire	Fire in air conditioning unit in roof of passenger carriage. Several passengers affected by smoke inhalation.
16 July 2010	Valley Heights, NSW (MRA)	Train fire	Traction motor fire. Passengers moved to cars which were separated from rest of train and returned to station. Driver taken to hospital for smoke inhalation.
28 July 2010	Riverstone, NSW (MRA)	Train fire	Arson-related fire. Crew were unable to contain fire and passengers evacuated.
27 April 2011	Macquarie Park, NSW (MRA)	Underground station fire	Transformers overheated causing electrical fire. Station evacuated and trains directed not to stop.
24 July 2012	Bondi Junction, NSW (MRA)	Underground station fire	Paper fire filled tunnel with smoke. Train services stopped and passengers evacuated from station.
1 March 2013	Wynyard, NSW (MRA)	Underground station fire	Train driver reported fire in cabling on tunnel wall. Platforms evacuated.

Another potentially serious fire-related risk highlighted in the examples of Table 15 is associated with underground railway environs. The three underground fires depicted in Table 15 required evacuation and fires such as these exposed potentially large numbers of passengers to harm. This aspect of risk is not explicitly modelled in the UK risk model but is relevant to Sydney's MRA, in particular, the underground sections of the central business district, the Eastern Suburbs Railway, Airport line and Epping to Chatswood rail line. The risk on these sections of lines will vary considerably according to many factors, including age and design of infrastructure and, in turn, the measures available to prevent fires and mitigate their impacts, for example, smoke management systems in the design of newer infrastructure. Beyond the direct risk associated with fire (burns, smoke inhalation), underground environs also give rise to a range of secondary risks associated with evacuation, as well as risks to the workforce and emergency crews fighting fires in underground railways.

The ONRSR will continue to monitor the improving performance in relation to passenger train fires generally. Its priority in relation to fire risk in 2013–14 will be that associated with underground passenger railways, given the unique aspects of the underground network and the range of potential consequences that may result from underground fires.

TRAIN COLLISION WITH BUFFER

A buffer stop is a structure at the end of a rail line designed to prevent rolling stock progressing beyond the end of the track. They vary considerably in terms of design and include solid wooden structures as well as reinforced concrete. They can be fitted with rubber pads or hydraulic arms to absorb impact forces. They are used in both passenger and freight operations, although the primary contributor to this risk is in-service passenger trains at terminal or 'dead end' station platforms.

Buffer stop collisions are a relatively small contributor to UK risk (Table 3, Section 3.1). However, the risk is relevant to Australian railways with both Adelaide and Sydney's heavy and light urban passenger networks, as well as those of some tourist and heritage railways, possessing terminal stations.

Buffer collisions are not uniquely identified in the current national reporting framework despite presenting a specific set of risks. For the purpose of this report, a manual review of occurrences within the ONRSR's area of operation was conducted, extending from July 2008. The most significant incidents from this exercise are summarised in Table 16.

Table 16: Passenger train collision with buffer stops, 2008–09 to 2012–13

DATE	LOCATION	TRAIN	DESCRIPTION
3 May 2010	Newcastle, NSW	Heavy rail	Intercity train collided with buffer stop resulting in extensive damage to train. No injuries to passengers but train guard injured and transported to hospital.
19 December 2010	Lidcombe, NSW	Heavy rail	Shuttle service between Sydney Olympic Park and Lidcombe struck hydraulic buffers. Minor damage to train and buffers but no injuries reported.
6 July 2012	Newcastle, NSW	Heavy rail	Intercity train struck buffer stop compressing the hydraulic arms several inches. No injuries or damage reported.
31 January 2013	Glenelg, SA	Light rail	Tram slid into concrete bollard at end of line. Driver stated brakes applied but train slid on wet rails. Tram terminated due to damage. No injuries reported.

In addition to the accidents listed within Table 16, the ATSB[40] is currently conducting an investigation outside of ONRSR jurisdiction into a serious collision between a passenger train and buffer stop in Queensland. On 31 January 2013, a passenger train carrying 19 people collided with an end of line buffer stop at Cleveland Station. The train was travelling at approximately 30 km/h at the point of collision and rode up and over the buffer stop and into a station building. Several people were treated for minor injuries resulting from this accident.

The immediate causes of buffer collisions are brake failure, poor adhesion between the train's wheels and the rails and driver related-factors such as train management approach and incapacitation. Poor adhesion is implicated in both the Queensland incident and the collision at Lidcombe in December 2010 (Table 16). Routine monitoring of precursor occurrences is hampered by lack of relevant data. Only braking irregularities are uniquely defined and routinely reported in the current occurrence reporting stream. Other relevant precursors associated with this risk, such as train management and driver condition are either outside the scope of notification or only captured sporadically.

For these reasons, the ONRSR approach to regulation of this risk includes compliance activity that focuses upon the relevant organisational and safety system contributors to this risk. A critical element in the prevention of these accidents is the driver's train management on the approach to stations. The ONRSR routinely considers relevant elements of operators' safety management systems including driver competence, health and fitness provisions and compliance with relevant safeworking rules. It also considers rail transport operators use of appropriate engineering controls to manage this risk so far as is reasonably practicable. In addition, the ONRSR will review the outcomes of the ATSB's investigation of the recent Cleveland collision and consider relevant recommendations.

40. Australian Transport Safety Bureau, *Collision of passenger train T842 with station platform, Cleveland, Queensland, 31 January 2013*, Rail Occurrence Investigation, RO-2013-005, Preliminary, ACT, March 2013

3.3 Precursor analysis for priority hazardous events

3.3.1 INTRODUCTION

Each of the hazardous events described previously (Section 3.1) has a range of potential consequences — from no harm through to fatalities. A subset of these events also has the credible potential for multiple fatalities in a single occurrence. The Granville rail accident in 1977 was the worst rail accident in Australia's history and led to 83 fatalities. The accident involved a passenger train derailing, striking a bridge and being crushed when the bridge collapsed. While this level of consequence is extremely rare, the potential remains.

Those hazardous events with a potential for greater consequences deserve particularly thorough analysis, to understand the range of potential precursors in order to target safety improvement initiatives accordingly. A *precursor* is a system failure, sub-system failure, component failure, human error or operational condition that could, individually or in combination with other precursors, result in the occurrence of a hazardous event.[41]

Precursor analysis is a vital part of safety risk modelling, particularly for those hazardous events with the potential for multiple fatalities. Risk models typically include *causal analysis* to identify all relevant precursors and their associated frequency, linked to *consequence analysis* to enable the calculation of the level of risk for each hazardous event. This information can then be used to quantify the specific contribution of each precursor to risk, and identify those precursors making a relatively large contribution to multi-fatality risk, such as passenger train derailment. With this knowledge, safety performance measurement of relevant precursors can be developed. One such approach is the Precursor Indicator Model (PIM) used by RSSB which tracks the rate of occurrence of specific precursors to provide a lead indicator 'barometer' of the risk associated with key hazardous events. The RSSB also reports against precursors in its Annual Safety Performance Report.

3.3.2 PRECURSOR ANALYSIS USING AUSTRALIAN DATA

Precursor analysis is challenging for a number of reasons. The specification for reporting of occurrence data was not designed with a risk model in mind and therefore the precursor detail in occurrences reported under the national reporting framework is limited. Another complication is that reporting to the ONRSR and ATSB principally focuses upon the initial notification of occurrences, with written reports required to be submitted within 72 hours of the occurrence. In the case of serious events it can take many months to investigate and determine the specific precursors involved, and this knowledge is often never incorporated into the notifiable occurrence information base.

Australia's current national occurrence notification and classification framework includes some precursor incident categories but is most reliable in its definition and categorisation of accidents. Some of the precursors directly related to hazardous events of concern are defined, while others are not. A SPAD is an example of a precursor that is defined, reported and relevant to risks of concern such as train derailment and collisions. However, definition and notification alone are insufficient, because in the absence of a risk model the individual contribution of the various forms of SPAD incidents to the likelihood of hazardous events and their associated risk is unknown.

41. Rail Safety and Standards Board, *Safety Risk Model: Risk Profile Report, version 7.5*, Issue 1.1, RSSB, London, March 2013

Despite the limitations described above, the ONRSR views precursor analysis as an important part of reporting on Australia's safety performance. For the purposes of this report, two hazardous events have been analysed — *passenger train derailment* and *collisions between trains – involving passenger train*. Both of these hazardous events have occurred in Australia as accidents that have led to multiple fatalities, most recently with the Glenbrook and Waterfall accidents in NSW in 1999 and 2003 respectively. It is possible that hazardous events of this nature could occur again and potentially result in a similar or even greater loss of life. This potential should never be forgotten but it should also be acknowledged that significant resources and effort have been applied in the wake of these accidents to learn from them and implement new and improved risk control measures.

For this analysis, a set of precursors related to passenger train derailment and collision involving passenger trains were compiled. The list was based on those used in the UK risk model for these two hazardous events, and included the percentage contributions of each precursor as reported in the UK risk report. The precursors and their individual risk contributions were then aggregated into summary precursor groups in order to identify the spread of risk across the main types of precursors.

From the above, the single precursor group contributing the majority of the risk was identified. The available occurrence data relating to this precursor group was then reviewed to identify potentially useful data for analysis. A maximum of five years' data was considered and the review considered both changes in the rate of individual incidents over time, as well as review and identification of individual significant events. Some effort was made to overcome the limitations of the available incident categorisation, including manual review of individual incident records to elicit the information reported in the following sections.

It is emphasised that given the distinct natures of the UK and Australian networks (the demographics and variations in rolling stock for example), this prioritisation should be used very guardedly.

3.3.3 PASSENGER TRAIN DERAILMENT

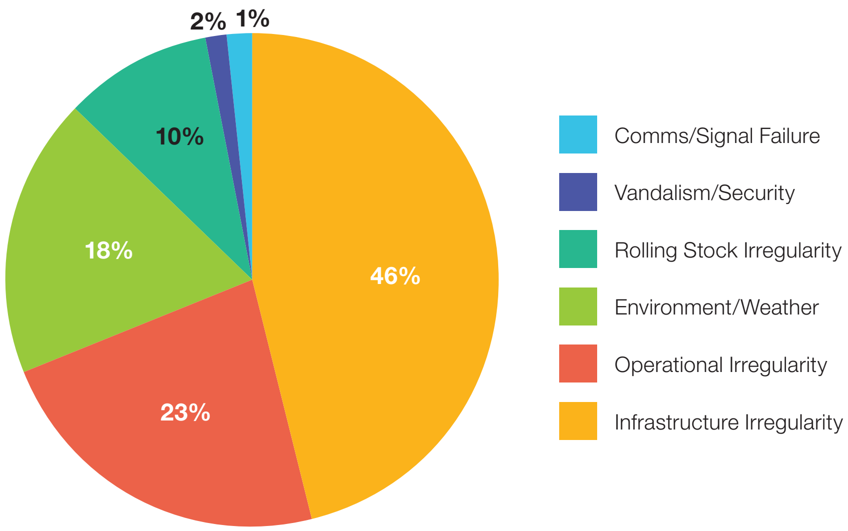
A total of 56 individual precursors to passenger train derailment were listed in the UK risk report. Each was assigned to one of six precursor groups as follows:

i. **Infrastructure irregularity:** track defects, points defects, track obstructions (except obstruction which is vandalism related)
ii. **Rolling stock irregularity:** bogie and wheelset failures, dragging equipment, overspeeding[42]
iii. **Operational irregularity:** SPADs, driver/shunter/train crew/signaller errors, failure to adjust points correctly
iv. **Communications/signalling failure:** wrong side signalling system failures
v. **Environment/weather:** structural damage or obstruction to infrastructure caused by earthquake/flooding, high winds, landslips, subsidence
vi. **Vandalism/security:** objects placed on track by vandals.

Mapping the risk estimates from the UK risk report to these six groups gives their respective contribution to the risk of passenger train derailments, as shown in Figure 12.

42. Overspeeding may be caused by a rolling stock defect or operational irregularity. The UK risk report does not split this further so for the purposes of this analysis overspeeding has been assigned wholly as rolling stock-related

Figure 12: Risk contribution for passenger train derailment in the UK
Source is Risk Profile Report Version 7.5. Refer Appendix B.



Infrastructure irregularities represent the largest contributor to the risk of passenger train derailments (46%) in the UK. Local occurrence data related to this precursor group was therefore examined in greater detail to determine Australian safety performance in this area. Based on data availability and quality, two sets of analyses were undertaken:

- broken rails
- train collision with track obstruction.

It is important to note that despite local data being available, the formal relationship between each of these two variables and passenger train collision risk has not been established. While it may be tempting to surmise that an increase in the frequency of these events corresponds to an increase in the risk of passenger train derailments, there are many other variables and dependencies associated with this hazardous event and a direct relationship between precursor rates and risk cannot be assumed.

BROKEN RAIL

Figure 13: Broken Rail, September 2009 to June 2013
Monthly total occurrences. OC-G1 class *Broken Rail – Detected Outside of Maintenance Inspections.* All railways within the ONRSR's area of operation.

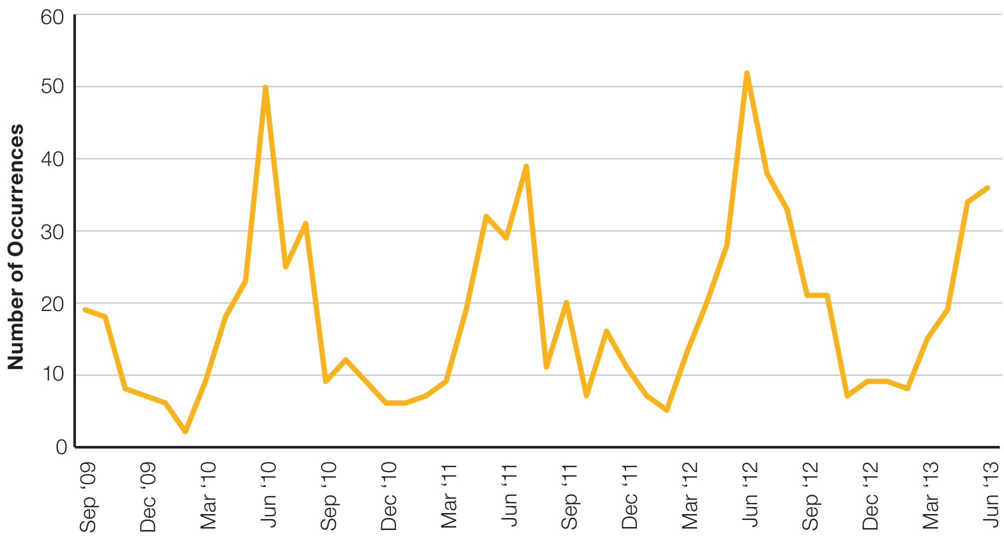


Figure 13 shows the monthly count of notified broken rails since 2009. The number of broken rails reported in the 2012–13 period is consistent with historic data. A strong seasonal pattern is evident with more breaks occurring during the cooler months of the year. The seasonality is consistent over time and reflects seasonal increase in stresses associated with rail contraction during very cold weather at which times the rail is more likely to break under load from rolling stock.

While broken rails are most certainly a precursor of passenger train derailment, the measured rate of broken rails should not be assumed to be directly proportional to the probability of a derailment. Factors such as the location and nature of breaks, methods of detection (routine inspection or chance observation), can all affect the rate of detection and, by extension, the likelihood a break results in a derailment. Nevertheless, as an overall indicator it has value.

TRAIN OBSTRUCTION

The derailment risk associated with track obstruction effectively involves three distinct events – a track obstruction, a train hitting the obstruction and finally one or more train wheels leaving the rail as a result of collision force. So while understanding the frequency and types of obstructions is important, any relationship between the frequency of the initiating event (an obstruction) and the outcome (train derailment) is complicated by various scenarios associated with the multi-event nature of this risk.

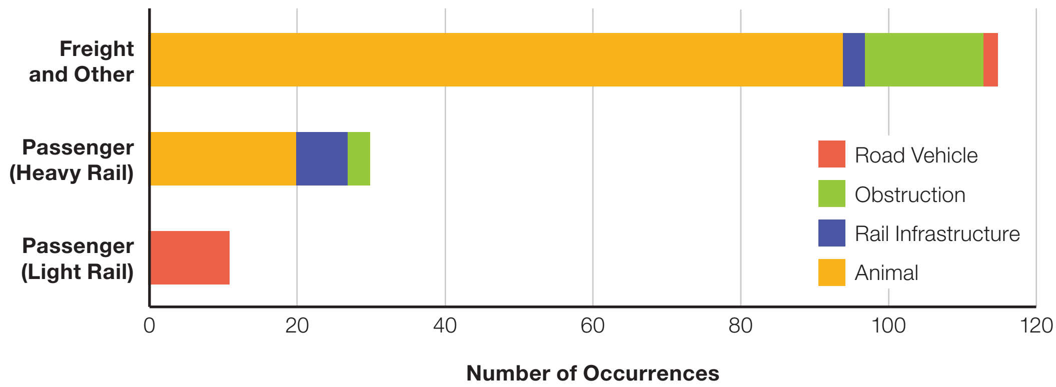
There were 880 occurrences involving trains hitting obstructions on running lines in 2012–13. This figure includes incidents across several notional occurrence categories including out of gauge infrastructure and animals. It also includes several occurrences in which a train struck, or was struck, by an out of gauge item on a train passing on an adjacent line, for example, an open container door or loose load fastenings.

Under the broad definition of collision within the national classification scheme, there is a tendency to notify and code any incident where a train makes contact with an object. Consequently, the category includes many events that pose no direct threat to safety and little chance of escalation. Common examples of notified occurrences include trains hitting small objects such as umbrellas, thin branches and birds.

A manual review of occurrences notified in 2012–13 was completed to identify the objects that primarily contribute to this risk (i.e. exclude the smaller objects that pose little risk). A summary of these incidents is shown in Figure 14.

Figure 14: Train collision with 'large' object, 2012–13

Excludes smaller objects and animals unlikely to pose a significant collision risk. *Freight and Other*, includes road/rail vehicles, on-track infrastructure maintenance vehicles and light engines.



Fewer than 20% of notified occurrences involve 'large' objects, i.e. those of sufficient size or mass to pose damage or derailment risk. Of course this depends on the relative mass of the train and objects, shape, nature and position of obstruction. For example, *Animal* in Figure 14 includes cattle and other animals of equivalent or larger size (in May 2012, a freight train derailment in NSW resulted from a collision with a cow). Similarly, *Obstruction* was limited to large trees or objects of equivalent size (size information is not always clear from the occurrence record so the reliability of these numbers is lower than other types of obstruction).

As noted previously, monitoring of derailment risk must consider the multi-step nature of this event. In addition to collisions between trains and track obstructions, there have been several significant events that have not escalated to a train collision but for which the potential consequences of collision may have been significant. Selected examples of these types of incidents are summarised in Table 17. Of particular note is a major landslip at Harris Park on Sydney's MRA on 30 June 2013 after heavy rain.

Table 17: Track obstructions not involving a train collision, July 2012 to June 2013
Selected occurrences only — examples on or potentially affecting safety of passenger lines. Network in brackets.

DATE	LOCATION	DESCRIPTION
6 August 2012	Eden Hills, SA (DIRN and Urban Passenger)	Driver of passenger train on broad gauge line reported rock slide onto adjacent standard gauge line.
1 September 2012	Mile End, SA (DIRN and Urban Passenger)	Speeding road vehicle crashed through boundary fence and rolled down onto rail lines obstructing standard and broad gauge lines.
26 November 2012	Alice Springs South, NT (DIRN)	Crew pulled up freight train due to four wheel drive stuck and obstructing the rail line.
4 November 2012	Beecroft, NSW (MRA)	Driver reversed car through boundary fence and into rail corridor blocking the rail line.
29 December 2012	Bundanoon, NSW (DIRN)	Car collided with bus shelter and both were obstructing the main line. Emergency transmission to halt trains approaching location.
5 June 2013	Riverstone, NSW (MRA)	Driver of car entered rail corridor at level crossing and turned onto rail line.
30 June 2013	Harris Park, NSW (MRA)	Embankment wall collapsed causing large earth slip onto rail lines at train station.

3.3.4 COLLISIONS BETWEEN TRAINS INVOLVING A PASSENGER TRAIN

Collisions between trains – involving a passenger train includes three types of hazardous event in the UK risk report:

- collisions between two or more passenger trains
- collision between a passenger train and non-passenger train (initiated by the passenger train)
- collision between a non-passenger train and passenger train (initiated by the non-passenger train).

Collisions involving passenger trains are complex events with a range of potential outcomes. Firstly, the type of collision – head on, rear end or side – can arise in different circumstances according to the nature of the signalling systems in use, the presence of points etc. Furthermore, factors including speed, point of impact, train loading, presence (or otherwise) of dangerous goods and fuel sources all contribute to the potential consequences of any accident. Thus, describing these events in terms of precursors is not straightforward.

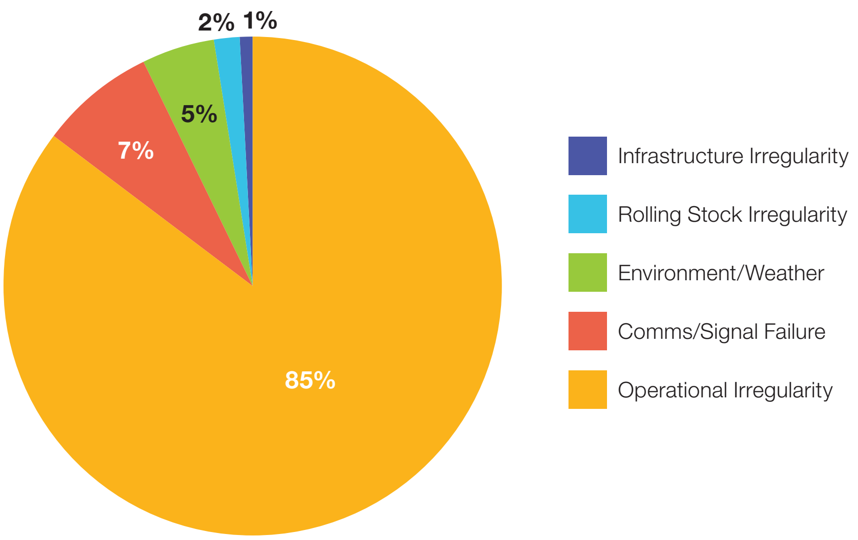
A total of 83 individual precursors were listed in the UK risk report. Each was assigned to one of five summary precursor groups as follows:

i. **Infrastructure irregularity:** track defects, rail contamination
ii. **Rolling stock irregularity:** braking system failures, traction control failure, other defects
iii. **Operational irregularity:** SPADs, driver/shunter/train crew/signaller errors, mis-communication, operators violations of rules, runaways
iv. **Communications/signalling failure:** wrong side signalling system failures
v. **Environment/weather:** obstruction to infrastructure caused by vegetation, and other environment condition.

Mapping the risk estimates from the UK risk report to these five groups gives their respective contributions to the risk of passenger train collision, as shown in Figure 15.

Figure 15: Risk contribution for collisions involving passenger trains in the UK

Source is Risk Profile Report Version 7.5. Refer Appendix B.



Operational irregularities represent the largest contributor to the risk of collisions involving passenger trains (85%) in the UK. In a similar approach to passenger train derailment considered earlier, local occurrence data related to this precursor group was examined in greater detail and three sets of analyses have been undertaken:

- authority exceedance (including Signals Passed at Danger)
- irregularities in the issuing of an authority
- runaway.

AUTHORITY EXCEEDANCE

Critical to safe train control is the use of systems to grant authority to permit train movements. Within ONRSR's area of operation, authority systems range from state of the art computer-based signalling systems to manual train orders.

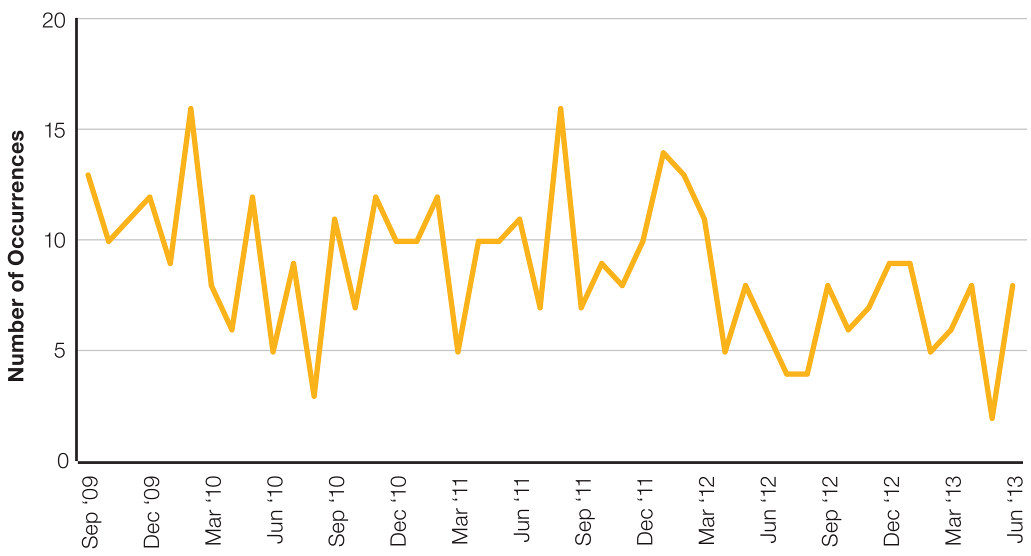
Authority exceedances can be caused by a range of factors, from operational issues (such as driver errors, deliberate violations or issuing of incorrect authorities), through to mechanical failures of rolling stock (such as braking systems). A number of key categories of authority exceedance events are analysed below.

Signals Passed at Danger (SPAD)

A SPAD is a specific form of authority exceedance and involves a train passing a lineside signal which has an indication of "danger" without authority.[43] The number of SPADs per month since September 2009 for New South Wales and South Australia are shown in Figure 16. The vast majority of these are associated with the MRA in New South Wales, which has exhibited a significant decrease in SPAD counts over time.

Figure 16: Signal Passed at Danger – Passenger Trains, September 2009 to June 2013

Monthly total occurrences. OC-G1 classes *Driver Misjudged, Completely Missed While Running* and *Start Against Signal*. NSW and SA data only. Excludes tourist and heritage operators.



43. In some limited cases, a lineside signal may indicate danger (stop) and the signaller may permit the driver to proceed past the signal – such instances are not included here

Other authority exceedances

Movement authorities are routinely given where there is no system of fixed signals in place. These authorities may place a specific geographic limit on the movement of a train, and are intended to protect the train itself or the section of track beyond the limit from the train entering. This limit may be imposed either due to the presence of another train, track workers or some other issue.

Some irregularities involving proceed authorities are more serious than others. The severity of an incident is often defined in terms of how close the event came to becoming an accident, and what potential consequence may have arisen from any such accident. Table 18 presents examples of proceed authority irregularities over the past five years which posed a significant threat of escalation.

IRREGULARITIES IN THE ISSUE OF AN AUTHORITY

As well as the exceedance of limits of authority by train crew, there are a range of operational irregularities associated with the issuing of authorities that are significant contributors to collision risk. These so-called 'false authorities' include wrong side failures of signalling and rolling stock systems, track circuits failing to detect the presence of trains and controllers issuing conflicting authorities. Like authority exceedances, these failures can sometimes result in a train entering a section of track already occupied by another train. Several examples of these types of incident are shown in Table 18.

RUNAWAYS

Runaway trains are a rare event but when they occur can have devastating consequences. In the early hours of 6 July 2013, a 74 car freight train carrying crude oil in Lac-Mégantic, Canada, ran away and derailed leading to a fire and explosion that killed at least 42 people.

The UK risk report estimates 26% of the risk associated with collisions involving passenger trains relates to runaway trains, the majority of which is associated with the runaway of a non-passenger train which subsequently collides with a passenger train.

Table 18 lists some notable runaways from recent years in ONRSR areas of operation. Local conditions can have a significant influence on the likelihood of runaways, for example, steep gradient of lines as noted in the last two examples of Table 18. Specific features of rail infrastructure will also influence the risk associated with a runaway event (for example, presence of catch-points to deliberately derail a runaway train and prevent escalation). The ONRSR uses available information on these types of factors to highlight particular locations of vulnerability on the network.

Table 18: Irregularities involving proceed authorities, 2008–09 to June 2012–13
Selected occurrences only — examples of proceed authority exceedances (other than SPAD), authority system irregularities and runaway trains potentially affecting safety of passenger lines.

DATE	LOCATION	CATEGORY	DESCRIPTION
		Authority Exceedance	
28 October 2009[1]	Ashfield, NSW	Safeworking Breach – Wayside Signalling	Empty passenger train commenced a movement in the wrong running direction bringing it into a conflicting movement with an approaching loaded passenger train.
26 November 2012	Tarcoola, SA	Proceed Authority Exceedance	Freight train departed Tarcoola exceeding the limit of the train authority. Train instructed to stop. Another freight train in an opposing movement also required to stop.
		False Authority	
14 January 2009[1]	Tarana, NSW	Safeworking Breach	Two passenger trains given authority to occupy same section of track. Drivers of both trains saw conflicting movement and stopped trains 524 m apart.
12 November 2009[1]	Cootamundra, NSW	Signal/PA System Irregularity	Signal design fault led to an intercity passenger train being put into conflicting movement with freight train.
10 February 2010[1]	Manildra, NSW	Safeworking Breach Communication System	Empty passenger train was authorised to travel on the mainline through Manildra Yard despite a freight train already standing on the mainline.
17 June 2010[1]	Moss Vale, NSW	Safeworking Breach	Network controller gave passenger service authority to pass signals at stop and enter a section of track occupied by a light locomotive.
5 March 2012	Ferguson, SA	Safeworking Breach Communication System	A network controller issued an authority for a passenger train to proceed to a location different to that intended. The line was clear to the intended location but not to the authorised location.
		Runaway	
7 February 2011[1]	Unanderra, NSW	Signal Passed at Danger	Driver of loaded freight train unable to control the speed of train coming down steep grade. Train passed a signal at stop without authority by 527 m.
5 July 2012	Unanderra, NSW	Signal Passed at Danger	Driver of loaded freight train unable to control the speed of train coming down steep grade. Train passed a signal at stop without authority by 400 m coming to stand on MRA mainline.

1. Subject of compliance investigation by ITSR

3.3.5 FUTURE APPLICATION OF PRECURSOR ANALYSIS

This section has briefly analysed the precursors of two important hazardous events on Australian railways – passenger train derailment and passenger train collision. Even at this summary level, the exercise has highlighted limitations of the existing Australian dataset and incident reporting framework for this type of task. Utilising UK risk estimates is helpful to determine those precursors of most significance, but this comes with a number of issues of applicability, given the various differences between the Australian rail network and that of the UK.

While the national occurrence classification scheme collects some data on precursors, it is insufficient to fully analyse the root causes of low frequency and potentially high consequence events, and in turn determine the risk contributors of precursors to risk. Achieving more robust and meaningful precursor analysis in Australia requires a framework that is targeted at collecting data aligned to the requirements of a national risk model. This means that some events currently reported will require additional detail in order to better understand the precursors (supported by formal integration with the relevant information sources). Equally, the reporting requirements for some relatively minor events could reasonably be scaled back. The key point is that the current classification framework will need to change.

In advance of a national solution to a risk-based data collection framework, and given the potentially catastrophic outcomes associated with these types of events, it is appropriate that rail transport operators collect and use failure data available within their own organisations and that of their suppliers to better understand and manage the precursors of these events.

4.0 REGULATORY OUTLOOK

Data is a core foundation to effective risk-based regulation. The data collected by the ONRSR is used for regulatory purposes in four ways:

i. at a national level, to assist in the development of the ONRSR national audit plan, for the development of safety improvement initiatives and in priority setting with RISSB on the projects for which the ONRSR and RISSB will work collaboratively

ii. at a branch, jurisdiction or sector level. In cases where issues relate to a particular aspect of the industry (such as a specific operation, asset or location), operational effort is focussed accordingly

iii. at a rail transport operator level. Data is collected and analysed to identify and act on the issues pertinent to particular operators

iv. for the purpose of compliance and investigation activity where serious breaches of the RSNL are suspected.

The ONRSR's regulatory philosophy is set out in its Regulatory Approach[44], and Compliance and Enforcement Policy.[45]

44. ONRSR, *ONRSR Regulatory Approach*, July 2013
45. ONRSR, *Compliance and Enforcement Policy*, version 2, September 2013

The 2013–14 regulatory work plan includes a range of safety improvement initiatives including collaboration with industry on standards and guidance, and focus of audit and inspection resources for the year. The detailed work plan was developed using a range of inputs including, but not limited to:

- Analysis of rail transport operator safety performance
- Previous audit and compliance findings (prior to the start of the 2013–14 financial year, the ONRSR undertook 68 audit and compliance activities and 30 investigations)
- Changes to working arrangements notified by rail transport operators
- Applications for new or variations to accreditations
- Obligations to governments to review the effectiveness of specific rail safety provisions in law, such as fatigue risk management and drug and alcohol testing.

The work plan is varied and has been developed cognisant of historical data. The ONRSR will reflect upon the findings from the analysis in this report and will amend its priorities, detailed work plan and approach to issues as it sees necessary. The ONRSR has a number of established fora in which it can debate, discuss and advise industry of its approach and priorities.

The ONRSR plans to visit every accredited rail transport operator at least once per year. The work plan and priorities include, but are not limited to:

- Public safety in underground commuter railways
- Rail transport operator arrangements for contractors undertaking work on their behalf
- Engineering management systems for significant rail projects, including focus upon integration of human factors consideration into the design
- Rail transport operator approaches to safeworking, including:
  - Competence and training of rail safety workers
  - Fatigue risk management
  - Compliance with rules and procedures including safety critical voice communications
  - Track worker safety including safeworking practices in the field.
- Safety management system compliance including approaches to human factors obligations
- Drug and alcohol testing and an assessment of its overall effectiveness
- Development of a safety management system maturity tool
- Development of asset management guidance
- Development of a level crossing policy and strategy
- Education and compliance enforcement of road/rail vehicle safety.

The ONRSR also responds to incidents, accidents and third party investigation reports and undertakes its own formal investigations into potential breaches of the RSNL. It treats the safety responsibilities of rail transport operator senior executives extremely seriously. The ONRSR has, and will continue, to discuss safety concerns with Chief Executives, as well as maintaining the normal channels of communication with nominated safety personnel in organisations.

The ONRSR will use its safety data on an ongoing basis to inform its operational priority setting by providing alerts on risks of particular concern. In practical terms this means that the work plan is constantly reviewed and resources are reallocated to meet emerging operational priorities and in light of increasing understanding and insights into the Australian rail safety risk profile.

APPENDIX A: DATA TABLES

Under Regulation 57 of the Rail Safety National Law (see Appendix D), rail transport operators are required to notify the ONRSR of defined rail safety occurrences.

Statistical summaries of certain categories of notifiable occurrences and periodic information have historically been reported by the Australian Transport Safety Bureau (ATSB) in its bi-annual Australian Rail Safety Occurrence Data transport safety report.

For completeness of this report the ONRSR has included raw counts of reported occurrences and periodic information for the categories previously reported by the ATSB. This information has either been notified to the ONRSR or to its predecessor regulators in the financial year 2012/2013. The ONRSR provides no commentary upon this data other than to note the following:

1. The major presumed contributors to rail safety risk have been identified, presented and discussed in the main body of this report and some level of data verification has taken place in regard to that data presented
2. No level of data verification has been undertaken in regard to the data in this appendix, except where these figures have also separately been reported in the body of this report. Extreme care should be taken in the use of this data
3. The categories of occurrences in OC-G1 are often broad and include events of both major and minor significance
4. As part of its future work program, the ONRSR will progressively cleanse historical data where it is seen as important.

Table A1: Annual count of notifiable occurrences, July 2012 to June 2013

Data is for all rail operations including heavy rail, light rail and isolated tourist and heritage operators. Categories are aligned to those previously reported by the ATSB and are based on notifiable occurrence categories of OC-G1 (2013). There are significant quality issues associated with this data and readers should refer to accompanying notes regarding data quality.

CATEGORY		SA	NSW	TAS.	NT
Fatality – passenger		0	1	0	0
Fatality – workforce		0	0	0	0
Fatality – public[1]	**Total**	4	23	0	0
	suspected suicide	(1)	(22)	(0)	(0)
Derailment – running line		14	32	6	3
Collision – running line – between trains		1	5	1	0
Collision – running line – with rolling stock		0	0	0	0
Collision – running line – with person		3	30	0	0
Collision – running line – with infrastructure		4	26	1	0
Collision – running line – with road vehicle		9	4	0	0
Level crossing collision – with road vehicle		2	5	1	0
Level crossing collision – with person		1	0	0	0
Signal passed at danger without authority (driver misjudged, completely missed, start against signal)		28	164	0	0
Signal passed at danger without authority (signal restored as train approached)		30	276	0	0
Load irregularity (door open, load shift, out of gauge, uneven distribution of load, lashings loose)		183	222	3	11
Track and Civil Infrastructure Irregularity (broken rail – detected outside of maintenance inspection; misaligned track)		128	548	57[2]	12
Passenger train kilometres (million km)		5.061	44.989	0.045	0.212
Freight train kilometres (million km)		8.914	19.901	0.825	1.520
Track length (as at June 2013) (kilometres)		4,749	10,096	896	1,740

1. Includes fatalities associated with trespass and suspected suicide
2. Includes irregularities detected during track inspections and irregularities on lines other than running lines

APPENDIX B: SCOPE AND METHODS

Geographic coverage: except where explicitly stated, all descriptions and statistics in this report apply only to those railways within the ONRSR's area of operation as of 30 June 2013 — South Australia, New South Wales, Tasmania and Northern Territory.

Reporting period: a minimum reporting period of 1 July 2012 to 30 June 2013 was chosen for this report to align with the final national safety statistics bulletin produced by the Australian Transport Safety Bureau[1] (selected incident statistics for the period to the end of June 2012).

Longer term data was obtained to examine incident trends over time. A maximum period of five years was chosen to align with the start of the revised national incident reporting[2] and classification[3] framework in July 2008. From that time, occurrence reporting and classification was relatively consistent across Australia.

Data sources: rail incident statistics are based on occurrence notifications — the initial written advice of a rail safety incident that a rail transport operator must submit to the ONRSR in accordance with the section 121 of the RSNL. The scope of incidents defined as "notifiable occurrences" under the RSNL is summarised in Appendix D. The specific information rail transport operators provide in a notifiable occurrence report is defined in ON-S1 (2013)[4].

Activity data (e.g. train km travelled, number of passenger journeys) is based on monthly periodic returns supplied by rail transport operators in accordance with section 120(3) of the RSNL. The specific information to be provided is defined in regulation 57 of the National Regulations.

Notifiable occurrence and activity records have been obtained from various sources including:

- Original notifications and periodic returns submitted to the ONRSR by rail transport operators.
- Incident databases of states and territories
    - NSW: PRISM database maintained by the NSW Independent Transport Safety Regulator
    - Tasmania: incident records maintained by the Tasmanian Department of Infrastructure Energy and Resources
    - SA and NT: summary incident reports generated from SA Department of Planning, Transport and Infrastructure's RSOD database (SA from September 2009; NT from January 2011); NT: locally held incident summary (to December 2010). SA occurrence data prior to September 2009 was not available for this report.

Data Preparation: data was compiled centrally. Initial preparation included: combining data from individual sources (within and across jurisdictions); confirming data fields and content with suppliers; identifying/removing duplicate records (both within and between overlapping sources); correcting obvious anomalies (e.g. dates in the future, removing occurrences in non-ONRSR jurisdictions).

1. Australian Transport Safety Bureau (ATSB), *Australian Rail Safety Occurrence Data*, 1 July 2002 to 30 June 2012, ATSB Transport Safety Report, RR-2012-00, ATSB, Canberra, 2012
2. Rail Safety Regulators Panel, *Guideline for the Reporting of Notifiable Occurrences: Occurrence Notification – Standard One (ON-S1)* RSRP, July 2008
3. Rail Safety Regulators Panel, *Guideline for the Top Event Classification of Notifiable Occurrences: Occurrence Classification – Guideline One (OC-G1)*, RSRP, July 2008
4. Office of the National Rail Safety Regulator, *ONRSR Guideline: Reporting Notifiable Occurrences - Occurrence Notification – Standard (ON-S1) (ONRSR, 2013)*

A master dataset was created for each of the four jurisdictions. For each data set, a process of data checking was performed, focussing on the records and fields relevant to occurrences of interest (primarily derailment, collision, fire, level crossing collision, fatal incidents). The main tasks were:

- Identifying multiple notifications of a single occurrence: some data sources did not identify multiple records of a single occurrence. In order to avoid double or triple counting, records were manually reviewed to identify these cases and exclude them from the analysis. In some cases the ability to reliably identify such cases was not possible due to limited data.
- Occurrence classification: for some sources, top event category values were either not available, not coded fully (e.g. coded to parent category only) or were something other than the national incident classes. These incidents were classified based on information available for the record.
- Entry of other category-based data: some records / sources did not include category values for occurrence-related data items such as fatality, injury, person type, train type. These items were coded based on details in the incident description. In some cases, other information was sourced from staff from individual jurisdictions with knowledge of data/incidents.
- Activity data: the same principles described above were applied to activity data. However there were gaps in the historical record for some aspects of activity data (e.g. certain operations, periods of time). Missing data was in-filled by various means including estimating from adjacent periods, use of annual activity estimates for 2013–14 submitted by rail transport operators.

Key data items for each record (OC-G1 category, train type etc.) were then cross validated against other information within the record. All obvious errors were corrected. Further information was sought in some instances (e.g. investigation findings). If there was doubt over the correct value for a specific record or data item then it was left as supplied.

Even though all data was collected and coded against a single reporting and classification framework there was significant variation in coding between sources. Some issues were specific to certain aspects of data such as inconsistencies in the identification and grading of injury, and in the sub-classification of Derailment and Collision occurrences as Running Line or Yard. More generally, there were multiple instances of incidents not appearing to correspond with the assigned occurrence category and events that did not appear to be notifiable occurrences as defined in the RSNL or supporting guidance.

Definitions: most statistical summaries presented in the body of this report are based on top event occurrence classes of the national occurrence classification guideline, OC-G1. The guideline was revised in January 2013, however, definitions for the subset of occurrence categories presented in this report have not changed between the 2013 and the previous 2008 version.

Some statistics and analysis are based on forms of categorisation developed specifically for this report, to support a more meaningful analysis of critical events and to align with the risk-based approach of the report. These are generally described in the report itself but include:

Collision between trains excludes collisions that involve out of gauge equipment, loads or other items on one train striking another train passing on an adjacent line.

Non-fatal injury the national occurrence guideline defines two classes of non-fatal injury — serious injury requiring admittance to hospital; minor injury requiring medical attention but not hospital admission.
The quality of injury-related data in source files was particularly poor for several reasons:

- some sources of data used for this report did not include any injury-related fields (severity, description, person type), while others only reported injury as fatal and non-fatal

- many incidents involving injury did not include details on the nature of medical attention received. This was a particular issue for injured passengers leaving rail premises and information necessary to grade severity (i.e. whether or not the person was treated as an outpatient or formally admitted[5]) was not provided
- some serious and minor injury data is based on criteria other than hospital admission, such as workplace injury-type categories which do not align directly with the serious / minor criterion of the national reporting framework
- there was evidence of differing and sometimes broad interpretation of "injury" and instances where an injury code was provided despite injury being unlikely or absent based on the circumstances of the incident.

These types of factors made supplied injury data unsuitable for meaningful summary. For this report a criterion of ambulance transported was used as a basis to delineate more significant injuries in a consistent manner. Information to support this criterion is generally available in the occurrence description. It should be noted that this criterion is far broader (more inclusive) than the hospital admittance criterion and also could not be reliably determined in all cases.

Location: location names provided in text and in incident summary tables are the nearest recognised geographic or railway-specific location to the occurrence. The nearest recognised location will often be at some distance form the point of an occurrence, particularly in remote areas.

Strike: is defined as a train or rolling stock hitting a person.

Incidents summaries: incident summaries presented in tables are qualitative summaries only and cannot be considered representative of the true rate of incidents, causes or failure modes over time or between locations. In particular, historical compliance activity data for NSW was available via a searchable database and was one of the primary means by which examples of noteworthy incidents were identified. This form of information was not readily available for other jurisdictions so many of the specific examples presented will reflect the availability of information for NSW.

Risk-based information: the data and analyses of Sections 3.1 (Risk Overview) and 3.3 (Precursor Analysis) draw heavily on estimates of risk for UK mainline railways. The source of these estimates is the UK Rail Safety and Standards Board's (RSSB) Safety Risk Model. The ONRSR did not have access to the model for this report but used summary outputs made available on the UK RSSB website (http://www.safetyriskmodel.co.uk), in particular:

- Risk contributions of Table 3 and the precursor analysis section were taken from spreadsheet RPB1.xlsx (downloaded October 2013).
- The incident rate statistics for the UK (Section 3.2) were based on the RSSB's Safety Risk Model: Risk Profile Report Version 7.5. Issue 1.1, RSSB, UK, March 2013.

Comparability with other sources of information: the incident-related statistics presented in the main body of this report may differ to those reported elsewhere. This will be due in part to the specific data collection and preparation methods used for this report, which included identification and correction of some longstanding and significant errors in historical data. The statistics presented in this report may be subject to future change as the ONRSR develops and refines its systems for data capture, validation and reporting.

5.Suggests a considerable proportion of people presenting at hospital will be admitted

APPENDIX C: GLOSSARY

SOURCE OF DEFINITIONS

Most definitions have been sourced from the national occurrence classification guideline (OC-G1, 2013), the Glossary for the National Codes of Practice[7] and the Glossary of Railway Terminology[8]. Level crossing definitions are from the NSW Staysafe Committee[9]. Some descriptions may differ from definitions contained in the legislation — for compliance purposes readers should refer to section 4 (Interpretation) of the Rail Safety National Law 2012

Accreditation requirements are outlined in the Rail Safety National Law. Rail transport operators must be accredited by the ONRSR or be exempt from the requirement to be accredited under the Law. The granting of accreditation indicates that a rail transport operator has demonstrated it has the competence and capacity to manage the risks to safety associated with the railway operations for which it is accredited.

Ballast refers to material, usually stone, that surrounds the sleepers to hold them in place.

Bank locomotive is an additional locomotive provided at the rear of a train to assist it up a steep hill.

Broad gauge is track gauge of 1600 mm (5'3").

Buffer stop is a structure erected across and at the end of a track at main line terminals or dead end sidings which is intended to stop rolling stock.

Catchpoints are single or double bladed points used to derail rail traffic that might enter or foul an adjacent running line.

Consist is the listed order of the vehicles arranged to make up a complete train.

Electric multiple unit is a multiple-unit passenger train in which the propulsion power is provided by electric power supplied from an external source such as overhead wires.

Freight trains are designed and used for carrying goods such as coal and minerals, grain, fuel, livestock and containers.

Hi-rail is a vehicle that is capable of running on both road and rail. Often these are standard road vehicles that have a pair of flanged rail wheels on the front and rear.

Infrastructure generally includes the track and its components, for example, rails, sleepers, bridges, ballast, and signalling equipment. Generally the term does not include stations or terminals.

Intermodal is freight moving via at least two different modes of transport such as rail to road, rail to sea. The usual form of intermodal freight is containerised freight.

Level crossing is any crossing of a railway at grade, providing for both vehicular traffic and other road users including pedestrians. The control of railway crossings is classified as either active or passive according to the following criteria:

- active control – control for the movement of vehicular or pedestrian traffic across a railway crossing by devices such as flashing signals, gates or barriers, or a combination of these, where the device is activated prior to and during the passage of a train through the crossing
- passive control – control for the movement of vehicular or pedestrian traffic across a railway crossing by signs and devices, none of which are activated during the approach or passage of a train and which rely on the road user, including pedestrians, detecting the approach or presence of a train by direct observation.

In addition to actively and passively controlled crossings there are also *occupational* or *accommodation* crossings between private property and public roads, maintenance crossings and illegal crossings.

Light locomotive(s) means one or more locomotives coupled together without any non-powered vehicles attached.

Narrow gauge is the track gauge of 1067mm (3'6").

National Regulations means the *Rail Safety National Law National Regulations 2012*, approved by the Standing Council on Transport and Infrastructure and made under the Rail Safety National Law.

Near miss is any occurrence where the driver of a moving train takes emergency action, or would have if there was sufficient time, to avoid impact with a person, vehicle or other obstruction and no collision occurred. Emergency action includes continuous audible warning and/or brake application.

Network rules are rules issued to mandate the requirements for safe operation on a rail network.

Net tonne-kilometres is a measure of the payload of wagons (the net tonnes) multiplied by the distance travelled.

Passenger journeys in urban areas measures the number of point to point journeys for each passenger, irrespective of the number of vehicles or mode used for the trip. For non-urban areas, it measures the number of point to point journeys for each passenger, but each change of vehicle along the route is a separate journey.

7. Australasian Railway Association, *Glossary for the National Codes of Practice and Dictionary of Railway Terminology*, ARA, May 2009
8. Rail Industry Safety and Standards Board, *National Guideline, Glossary of Railway Terminology*, Version 1.00, RISSB December 2010
9. NSW Staysafe Committee, *Report on updating progress on railway level crossing safety*, rep. no. 254/09, Staysafe Committee, Parliament of NSW, June 2009

Passenger trains are trains designed and used for carrying passengers.

Rail infrastructure manager is the person who has effective control and management of rail infrastructure of a railway, whether or not the person owns the rail infrastructure or has a statutory or contractual right to use the rail infrastructure or to control, or provide, access to it.

Rail Safety National Law means the law which has been enacted as a Schedule to the *Rail Safety National Law (South Australia) Act 2012* (SA).

Rail safety worker is an individual who has carried out, is carrying out or is about to carry out rail safety work. Rail safety work is defined in section 8 of the Rail Safety National Law.

Rail transport operator is a rail infrastructure manager, a rolling stock operator, or both.

Risk is the effect of uncertainty on objectives. Risk is often expressed in terms of a combination of the consequences of an event and the associated likelihood of occurrence.

Road/rail vehicle is a vehicle that is capable of running on both road and rail. Often these are standard road vehicles that have a pair of flanged rail wheels on the front and rear.

Rolling stock means any vehicle that operates on or uses railway track.

Rolling stock operator is a person who has effective control and management of the operation or movement of rolling stock on rail infrastructure for a particular railway, but does not include a person merely because the person drives the rolling stock or controls the network or the network signals.

Running line is railway track used primarily for the through movement of trains.

Safeworking system is an integrated system of operating procedures and technology for the safe operation of trains and the protection of people and property on or in the vicinity of the railway.

Shunt is to move trains or vehicles on lines for purposes other than through movement.

Siding is a portion of railway track, connected by points to a running line or another siding, on which rolling stock can be placed clear of the running line.

Standard gauge is the name given to the gauge of track of 1435mm (4'8½").

Terminal is a place where freight is loaded onto or unloaded from trains. A passenger terminal is a place where passenger trains commence or terminate for passengers to board or alight.

Track maintenance vehicle is a specialised piece of rail-bound rolling stock used to maintain infrastructure.

Train is two or more units of rolling stock coupled together, at least one of which is a locomotive or other self propelled unit; or a unit of rolling stock that is a locomotive or other self propelled unit.

Train kilometre refers to the total kilometres travelled by a rolling stock operator's trains.

Train order is an instruction issued by the Train Controller using a computerised system that maintains blocking facilities against the issue of main orders for conflicting movements and occupancies.

Wrong side failure refers to a failure in the signalling system which results in the signal displaying a less restrictive aspect than required, for example, showing a proceed indication when the correct indication should be stop.

Yard is a network of railway tracks and sidings for marshalling, storage, and/or maintenance of locomotives, engines or wagons.

APPENDIX D: NOTIFIABLE OCCURRENCES

Under the Rail Safety National Law 2012 (section 121), rail transport operators are required to report to the Regulator, or another authority specified by the Regulator, all notifiable occurrences that happen on, or in relation to, the operator's railway premises or railway operations.

Notifiable occurrences are defined in the Rail Safety National Law 2012 (section 4) as any accident or incident associated with railway operations (a) that has, or could have, caused significant property damage; or serious injury; or death; or (b) that is, or is of a class that is, prescribed by the national regulations to be a notifiable occurrence or class of notifiable occurrence.

For the purposes of reporting notifiable occurrences, regulation 57 of the National Regulations defines the following notifiable occurrence classes:

Category A

i. an accident or incident that has caused death, serious injury or significant property damage

ii. a running line derailment

iii. a running line collision between rolling stock

iv. a collision at a road or pedestrian level crossing between rolling stock and either a road vehicle or a person

v. a suspected terrorist attack

vi. an accident or incident involving a significant failure of a safety management system that could have caused death, serious injury or significant property damage

vii. any other accident or incident likely to generate immediate or intense public interest or concern

Category B

i. a derailment, other than a running line derailment

ii. a collision involving rolling stock, other than a collision described in paragraph (a) (iii) or (iv)

iii. an incident at a road or pedestrian level crossing, other than a collision described in paragraph (a) (iv)

iv. an incident in which a vehicle or vessel strikes an associated railway track structure

v. the passing of a stop signal, or a signal with no indication, by rolling stock without authority

vi. an accident or incident where rolling stock exceeds the limits of authorised movement given in a proceed authority

vii. a rolling stock run-away

viii. a failure of a signalling or communications system that endangers, or that has the potential to endanger, the safe operation of trains or the safety of people, or to cause damage to adjoining property

ix. any slip, trip or fall by a person on railway premises

x. a person being caught in the door of any rolling stock

xi. a person suffering from an electric shock directly associated with railway operations

xii. any situation where a load affects, or could affect, the safe passage of trains or the safety of people, or cause damage to adjoining property

xiii. an accident or incident involving dangerous goods that affects, or could affect, the safety of railway operations or the safety of people, or cause damage to property

xiv. any breach of a network rule

xv. any breach of the work scheduling practices and procedures set out in the rail transport operator's fatigue risk management program

xvi. the detection of an irregularity in any rail infrastructure (including electrical infrastructure) that could affect the safety of railway operations or the safety of people

xvii. the detection of an irregularity in any rolling stock that could affect the safety of railway operations

xviii. a fire or explosion on, in, or near, rail infrastructure or rolling stock that endangers the safety of railway operations or the safety of 1 or more people, or causes service terminations or track or station closures

xix. any incident on railway property where a person inflicts, or is alleged to have inflicted, an injury on another person

xx. a suspected attempt to suicide

xxi. the notification that a rail safety worker employed by a rail transport operator has returned a result to a test designed to determine the concentration of drugs or alcohol in a sample of breath, blood, oral fluid or urine that suggests that the worker was in breach of a relevant safety requirement concerning the use of drugs or alcohol at a relevant time

xxii. the infliction of wilful or unlawful damage to, or the defacement of, any rail infrastructure or rolling stock that could affect the safety of railway operations or the safety of people

xxiii. a security incident associated with railway premises that affects the safety of railway operations, including an act of trespass, vandalism, sabotage or theft that could affect the safety of railway operations.

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