OFFICE OF THE national rail safety regulator

Fatigue Risk Management Review Discussion Paper

May 2018

safe railways for Australia

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1 Introduction

ONRSR is currently undertaking a review of the fatigue risk management requirements under *the Rail Safety National Law* (RSNL) as requested by Ministerial Council. The purpose of this discussion paper is to seek stakeholder input to help inform the development of the most appropriate regulatory framework for the management of fatigue under the RSNL.

In doing so, the paper has drawn on research undertaken nationally and internally and also provides context into the operations, investigations and regulatory activities undertaken since the commencement of the RSNL.

Stakeholder input will be considered in forming the framework upon which the final recommendations are made for consideration by the Transport and Infrastructure Council (Ministerial Council) in May 2019.

2 Background

In May 2012, prior to the commencement of the RSNL and National Regulations, Ministerial Council noted that the National Regulations would allow NSW to supplement the risk based approach with prescribed outer limits for hours of work and rest for rail safety workers who drive trains.

Ministerial Council also agreed that a further review of fatigue arrangements be undertaken by the National Regulator within three years from the commencement date of the National Regulator. Since the decision of May 2012 by Ministerial Council, the timeframe for the review was extended recognising the time it has taken for all jurisdictions to transition to the RSNL and the complexity of the task of reviewing fatigue risk management requirements and practices in the rail industry.

Also conditional of Queensland joining ONRSR was the acceptance into the RSNL of fatigue provisions which had previously been passed by the Queensland Parliament but had not been implemented. These included prescribed outer limits of hours of work and rest for train drivers in Queensland, however the requirements are different to those included by NSW.

The objectives of the fatigue risk management review are to:

- examine current fatigue risk management legislation and policies to determine the appropriateness and effectiveness of different requirements prescribed within the RSNL;
- consider leading practice approaches to the regulation of fatigue risk for all rail safety workers, particularly within a co-regulatory model;
- assess options for fatigue risk management in terms of safety and regulatory burden on industry; and
- recommend a consistent national regulatory approach.

The scope of the review includes:

- Examination of the degree to which fatigue is a risk factor for rail incidents;
- Assessment of the effectiveness of rail transport operators in managing the fatigue risk on rail safety workers while operating under the national law and NSW’s specific provisions;
- Investigation into current and innovative fatigue risk management frameworks and research:
    - o from Australia and overseas; and
    - o from within and outside the rail industry;
- Development of options for an effective legislative framework to reduce the safety risks arising from fatigue;
- Assessment of the current legislative framework against the recommended option.

In terms of what is out of scope for the review, ONRSR and stakeholders agreed that while the review may recommend legislative change, the process for implementing such change would be addressed following a Ministerial Council decision.

In progressing the review to date, ONRSR has worked with a Fatigue Review Reference Group, comprising representatives from the rail industry, ARA, RTBU, governments and independent experts: Professors Drew Dawson and Ann Williamson.

The review has also been guided by COAG endorsed principles of best practice regulation, and references the research and recommendations of the Independent Expert Panel on Rail Safety in 2011 (the Expert Panel) and the recommendations of the *Rail Safety National Law Fatigue Risk Management – Hours of Work and Rest Regulatory Impact Statement* prepared by the National Transport Commission.

3 How information you provide will be used

Your response to this discussion paper will assist with the development and analysis of options as part of the fatigue risk management review.

Your responses will be treated as confidential. ONRSR may use concepts and ideas, and develop material for subsequent consultation but will not identify the specific proponent of the material presented. ONRSR may however identify the broader class of the proponent if this does not identify the specific individual. ONRSR will not share information that may identify a particular respondent unless explicit permission is sought by ONRSR and permission is granted by the respondent.

4 Existing requirements under the RSNL

4.1 Requirements under the RSNL

A rail transport operator's statutory obligations are to ensure, so far as is reasonably practicable (SFAIRP), that rail safety workers who perform rail safety work in relation to the rail transport operator's railway operations, do not carry out such work while impaired by fatigue or if they may become so impaired (s52(2)(d) of the RSNL). **This requirement applies to all rail safety workers**.

Rail safety workers themselves also have a responsibility under section 56 of the RSNL whereby they are required to take reasonable care of his or her own safety and that of others, which includes not undertaking rail safety work when fatigued.

Shared responsibility is also a core principle under section 50 of the RSNL. The level and nature of responsibility that a person has for rail safety is dependent on the nature of the risk that the person creates from the carrying out of an activity or the making of a decision, and the capacity that person has to control, eliminate or mitigate those risks (s50(2)).

A duty under the RSNL:

- cannot be transferred to another person;
- a person can have more than one duty by virtue of being in more than one class of duty holder; and
- more than one person can concurrently have the same duty under the RSNL and each duty holder must comply with that duty even if another duty holder has the same duty.

Rail safety duties under the RSNL apply to contract workers undertaking rail safety work. This means that 'contracting out' this duty or using exclusion clauses, is not permitted under the RSNL, unlike contracting out railway operations, which is permissible[1]. Further, while labour hire companies do not have duties under the RSNL, rail safety duties do apply to rail safety workers working under labour hire agreements with an accredited operator.

Accredited rail transport operators must have a safety management system which must include a fatigue risk management program (s99(2)(f) of the RSNL) to be prepared and implemented by the rail transport operator (s116 of the RSNL).

The fatigue risk management program must meet the requirements set out in regulation 29 of the National Regulations. Regulation 29 identifies the key fatigue related risk factors a rail transport operator must take into account when preparing a fatigue risk management program. These factors are not however exhaustive and any potential issue that may relate to fatigue must be considered by the rail transport operator as part of a thorough risk assessment process.

It is also an existing requirement under regulation 29(2) of the National Regulations that a rail transport operator must establish and maintain documented procedures to manage, SFAIRP, fatigue related risks.

Since the introduction of the RSNL, ONRSR has undertaken one safety improvement project assisting operators in managing their rail safety risk caused by fatigue likelihood. ONRSR has also provided advice on many occasions to rail transport operators to assist them in managing this risk.

It is also noted that to support rail transport operators in managing fatigue likelihood impacting on their rail safety risk and complying with the requirements for fatigue risk management under the RSNL, the Rail Industry Safety and Standards Board (RISSB) developed a guideline for its members.

4.2 Prescribed hours for train drivers in NSW and Qld

Schedule 2 of the National Regulations prescribes work scheduling practices and procedures (i.e. outer limits of work and rest) specific to NSW (Schedule 2 Part 1) and Queensland (Schedule 2 Part 2). The prescribed 'outer limits' of work and rest in Schedule 2 are only applicable to rail safety workers driving trains in prescribed circumstances and are not applicable to all types of rail safety workers. The requirements under this schedule were law (however not implemented in Queensland) in both states prior to transitioning to the RSNL.

The prescribed hours must be used in conjunction with a risk based approach as in isolation, they do not consider the totality of operational contexts such as control measures (e.g. operating under Automatic Train Protection) or the maturity of operators and their capabilities to deliver robust fatigue risk management programs. Further, they, are not applicable to all types of rail safety worker.

The requirements of Schedule 2 in NSW and Qld do not however preclude other conditions of work (such as shorter or less frequent shifts than those specified in Schedule 2) from being provided by a rail transport operator for the purposes of managing fatigue related risks. Operators within NSW and Qld are still required to undertake a risk based approach to work scheduling albeit under the prescribed outer limits of work and rest for drivers.

Rail safety workers other than train drivers in NSW and Qld, operate under a risk based system of fatigue risk management with no prescribed hours. This approach mirrors the national risk based scheme for *all rail safety workers* (including train drivers) operating in all other States and Territories.

Broadly speaking the provisions in NSW and Qld prescribe the 'outer limits' of rail safety work for train drivers relating to:

- maximum shifts lengths depending on the type of train driven (freight or passenger) and whether it is a single manning or two person operation;

[1] *Contracting in the Rail Industry: Accreditation and Safety Management Systems Guideline*, RISSB, 21 September 2017, p. 11.

- minimum break length between shifts depending on whether taken at or away from the home depot;
- maximum numbers of shifts and hours in any 14 day period;
- requirements in relation to the maximum amount of time allowed between signing on for a shift and reaching the home depot or barracks when travel is involved in getting to the home depot or barracks.

NSW and Qld are not however identical, meaning that those who operate within both jurisdictions must comply with the variations between driver scheduling leading to further jurisdictional inconsistencies. For example, NSW provides the ability for two person operations where the second person is not a fully qualified driver for a maximum of 11 hours, but in Qld the second person is required to be a qualified driver.

The variations between NSW and Qld are:

Configuration type	Variation
Freight train ***Single***	• Qld has no prescribed breaks whereas NSW has a minimum prescribed break period of not less 30 minutes between the third and fifth hour of each shift.
Freight train ***2 person***	• NSW delineates the maximum shift length hours as: o 12 hours where the second driver is a qualified train driver (including a qualified train driver who is learning a route or undergoing an assessment); and o 11 hours in the case of any other 2 person operation. • Qld only has a maximum 12 hour shift length where the second driver is a qualified train driver (including a qualified train driver who is learning a route or undergoing an assessment)
Freight train ***All rail safety workers driving freight trains***	• NSW has one hour less of a prescribed break (hours to be continuous hours) between each shift where: o Shift ends at home depot (11 hrs NSW vs 12 hrs Qld) o Shift ends away from the home depot and the break is taken away from the home depot (7 hrs NSW vs 8 hrs Qld) • In any 14 day period, both NSW and Qld have a prescribed maximum of 12 shifts. However NSW prescribes that not more than 6 of those shifts are to be 12 hours whereas in Qld there is a limit of 132 hours of work within the 12 shifts.
Passenger ***Single***	• For suburban services, NSW and Qld both have the same prescribed maximum shift length of 9 hours but Qld drivers can only drive for 8 hrs max. • The maximum shift length in NSW for interurban or long distance services is 10 hrs whereas 'any other passenger train' in Qld (that is not suburban) the maximum shift length is 9 hrs (with no limit on driving time). A one hour difference. • As per freight train drivers, Qld has a 1 hr longer (continuous) break between each shift where work ends both at the home depot or away (12 hrs at home and 8 hrs away) versus NSW (11 hrs at home depot and 7 hrs away). • In a 14 day period, NSW and Qld both have a maximum of 12 shifts but Qld prescribes a maximum amount of work hours of 132. NSW does not prescribe a maximum amount of work hours.

Passenger
2 person
	• NSW delineates the maximum shift length hours as:
	  o 12 hours where the second driver is a qualified train driver (including a qualified train driver who is learning a route or undergoing an assessment); and
	  o 11 hours in the case of any other 2 person operation.
	• Qld only has a maximum 12 hour shift length where the second driver is a qualified train driver (including a qualified train driver who is learning a route or undergoing an assessment).

Passenger
All rail safety workers driving passenger trains
	• NSW has one hour less of a prescribed break (hours to be continuous hours) between each shift where:
	  o Shift ends at home depot (11 hrs NSW vs 12 hrs Qld)
	  o Shift ends away from the home depot and the break is taken away from the home depot (7 hrs NSW vs 8 hrs Qld)
	• In any 14 day period, both NSW and Qld have a prescribed maximum of 12 shifts. However NSW prescribes that not more than 6 of those shifts are to be 12 hours whereas in Qld there is a limit of 132 hours of work within the 12 shifts.

Train drivers who are transported to home depot or rest place	Similar provisions in NSW and Qld.
Emergencies and accidents	No variations.

As demonstrated above the variations between borders can have an effect on driver rostering between jurisdictions depending on the type of configuration of drivers, train type and journey (i.e. whether the journey operates across multiple jurisdictions).

As of January 2018, there were 186 accredited operators across Australia. Forty four national operators have to work across two to three different sets of requirements if they operate both within and outside of NSW and or Qld.

In November 2016, Ministerial Council noted a review undertaken by ONRSR, relating to derogations from the RSNL, which identified over 80 derogations. Of these, industry identified fatigue risk management as one of the top four along with drug and alcohol testing, data logger and train communications, that most impacted their operations from a safety and productivity perspective.

4.3 Exemptions

The RSNL contains provisions for Ministerial exemptions and exemptions granted by the Regulator from any requirement, including the requirements for fatigue risk management and the limits on hours of work and rest prescribed in Schedule 2.

As of May 2018, one Ministerial exemption has been granted with a further four exemptions granted by the Regulator. One exemption was also transitioned over to ONRSR that was granted by the Queensland Regulator prior to transition. Prior to the RSNL a further exemption was granted by the NSW Regulator.

When submitting an application for exemption to the Regulator the operator must demonstrate that they are managing any fatigue related risks to safety SFAIRP.

5 Fatigue risk management in other industries and rail internationally

The use of risk based approaches to safety regulation dates back to the Robins report in the UK (1972) where the benefits of performance based regulatory models were first articulated as a regulatory principle.

These principles were reflected in amendments to Australia's WHS laws from the 1980's and have developed and grown in regulatory influence both internationally and Australia ever since. The development of risk based approaches led to the development of the Australian standard for risk management (AS 4360) which has formed the basis of the ISO standard for risk management (ISO 31000).

Industry specific fatigue risk management regulations in the transport industry in Australia provide varying degrees and methods of regulation. The RSNL risk based legislative framework differs in its overall approach to some of the more prescriptive regimes such as heavy vehicles and aviation which operate on a more prescriptive basis, with more complex regulatory mechanisms that allow operators to work additional hours where approved by the regulators.

In marine legislation, the national law aligns with the general safety obligations under the model Work Health and Safety (WHS) laws and does not prescribe specific limits on hours of work.

Further, WHS laws in Australia are crucial in terms of their inter-operability with the RSNL for operators and workers. Much like the RSNL, WHS laws in Australia set out primary work health and safety duties of employers and employees (be they government, private sector, or otherwise). The WHS framework is risk based and supported by a mix of both statutory and non-statutory instruments to support its operation. This includes regulations, national compliance and enforcement policies, Codes of Practice and guidelines e.g. *Model Code of Practice: How to manage work health and safety risks*, *Code of Practice: Working Hours 2006 (WA)* and the *Guide for Managing the Risk of Fatigue at Work 2013*.

The rail industry internationally operates under a variety of frameworks encompassing both regulated hours and varying degrees of risk based and prescription within regulatory frameworks. As will be demonstrated however, there has been a general move towards risk based frameworks internationally.

In New Zealand, the rail industry is regulated under the *Railways Act 2005* that legislates general safety duties of rail participants and persons working for rail participants. Under this, each operator's safety case must contain policies to ensure that rail personnel are not suffering impairment or incapacity as a result of fatigue. There are no mandated hours of operations under the Act.

Amendments to the *Railway Safety Management System Regulations 2015* in Canada required Federal railway companies to develop and implement a safety management system, create an index of all required processes, keep records, notify the Minister of proposed changes to their operations, and file safety management system documentation with the Department of Transport when requested. However, Canada still operates under the *Work/Rest Rules for Railway Operating Employees* pursuant to section 20 (1) of the *Railway Safety Act 1985* which defines the requirements for hours of work and rest. The rules include maximum duty time and mandatory off-duty times for railway employees.

On April 26, 2017, the Honourable Marc Garneau, Minister of Transport in Canada launched a Statutory Review of the *Railway Safety Act*. The review which will run between 2017 and 2018, will focus on the effectiveness of the federal rail safety legislative and regulatory framework, the operations of the Act itself, and the degree to which the Act meets its core objective of ensuring rail safety is in the best interest of Canadians. ONRSR has been contacted on a number of occasions during this review however and none of these discussions have been in relation to fatigue or mandated hours.

In the United Kingdom, prescribed limits on hours of work and rest were removed and in 2006 a risk based approach to fatigue was introduced. Additionally, the *Railways and Other Guided Transport Systems (Safety) Regulations 2006* (ROGS) give employers specific duties to make sure employees who perform safety-critical tasks are competent and fit enough to do so, and are not affected by fatigue. Safety critical tasks under the ROGS apply to all duty holders working on a transport system and not just train drivers.

Legislation relating to rail safety in the United States is generally prescriptive and the Hours of Service laws control how many hours train employees, dispatching service employees, and signal employees may work. The statute provides maximum on-duty periods for each group of employees, minimum off-duty periods for train employees and signal employees, and establishes how time on duty is to be calculated. The statute also provides additional limitations on consecutive days and certain monthly limitations on the activity of train employees.

5.1.1 Observations

Across other industries in Australia and the rail industry internationally there is a mix of risk based approaches to managing the fatigue risk as is currently in the RSNL and examples of industries where hours of work and rest are prescribed for some or all rail safety workers.

The legislative and operational environments, evidence of fatigue as a causal factor in major incidents, and differences in rail, maritime, heavy vehicles and aviation make it difficult to draw meaningful comparisons as to whether one system is safer than the other. Driving a train is unlike driving a heavy vehicle or vessel. A public road provides a different set of hazards to a rail corridor. Similarly, travel in airspace is three dimensional, whereas rail is restricted by the limits of the physical track. Additionally, a large proportion of air traffic is international, and therefore governed by a more complex international system of regulations.

The heavy vehicle and aviation industries also rely on an approval process that requires the regulators to assess and approve applications for operators to exceed the prescribed limits.

However in comparison with other legislative regimes, both in Australia and internationally, the RSNL sets out an extensive and comprehensive set of requirements using a risk based system to manage fatigue.

While opportunities exist to improve Australia’s regulatory environment, education and support for industry, some conclusions can be inferred between the approach under the RSNL and those nationally and internationally:

- most jurisdictions operate under a risk based framework with a varying mix of prescribed and non-prescribed hours of work and rest;
- in recent years regulation nationally and internationally has generally been moving to less prescriptive regulation and a greater focus on risk based regulation;
- applying to a regulator to operate outside of prescribed limits is not a feature in rail internationally;
- prescribed hours of work and rest apply to broader categories of rail safety workers than train drivers.

6 Emerging challenges

The rail industry is growing and changing rapidly both in Australia and internationally. Examining emerging challenges and opportunities in fatigue risk management associated with rail industry changes has helped inform recommendations for this review.

A major fatigue related challenge facing the rail transport industry relates to the increasing role of automation and its impact on safety critical roles of rail safety workers. For example, the introduction of technology such as automatic train protection significantly impacts traditional high risk tasks such as driving trains. While such technologies can result in safer railways, they may present challenges for human operators as passive monitoring may impact alertness and performance.

Importantly these technologies will affect a variety of different types of rail safety work (not just train drivers) who may be required to perform a variety of tasks including maintenance, monitoring of screens or equipment and other safety critical tasks, all of which potentially have different fatigue factors which would require assessing as part of a fatigue risk management program.

7 Discussion

7.1 Current fatigue risk management arrangements

Risk managing fatigue factors that contribute to rail safety risks relies on a thorough fatigue risk assessment. An operator should, SFAIRP, ensure a rail safety workers need for rest breaks from work (both within work hours and between shifts to allow sufficient sleep opportunities) are balanced by work demands to ensure alertness levels and performance capacity are sufficient to safely and efficiently carry out rail safety work.

Risk managing fatigue however does not draw solely on, for example, work scheduling or defined hours of work and rest but can also include control measures such as engineering controls (e.g. Automatic Train Protection) that aid in mitigating rail safety risks. As noted previously, regulation 29 of the National Regulations provides the key factors to consider at law to aid operators manage fatigue factors that can contribute to rail safety risks.

As part of the analysis of fatigue risk management by ONRSR, one of the observations has been that there are variations in the maturity and capabilities of operators in being able to adequately implement and monitor fatigue risk management programs. Simply adhering to mandated hours does not satisfy this requirement.

To support industry being able to manage their fatigue risk in accordance with the RSNL, ONRSR has undertaken a Safety Improvement Project on fatigue risk management and provided education and assistance through its auditing function. A number of large operators engage fatigue risk management specialists and all operators who are RISSB members have access to the RISSB Guideline on fatigue risk management but there is no requirement to either utilise this guideline or adhere to it.

ONRSR currently has a comprehensive risk management guideline in relation to the *Meaning of duty to ensure safety so far as is reasonable practicable (SFAIRP)*, however through ONRSR's safety improvement project and audit and compliance activities, it has become evident to ensure a truly risk based approach is undertaken to a high standard, further assistance would be beneficial.

7.1.1 ONRSR's risk based approach to compliance

Rail transport operators must be accredited under Part 3 Division 4 of the RSNL. As part of the accreditation process, applicants must demonstrate that they have the competence and capacity to manage risks to safety associated with the railway operations for which accreditation is sought under s65(b) of the RSNL. This includes having a fatigue risk management program.

ONRSR is a risk based regulator and has a risk based audit and compliance program in place, whereby the greatest regulatory effort is exerted on the operators with the greatest risk profile.

In addition, ONRSR continuously monitors various data sources and other intelligence and conducts reactive regulatory activities where anomalies or trends are detected. In terms of monitoring the management of fatigue risk by operators this includes notifiable occurrences, observations, confidential reports, incident investigations, outcomes of audits and inspections.

Any concerns with an operator's fatigue risk management program are identified through audits and inspections and the operator must take steps to rectify the concerns. However, if appropriate, ONRSR may use stronger enforcement options dependent on the circumstances.

The causal link between fatigue and rail incidents is complex and involves multiple factors. In its analysis, ONRSR has met some of the same challenges as those contained in the Rail Safety and Standards Board (RSSB) UK 2015 report, *Fatigue and its contribution to railway incidents.* Several key observations from ONRSR's experiences and RSSB UK's findings include:

- There is not a truly objective measure of how fatigued a person was at the time of an incident or the extent to which that affected the individual's performance at the time;
- Determining the role and extent of fatigue (if present) in incidents is a complex task. This has been a challenge in examining the investigation reports and occurrence reporting data;
- The RSSB report noted that when examining fatigue related incidents by job role, 80% of affected persons were drivers. RSSB concluded that this was predominantly due to the fact that driver related incidents, particularly SPAD reports, were made more readily available in their database and that fatigue may be more routinely considered for drivers in these SPAD events.

The RSSB report noted that fatigue was identified as a Causal or Contributory factor in 6% of the 246 incidents on their database. However given the difficulties of measuring fatigue, it should be noted that it may not always be reported as 'fatigue' but may be rather as human error or loss of situational awareness in some cases.

7.1.2 **Investigations**

Since the introduction of the RSNL in January 2013 up to 1 February 2018, there have been 85 safety investigations completed by the ATSB, OTSI, CITS and TMR.

Fatigue was identified as a contributing factor in three of the incidents. All three incidents occurred in NSW at night or in the early morning. Two of the incidents involved the train crew of freight trains and were compliant with the mandated hours and the third involved the network controller of a passenger train.

Below is a summary of the investigation findings and links to the reports:

Investigation	Description
ATSB RO-2013-003 NSW	*<u>Summary:</u>* On 30 January 2013, Pacific National (PN) freight train 9837, travelling from Nowra to Orange, passed signals SM109G and SM115G at stop on the Down Goods line between Dulwich Hill and Hurlstone Park in Sydney. Just prior to this incident a work crew had been working on the track but moved off the tracks once alerted to the trains approach. There were no injuries or damage. *<u>Findings:</u>* The co-driver had inadvertently fallen asleep on the approach to the signals. The trainee driver missed the first signal at caution, and the next signal at stop. He applied the brakes once the train passed the final signal at stop after realising this signal applied to his train.

	ATSB found fatigue was a contributing factor to the incident. In particular an over reliance on the use of bio-mathematical model scores used to roster train crew. Further that PN Bulk Rail division did not provide training on fatigue management to the driver. https://www.atsb.gov.au/publications/investigation_reports/2013/rair/ro-2013-003/
ATSB RO-2015-005 NSW	*Summary:* At approx 0513 on 12 March 2015, the driver of a Sydney Trains passenger train went in the wrong direction from Mt Druitt station. Instead of travelling towards St Marys on the Down Suburban line, he drove 761 m in the opposite direction towards Blacktown. The driver only braked after a network control officer (NCO) contacted him and told him to stop. At the time, only the driver and guard were on board. At the same time, a PN freight train was about four kilometres away and travelling towards the passenger train on the same line. The NCO also called the driver of the freight train and told him to stop. There were no injuries or damage. *Findings:* Multiple factors contributed to the driver losing awareness of the direction the train was facing including that the driver was: • impaired by fatigue due to being awake for over 21 hours and in the low range of the circadian sleep cycle • confused about the direction due to changing ends seven times • distracted from the main task of driving as he had spent over three hours at Mt Druitt station performing other tasks before he started driving • at risk of making an error due to his high workload • feeling under pressure to move the train Fatigue was identified as a contributing factor with the ineffectiveness of Sydney Trains fatigue management processes in identifying the fatigue impairment experienced by the driver sighted as a key contributing factor. However, mandated working hour provisions were not breached. https://www.atsb.gov.au/publications/investigation_reports/2015/rair/ro-2015-005/
OTSI 04631 NSW	*Summary:* At approximately 2214 on 21 December 2013 near Moss Vale station, passenger service ST21 passed a stationary PN freight service 6AB6. This alerted the crew of 6AB6 to the fact that worksite protection had not been in place for the co-driver while he was investigating a report of a warm axle on one of the train's wagons. Protection was sought by the driver of 6AB6 and was understood to have been implemented by the network controller located at the ARTC's Network Control Centre South at Junee. When the network controller was about to implement protection arrangements, he was distracted by a personal phone call which resulted in him moving away

	from the control panel. He was not relieved and, on return, took no further action. Even though controlled signal blocking was not implemented, the network controller told the crew that it had. *Findings:* The investigation found for ARTC that: • the network controller's performance may have been fatigue-impaired. He had been working for 9 hours of a 10 hour shift without a scheduled break. It was normal practice in the control centre not to have scheduled breaks. • inadequacies in the use of verbal communication protocols • inadequacies in post-incident drug and alcohol testing and • inadequacies in the train driver's adherence to procedures in the implementation of controlled signal blocking. For PN, it was recommended that the auditing of verbal communications be undertaken and it was recommended they have regular refresher training for train crew about the implementation of worksite protection. http://www.otsi.nsw.gov.au/rail/Moss_Vale_Report_Final.pdf

While there is limited conclusive information to be gleaned from a small sample of investigations, several observations can be made.

While all these incidents occurred in NSW, nothing in the investigation data suggests that the limits on hours of work and rest prescribed in Schedule 2 were breached in these instances. All of the incidents did however occur during night and early morning periods where the risk of fatigue is highest. This example demonstrates that while the prescribed limits were adhered to, fatigue was still considered a contributing factor in the investigations.

The safety message from the ATSB in investigation RO-2015-005 noted that: *Rail operators should ensure that adequate strategies exist to safeguard against fatigue impairment of train crew. It should also be noted that train crew have a responsibility to decline a shift if they feel that their performance may be affected by fatigue* (consistent with the duty of a rail safety worker under s56 of the RSNL to take reasonable care of his or her own safety and that of others).

While for incident RO-2013-003 the ATSB noted that in order to minimise fatigue-related errors, rail operators should ensure that fatigue management systems incorporate integrated and multi-layered risk control mechanisms.

In all instances, operators agreed to review and or update standards or policies to better meet the requirements of the RSNL. While in RO-2013-003, PN Bulk rail also agreed to review the appropriate use of bio-mathematical tools as part of the fatigue risk management review process.

7.1.3 Non-conformance reports

Based on analysis of 2016 to 2017 audits and inspections, non-conformance rates for fatigue management are broadly in line with average non-conformance rates for other elements of an SMS (48% resulting in at least one fatigue-related NCR compared to 58% without fatigue in scope that resulted in at least one non-fatigue-related NCR).

There have been no statutory notices issued under the RSNL to operators with regards to not meeting the requirements for fatigue risk management.

7.1.4 Occurrence data

As at 1 February 2018, there have been 819 occurrences reported to ONRSR by rail transport operators under reg 57(1)(b)(xv) of the National Regulations (any breach of the work scheduling practices and procedures set out in the rail transport operator's fatigue risk management program), since operators have been regulated under the RSNL.

86% of these occurrences were reported by one operator.

On a breakdown by State this includes:

Jurisdiction	Number
ACT	1
NSW	460
Qld	75
SA	142
TAS	2
VIC	33
WA	106
NT	0
TOTAL	**819**

Little if any of this data however can conclusively point to whether a worker was indeed fatigued or whether trends of fatigue in NSW and Qld differ greatly than those in other jurisdictions. What can be observed however is that notification of work scheduling practice breaches does appear proportionally higher in NSW and Qld i.e. the states in which prescribed hours are in effect however this is not a measurer of fatigue.

Importantly, it should be noted that a lack of or inconclusive data, does not mean that fatigue is not an issue in Australia.

7.1.5 Discussion

Since operating as a national regulator, ONRSR has no evidence nationally to show that the management of the fatigue risk is not generally being handled in accordance with the risk based framework of the RSNL. In assessing the top risks/priorities for ONRSR based on the evidence of operations since the commencement of the RSNL, there has been no evidence to indicate that the management of fatigue under the RSNL is a major concern. Accepting that some operators manage fatigue related risks more effectively than others, means that work is always required to support and educate operators and to apply compliance tools if operators fail to take action when identified by ONRSR.

Little of the investigation, occurrence or non-conformance report data provides any clear indication that rail safety risks in jurisdictions without prescribed hours are any more or less safe than those with prescribed hours. While the three fatigue related investigations all occurred in NSW, there was no evidence the prescribed hours were breached yet fatigue was still a causal factor. Investigation reports and operational responses however were based on improvements in policies, practices and controls relating to fatigue risk management which would all occur using risk based management methodologies.

This does not discount the safety risks of fatigue. Studies confirm the risks associated with fatigue, in particular the risks associated with a variety of causal factors such as extended work hours, insufficient rest, recovery and reset breaks. Studies in transport sectors internationally such as the UK RSSB report identified fatigue as a factor in 21% of the 246 incidents studied and that it was more likely to be identified as a Performance Shaping Factor (15%) than as a Causal or Contributory factor (6%). While nearly 20% of the 182 major U.S. National Transportation Safety Board investigations across transport modes including civil aviation, rail, highway, marine and pipeline, completed between January 1, 2001, and December 31, 2012, identified fatigue as a probable cause, contributing factor, or a finding.

However, ONRSR has been unable to identify any evidence that a national risk based system increases rail safety risks when comparing the effective management of fatigue risk across Australia to that in NSW and Qld with prescribed outer limits. Conversely, there is little to no evidence that a system of prescribed hours for drivers in Australia under the RSNL provides a better safety outcome.

Discussion points: Current requirements under the RSNL

1. Within the risk based legislative framework, are you able to provide evidence that prescribing hours of work for train drivers provides safer outcomes than operating solely under the risk based approach?

2. What evidence is there to support the variations in the current system of prescribed hours in NSW and Qld?

3. What are the impacts in relation to safety and productivity for those operators that carry out railway operations under the differing requirements of the RSNL for fatigue risk management?

7.2 Prescribed outer limit

Research is clear that there is a point, irrespective of what controls are put in place, fatigue would impact the safety risk and has been referred to in some cases as a “no go zone”. Generally it is recognised that shifts beyond 12 hours will put a rail safety worker (or any person), regardless of their principle duties, at risk of higher fatigue likelihood. Studies across industries have shown that increases in safety risks do occur with increases in fatigue, and require additional controls. Mandating an outer limit on hours is a way to address continuous excessive working arrangements resulting in high fatigue likelihood, recognising that activities undertaken by the RSW when not on shift also have a major impact on fatigue likelihood.

ONRSR therefore seeks stakeholder feedback on the feasibility of implementing a prescribed outer limit for all rail safety workers nationally within a risk based framework.

A key regulatory component of a fatigue risk management system is to ensure that it is applied across the industry in a consistent manner tailored to the requirements of individual workers and their roles. Safety outcomes of rail operations are based on each party fulfilling their roles (e.g. drivers, signallers or track workers) as each role potentially affects the safety outcomes of the other.

It is within this context that any system of prescribed outer limits of hours operating across the rail industry should apply **to all rail safety workers** and that within those outer limits, a robust fatigue risk management process is undertaken to ensure fatigue risk likelihood is effectively managed.

One potential concern with introducing prescribed outer limits may be that operators simply accept those hours as safe. After examining this issue since the implementation of the RSNL, ONRSR has found few examples through its auditing processes that operators have used the outer limits in NSW and Qld in this way without conducting a thorough risk based fatigue risk management assessment noting that the quality of the risk assessment may vary

Considering the diversity of rail safety work, operations, environments and conditions across Australia, a prescribed outer limit for all rail safety workers of 12 hours applied within a risk based framework would provide regulatory certainty for workers, governments and operators to work within.

It is recognised that situations occur such as accidents, emergencies (encompassing situations arising out of an actual or imminent event such as fire, flood, storm or earthquake that may endanger the safety of persons or property) and unforeseeable circumstances that are rare and out of the control of the operator. Under these circumstances, provision would be required to work a shift longer than 12 hours but with Regulator oversight on how fatigue was being managed.

Approval for exemptions may also be sought for one-off planned situations where the operator can demonstrate that they are managing risks SFAIRP. Such exemptions would need to be approved by the Regulator on a case by case basis.

Discussion points: Prescribed outer limit

4. Would the introduction of a prescribed outer limit on hours of work for **all** rail safety workers within a risk based framework provide clarity in respect of regulatory requirements and what is not acceptable?

5. a) If a 12 hour outer limit on hours of work for all rail safety workers was implemented, would this have a major impact on your operations?

   b) If so please provide examples and details of how you are managing the risk to safety under current circumstances.

6. Examples as to when an exemption to the outer limit of 12 hours may be required, have been listed above. Are there any other situations, which may require such an exemption?

7.3 Code of Practice

As the review has progressed, ONRSR has also explored the concept of a Code of Practice approved by Ministers under the RSNL. The introduction of such a Code would be used to support operators to adhere to the primary safety duty by providing a robust risk based framework for fatigue risk management tailored to the operational needs of the Australian rail industry.

The draft Code at Attachment A has been developed using scientific evidence and incorporates a six step process underpinned by seven principles identified as important for effective fatigue risk management. The principles address each of the seven major factors that rail transport operators need to consider to ensure that rail safety workers are sufficiently alert and have the capacity to undertake all work related tasks. The evidence statement at Attachment B was developed by Professors Drew Dawson and Ann Williamson and articulates the evidence base for the principles.

The evidence in the Code reflects and addresses the core factors that may lead to an elevated risk of fatigue likelihood. It does this by setting out clear parameters relating to elevated fatigue likelihood using the 7 principles of rest and recovery which fall into three main types of rest breaks which are:

- *Work-related Rest Breaks:* Breaks from work within shifts to reduce performance impairment due to extended time-on-task;
- *Recovery Breaks:* Sleep opportunities between shifts to provide enough time to obtain sufficient sleep in order to reduce the likelihood of unsafe levels of fatigue;
- *Reset Breaks:* Breaks in sequences of shifts to reduce the likelihood of the build-up of unsafe levels of fatigue over an extended sequence of shifts.

By using the parameters and principles of the Code, operators can address each of the major factors that should to be considered to ensure that rail safety workers are sufficiently alert and have the capacity to undertake all work related tasks. Of importance in applying the Code is that the principles interact. Where work scheduling practices have an elevated fatigue likelihood under one or more of the principles under the fatigue likelihood considerations in Table 2, this can be managed via offsetting other principles to reduce fatigue likelihood or by introducing controls to reduce the likelihood or consequences of fatigue related errors.

Having a Code which can set out key fatigue likelihood considerations can and should aid operators to efficiently address risks of fatigue likelihood through better work scheduling, education and controls.

The Code would not alter any existing legal requirements under the RSNL, but would be referenced in the National Regulations. Operators are, and would still be, under a legal obligation to implement a fatigue risk management program as a part of their Safety Management System and to establish and maintain documented procedures to manage, SFAIRP, fatigue related risks. The Code would assist in strengthening these programs.

The Code of Practice would not be mandatory, therefore it provides operators with the flexibility to adhere to the ONRSR Code or implement fatigue risk management systems and practices that are of an equivalent or higher standard where demonstrated through a robust fatigue risk management process.

Further the Code would apply to all rail safety workers equally subject to the tailoring of it to their specific operational requirements and fatigue risks.

Use of Codes of Practice are prevalent in a wide variety of industries including under WHS laws e.g. *the Code of Practice: Working Hours 2006* (WA) which applies to all workplaces in WA covered by the *Occupational Safety and Health Act 1984* and the *Mines Safety and Inspection Act 1994*. The risk based nature of the Code of Practice is flexible enough to align with WHS requirements which is critical due to the relationship and interoperability between WHS laws and duties under the RSNL.

However a Code is not just a document to provide advice and support to industry. Codes also set out the expectations for the rail industry on how to manage a risk.

The introduction of the Code may provide a significant step towards offering guidance to assist operators, both large and small, to develop work scheduling practices to mitigate fatigue likelihood and increase industry maturity in such an important safety critical area. In this regard, the Code may enhance the ability of industry to better manage fatigue by adding to the resources already available including the RISSB guidelines.

A Code may also provide compliance related benefits including:

- Benefits for industry to assist in proving compliance with the fatigue risk management requirements under the RSNL by following the Code;
- Admissibility in proceedings as evidence of whether or not a duty or obligation has been complied with (see s250(2) of the RSNL);
- Use in a direction included in an improvement notice or prohibition notice (see s188 of the RSNL);
- A Court may have regard to the Code as evidence of what is known about a hazard or risk, risk assessment or risk control and may rely on the Code in determining what is reasonably practicable in the circumstances (See s250(3) of the RSNL).

The Code is intended to support enhanced safety, efficiency, productivity and innovation. The Code could also compliment a risk based approach, allowing operators to take a holistic approach to risk management in general by integrating fatigue risk management with the management of other risks.

If the Code was implemented, ONRSR would work cooperatively with all areas of industry including unions, in the development of guidelines to support and encourage a clear approach to compliance in the co-regulatory environment. ONRSR would also provide education and training sessions for all of industry to ensure all of industry have a sound understanding of the requirements of the Code and ONRSR's expectations for managing fatigue likelihood and rail safety risk.

Further, implementation of such a Code would be accompanied by a review timeframe (for example, every five years from the date of commencement).

Review periods across industries and Acts vary. For example the guidelines produced by the Commission for Occupational Safety and Health in WA recommends that industries review their codes of practice at least every five years. Whereas the Australian Dangerous Goods Code produced by the NTC, is reviewed every two years to help meet international best practice and evolving user needs in Australia. While regulations in South Australia under section 16B(1)(g) of the *Subordinate Legislation Act 1978* expire on 1 September of the year following the tenth anniversary of the day on which the regulation was made (with postponement periods not exceeding two years at a time and not exceeding four years in aggregate also permitted (see s16C)).

It is envisaged that a five year period would allow time for the Code to operate before review while also acknowledging that regular reviews can have resourcing impacts on both industry and the Regulator.

Discussion points: Code of Practice

7. Would the draft Code of Practice support operators by providing a robust risk based framework for fatigue risk management and clearly articulate what ONRSR expects of operators when managing fatigue in their operations?

8. Are there areas within the Code of Practice that could be strengthened to provide greater clarity for fatigue risk management? Please provide as much detail as possible of these areas.

9. Would there be any adverse safety impacts if the Code was introduced? Please give examples.

7.4 Consultation with workers

Operators are currently required under the RSNL to consult with persons affected by the SMS e.g. rail safety workers, health and safety representatives, any union representatives, other rail transport operators with whom the operator has interface agreements and the public (as appropriate). This also includes when developing a fatigue risk management program and/or proposing changes to the fatigue risk management program. A rail safety worker's likelihood of fatigue is not reflective of their working hours alone, but also their time outside of work.

To this extent it is essential that extensive consultation takes place before any changes are made to an operators fatigue risk management program.

The extent and effectiveness of this consultation is sometimes questioned and due to the importance of the rail safety worker's input into managing fatigue likelihood, to specifically include this requirement as part of the requirements of Regulation 29 would potentially make this requirement more explicit and strengthen the overall management of fatigue.

Discussion points: Consultation with workers

10. Under current RSNL regulations there is a requirement to consult with rail safety workers who are affected by the SMS which includes varying the fatigue risk management program. Is this effective? If not, why not?

11. Would specifically articulating in the RSNL regulations the requirement to consult with rail safety workers when varying the fatigue risk management program provide greater clarity in relation to this requirement? Are there any reasons why this should not be specifically articulated in regulations for fatigue risk management programs?

7.5 Transition arrangements

Providing stakeholders with a sufficient transitional period before implementing any major change is key to ensure a smooth rollout of the change.

For any resultant changes, a transition period will be implemented which will be sufficient to enable industry to review fatigue risk management programs and requirements under the RSNL, work scheduling practices, as well as for ONRSR to provide guidance materials and education for industry and ONRSR staff.

8 Next Steps

ONRSR is now seeking the views of stakeholders on the discussion areas presented in this paper.

The ONRSR, in consultation with the Fatigue Review Reference Group, will review responses from stakeholders. Feedback will be evaluated and incorporated into draft key recommendation areas for further consultation before progressing to Ministers in May 2019.

Further information about the review will be made available on the ONRSR website.

OFFICE OF THE national rail safety regulator

ONRSR Code of Practice

Fatigue Risk Management

safe railways for Australia

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Policy changes to *Rail Safety National Law*

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1 Introduction

1.1 Purpose

The Office of the National Rail Safety Regulator (ONRSR) *Code of Practice: Fatigue Risk Management* (the Code) provides accredited Rail Transport Operators (RTO) (as defined under s4 of the RSNL) with a minimum standard on how to meet the requirements of the *Rail Safety National Law* (RSNL) to manage the fatigue related risks associated with rail safety work.

The Code presents a nationally consistent framework that supports the co-regulatory model of the RSNL in taking a risk based approach to fatigue risk management and recognises the primary duty of RTOs to ensure the safety of the operator's railway operations so far as is reasonably practicable (SFAIRP).

The Code provides a framework for RTOs for fatigue risk management using a step by step approach underpinned by key scientific principles to apply when developing work scheduling procedures and practices as part of the Fatigue Risk Management Program (FRMP).

The way in which the principles are applied will be determined by the operator’s individual circumstances. This ensures that operating procedures are tailored to best suit an RTO’s individual circumstances and the roles, responsibilities and risks associated with all classes of work performed by Rail Safety Workers (RSW) to manage fatigue and safety.

1.2 What is a Code of Practice and how is it applied to the RSNL?

This Code is an approved Code of Practice under s249 of the RSNL.

The RSNL sets out clear requirements with regards to fatigue risk management. The Code does not replace the requirements under the RSNL. Rather it sets the minimum standards to be followed by RTOs who are under a duty to ensure, SFAIRP, the safety of the operator's railway operations and to ensure, SFAIRP, that RSWs, do not carry out rail safety work while impaired by fatigue or do not continue to work if they become impaired.

The Code provides ONRSR with a legally enforceable minimum standard upon which a Court may have regard to assessing compliance with the fatigue risk management requirements of the RSNL. This is due to the fact that the Code is admissible in a proceeding for an offence against the RSNL as evidence of whether or not a duty or obligation under the RSNL has been complied with (see s250(2) of the RSNL).

Further, a Court may have regard to the Code as evidence of what is known about a hazard or risk, risk assessment or risk control and may rely on the Code in determining what is reasonably practicable in the circumstances under s250(3) of the RSNL.

ONRSR also has the power to refer to an approved Code of Practice in a direction included in an improvement notice or prohibition notice (RSNL s188).

ONRSR nevertheless recognises that there may be equivalent or better ways of achieving compliance with the RSNL. As specified in section 250(4) of the RSNL, nothing prevents a person from introducing evidence of compliance with the RSNL in a manner that is different from the Code but provides a standard of safety that is equivalent to or higher than the standards outlined in the Code.

The Code will be reviewed every 5 years.

In providing the minimum standard for fatigue risk management established by this Code, the word ‘should’ is used to indicate a recommended course of action, while ‘may’ is used to indicate an optional course of action.

The words ‘must’ or ‘requires’ indicate that a legal requirement exists and must be complied with.

The Code applies to all RTOs accredited under the RSNL and all types of RSW as defined in the RSNL.

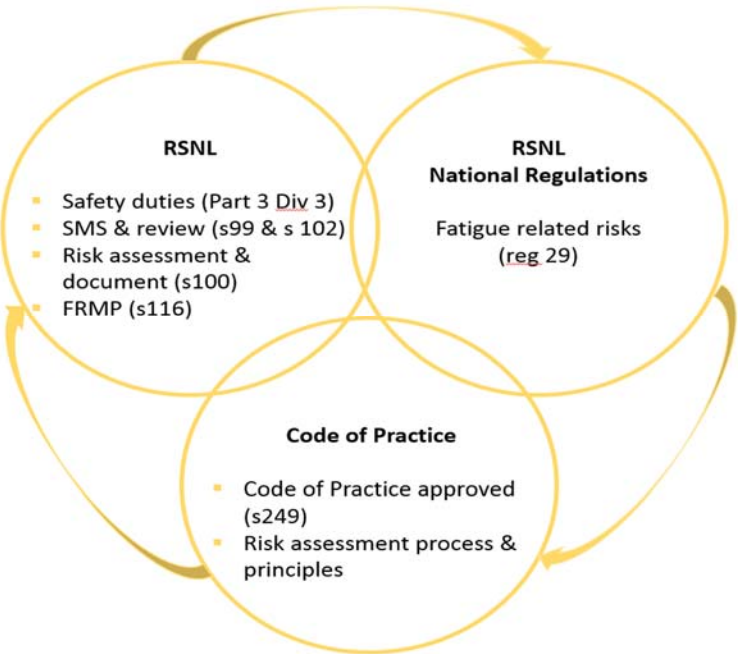
In summary, the Code:

1. Provides a minimum standard on how to meet the fatigue risk management requirements of the RSNL;
2. Should be followed unless there is an alternative course of action which achieves the same or a better standard of rail safety;
3. Is admissible in proceedings as evidence of whether or not a duty or obligation under the RSNL has been complied with and can be referred to in a direction included in an improvement notice or prohibition notice.
4. Will be reviewed every 5 years.

1.3 Requirements for fatigue risk management under the RSNL

The core requirements for fatigue risk management under the RSNL are highlighted in Diagram 1 below.

Diagram 1. RSNL fatigue risk management regulatory framework



Without limiting the overarching duty for RTOs to ensure, SFAIRP, the safety of the operator's railway operations, an RTO’s obligations regarding fatigue risk management are to ensure, SFAIRP, that RSWs who perform rail safety work in relation to the RTO’s railway operations do not carry such work while impaired by fatigue or if they may become so impaired (see RSNL s52(2)(d)).

Similar requirements also apply to all classes of RSW and others under Part 3 Division 3 of the RSNL. For example RSW’s have safety duties as individuals under s56 to take care for their own safety and that of others, and must not intentionally or recklessly interfere or misuse anything provided to them by the RTO. This includes RSW’s employed through labour hire agreements. Fatigue is a vitally important area for an individual when reporting to work and being fit for duty.

While the dangers and safety impacts of drugs and alcohol or injuries have long been recognised in the workplace, fatigue is considered to be just as important regarding fitness for work. Workers should assess their own fitness for work before starting a shift to ensure they fulfil their duty to take reasonable care for their own safety and health and make sure their acts or omissions don't adversely affect the health or safety of others.

Further, shared responsibility for rail safety is also a core principle of the RSNL. Section 50(1) states the persons to whom the principles are applied which includes a diverse range of stakeholders from RTOs, RSWs and ONRSR to the public and other persons involved indirectly with rail operations, such persons who design, commission, manufacture, supply, install or erect anything that they know or reasonably ought to know is to be used as or in connection with rail infrastructure or rolling stock. The level and nature of responsibility that a person referred to has for rail safety, is dependent on the nature of the risk that the person creates from the carrying out of an activity or the making of a decision and the capacity that person has to control, eliminate or mitigate those risks (see s50(2)). With regards to the principles applying to rail safety duties under the RSNL, s51 clearly states that:

- a duty under the RSNL cannot be transferred to another person;
- that a person can have more than one duty by virtue of being in more than one class of duty holder; and
- that more than 1 person can concurrently have the same duty under the RSNL and each duty holder must comply with that duty even if another duty holder has the same duty.

Sections 99(1)(b),(c),(d),(e) and (f) of the RSNL outlines the risk management requirements for an RTO required in a Safety Management System (SMS) for railway operations. While under s99(2)(f), the SMS for an RTO must include an FRMP.

Further, section 100 of the RSNL sets out factors that an RTO must comply with when conducting an assessment for the purposes of s99(1)(d) for identified risks.

RTOs should also keep a detailed record of all aspects of the assessment process as per s100(2). This includes documenting the risks considered, the likelihood, severity of consequences and control measures considered (including reasons for selecting certain control measures and rejecting others).

While s116 of the RSNL requires RTOs to prepare and implement an FRMP that complies with the prescribed requirements for the management of fatigue of RSWs who carry out rail safety work.

The FRMP must also meet the requirements set out in reg 29 of the National Regulations. Under reg 29(1), the FRMP must take into account and assess fatigue related risks to safety. The FRMP must also establish and maintain documented procedures to manage, SFAIRP, fatigue related risks (see reg 29(2) of the National Regulations).

Hours of work or time between shifts are taken to be safe if the effect is sufficient to manage the risks arising from fatigue SFAIRP (see reg 29(3) of the National Regulations).

RTOs also have notification requirements relating to fatigue under the RSNL. An RTO must notify ONRSR in writing of any proposed decisions, events or changes to any work scheduling practices and procedures set out in the operator's FRMP at least 28 days before the date the operator intends to bring the change into effect (see reg 9(1)(a) of the National Regulations). Further, that under reg 57(1)(xv) and 57(3) of the National regulations, an RTO must give ONRSR a written report of any breach of the work scheduling practices and procedures set out in the RTO's FRMP.

1.4 The RNSL and the interaction with Work Health and Safety Legislation

Under s48 of the RSNL, if a provision of the Work Health and Safety (WHS) legislation applies to railway operations, that provision must be observed. In addition to this, s48(2) explicitly states that WHS laws will prevail over the RSNL to the extent of any inconsistency.

While this Code is specifically tailored to the operational requirements of the rail industry and the legal requirements of the RSNL as discussed at 1.3, it must be used in conjunction and be compliant with, WHS laws in each state and territory.

Under WHS legislation, employers have a general 'duty of care' obligation to ensure that employees are not exposed to hazards or an increased risk level that could arise from their working hours arrangements. In the fatigue risk management context this includes ensuring that working arrangements allow sufficient and appropriately timed rest opportunities for RSWs to exercise their duty to be fit for work. Likewise, RSWs also have a reciprocal duty to take reasonable care for the health and safety of themselves and other persons who may be affected by their actions or omissions.

To be clear, the Code forms only one important part of an RTO's obligations regarding fatigue management. A fully compliant system must adhere to all legislative requirements be they under the RSNL or WHS laws.

WHS regulators in the Commonwealth and in each state and territory are responsible for regulating and enforcing the WHS laws in their jurisdictions. For further information please contact your WHS regulator: https://www.safeworkaustralia.gov.au/

2 What is fatigue?

2.1 What is fatigue?

Fatigue is a state of mental and or physical tiredness or exhaustion that impedes or reduces a person's ability to work in a safe and efficient manner in the context of rail operations.

Fatigue does not merely manifest itself in physical irregularities but also has cognitive, psychological and physiological effects that may combine to impede performance and exacerbate safety risks. The symptoms of fatigue may include excessive tiredness either physically or mentally, feeling drowsy, having difficulties in concentration, focus or the ability to recognise and respond to risks.

2.2 Why is fatigue a problem?

Fatigue is a serious risk factor in the context of the rail industry not only to RSWs and RTOs but to the community at large. The rail industry poses an increased risk of fatigue likelihood due to:

- the widespread use of non-standard hours (e.g. 24/7 operations, night work, shiftwork or being on-call);
- diverse operational environments;
- variety and demands of work tasks which may cause fatigue either physically or mentally in rail safety workers including:
  - physically demanding tasks;
  - environmentally challenging conditions (e.g. extreme heat);
  - monotonous or repetitive tasks;
  - tasks that require a high level of concentration.
- the interaction with the community at large including pedestrians and vehicles, freight and the carriage of passengers.

It is widely recognised that fatigue, sleepiness and consequent lowered alertness can lead to catastrophic rail safety risks to people and property if not properly managed. Studies[1] specific to rail have shown that train drivers for example, exhibited slower reaction time, more instances of extreme speeding, more braking errors and penalty braking when affected by fatigue.

Further, fatigue may affect behavior by making RSWs operate less efficiently, making this an area of commercial interest beyond the critically important safety ramifications. Given the clear safety risk factors, it is imperative that fatigue is taken seriously, managed and monitored on an ongoing basis to ensure the safety of rail operations SFAIRP.

[1] Dorrian, J., Roach, G. D., Fletcher, A., & Dawson, D. (2007). Simulated train driving: Fatigue, self-awareness and cognitive disengagement. *Applied Ergonomics*, 38(2), 155–166. https://doi.org/10.1016/j.apergo.2006.03.006 and Dorrian, J., Roach, G. D., Fletcher, A., & Dawson, D. (2006). The effects of fatigue on train handling during speed restrictions. *Transportation Research Part F: Traffic Psychology and Behaviour*, 9(4), 243–257. https://doi.org/10.1016/j.trf.2006.01.003

3 Fatigue risk management process

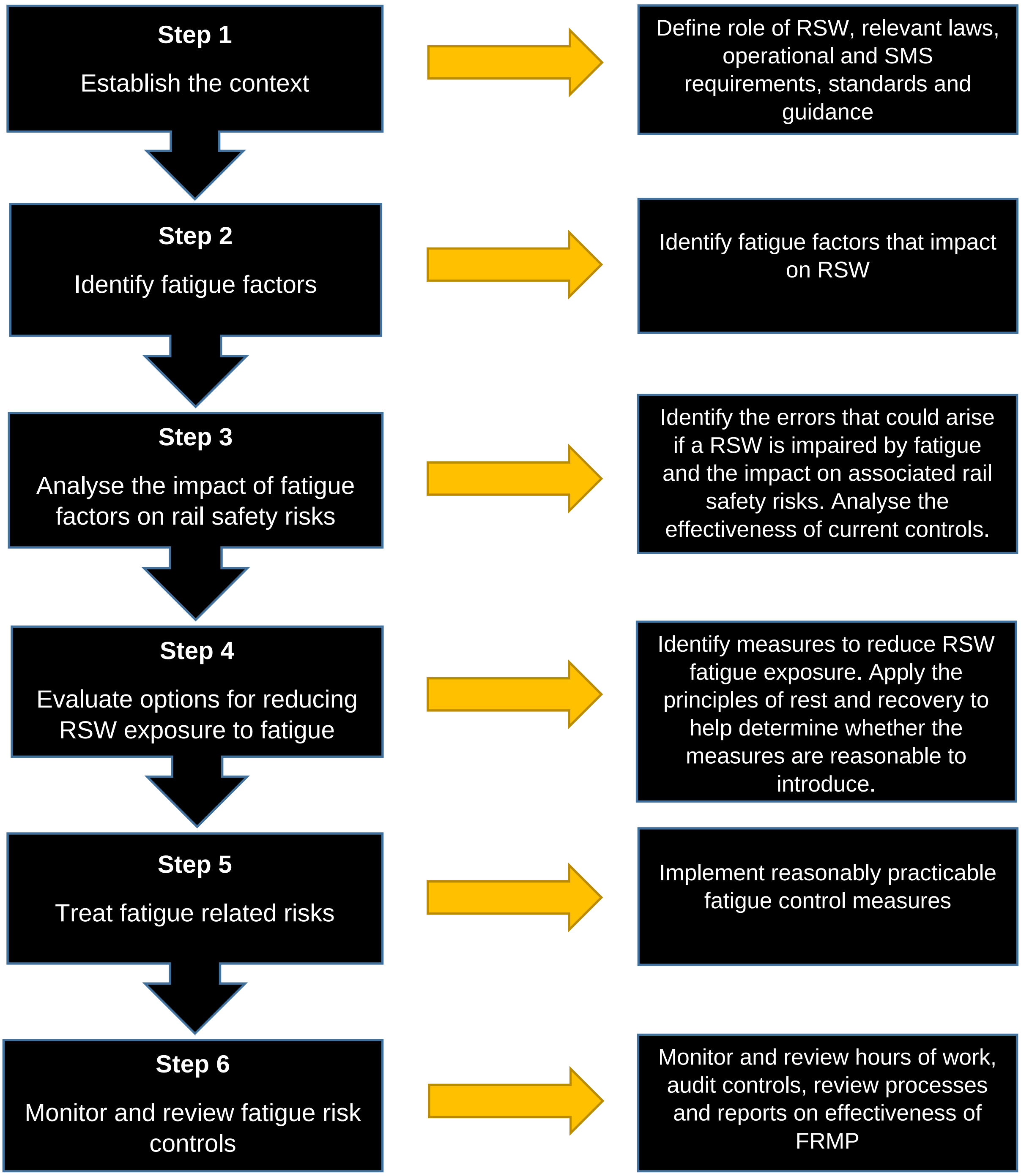
3.1 Overview

The RSNL requires the effective management of fatigue related risks. The Code outlines ONRSR's expectations of an RTO in undertaking the fatigue risk management process. Diagram 2 below provides a summary of the process to address fatigue risk management under this Code:

3.2 Steps in the fatigue risk management process

The following steps are designed to provide a minimum standard process in order to meet the fatigue risk management requirements of the RSNL.

Diagram 2. Overview of fatigue risk management process under the Code



3.3 The principles of rest and recovery

The fatigue risk management framework in the Code is based on the primary need for well-timed breaks from work and the need to balance work demands and rest opportunities to ensure alertness levels and performance capacity are sufficient to safely and efficiently carry out rail safety work. In addressing this balance, the types of rest opportunities cover three clear dimensions:

> **Work-related Rest Breaks:** Breaks from work within shifts to reduce performance impairment due to extended time-on-task;

> **Recovery Breaks:** Sleep opportunities between shifts to provide enough time to obtain sufficient sleep in order to reduce the likelihood of unsafe levels of fatigue;

> **Reset Breaks:** Breaks in sequences of shifts to reduce the likelihood of the build-up of unsafe levels of fatigue over an extended sequence of shifts.

These three dimensions have been further subdivided into a set of seven principles for fatigue risk management in the rail industry. The principles support an RTO to undertake a risk assessment of the working time arrangement and to determine, where appropriate, the level of risk mitigation required in order to undertake the pattern of work safely.

Work-related Rest Breaks

1. Ensure sufficient time off-task
2. Ensure regular rest breaks

Recovery Breaks

3. Ensure break provides opportunity for sufficient sleep
4. Maximise night sleep
5. Minimise night work
6. Minimise very long shifts particularly those ending between 00:00 and 06:00

Reset Breaks

7. Prevent the accumulation of fatigue over a sequence of shifts

The following provides a further explanation for the basis of the principles:

Table 1: Explanation of the principles of rest and recovery

Rest type	Scheduling principle	Explanation
Work related rest breaks	*1. Ensure sufficient time off-task* *2. Ensure regular rest breaks*	• Regular rest breaks are needed to help maintain stable performance over long periods of work. • Many rail safety tasks require continuous attention and vigilance. This requires effort, particularly if tasks are mentally challenging or monotonous with little action required. If work tasks do not involve natural periods of downtime and enable breaks to be reliably taken, performance will deteriorate over time. The rate of decline will depend on the type of task, how long the person has been awake and time of day. • Regular rest breaks are needed to ensure that workers can meet physiological needs including meals, toilet stops and

		potentially a nap if the work opportunity is very long and spans the night.
Recovery breaks between shifts	3. *Ensure break provides opportunity for sufficient sleep* 4. *Maximise night sleep* 5. *Minimise night work* 6. *Minimise very long shifts particularly those ending between 00:00 and 06:00*	• Recovery time between shifts needs to be sufficient to accommodate all of the activities of daily living including meals, self-care, family and social time (especially resting at home) as well as sleep. • Amount of sleep obtained is strongly determined by time of day of the sleep opportunity. Night shifts that include 00:00-06:00 generally cause the most sleep loss because sleep is harder to sustain outside these times. Day sleep is especially difficult as it is shorter and of poorer quality so should be avoided where possible. • Early morning shifts are also a problem as they cause sleep loss because it is hard to adjust to early bedtimes and to go to sleep early in order to compensate for the early start. • Very long shifts are a problem as alertness and performance deteriorate towards the end of long shifts. • Long shifts that extend into the midnight to dawn period are a particular problem as they exposure RSWs to two high fatigue risk factors of long work period and the lowest point of the body clock which reduces the worker's capacity to be alert and to perform safely. • Fatigue may also be likely where night workers commence their first night shift after a recovery break.
Reset breaks to prevent cumulative sleep loss	7. *Prevent accumulation of fatigue over a sequence of shifts*	• Reset breaks allow two successive night sleep opportunities to help prevent chronic sleep loss building up over consecutive work periods especially where work hours limit opportunity for recovery sleep. • Reset breaks help maintain optimal performance for subsequent blocks of shifts. • Reset breaks are also important for providing time for family domestic and social needs which need to be acknowledged in shift planning and if not planned for may displace time for sleep.

These principles address each of the major factors that should to be considered to ensure that RSWs are sufficiently alert and have the capacity to undertake all work related tasks.

An essential element of the risk management process is how the principles interact. By using the principles to manage the likelihood of fatigue, it is possible to design a schedule whereby a higher level of fatigue risk exposure is tolerated for one or two principles, providing that the principles are balanced by a selection of lower fatigue risk options for other principles. For example, if for operational reasons, it is necessary to schedule a long work shift, even though it represents a high fatigue likelihood factor, the higher fatigue risk may be offset by ensuring that the schedule involves low risk factors on other characteristics. This could include:

- The shifts only involve day work and do not begin too early or extend beyond midnight;
- The schedule involves a longer rest before the extended shift in order to ensure RSW are sufficiently rested before the extended shift commences; and
- The schedule includes sufficient rest to allow for recovery after the shift.

4 Applying the fatigue risk management process

Step 1

Establish the context → Define role of RSW, relevant laws, operational and SMS requirements, standards and guidance

It is important to note that not all RSWs perform the same roles and the same tasks. In setting the context, generally more than one risk assessment will be required to assess fatigue-related risk for different groups of RSWs within an RTO's operations according to the varied roles, working hours and risk profiles that exist. Safety risks and fatigue risk factors will differ according to the task and operating conditions. A robust FRMP will set the context, identify fatigue risks and control measures for RSWs to ensure the specific work context is considered from a fatigue risk management perspective.

Information sources for determining the scope and context of the fatigue risk assessment, include:

- the grouping of RSWs according to the type of work they do to ensure that the specific risk factors and safety risks of the particular tasks can be assessed;
- any contextual information including work locations, operating conditions varying work requirements, operational and business objectives;
- existing safety data, reports of monitoring of hours of work, incident reports;
- relevant legislation including the RSNL or WHS law;
- relevant standards and guidance.

ACTIONS TO APPLY THE MINIMUM STANDARD – STEP 1

1. Define the scope for the fatigue risk assessment by establishing the context.

Step 2

Identify fatigue factors → Identify fatigue factors that impact on RSW

This step involves an RTO identifying any factors that may contribute to RSW experiencing fatigue. For the purposes of s116 of the RSNL, when preparing an FRMP, an RTO must take into account, and assess, any fatigue related risks to safety including those that arise from factors listed in reg 29 of the National Regulations. An overview of these requirements is listed below:

Summary of fatigue factors from RSNL Regulation 29 - to be taken into account and assessed:

PHYSIOLOGICAL & TASK FACTORS	SOCIAL AND PSYCHOLOGICAL FACTORS	ORGANISATIONAL FACTORS	INDIVIDUAL FACTORS
Circadian effects 29 (1)(d)	Work schedule predictability & irregularity 29(1)(c)	Extended hours and overtime 29(1)(b)	RSW education and information in identifying and managing fatigue 29(2)(c)
Extended wakefulness 29(1)(d)	Control over work hours 29(1)(c)	Lift up and lay back 29(1)(b)	
Chronic sleep loss 29(1)(d)		Call in and on-call 29(1)(b)	
Sleep inertia (grogginess) 29(1)(d)		Commuting 29(1)(d)	
Scheduling of work and non work: time on task, rest opportunities, break length & frequency, total work time 29(1)(a)		Routes 29(1)(f)	
High cognitive demand 29(1)(e)(i)		Crew calling practices 29(1)(f)	
Monotony, boredom low cognitive demand 29(1)(e)(ii)		Work environment (climate, noise, vibration,fumes) 29(1)(h)	
		Rest environment (Barracks, rest houses, relay vans) 29(1)(g)	
		Abnormal, degraded, emergency conditions 29(1)(i)	

Factors occurring outside of work may also contribute to fatigue. A worker's lifestyle, family responsibilities, mental or physical health (e.g. insomnia, sleep apnoea, taking of medication or drugs), or extended travel between work and home may all increase the risk of fatigue. As discussed at 1.4, RSWs should note that they have a reciprocal duty to take reasonable care for the health and safety of themselves and other persons who may be affected by their actions or omissions under both RSNL and WHS laws.

Sources of information to identify the fatigue factors can include:

- Results of consultation with workers to identify fatigue risk factors associated with work scheduling and workload or other factors e.g. work and rest environments;
- Incident investigation reports (rail and WHS) where fatigue is a factor;
- Historical reports on the results of monitoring hours of work including planned versus actual;
- Reports of fatigue events where workers have self-identified as being fatigued;
- New research or industry guidance on fatigue risk factors.

ACTIONS TO APPLY THE MINIMUM STANDARD – STEP 2

1. Identify factors that may contribute to RSWs experiencing fatigue according to tasks and work contexts.

Step 3

Analyse the impact of fatigue factors on rail safety risks

Identify the errors that could arise if a RSW is impaired by fatigue and the impact on associated rail safety risks. Analyse the effectiveness of current controls

After completing Steps 1 and 2, the RTO should have established the context and identified factors that may contribute to RSWs experiencing fatigue. Step 3 requires the RTO to assess its operations to analyse:

1. The errors and rail safety risks that may arise if a RSW is impaired by fatigue; and
2. The effectiveness of existing controls at reducing the likelihood of RSW fatigue and managing the associated rail safety risks.

Step 3.1 Analyse the errors and rail safety risks that may arise if an RSW is impaired by fatigue

An RTO must under s100 of the RSNL, conduct assessments of identified risks and use assessment methodologies that are appropriate (i.e. the Code or an equivalent or higher standard) under s100(1)(c).

Using the information from the analysis undertaken in Steps 1 and 2, determine how the fatigue factors may affect rail safety according to the safety critical nature of the RSW's work, the errors that could arise if an RSW is impaired by fatigue, and the rail safety risks that fatigue-related errors could contribute to. This will assist the RTO to adequately plan contingencies for the FRMP.

Identifying errors and associated rail safety risks could be done by:

- reviewing the risk register and analysing if fatigue could contribute to any risks that may occur though human error;
- analysing the safety criticality of the tasks done by the RSW by looking at job descriptions, work method statements and consultation with the RSW who undertake the tasks;
- undertaking a detailed task analysis if the tasks are more complex and safety critical;
- applying different "what if" scenarios to identify errors, short cuts or violations that could occur if RSW are fatigued;

Examples of rail safety risks that could arise from fatigue related errors or short cuts may include:

- a derailment resulting from a train driver speeding;
- a signaller applying the wrong signal block leading to a worker being struck by a train;
- a signaller giving incorrect authority to proceed leading to a train collision;
- a track maintainers error leads to a track misalignment or broken rail and derailment;
- a tamping machine driver damages the rail foot leading to a broken rail and derailment;

- a track patrol inspector fails to identify component failure leading to a derailment.

Further considerations when analysing the impact of fatigue factors on rail safety risks should include:

- examining the potential severity of fatigue depending on how many fatigue risk factors may be impacting on the RSW. Consideration should also be given to how often these factors may or are likely, to impact the RSW; and
- analysing the impact of the timing of safety critical tasks relative to times when workers are likely to experience elevated fatigue.

> ***Example***
>
> *A 2007 study showed that high levels of fatigue in train drivers produced slower reaction time, more instances of extreme speeding, more braking errors and penalty braking over 8 hour shifts of driving a rail simulator.* [2] *The authors concluded that increasing fatigue in train drivers produced more failures to respond, which they attributed to greater cognitive disengagement with the task of driving. Another study of the management of speed restrictions by Australian train drivers also showed adverse effects on performance when train drivers experienced high levels of fatigue.* [3] *Again, higher fatigue produced less braking and overall higher speeds.*
>
> *As can be demonstrated by the examples in the studies above, the impacts of fatigue factors on rail safety risks could include excessive speeding or braking errors on train drivers who are fatigued. This could lead to safety risks such as derailments and collisions, as well as increased wear and tear on rail assets and increased costs for operators on maintenance e.g. due to excessive braking.*

Step 3.2 Analyse the effectiveness of existing controls

Here an RTO should analyse the controls currently in place to manage fatigue. This is likely to include measures such as work-scheduling practices. An RTO must establish work scheduling procedures and practices that provide for safe hours of work, safe periods of time between shifts, and ensure there are sufficient RSWs to be available to meet reasonably foreseeable demands for relief arrangements (see reg 29(2)(a)(i),(ii) and (iii) of the National Regulations). The RTO should therefore:

- analyse the effectiveness of existing work scheduling / rostering practices to manage identified fatigue factors (including commuting time);
- identify ways to improve ineffective controls;
- analyse risks arising from any proposed changes;
- analyse RSW resourcing requirements;
- analyse the effectiveness of any other controls such as systems, equipment, tasks, work methods and procedures for detecting and managing fatigue related errors and violations.

Issues that may affect whether existing controls are effective include:

- work scheduling practices and procedures in managing the identified fatigue factors and risks:

[2] Dorrian, J., Roach, G. D., Fletcher, A., & Dawson, D. (2007). Simulated train driving: Fatigue, self-awareness and cognitive disengagement. *Applied Ergonomics*, 38(2), 155–166. https://doi.org/10.1016/j.apergo.2006.03.006

[3] Dorrian, J., Roach, G. D., Fletcher, A., & Dawson, D. (2006). The effects of fatigue on train handling during speed restrictions. *Transportation Research Part F: Traffic Psychology and Behaviour*, 9(4), 243–257. https://doi.org/10.1016/j.trf.2006.01.003

- the effectiveness of methods of forecasting staffing needs based on available data and foreseeable impacts e.g. historical patterns of absence, leave liability, new business impacts, and organisational restructures;
- the sufficiency of relief arrangements available to meet foreseeable demand, particularly where planned shifts are close to tolerable limits and cannot be extended;
- procedures to encourage and support RSW to report if they are impaired by fatigue or likely to become so while carrying out rail safety work.

An RTO should also give consideration to any controls in place that help prevent an escalation of fatigue-related errors. Whilst such controls are not designed to prevent a RSW becoming fatigued, they reduce the likelihood of a fatigue-related error resulting in a rail safety incident. Examples of such controls include vigilance monitoring systems, speed warning systems and automatic train protection.

ACTIONS TO APPLY THE MINIMUM STANDARD – STEP 3

1. Analyse the errors and rail safety risks that may arise if a RSW is impaired by fatigue;
2. Analyse the effectiveness of existing controls on work scheduling / rostering practices to manage identified fatigue factors and fatigue related risks.

Step 4

Step 4 requires the RTO to evaluate the fatigue risk factors identified in the previous steps and identify reasonably practicable ways to reduce or better manage them. In Step 4 an RTO should:

1. Evaluate work scheduling practices and procedures against the principles of rest and recovery in Table 2, to identify whether the RTO's practices and procedures meet the fatigue parameters;
2. Consider and evaluate any other measures to eliminate or mitigate the risk of RSW fatigue likelihood.

Step 4.1 Evaluate work scheduling practices and procedures

Table 2 below is designed as a reference point for the main scheduling dimensions identified by scientific research that impact on fatigue likelihood. The table does not address safety risk as this will depend on the rail safety tasks and the potential adverse consequences if workers are fatigued. For this reason the table is not designed to determine if work schedules are acceptable based on fatigue likelihood alone e.g. in order to mitigate rail safety risks, rail safety work is performed at night where train movement is substantially reduced or non-existent. Scheduling decisions should therefore be made on the basis of the entire risk assessment process.

Table 3 is also a means of evaluating whether current controls on work schedules effectively manage the major physiological fatigue factors. It can be used as a tool to generate options for improved, work schedules by offsetting dimensions of schedules that increase and decrease the likelihood of fatigue.

Note that the principles in the table address the major factors that cause fatigue, but other relevant risk factors identified by the RTO in Step 2, must also be considered in applying the principles. For example short notice changes to shifts and crew calling practices may reduce the ability of workers to plan sleep or may interrupt sleep therefore reducing the opportunity for sleep provided by a particular break.

For this reason schedules that are within the lowest fatigue likelihood zone of Table 2 may not be sufficient to comply with the RSNL, unless the risk assessment demonstrates that all reasonably practicable measures to manage risk have been implemented.

Table 2: Fatigue likelihood considerations

Principle	Measure	Lower fatigue likelihood	→	Higher fatigue likelihood
Work-related rest breaks during shifts to reduce performance impairment due extended time-on-task				
1. Ensure sufficient time off-task	Percentage of time in shift on tasks that require sustained attention	Up to 80-85% of shift	Between 85 – 90% of shift	Over 90% of shift
2. Ensure regular rest breaks	Time on task before a rest break of 15 minutes or more	At least once every 3hrs	At least once every 4hrs	At least once every 5hrs
Recovery breaks between shifts to provide opportunity for sufficient sleep to perform the required tasks satisfactorily during subsequent shifts				
3. Ensure break provides opportunity for sufficient sleep	Length of recovery break between shifts	More than 10 hours	Between 8 and 10	8 hours or less
4. Maximise night sleep	Proportion of recovery breaks in shift sequence (between reset breaks) that preserve night sleep opportunity 00:00-06:00	All recovery breaks in sequence include 00:00 to 06:00 period	Half or more recovery breaks in sequence include 00:00 to 06:00	Less than half recovery breaks in sequence include 00:00 to 06:00
5. Minimise night work	Proportion of shifts in a sequence that end between the hours of 00:00 and 06:00	No shifts end between 00:00 and 06:00	Half or less of shifts in sequence end between 00:00 and 06:00	More than half of shifts in sequence end between 00:00 and 06:00
6. Minimise very long shifts particularly those ending between 00:00 and 06:00	Shift length	8– 10hr shifts	10 – 12hr shifts	More than 12hr shifts
Reset breaks: breaks in sequences of shifts to prevent cumulative sleep loss and eliminate the build-up of unsafe levels of fatigue over an extended sequence of shifts				
7. Prevent the accumulation of fatigue over a sequence of shifts	Number of shifts in sequence prior to reset break of at least 34hrs which includes two night sleep periods, (00:00- 06:00) between shifts	2-4 days (48-72 hrs) between reset breaks over a sequence of shifts	5-7 days (96-168 hrs) between reset breaks over a sequence of shifts	8 days or more (192 hrs or more) between reset breaks over a sequence of shifts

Using Tables 2 and 3 to evaluate options for improving work scheduling practices

An essential element of applying the principles in Table 2 is to manage their interaction with each other.

The Code does not preclude work scheduling dimensions associated with elevated fatigue likelihood but requires a much more detailed and rigorous risk assessment to demonstrate that the risks are effectively managed.

RTO's should aim to implement work scheduling practices with the lowest fatigue likelihood SFAIRP. If work schedules have an elevated fatigue likelihood, this can be managed via offsetting principles to reduce fatigue likelihood or by introducing other controls to reduce rail safety risks. Importantly controls may not just relate to work scheduling. Controls may also include engineering controls or ways in which to adjust work procedures or practices to reduce the likelihood of fatigue or the consequences of fatigue related errors.

Alternatively the risk assessment may demonstrate that engineered controls effectively mitigate the risk of fatigue related error in which case the RTO may tolerate greater exposure to work schedules that fall in the medium-high fatigue likelihood zones. However, the greater the number of parameters that fall in the higher fatigue likelihood zones the greater the detail required of context specific risk assessments and ongoing safety assurance.

It is also acknowledged that there are exceptional circumstances relating to some contexts, generally in remote areas where there may be fewer scheduling options and or the safety risks may be lower. In such cases planned operations may operate with schedules that have higher fatigue likelihood but such scheduling practices must be justified by a detailed context specific fatigue risk assessment.

Operators should also show in any of their fatigue risk assessments that they have developed contingency plans for situations involving degraded or emergency conditions.

Table 3: Applying offsets to balance elevated fatigue likelihood

Principle	Elevated fatigue likelihood due to:	Examples of options to offset elevated fatigue on each dimension
1. Ensure sufficient time off-task	Tasks are mostly high fatigue susceptibility. Attentional demands exceed capacity of individual	Redesign work to introduce more downtime, vary or rotate tasks (P1) Minimise very long shifts (P6) or increase break length/frequency (P2) Increase team interaction and supervision Review and redesign procedures to improve error tolerance
2. Ensure regular rest breaks	The work involves extended periods without a rest break Attentional demands exceed capacity of individual	Redesign work to introduce more downtime, vary or rotate tasks (P1) Minimise very long shifts (P6) Rotate RSW in and out of high risk tasks more frequently (P1) Provide relief to enable more frequent breaks
3. Ensure break provides opportunity for sufficient sleep	Recovery breaks too short to provide adequate sleep opportunity	Avoid short breaks at time of day that is low sleep opportunity (P4) Extend subsequent recovery break following shorter break Optimise sleep environment
4. Maximise night sleep	Recovery breaks don't include 00:00-06:00 making sleep hard to obtain due to biological & social impacts	Maximise break between shifts (P3) Minimise long shifts (P6) Provide longer rest break in shift for nap (P2), formal napping policy Provide more frequent reset breaks (P7) Pre-start fitness for duty check, promote fatigue reporting
5. Minimise night work	Shifts include the hours between 00:00 and 06:00 making it hard to maintain alertness due to circadian effects and extended wakefulness	Adjust shift timing to maximise night sleep (P4) Minimise very long shifts to reduce time awake (P6) Provide more frequent or longer break for nap (P2), napping policy Redesign procedures to improve error tolerance Redesign work to allocate high risk tasks to periods of lower fatigue Increase team interaction and supervision
6. Minimise very long shifts particularly those ending between 00:00 and 06:00	Fatigue accumulates with time on task and long shifts may reduce recovery time before the next start	Extend shifts during time of max alertness after night sleep (P4) Reduce time spent continuously working (P1) Provide SO prior to commencing long shifts (P3) Delay start of subsequent shift to provide recovery opportunity (P3) Redesign work to avoid high risk tasks at times of elevated fatigue Increase team interaction and supervision, promote fatigue reporting
7. Prevent the accumulation of fatigue over a sequence of shifts	There are longer blocks of shifts between reset breaks increasing likelihood of fatigue accumulation or incomplete recovery	Minimise night work if extended periods without reset (p5) Provide longer reset break >34hrs after extended night sequence Provide two 9.5 hour sleeps to prevent longer term accumulation Minimise late finishes and early starts before and after reset Allocate high risk tasks to lower risk periods of sequence

> ***Example***
>
> *Some rail safety work can only be performed at night, which presents a higher likelihood of fatigue because:*
>
> - *the work is done at times when alertness is reduced and the likelihood of fatigue is high (Principle 5); and*
> - *it is not possible to obtain night sleep which is known to be most efficient for recovery (Principle 4).*
>
> *The higher likelihood of fatigue from this work scheduling can be balanced by reducing the exposure to other risk factors. This could include:*
>
> - *shortening the total shift length of these night shifts (Principle 6);*
> - *extending the amount of time available to obtain sleep during the day (Principle 3);*
> - *minimising the number of consecutive shifts (Principle 5); and*
>   - *implementing a reset break of at least 34 hours following the period of night work, including two periods between 00:00-06:00, to ensure sufficient night sleep for recovery (Principle 7).*

Step 4.2 Consider and evaluate any other measures to eliminate or mitigate the risk of RSW fatigue.

Risk evaluation involves the RTO comparing the results of the risk analysis with the fatigue parameters in Table 1 to determine if the risks are acceptable or if anything more can be done such as implementing new control measures or eliminating or modifying existing measures, SFAIRP.

For the relevant RSWs, the RTO should:

- identify if anything else can be done (in addition to existing controls) to reduce fatigue or lower risk;
- adopt or reject the options based on whether they are reasonably practicable to introduce. ONRSR's guideline: *Meaning of duty to ensure safety SFAIRP,* can assist RTOs in determining whether a new control measure is reasonable to introduce. The Guideline can be found at:

  http://www.onrsr.com.au/__data/assets/pdf_file/0009/2412/Guideline-Meaning-of-Duty-to-Ensure-Safety-SFAIRP.pdf
- consider unintended consequences of modifying existing controls or introducing new controls (e.g. changing one part of the roster may reduce fatigue for some workers but increase it for others).
- consult with the RSW who may be affected by any changes.
- document the decision making process (s100(2) of the RSNL), including keeping a record of any scientific information or expert inputs.

ACTIONS TO APPLY THE MINIMUM STANDARD – STEP 4

1. Evaluate work scheduling practices and procedures against the principles of rest and recovery in Table 2 to identify measures that better manage fatigue by applying offsets;
2. Consider and evaluate all other measures, including offsets, to eliminate or mitigate the risk of RSW fatigue and document the process.

Step 5

Treat fatigue related risks	→	**Implement** reasonably practicable fatigue control measures

Following the evaluation of control measures in Step 4, RTOs should implement all new or improved control measures that are reasonably practicable to introduce. As part of this process it will be important to:

> assign accountability and responsibilities for implementing the new or amended control measures;

> communicate and consult with those who will be affected by the change;

> update relevant systems and procedures;

> provide any necessary information or training to RSW;

> establish and maintain documented procedures to manage, so far as is reasonably practicable, fatigue related risks. These requirements are listed below.

Regulation 29(2) of the National Regulations requires RTOs to establish and maintain document procedures, including:

a) Specified work scheduling practices and procedures that provide for—

i. safe hours of work; and

ii. safe periods of time between shifts; and

iii. sufficient RSWs to be available to meet reasonably foreseeable demands for relief arrangements.

ACTIONS TO APPLY THE MINIMUM STANDARD – STEP 5

1. Treat fatigue related risks by implementing any additional controls required to manage the risk so far as reasonably practicable.

Step 6

Monitor and review fatigue risk controls → Monitor and review hours of work, audit controls, review processes and reports on effectiveness of FRMP

Reg 29(2)(b) of the National Regulations states that RTOs must establish and maintain documented provisions for monitoring of hours of work, in particular:

> procedures for monitoring how actual hours of work of RSWs compare with planned hours of work; and
> procedures for monitoring the impact to changes to planned rosters due to shift swapping, overtime and on-call working.

Further, in the content of an SMS under Schedule 1(8) of the National Regulations, RTOs must also ensure reviews of the systems and procedures of the SMS in accordance with section 102 of the RSNL (Review of safety management system) and reg 17, with the documentation requirements set out in reg 17(3).

An RTO should also monitor and review the FRMP and in particular risk controls to ensure they continue to be effective. This may include:

- setting scheduled intervals for review of the FRMP;
- conducting triggered reviews in response to set criteria such as an incident or fatigue report from RSWs;
- auditing at set intervals including monitoring of fatigue related risk controls to check they are in place and working effectively;
- investigating fatigue as a contributing factor for human error incidents by inclusion of criteria in investigation protocols;
- providing monitoring reports to accountable managers at set intervals;
- implementing corrective actions where indicated, to reduce fatigue, improve roster stability or correct staffing shortfalls.
- monitoring hours of work for fatigue using risk based KPI's that include:
  - planned vs. actual hours including impact of swapping, overtime and on call;
  - compliance with standards for 'safe' hours of work;
- providing monitoring reports to accountable managers at set intervals;
- implementing corrective actions where indicated, to reduce fatigue, improve roster stability or correct staffing shortfalls.

The National Regulations also require RTOs to:

- notify ONRSR of a decision to change any work scheduling practices and procedures set out in the operator's FRMP (section 9(1)(a) at item 10 in the table).
- report any breach of the work scheduling practices and procedures set out in the RTO's FRMP under s57(1)(b)(xv) where a Category B notifiable occurrence occurs (unless that occurrence is also a Category A notifiable occurrence).

RTOs should therefore develop and implement systems to notify ONRSR where requirements are prescribed.

ACTIONS TO APPLY THE MINIMUM STANDARD – STEP 6

1. Include within the FRMP, provisions for monitoring of hours of work;
2. Establish a regular schedule for review of the FRMP;
3. Adhere to the reporting requirements under the RSNL.

Fatigue risk management for rail safety workers: summary of the evidence

Seven basic principles have been identified as important for effective fatigue risk management in rail or any transport system. These principles address each of the seven major factors that need to be considered to ensure that rail safety workers, are sufficiently alert and have the capacity to undertake all requirements of their jobs. These principles were originally developed to provide a framework for estimating fatigue likelihood in any workplace that involves twenty-four hour operations. They were originally developed for the long distance road transport industry but this paper adapts them to the particular characteristics of work for rail safety workers.

It is widely recognised that fatigue, sleepiness and lowered alertness is important as it impairs the capacity to work safely. This has been demonstrated in a wide range of occupations including the Australian rail industry. For example, Dorrian et al (2007) showed that high levels of fatigue in train drivers produced slower reaction time, more instances of extreme speeding, more braking errors and penalty braking over 8 hour shifts of driving a rail simulator. The authors concluded that increasing fatigue in train drivers produced more failures to respond, which they attributed to greater cognitive disengagement with the task of driving. Another study of the management of speed restrictions by Australian train drivers also showed adverse effects on performance when train drivers experienced high levels of fatigue (Dorrian et al, 2006). Again, higher fatigue produced less braking and overall higher speeds.

While there has been less research on other rail safety workers, most transport authorities have identified fatigue as a major issue. This includes national (ATSB) and international (NTSB and RSSB) transport safety authorities, all of which cite data indicating that fatigue has often been identified as a significant risk factor for drivers. This is not surprising since the impairing effects of fatigue are quite general and effect cognitive function globally – leading to impaired awareness, responses, judgement, decision making across a wide range of tasks

The aim of this paper is to summarise the research literature on each of the seven principles in order to identify the best approaches to identifying and managing fatigue risk for rail safety workers in the rail industry. The seven principles identified are known to have the potential to independently increase the likelihood of fatigue and fatigue-related error. Each of these principles, in practice, encompasses a range from low to high fatigue likelihood depending on the specific characteristics of a work schedule. In addition, the seven principles can interact with each other such that work schedules that include high fatigue likelihood on one principle may result in moderate or even low fatigue if fatigue risk on most other principles is low.

In this document the available scientific evidence is summarised and used to explain the rationale for each of the principles. It is important to recognise that while the scientific evidence identifies each of these principles as important for workers in general, specific evidence from rail safety occupations is not always available. This means that while the evidence for the fatigue risk framework in general is strong, the evidence for each particular group of rail safety workers is not definitive because of the lack of available research. This is not really a problem since the factors that increase the likelihood of fatigue and each of the principles are common to most humans. The effects of differences in the nature of the task undertaken and their effects on subsequent risk are determined during the broader risk assessment process that is already undertaken as part of WHS practice (e.g., based on ISO31000 or equivalent). This relates to the consequence assessment in risk management involving an analysis of the '*consequence'* of a fatigue-related error. Thus, differences in risk attributable to differences in the circumstances of the work or task for each work group (e.g., timing, location, work pace etc) can be determined during the assessment of consequence.

This means that the proposed fatigue risk framework should be dynamic, flexible and easily changed to reflect the differences in fatigue risk likelihood amongst the various work groups and tasks involved in the rail industry. While estimating the likelihood of fatigue has been formalised, estimating differential risk is facilitated through analysis of other factors that contribute to estimates of the *"consequence"* dimension.

Overview

The use of risk-based approaches to safety regulation have a long history beginning with the Robins report in the UK (1972) where the benefits of performance based regulatory models were first articulated as a regulatory principle.

These principles were reflected in changes to Australian WHS laws since the mid 1980's and have continued ever since. The development of risk-based approaches led to the evolution of the Australian standard for risk management (AS 4360) which has formed the basis of the ISO standard for risk management (ISO 31000).

With respect to fatigue, risk-based approaches are currently advocated in in many transport modalities including the US, UK and Canada as well as Australia and NZ. In Australia, the current fatigue regulations for rail are based on a [fatigue] risk management approach. This requires rail transport operators to take into account and assess any fatigue-related risks to safety arising from work practices, scheduling of work and rest, the nature of the work and the work and rest environment as well as relevant developments in research related to fatigue and technology that can be applied to manage work-related fatigue. The risk assessment and review carried out by the operator is used to develop a fatigue risk management program and procedures.

The objective of this document is to review the current research evidence on the general principles that enable an operator to estimate the likelihood of fatigue associated with a working time arrangement and to be aware of current knowledge about the causes and the solutions to fatigue in rail safety workers and so contribute to fatigue management programs in the rail industry. This review is organised around the seven principles for fatigue management developed for road transport.

The framework is based on the primary need in fatigue risk management for well-timed breaks from work to restore alertness levels and performance capacity and covers three clear dimensions:

1. **Work Related Rest Breaks** : frequency and timing of breaks from work within a work period or work opportunity (WO) to reduce performance impairment due to extended time-on-task

2. **Recovery breaks:** frequency and timing of sleep opportunities between work periods to provide enough time to obtain sufficient sleep in order to reduce the likelihood of unsafe levels of fatigue
3. **Reset breaks:** frequency and timing of breaks in sequences of work periods to reduce the likelihood of the build-up of unsafe levels of fatigue over an extended sequence of shifts

These 3 dimensions have been further subdivided into a set of seven principles for fatigue risk management that enable an operator to undertake a risk-assessment of the working time arrangement and to determine, where appropriate, the level of risk mitigation required in order to undertake the pattern of work safely.

The seven principles for fatigue risk management are:

Work-related Rest Breaks

1. Ensure sufficient rest breaks involving time off-task
2. Ensure regular rest to break up time on task

Recovery Breaks

3. Ensure an adequate sleep opportunity in order to obtain sufficient sleep
4. Maximise night sleep
5. Minimise shifts ending between 00:00 and 06:00
6. Minimise extended shifts

Reset Breaks

7. Prevent accumulation of fatigue with long reset breaks including two night periods (00:00-06:00) between work sequences

These seven principles can be used to design work rest schedules that take into account operational demands for continuous, round the clock services but at the same time manage fatigue risk. The principles can be used to identify the working and resting hours practices that produce high fatigue risk and that need to be managed so ensuring that rail safety workers are not experiencing high levels of fatigue risk.

An essential element of the risk assessment approach is that the seven principles interact. By using the principles to define levels of risk, it is possible to create a schedule that involves combinations of high to medium risk on one or more principles, but to ensure that these higher risk elements are balanced by elements that low risk for other principles. For example, the high fatigue risk of extended work shifts may be reduced by ensuring that work shifts do not begin too early and rail safety workers are sufficiently rested before the shift commences and have sufficient rest to allow for recovery after the shift.

Principles 1 and 2. Reduce extended periods spent on sustained attention tasks during the work opportunity

1. **Ensure sufficient rest breaks involving time off-task**
2. **Ensure regular rest to break up time on task**

Evidence

There is considerable research evidence that fatigue increases with increasing time on task and that rest breaks are needed within work periods in order to manage fatigue. Evidence from large industrial studies have shown that the increasing accident and injury risk with increasing time on task can be reduced by taking regular rest breaks during work time. Large scale studies of Injury and accident risk show that risk decreases immediately following a rest break, but then begins to increase within the next 30 to 60 minutes, until the next rest break (Folkard and Lombardi, 2006; Tucker, et al., 2006).

Despite this evidence, there has been comparatively little research on the exact timing and duration of rest breaks during work to manage fatigue most effectively. A number of factors are likely to determine when rest breaks should be taken to be most effective, including the length of the overall work period, the time of day and the nature of the work being undertaken. In the rail industry, train drivers are likely to be particularly vulnerable to fatigue as their work is monotonous and often requires train drivers to be alert and attentive over very long periods. Research in a car simulator showed that driving on straight roads induced higher levels of fatigue and poorer performance than driving on curving roads (Matthews and Desmond, 2002). Studies of train drivers showed similar findings. A study of train driving in a realistic rail simulator showed that fatigued drivers' use of brakes was poorer when terrain was more monotonous compared to undulating territory that required drivers to actively engage with the braking system (Dorrian et al, 2006). A second study of train drivers also showed that the effects of fatigue on performance can be reduced by making the driving task more interesting (Dunn and Williamson, 2012).

These studies indicate not only that regular rest breaks are needed during work to manage fatigue, but also that train drivers and rail safety workers in general need more frequent rest breaks in order to reduce the additional effects of monotonous driving on fatigue and performance.

There is less evidence however on when rest breaks should be taken during the work period or how long the break should be. A review of the evidence on the impact of rest breaks in industry in general concluded that short frequent rest breaks are most beneficial especially early in a shift, and workers should be encouraged to take breaks in response to their experience of fatigue (Tucker, 2003) however the authors point out that evidence on the optimum duration and frequency of rest breaks during work is lacking. A study of breaks during car driving found that 15 minute and 60 minute breaks had similar benefits for performance (Lisper and Eriksson, 1980) although including food increased the value of breaks, no matter for how long. This study suggests that even short breaks can be worthwhile. A study of simulated highway driving found substantial increases in sleepiness and poorer driving performance occurred by the end of 90 minutes of driving (Ting, et al., 2008) suggesting that rest breaks should ideally occur before that time.

Evidence from the rail industry shows similar results. In a simulated train driving study (Dunn and Williamson, 2012) that when the driving task was very monotonous and required little effort, performance deteriorated very rapidly and within 15 minutes of commencing driving. This finding is also consistent with the results of Chang and Ju (2000) which showed that freight train driving was associated with a peak in accident risk in the first hour of driving. A study of the duration and frequency of breaks showed that short frequent breaks reduced errors compared to waiting for longer periods (Kopardekar and Mital, 1994), although this was in a computer operations task, rather than train driving. Certainly, it seems that short frequent breaks are needed to reduce fatigue risk when the train driving, or any rail safety work, is very monotonous.

There is some evidence that breaks that include a nap are beneficial for reducing fatigue, although the effectiveness depends when the napping break is taken and the extent of sleep deprivation. Unfortunately, there seem to be no studies of the effect of napping in rail operations. Nevertheless, a meta-analysis of the effect of naps on fatigue management (Driskell and Mullen, 2005) concluded that the benefit of naps is directly proportional to their length. A 15 minute nap produced benefits lasting two hours while a four hour nap benefited performance for 10 hours. They also concluded that timing of naps was important as the benefits decreased with the longer time between naps, regardless of the length of the nap.

A review of nap lengths showed that the shortest duration to maintain performance was four minutes and that naps longer than 20 minutes lose their benefits as they are much harder to wake from (Naitoh, 1992). Also, there is evidence that longer naps are needed to overcome longer periods without sleep (Caldwell, et al., 2008) and that naps taken early, before a period of work, will benefit performance Bonnet, 1991; Scheitzer, Muehlbach and Walsh, 1992). For example, a study of long haul truck drivers (Macci, Boulos, et al., 2002) showed that a three hour nap taken before night time driving in a simulator improved sleepiness and fatigue and produced faster reaction speeds and more consistent performance on psychomotor tasks. Also important is when the nap is taken with respect to the circadian rhythm as this determines the ease of falling asleep. Naps taken closer to the circadian peak will be harder to initiate and not last as long (Gillberg, 1984), but those taken at the circadian trough (between 00:00 and around 06:00) when the body is naturally most prepared for sleep, are harder to awake from and can have adverse effects of 'sleep inertia' on performance as a result.

In summary, the research evidence relating to rail safety operations supports the use of regular rest breaks to manage the build-up of fatigue risk during a period of work and highlights the need for frequent breaks from monotonous work due to the higher fatigue risk in these jobs. The evidence on break duration shows that breaks within work may be quite short and still have benefit especially in monotonous conditions provided that the person is not already experiencing fatigue due to other causes. The evidence on how naps might be used in rail safety is less clear, although the evidence is strong on their overall benefits to reduce fatigue risk. In general, the evidence suggests that lengths of naps should be proportional to the level of fatigue risk; overcoming high fatigue risk needs longer naps, but naps should be taken earlier, before fatigue levels are highest rather than to use them to recover from high levels of fatigue.

3. Ensure an adequate sleep opportunity in order to obtain sufficient sleep

Evidence

In determining what constitutes an ‘adequate sleep opportunity’ it is generally viewed as sufficient time in order to obtain the amount of sleep necessary to return to the workplace in a state ‘fit-for-work’. This means that rest breaks intended to allow a sleep opportunity must be longer than the amount of time required for sleep to allow for meals and other normal daily activities.

Although there is some debate on the minimum amount of sleep people require each night to perform safely, there is broad agreement that, on average, workers require at least 6 hours sleep each night (Ferrara and De Gennaro, 2001, Dawson and McCulloch, 2005) to ensure the rest and recuperation necessary to work safely. Multiple days of only 6 hours sleep, however, are likely to lead to an increasing sleep debt and to be insufficient to maintain adequate, safe performance in many people. It is important to note that there is considerable individual variability in the amount of sleep needed to perform well or safely, however, principles for fatigue risk management in the workplace must apply to at least the average worker.

With the caveats above noted, it is important to understand that the duration of the rest breaks/sleep opportunities is not the same as the amount of sleep obtained. The amount of sleep obtained is always less than the break duration since that time will often require the worker to address other activities of daily living in addition to sleep.

Despite typical break durations of at least 9-10h, a study of a range of rail industry employees in Australia showed that around 12% obtained five hours or less sleep in the last 24 hours (Dorrian, Baulk and Dawson, 2011). Evidence from the rail industry showed that the length of time available for sleep (the sleep opportunity) influences the duration of sleep obtained. Based on a survey of Australian train drivers, Roach, Reid and Dawson (2003) found that comparing the same time of day, longer breaks provided opportunity for more sleep. During rest breaks of 12 hours, train drivers obtained around five hours of sleep on average, in 16 hour breaks average sleep reported was around 6.5 hours and in a break of 24 hours drivers reported 8.9 hours. There was some variation in the amount of sleep obtained depending on the time the break commenced. More sleep was obtained in shorter break lengths if they commenced in the usual bedtime period between 22:00 and 24:00.

A study of US locomotive engineers also showed a relationship between work start and end time and the amount of sleep obtained. Shifts that commenced work between 22:00 and 03:00hrs had only five hours sleep, while those ending in the period 02:00 to 11:00hrs had less than six hours sleep (Pollard, 1996 cited in Sussman and Coplen, 2000). A Swedish study of train drivers (Ingre, Keckland, Akerstedt and Kecklund, 2004) also confirmed that work shifts that start early (before 06:00) also resulted in significantly shorter sleep duration, with drivers doing early starts getting less than 6 hours sleep on average compared to between 7 and 8 hours sleep if work started closer to 10:00hrs. Furthermore, this study also showed that drivers doing early starts experienced nearly five times more severe sleepiness events than those doing day shifts with starts closer to 08:00hrs.

Australian studies of sleep on relay operations when pairs of train drivers alternate between 8 hr periods of work or sleep over a round trip suggest that time in bed does not necessarily reflect actual sleep time (Lamond, Dawent and Dawson, 2005; Darwent, Lamond and Dawson, 2008. These studies of round trips between Adelaide and Melbourne and Adelaide and Perth used diaries and actiwatches to validate actual sleep of train drivers. The results showed that sleep obtained in relay vans en route was significantly reduced compared to sleep at home. Furthermore, total sleep time (as measured by actiwatch) was only around half of the total time in bed, indicating that actual sleep is much less than might be interpreted based on time in bed. In these studies too, time of sleep also influenced sleep duration with least sleep if the sleep opportunity was 08:00-14:00hrs or 14:00-20:00hrs. In addition, as the studies also showed, it seems that train drivers often do not attempt to sleep at these times, when sleep is least likely and hence the duration of sleep is low.

This evidence leads to the conclusion that obtaining sufficient sleep during rail operations is dependent on having sufficient time to allow for sleep and acknowledging the time of day in which the opportunity for sleep occurs. Essential considerations here are to ensure that shifts do not begin too early and that sufficient time is allowed to obtain enough recovery sleep. An important consideration in designing rest periods is that the entire rest period cannot be assumed to contain sleep. Even in operations where sleep facilities are immediately available, such as in relay vans, train drivers or any rail safety workers who can sleep on-site will only obtain around half of the available time as sleep, and this is especially the case during irregular sleep times such as daytime. Rest times should be designed to maximise the likely sleep period.

4. Maximise night sleep

Evidence
There is abundant evidence that the daily body or circadian rhythm exerts a strong influence on when sleep is most likely to occur and be of best quality. Sleep is most likely at night and sleep during the day is shorter and more fragmented than sleep during night (Dijk, Duffy and Czeisler, 1992). There is also considerable research evidence that shift workers and people who are required to work at night develop chronic partial sleep deprivation. This has been shown to adversely affect alertness and performance (Balkin, Rupp et al., 2008).

Evidence from rail operations shows similar findings and confirms that rail workers are also vulnerable to the disruption to sleep of when work hours impinge on night sleep. Research by Torsvall and Akerstadt (1987) showed that compared to day work, train drivers required to work at night had markedly higher ratings of sleepiness that were confirmed by EEG records. In fact, four of the 11 train drivers participating in the study admitted falling asleep during the night drive and two missed signals during the night drive. A study of sleep and vigilance in French train drivers (Cabon et al., 1993) also showed longer duration sleep at night than daytime. Evidence on the interaction between break duration and time of day discussed in the previous section is relevant here too because of the problem of attempting to gain good quality sleep in the daytime. Comparing breaks of the same duration, those taken at night got more sleep (Roach et al, 2003) compared to day sleep.

Consistent with research in other sectors, it is clear that for all rail safety workers including train drivers night sleep is more efficient and sleep is more likely at night. Operational demands that impinge on the opportunity for night sleep will significantly reduce the availability of sleep for rail safety workers and the benefits for managing fatigue risk.

5. Minimise shifts ending between 00:00 and 06:00

Evidence
Many studies have shown performance in general is poorer during the night period compared to the day period, especially during 00:00 to 06:00 hours (Williamson, et al, 2013). The worst performance decrements are found in the period of circadian low (00:00-06:00h) (Barger, et al., 2009).

In situations where the end of a work period coincides with the 00:00 to 06:00h period, the problem is even greater. The problem occurs when night workers who are already tired due to the time already worked and then encounter the circadian low point produce. This combination produces lowest alertness and performance and significantly higher crash risk than shifts that end outside this period. This effect is confirmed in rail by the study of Torsvall and Akerstedt (1987) which found that sleepiness was highest at the end of night work in the period 03:00-05:00hrs. In addition, there is evidence that shifts that end in the 02:00 to 11:00hrs period also disrupted subsequent sleep to less than six hours sleep (Pollard, 1996, cited in Sussman and Coplen, 2000).

Overall, the evidence shows strongly that the combined effect of a long period without sleep and the circadian low period produces greater sleepiness, disrupts subsequent sleep in rail safety workers and, as shown in other industries, also has highest crash risk.

***6.* Minimise extended shifts**

Evidence

There is a large amount of research evidence that across many transport sectors that in general, that crash risk increases with increasing hours of time at the controls. In the rail sector, a study by Chang and Ju (2000) analysed train-driver responsible accidents and found that accident risk doubled after 4 consecutive hours of driving compared to the first hour. Furthermore the increased accident risk occurred much earlier in a trip for train drivers compared to car drivers, which the authors attributed to the greater monotony in train operations. As discussed above, a number of studies have also highlighted the greater vulnerability of train drivers to the fatigue effect of monotony (eg: Dorrian et al, 2006).

A study of relay driving where two crew members alternate between 8 hours train driving or 8 hours rest, train drivers showed significantly increased fatigue by the end of each shift that reduced following the 8 hour rest period (Jay, Dawson, Ferguson and Lamond, 2008). In contrast, a UK survey of rail signallers found support for 12 hour work shifts over shorter rotating shifts (Ryan, Wilson, Sharples Kenvyn and Clarke, 2008), although the authors argued that these preferences were likely to be due to recreational and social preferences rather than for fatigue management.

A review of the effects of short cycle work schedules involving shifts of up to 8 hours in transport operations including long haul train drivers concluded that better fatigue management is achieved by very short shifts of 4h on/8h off than 6/6 and 8/8 arrangements because the short shift maximises sleep. The 4 on/8 off schedule consistently showed more sleep than the other schedules which the authors argued will benefit sleepiness and performance, although they argue for the need for research to test this hypothesis. (Short et al, 2015).

In summary, the overall evidence on the best length of shifts for rail operations suggests that it is difficult to draw conclusions based on shift duration alone. While there is little doubt that the likelihood of fatigue can increase with longer shifts, other aspects of the working time arrangement may work to mitigate that risk. For example, if you work fewer shifts per week this may offset the increased likelihood of fatigue associated with longer shifts. A recent review article on this topic (Ferguson and Dawson) suggests that shifts between 8-12h in duration do not produce consistent significant increases in the likelihood of fatigue - *all other things being equal.* However, this is not always the case.

7. Prevent accumulation of fatigue with long Reset breaks including two night periods (00:00-06:00) between work sequences

Evidence

The problem of chronic partial sleep deprivation was described above. A number of studies have shown that successive days of sleep restricted to less than 6 hours produces adverse effects on alertness and performance (Dinges et al., 1997; Van Dongen, et al., 2003; Belenky et al., 2003). While there is a view that some people are habitually short sleepers and that most people can adapt to lower levels of sleep (Horne, 2011), the limit of safe adaptation is around 6 hours of sleep. In all of the studies of partial sleep deprivation, the accumulated sleep loss was only overcome by a significantly longer sleep opportunity. In fact, some studies that allowed only a moderate sleep opportunity following 7 days of shorter sleep showed that even two further days of 8 hours sleep was insufficient to return alertness and performance levels back to baseline (Belenky, et al., 2003).

There is some evidence on the need for long or reset breaks in the rail industry. A recent survey of the views of Australian rail safety workers including train drivers and terminal operators about the best countermeasures for fatigue, found that rail safety workers reported lack of recovery time between shifts to be a cause of fatigue. Consistent with this view, Kandelaars, Lamond, Roach and Dawson (2005) found that longer breaks of 48 hrs or more between shifts increased significantly the length of sleep obtained in the break which has benefits for rest and recovery and also reduced the length of time awake before the start of the next shift so reducing the likelihood of fatigue during that shift.

In summary, this evidence from rail and other industry shows that where sleep debt has accumulated due to inadequate sleep over a period of work, longer break periods are needed to allow rail safety workers to recover the build-up of fatigue. For these reasons, an extended period that includes at least two, night rest periods (nominally 00:00 til 06:00 is needed to ensure that rail safety workers are able to obtain sufficient sleep to prevent significant likelihood of fatigue due to cumulative sleep loss.

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