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ONRSR Guideline

Fatigue Risk Management

safe railways for Australia

Document ID:	ONRSR-1963997744-289
Version number:	1.1
Approved by:	Chief Executive
Date approved:	29/10/2020

Policy changes to 1.0

> Minor amendments to align with implementation of the National Rail Safety Data Strategy

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1.1 Purpose

This guideline has been developed to provide practical guidance to rail transport operators on how to manage the fatigue-related risks associated with rail safety work and meet the requirements of the *Rail Safety National Law 2012* (RSNL).

The guideline presents a nationally consistent framework for fatigue risk management that supports the co-regulatory model of the RSNL and recognises the primary duty of rail transport operators to ensure the safety of their operations so far as is reasonably practicable (SFAIRP).

1.2 Who should use this guideline?

The guideline should be used by rail transport operators who are responsible for developing, implementing and managing a Fatigue Risk Management Program (FRMP) under the RSNL.

1.3 How to use this guideline?

The guideline outlines a step by step approach for rail transport operators to apply when developing work scheduling procedures and practices as part of their FRMP. Each step includes a summary of ONRSR's minimum expectations for operators to understand what ONRSR will take into consideration when reviewing a FRMP.

Fatigue risk management is an important part of the overall risk management process and the way in which the fatigue risk management process is applied will be determined by an operator's individual circumstances and the tasks, responsibilities and risks associated with all classes of work performed by its Rail Safety Workers (RSWs). Four scenarios to illustrate the fatigue risk management process in practice are provided in Appendix 1.

This guideline should be read in conjunction with other relevant ONRSR documents, including:

> Safety Management System guideline;

> Meaning of duty to ensure safety so far as is reasonably practicable guideline;

> Identifying rail safety work under the RSNL guideline.

To ensure the validity of risk assessment outcomes and the appropriate management of relevant risks, it is important that the fatigue risk management process is undertaken by suitably qualified persons with the appropriate competencies and expertise.

1.4 Scope

This guideline should be used alongside the RSNL and National Regulations and the relevant state and territory work health and safety (WHS) laws. In reading the guideline, the word 'must' indicates that a legal requirement exists and must be complied with.

This guideline does not replace the fatigue risk management requirements under the RSNL.

In summary, the guideline:

> Provides practical guidance on how to manage the fatigue-related risks associated with rail safety work and meet the requirements of the RSNL.

> Articulates ONRSR's minimum expectations for fatigue risk management.

> Should be used in conjunction with the RSNL and National Regulations and the relevant state and territory WHS laws.

> Does not replace the fatigue risk management requirements of the RSNL.

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.[1]

Fatigue does not only 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 with cognition, 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 rail transport operators but to the community at large. Railway operations pose an increased risk of fatigue likelihood due to:

- the widespread use of non-standard hours (e.g. 24/7 operations, night work, shift work 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 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.[2]

Further, fatigue may affect behaviour 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 'so far as is reasonably practicable'.

[1] For a detailed review and discussion on the definition of fatigue refer to: Phillips, R. (2015). A Review of definitions of fatigue – And a step towards a whole definition. *Transportation Research: Part F: Traffic Psychology and Behaviour*, 29, 48-56. https://doi.org/10.1016/j.trf.2015.01.003

[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 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

3.1 Overview

The RSNL sets out clear requirements for rail transport operators and rail safety workers regarding fatigue risk management.

A rail transport operator's statutory obligations are to ensure 'so far as is reasonably practicable' (SFAIRP)[3] that RSWs who perform rail safety work in relation to the 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 RSWs and ensures that fatigue risk management is a central consideration when planning and scheduling work.

RSWs themselves have a responsibility under s56 of the RSNL where they are required to take reasonable care of their own safety and that of others, which includes not undertaking rail safety work when fatigued. Fatigue is a vitally important area for RSWs to consider when reporting to work and being fit for duty.

3.2 Fatigue risk management program

Accredited rail transport operators must have a safety management system (SMS) that includes a FRMP (s99(2)(f) of the RSNL) to be prepared and implemented by the operator (s116 of the RSNL). The FRMP must meet the requirements set out in regulation 29 of the National Regulations which identifies the key fatigue-related risk factors that a rail transport operator must take into account when preparing a FRMP. Regulation 29 also sets mandatory documentation requirements for operators regarding work scheduling procedures and practices, provisions for monitoring of hours of work, and education and information in relation to the identification and management of fatigue risks.

It is important to note that the factors listed in regulation 29 are not exhaustive and any potential issue that may relate to fatigue must be considered by the operator as part of a thorough risk assessment process. The extent of detail and the degree of risk controls required for the various elements of the FRMP can be appropriately scaled commensurate with the rail transport operator's assessment of the fatigue-related risks associated with its railway operations.

In developing a FRMP, as with any aspect of the SMS, rail transport operators should consider their own individual circumstances and tailor their policies, procedures and risk controls to their specific operational environments. In addition, anyone undertaking railway operations under the accreditation of a rail transport operator, including the construction, maintenance, repair of railway, infrastructure, must comply with all aspects of the operator's SMS including their FRMP (s119 of the RSNL).

3.3 Contract workers and labour hire

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. Further, rail safety duties apply to RSWs working under labour hire agreements. The RSNL also places a rail safety duty on persons other than rail transport operators, who carry out operations in the same way as it applies to a rail transport operator (see s52(5) of the RSNL).

[3] The meaning of 'reasonably practicable' in relation to a duty to ensure safety is contained in s47 of the RSNL.

3.4 Prescribed hours for train drivers in NSW and Queensland

Schedule 2 of the National Regulations prescribes additional requirements for 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 RSWs driving trains in prescribed circumstances and are not applicable to all types of RSWs. The requirements for NSW and Queensland are different.

The requirements of Schedule 2 in NSW and Queensland do not 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 Queensland are still required to undertake a risk-based approach to work scheduling albeit under the prescribed outer limits of work and rest for drivers.

3.5 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. Most exemptions relate primarily to defined circumstances, such as yard operations or seasonal work.

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

3.6 Interaction with Work Health and Safety Legislation

Under s48 of the RSNL if a provision of the 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.

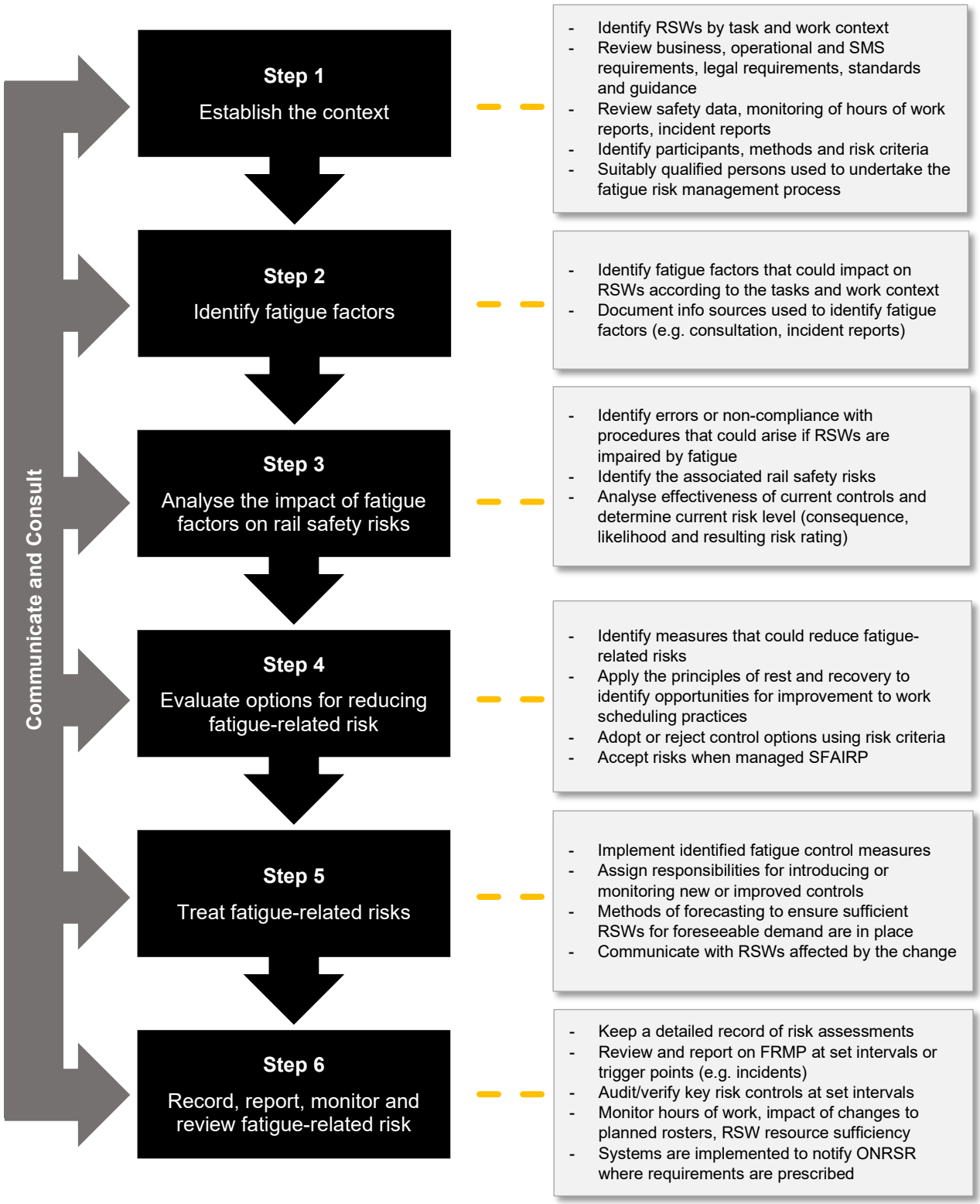
While this guideline has been tailored to the operational requirements of the rail industry and the legal requirements of the RSNL, it should be used in conjunction with WHS laws in each state and territory.

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 the relevant local WHS regulator.

4.1 Steps in the fatigue risk management process

The following steps have been designed to provide a framework for operators to apply when developing work scheduling procedures and practices as part of their FRMP in order to meet the fatigue risk management requirements of the RSNL. The steps are outlined in Figure 1 below and described in further detail at Section 5.

Figure 1: Overview of the fatigue risk management process



4.2 The principles of rest and recovery

The fatigue risk management framework in the guideline 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:

- **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 opportunity
    5. Minimise night work
    6. Minimise very long shifts
- **Reset Breaks:**
    7. Minimise the accumulation of fatigue over a sequence of shifts.

The principles address key factors associated with the scheduling of work and may assist rail transport operators when undertaking risk assessments of working time arrangements and to determine, where appropriate, the level of risk mitigation required in order to undertake the pattern of work safely. It is important to emphasise that these principles be considered in context of the RSNL requirement that operators identify and assess other relevant fatigue factors as listed in regulation 29 of the National Regulations (refer to Step 2 of the fatigue risk management process).

Table 1 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 opportunity 5. Minimise night work 6. Minimise very long shifts	• 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 work during the period of circadian low[4] 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. • Long shifts can be a problem as alertness and performance deteriorate towards the end of long shifts. • Long shifts that extend into the circadian low period are a particular problem as they expose RSWs to two high fatigue risk factors of long work periods 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 and have been awake for a long time before they sign on.

[4] **Circadian low period** is the time in the circadian body clock cycle when fatigue and sleepiness are greatest and people are least able to do mental or physical work. The circadian low period occurs around the time of the daily low point in core body temperature - usually around 02:00 to 06:00. However, there is variation in the exact timing of the circadian low period due to individual differences as well as time of year, light exposure and time zone. [Definition based on the International Civil Aviation Organization (ICAO) definition of the Window of Circadian Low (WOCL)]

Reset breaks to prevent cumulative sleep loss	7. Minimise the accumulation of fatigue over a sequence of shifts	• Reset breaks allow two successive night sleep opportunities to help minimise 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.

An essential element of the fatigue 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 reduced by ensuring that the schedule involves low risk factors on other characteristics to reduce rail safety risk. This could include:

> the shifts only involve day work and do not begin too early or extend beyond the commencement of the circadian low period;

> the schedule involves a longer rest before the extended shift in order to ensure RSW are sufficiently rested before the extended shift commences;

> the schedule includes sufficient rest to allow for recovery after the shift.

Note that when using the interaction of principles to manage the likelihood of fatigue, any proposed change in arrangements must always be assessed to ensure that the effect of implementing those work scheduling practices is sufficient to manage risks arising from fatigue SFAIRP.

Step 1 – Establish the context

Step 1 establishes the scope and operational context for the FRMP and fatigue risk assessment.

A rail transport operator's safety risks and fatigue risk factors will differ according to the scale of its operations and the tasks and responsibilities of its RSWs. In setting the context, generally more than one risk assessment will be required to assess fatigue-related risks for different groups of RSWs according to the varied tasks, working hours, rostering practices and risk profiles that exist.

Determining the scope and context for the FRMP and fatigue risk assessment should include:

> the grouping of RSWs by task to ensure that the specific risk factors and safety risks of the tasks can be assessed. Grouping will enable risk assessments to demonstrate that the controls are relevant and sufficient to manage fatigue-related risk in the particular contexts they will be applied;

> any other contextual information including work locations, operating conditions (including abnormal, degraded or emergency conditions), varying work requirements (e.g. shift work, seasonal etc…), network rules, and operational, business and stakeholder objectives;

> review of existing safety data, reports of monitoring of hours of work, incident reports;

> review of applicable legislation or legal requirements including the RSNL, WHS law, industrial agreements or contracts;

> review of relevant standards, codes and guidance;

> selecting the appropriate expertise, people and methods needed to identify and analyse fatigue-related risk.

To ensure the validity of risk assessment outcomes and the appropriate management of relevant risks, it is important that the fatigue risk management process is undertaken by suitably qualified persons with the appropriate competencies and expertise.

As a minimum ONRSR expects:

> the scope and operational context of the FRMP is clearly articulated;

> RSWs are identified and grouped by task;

> operating conditions and varying work requirements are clearly outlined;

> reference to relevant legislation, standards and guidance, which support or have been used in the development of the FRMP;

> suitably qualified persons with the appropriate competencies and expertise have been used to undertake the fatigue risk management process.

Step 2 – Identify fatigue factors

Step 2 identifies the factors that may contribute to RSWs experiencing fatigue. When preparing an FRMP, a rail transport operator must take into account and assess any fatigue-related risks to safety that arise from the factors listed in regulation 29 of the National Regulations. An overview of these requirements is shown in Figure 2 below:

Figure 2: Summary of fatigue factors 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 knowledge and skills 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)	
		RSW education and information in identifying and managing fatigue 29(2)(c)	

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 drug use), secondary employment or extended travel between work and home may all increase the risk of fatigue.

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:

> consultation with a range of RSWs to identify fatigue risk factors specific to their work context, including work scheduling, workload or other factors (e.g. work and rest environments);

> incident investigation reports (rail and WHS);

> research findings or industry guidance on fatigue risk factors;

> reports on results of monitoring hours of work including planned versus actual to assess factors such as predictability and regularity of work hours and sufficiency of resourcing;

> reports of fatigue events where workers have self-identified as fatigued or reported fatigue issues such as inability to take breaks, poor accommodation etc.

As a minimum ONRSR expects:

> the factors that may contribute to RSWs experiencing fatigue are identified by task and work context;

> information sources used to identify fatigue factors are clearly documented, including the relevant RSWs consulted regarding fatigue factors relevant to their tasks.

Step 3 — Analyse the impact of fatigue factors on rail safety risks

After completing Steps 1 and 2, the rail transport operator will have established the context and identified factors that may contribute to RSWs experiencing fatigue. Step 3 is a two-stage process that requires the rail transport operator to assess its operations to analyse the:

1. Errors, non-compliance with procedures and rail safety risks that may arise if a RSW is impaired by fatigue.
2. Effectiveness of existing controls at reducing the likelihood of fatigue and managing the associated rail safety risks.

Step 3.1 Analyse the errors, non-compliance with procedures and rail safety risks that may arise if a RSW is impaired by fatigue

Using the information gathered in Steps 1 and 2, the rail transport operator should determine how the fatigue factors may affect rail safety according to the:

> safety critical nature of the RSW's tasks;

> errors that could arise if a RSW is impaired by fatigue;

> rail safety risks that fatigue-related errors could contribute to.

This will assist the rail transport operator to adequately plan contingencies for the FRMP.

Identifying errors, non-compliance with procedures 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 RSWs by looking at job descriptions, work method statements and consultation with RSWs 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 procedural variations that could occur if RSWs 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 likelihood of fatigue depending on how many fatigue risk factors may be impacting on a RSW. Consideration should also be given to how often these factors may or are likely to impact the RSW and the potential interaction between the fatigue factors;

> analysing the impact of the timing of safety critical tasks relative to times when workers are likely to experience elevated fatigue;

> documenting any assumptions or limitations of the method or tools used to analyse the impact of fatigue factors.

Example

A 2007 study showed that high levels of fatigue in train drivers produced slower reaction times, more instances of extreme speeding, more braking errors and penalty braking over 8 hour shifts of driving a rail simulator. [5] *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.* [6] *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.

[5] 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

[6] 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

Step 3.2 Analyse effectiveness of existing controls and determine current level of risk

Here a rail transport operator should identify and analyse the controls currently in place to manage fatigue. This will include measures such as work-scheduling practices, relief arrangements, fatigue management policies and fatigue reporting systems.

In analysing the effectiveness of existing controls, the rail transport operator should:

> analyse the effectiveness of existing work scheduling / rostering practices to manage identified fatigue factors (including commuting time);

> analyse the effectiveness of methods of forecasting staffing needs and relief arrangements based on available data and foreseeable impacts (e.g. historical patterns of absence, attrition, leave liability, route knowledge, new business impacts, and organisational restructures);

> analyse RSW resourcing requirements and review of the sufficiency of relief arrangements available to meet foreseeable demand, particularly where planned shifts are close to tolerable limits and cannot be extended;

> review of 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;

> analyse the effectiveness of any other controls such as systems, equipment, tasks, work methods and procedures for detecting and managing fatigue-related errors and procedural variations.

Information sources to assist with this step may include:

> review of fatigue reporting data to assess if workers are using the fatigue reporting system and a positive safety culture is applied to encourage reporting;

> review of performance metrics embedded in data captured by operational systems or fatigue detection technologies;

> fatigue risk factor analysis tools and bio-mathematical models;

> worker surveys and use of validated sleepiness scales;

> consultation with RSWs.

It is important to understand that although the fatigue management models, tools or technologies noted above may form part of a FRMP, they do not replace the fatigue risk management process. Operators must ensure that they obtain information on the properties, including assumptions, limitations and validations in operational settings (including rail), of any fatigue management model, tool or technology that they plan to use. This information will allow the identified model, tool or technology to be risk assessed for the operator's operational context, in order to determine appropriateness of use and what else would be needed to effectively manage risk.

A rail transport operator 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 fatigue-related error or incapacitation (e.g. microsleep) resulting in a rail safety incident. Examples of such controls include vigilance monitoring systems, speed warning systems and automatic train protection.

The current level of risk will then be determined by the likelihood of RSW fatigue, vulnerability of RSW tasks to errors or short cuts and the rail safety risks (likelihood of consequences). The risk assessment process may be linked to, or part of more general human factors and risk management activities within the SMS.

As a minimum ONRSR expects:

> evidence of assessment of fatigue likelihood, errors and non-compliance with procedures on rail safety risks, and the effectiveness of existing controls on the level of risk;

> any assumptions or limitations of the method or tools used to analyse the impact of fatigue factors are documented;

> documented polices or procedures to encourage and support RSWs to report if they are impaired by fatigue or likely to become so while carrying out rail safety work.

Step 4 – Evaluate options for reducing fatigue-related risk

Step 4 sets out a two-stage process for the evaluation of fatigue risk factors identified in the previous steps and identify reasonably practicable ways to reduce or better manage them.

At Step 4 a rail transport operator should:

1. Evaluate work scheduling practices and procedures against the principles of rest and recovery in Table 2 to identify the fatigue likelihood.
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 has been designed as a reference point for the main scheduling dimensions identified by scientific research that impact on fatigue likelihood. The table does not address rail safety risk as this will depend on the rail safety tasks and the potential adverse consequences if workers are fatigued. It is also not designed to determine if work schedules are acceptable based on fatigue likelihood alone and should not be used in a prescriptive manner. Scheduling decisions should be based on the entire risk assessment process.

Note that the principles in the table address the major factors that cause fatigue, however other relevant risk factors identified by a rail transport operator 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 and therefore reduce the opportunity for sleep provided by a particular break.

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 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	More than 8 and up to 10	8 hours or less
4. Maximise night sleep opportunity	Proportion of recovery breaks in shift sequence (between reset breaks) that preserve night sleep opportunity between 00:00 and 06:00	All recovery breaks in the sequence include 00:00 and 06:00 period	More than half of recovery breaks in the sequence include 00:00 and 06:00 period	Half or less of recovery breaks include 00:00 and 06:00 period
5. Minimise night work	Proportion of shifts in a sequence that end between 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	Length of shifts particularly those ending between 00:00 and 06:00	Less than 10hr shifts	Between 10 – 12hr shifts	More than 12hr shifts
Reset breaks: breaks in sequences of shifts to minimise cumulative sleep loss and eliminate the build-up of unsafe levels of fatigue over an extended sequence of shifts				
7. Minimise 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 (between 00:00 and 06:00) between shifts	2-4 shifts between reset breaks over a sequence of shifts	5-7 shifts between reset breaks over a sequence of shifts	8 or more shifts between reset breaks over a sequence of shifts

Table 2 has been developed through a combination of expert input and consultation with industry. The table is for general guidance only and should not be used in a prescriptive manner. Scheduling decisions should be based on the entire risk assessment process including consideration of the consequences of fatigue-related error in terms of rail safety risks.

A **shift is defined as the period between 'signing on' and 'signing off' a work shift and includes all of the hours spent working or resting during a split shift.*

*** A **sustained attention task** requires continuous attention to detect and readily respond to information such as a signal or event, which may occur infrequently or unpredictably.*

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

The fatigue risk management process 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 to rail safety are effectively managed.

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 or consequences of fatigue-related errors.

In some cases, the risk assessment may demonstrate that engineered controls effectively mitigate the risk of fatigue-related error and enable the rail transport operator to tolerate greater exposure to work schedules that have medium to higher fatigue likelihood. However, the greater the number of parameters that have higher fatigue likelihood, the greater the detail required of context specific risk assessments and ongoing safety assurance.

It is also acknowledged that there are exceptional circumstances where planned operations may need to operate with schedules that have higher fatigue likelihood. In such cases, scheduling practices must be justified by a detailed context specific fatigue risk assessment demonstrating that risk is effectively managed and other scheduling options are not reasonably practicable.

Workers on permanent night shifts may also have higher fatigue likelihood on the basis of performing permanent work in the circadian low period. While some individual workers may report being able to adapt to night shifts, in such situations expert advice should be sought as the level of adaptation may depend on factors ranging from light exposure at work and on days off, duration of shift sequence or other factors contained in the principles. These issues should be examined as part of the fatigue risk assessment process.

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

Table 3 provides examples to aid in evaluating whether current controls on work schedules effectively manage the major physiological fatigue factors. It can be used as a tool alongside Table 2 to generate options for improved work schedules.

Table 3: Applying the principles to balance elevated fatigue likelihood

Principle	Elevated fatigue likelihood due to:	Examples which may help to reduce 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 between shifts at time of day that is low sleep opportunity (P4) Extend subsequent recovery break following shorter break Optimise sleep environment
4. Maximise night sleep opportunity	Recovery breaks don't include the 00:00 to 06:00 period making sleep hard to obtain due to biological and 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 the 00:00 to 06:00 period making it hard to maintain alertness due to circadian effects and extended wakefulness.	Adjust shift timing to maximise night sleep opportunity (P4) Minimise very long shifts to reduce time awake (P6) Provide more frequent or longer break for nap (P2), formal 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	Fatigue accumulates with time on task (particularly during the circadian low period) 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 sleep opportunity 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. Minimise 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 sleep opportunities during the circadian low period 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

An example of using Tables 2 and 3 to evaluate options for improving work scheduling practices is given below:

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 a sequence of night work, including two periods during the circadian low period (i.e. 2 nights sleep), 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 rail transport operator comparing the results of the risk analysis with other options to determine if the risks are acceptable or if anything more can be done to manage risk SFAIRP, such as implementing new control measures or eliminating or modifying existing measures.

For the relevant RSWs, the rail transport operator should:

> identify if anything else can be done (in addition to existing controls) to reduce fatigue or lower risk such as improving scheduling of work and rest (using the principles of rest and recovery), changing the timing of safety critical tasks to periods of lower fatigue, improving rest environments, improving methods of managing changes to work hours, and improving fatigue education and information for RSWs;

> look for improvements to staffing arrangements including forecasting of demand based on historical patterns of absence, attrition, leave liability, route knowledge, new business impacts and organisational restructures;

> identify options to make systems and procedures more resilient to human error and adopt or reject based on whether they are reasonably practicable to introduce;

> consider unintended consequences or transfer of risk as a result 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 RSWs who may be affected by any changes to support decision making;

> adopt or reject controls using risk criteria and accept risks when risk is managed SFAIRP;

> document the decision-making process (s100(2) of the RSNL), including keeping a record of consultation, scientific information or expert inputs.

As a minimum ONRSR expects:

> measures to reduce fatigue-related risk are identified and assessed;

> where the principles of rest and recovery and associated measures have been applied to balance elevated fatigue likelihood, these are clearly documented;

> fatigue-related risks are accepted when reduced SFAIRP.

Step 5 – Treat fatigue-related risks

Following the evaluation of control measures in Step 4, rail transport operators 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 RSWs who will be affected by the change;

> update relevant systems and procedures to ensure that all controls in the fatigue risk management program are documented;

> update and provide any necessary information, education or training to RSWs where the change impacts on the ability of workers to identify and manage fatigue (regulation 29(2)(c));

> establish and maintain documented procedures to manage, SFAIRP, fatigue-related risks in line with regulation 29(2) of the National Regulations. This includes:

- 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;
- provisions for monitoring of hours of work including how actual hours compare with planned hours of work for RSWs and procedures for monitoring the impact to changes to planned rosters due to shift swapping, overtime and on-call working;
- provision of appropriate education and information in relation to the identification and management of fatigue risks that are relevant to the rail safety work being undertaken.

As a minimum ONRSR expects:

> measures to reduce fatigue likelihood or otherwise manage risk are implemented SFAIRP;

> measures including work scheduling practices are documented and responsibilities are assigned;

> methods of forecasting to ensure sufficient RSWs for foreseeable demand are in place;

> information, education or training for RSWs on identification and management of fatigue is provided.

Step 6 – Record, report, monitor and review fatigue-related risk

Step 6 requires that a rail transport operator records the fatigue risk management process and establishes a regular schedule to monitor and review the FRMP and fatigue risk controls to ensure they continue to be effective and in order to adhere to the reporting requirements under the RSNL. This may include:

> keeping a record of all aspects of the risk assessment including the decision-making process (s100(2) of the RSNL), the consultation, scientific information or expert inputs;

> 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;

> reporting results of monitoring of hours of work to accountable managers at set intervals;

> setting scheduled intervals for review of the FRMP;

> setting criteria for and conducting triggered reviews in response to incident data, fatigue reports or an operational change that impacts on workload, scheduling or predictability of work hours;

> auditing at set intervals to check that fatigue controls are in place and working effectively;

> including set criteria for investigating fatigue as part of investigation protocols;

> implementing corrective actions where indicated, to reduce fatigue, improve roster stability or correct staffing shortfalls;

> keeping in touch with recent developments in fatigue research and technologies.

The National Regulations also require rail transport operators to:

> notify ONRSR of a decision to change any work scheduling practices and procedures set out in the operator's FRMP (s9(1)(a) at item 10 in the table);

> annually report a breach or omission of, or failure to comply with, the work scheduling practices and procedures set out in the rail transport operator's FRMP under s28 of Schedule 1A, Part 3 as a Category C notifiable occurrence.

Rail transport operators should develop and implement systems to notify ONRSR where requirements are prescribed.

As a minimum ONRSR expects:

> detailed records of risk assessments including decision making processes are kept;

> procedures for monitoring of hours of work and the impact of changes to work schedules are documented within the FRMP;

> regular schedule for review of the FRMP is established;

> systems are implemented to notify ONRSR where requirements are prescribed;

> ONRSR is notified of any decision to change work scheduling practices.

Appendix 1 presents four scenarios to illustrate the fatigue risk management process in practice. Note that these scenarios are not designed to provide a comprehensive guide to the fatigue risk management process as this will depend on the scope and context of the particular railway operations.

Appendix 1: Fatigue risk management scenarios

The following scenarios are for illustrative purposes only and are not designed to provide a comprehensive guide to the fatigue risk management process as this will depend on the scope and context of the particular railway operations. Please refer to the guideline to understand ONRSR minimum expectations at each step of the fatigue risk management process.

Scenario 1 - Major metropolitan road/rail grade separation

Fatigue risk management process	Example approach
Step 1 Establish the context	A large consortium has won a contract for five major metropolitan road/rail grade separation projects to be completed over a three year period. This grade separation project is the third and includes the construction of a new railway station. Part of the project is scheduled for October and will involve a major 30-day shutdown with round the clock (24/7) work. The consortium will work under the safety management system (SMS) of the accredited rail infrastructure manager (RIM). The project team will include a range of rail safety worker (RSW) tasks and will require the use of labour hire. The scope of the work will be analysed and programs developed to complete the works in the allotted timeframe. The SMS of the accredited RIM specifies Fatigue Risk Management Program (FRMP) requirements including indicative controls on hours of work and the requirement for business units and principal contractors of major projects to assess and manage context specific fatigue-related risks associated with the type of RSW work being undertaken and the different operating conditions of a project. The RIM's SMS also outlines requirements for RSW education and monitoring/reporting of hours of work for the purposes of fatigue risk management. The principal contractor has additional FRMP requirements outlined in their own SMS and have already established processes that meet the fatigue reporting requirements of the RIM's SMS. In establishing the FRMP that will apply to the project, the Project Leader and Safety Manager of the principal contractor work with the RIM and the relevant consortium representatives to document the operating conditions and varying work requirements for the project. RSWs tasks are identified and grouped to align with project delivery tasks in order to inform the fatigue risk management process.
Step 2 Identify fatigue factors	The principal contractor's SMS includes a fatigue risk profile template (developed in-house by the principal contractor) to assist project teams to assess the factors listed in regulation 29 of the National Regulations. Using this fatigue risk profile template, the Project Leader asks the Safety Manager to begin to compile a list of fatigue factors for the project. Key information sources include the RIM and principal contractor's risk registers and general RSW fatigue risk profile, the principal contractor also uses monitoring hours of work reports (planned vs. actual) and incident reports for the last two projects. Identified fatigue factors include:

	• *Environmental conditions* October is usually wet and the previous year recorded record levels of rainfall. The site conditions will make the work more physically demanding. • *Scheduling of work* Round the clock (24/7) work means that there will be work carried out during the circadian low period. The first night shift will be challenging due to longer time awake at sign on and sleep loss is likely to increase over consecutive night shifts. • *Work schedule irregularity* Project timeframes will require on-call and call-out shifts. On a past project people were called at short notice due to project hold-ups and there was an increase in shift extensions in the last three days. Some people reported that their recovery sleep was interrupted by work calls. • *Use of labour hire* Labour hire staff are likely to have other employment responsibilities and past projects have found it difficult to determine work history and any risk associated with cumulative fatigue. • *Combination of high cognitive and monotonous tasks* Some tasks are monotonous but may also have periods where a high level of cognition is required such as manual data entry of coordinates into track machinery. Tasks that require prolonged sustained attention are identified. Once a complete list of fatigue factors is identified, the Safety Manager groups these factors by RSW tasks and the relevant work context in order to inform Step 3.
Step 3 Analyse the impact of fatigue factors on rail safety risks: *Analyse the errors, non-compliance with procedures and rail safety risks that may arise if an RSW is impaired by fatigue* *Analyse the effectiveness of existing controls and determine current level of risk*	Using the information gathered in Steps 1 and 2, the Safety Manager begins to develop a RSW fatigue risk profile specific to the project. This includes assessing how likely it is that workers may experience fatigue (based on the extent of fatigue factors impacting on them) and then assessing the likelihood and consequences of fatigue related errors on rail safety risks. To assist with developing the RSW fatigue risk profile and identifying associated rail safety risks, the Safety Manager hosts a workshop with the Project Leader and a sub-group of RSWs involved in current and previous grade separation projects. The purpose of this workshop is to develop a series of “what if” scenarios to identify errors, short cuts or procedural variations that could occur if RSWs are fatigued. Example “what if” scenarios include: • Task completed incorrectly results in latent defect that leads to significant rail safety incidents (e.g. track failure leading to the derailment of rolling stock). • Track patrol inspector fails to identify component failure leading to a derailment. • Communication failures in handover lead to overrun of authority of a track machine.

- Worksite protection error leads to worker struck by train.

At the end of the process both high and low risk tasks are identified:

- High risk tasks include wiring and electrics, testing, commissioning and certification, worksite protection and managerial decision making.
- Low risk tasks include those the simple tasks performed frequently with well-defined procedures where the likelihood of error is low, and the consequences of error are low.

The Safety Manager then uses the information gathered as part of Step 2 to determine the likelihood of fatigue risk associated with these high and low risk tasks. This allows the Safety Manager to categorise the RSWs according to fatigue related risk.

The Safety Manager analyses the effectiveness of existing controls to reduce fatigue likelihood or reduce risk arising from errors, examples include:

- *Measures for forecasting staff needs*
  Scheduling an increased pool of skilled staff for the last week of a project is considered effective in reducing the need for overtime, multiple nightshifts and labour-hire brought in last-minute. This was implemented following the first project where the staff resourcing formulae used had not provided enough contingency for delays later in a project, resulting in excessive nightshifts and labour-hire brought in last-minute.
- *Project planning and safety criticality of tasks*
  Scheduling of RSWs responsible for checking defects and undertaking certification prior to a project being completed to periods of lower fatigue is effective in reducing the risk of fatigue impairment whilst undertaking these tasks. Where the tasks must occur at night, where possible these will be completed in the hours before midnight and certification of the work will be done by an incoming early morning shift.
- *Call out procedures*
  Although formal call out procedures exist for the company these are not consistent with the resourcing requirements for technical managers who have found themselves on call for longer periods during the previous projects.
- *Design of work schedules*
  Existing rostering principles limit night shifts and require more stringent limits for higher risk tasks. However actual hours worked by high risk workers have often ballooned out at the end of projects resulting in testing and commissioning being done under conditions of time pressure and elevated fatigue. People are often called to the next project before they have recovered from the last one.
- *Labour hire/contract work arrangements*
  Distributing labour hire workers across established work groups is effective in helping to identify any workers who may have worked multiple shifts prior to commencing on a project or are working multiple shifts across other projects.

	• *Handover* There has not always been an adequate opportunity for handover at the end of a shift, which has resulted in some incidents as a result of communication breakdown.
Step 4 Evaluate options for reducing fatigue-related risk: *Evaluate work scheduling practices and procedures* *Consider and evaluate any other measures to eliminate or mitigate the risk of RSW fatigue*	Following an assessment of the impact of fatigue factors on rail safety risks and existing controls to manage fatigue risk, the Safety Manager identifies some required improvements to existing work scheduling practices and procedures that will help reduce RSW exposure to fatigue. These required improvements are discussed with the Project Leader and the following changes are implemented: • Workforce planning is strengthened and data on actual hours from previous projects is used to better forecast the resources needed at each stage of the project. • Workers must have a minimum reset break to allow full recovery from a sequence of shifts. The frequency of reset breaks takes into account how much night work they have done and how many consecutive shifts they have worked. • Where possible, changing the timing of safety critical tasks away from the circadian low period to periods of lower fatigue. High risk tasks are also avoided where possible towards the end of the first and last night shift where the combined impact of extended wakefulness and circadian low could impact on performance of some complex tasks. • The skill mix on site is reviewed twice a day to ensure people operating track machines or doing manual tasks in wet and muddy conditions can rotate and take breaks. • Rosters and shift sequencing include scheduled time overlap for handover between workers to reduce the risk of fatigue contributing to communication errors. The handover process is formalised and checklist developed to assist workers with what information needs to be passed on. • Improving the predictability of work hours for technical managers by introducing call-out practices to reduce sleep disruption from work calls and establishing a new call-out roster that better manages the exposure time on-call. • Strengthening the contractual arrangements between the principal contactor and the labour hire firm to address any identified fatigue related risks associated with labour hire workers (e.g. cumulative fatigue). Additional measures are also implemented: • *Improving rest environments* An air-conditioned break out area is constructed offering tea, coffee and hot chocolate, as well as blankets and chairs to allow workers to have a short nap during, prior and after shifts. • *Improving education and information on sleep optimisation/fatigue management* Development of information for RSWs regarding the identification and management of fatigue for use in briefings and display within the work environment.

Step 5 Treat fatigue related risks	The Project Leader and Safety Manager complete the risk register, assigning accountability and responsibilities for new and amended controls to key project staff. Prior to implementation a targeted communication and consultation plan is prepared to guide discussions with RSWs who will be affected by the change. Once the project has commenced, fatigue is regularly discussed as part of on-site safety briefings (e.g. Toolbox Talks) and RSWs can also access fatigue related information on their digital and physical staff noticeboards.
Step 6 Record, report, monitor and review fatigue-related risk.	Following the completion of the project, the Project Leader hosts a project debrief, collective insights and lessons learned workshop in order to identify what worked well and areas for improvement. These workshops involve representatives of frontline staff as well as those overseeing the project; Project Managers responsible for the next round of grade separation projects are also invited. The Safety Manager presents on the fatigue risk management process and key lessons learned including: • Where possible, the timing of safety critical tasks should be shifted to periods of lower fatigue and high-risk tasks avoided towards the end of the first night shift. • Importance of scheduling time overlap for handover between workers to reduce the risk of fatigue contributing to communication errors. • Strengthening contractual arrangements with labour hire firms to help capture risks associated with cumulative fatigue. The lessons learned are then implemented into project planning for the next round of grade separation projects and inform a number of changes and measures to reduce fatigue risk.

Scenario 2 - Regional track work upgrade project

Fatigue risk management process	Example approach
Step 1 Establish the context	A regional track work upgrade project is a six-month project from January to June. The initial months are usually hot, dry and the previous year experienced poor air-quality issues as a result of an extreme bushfire season. The main section of track to be upgraded is approximately 30mins from the nearest township offering food and drink, and accommodation. The project will be contracted out to a large rail construction and maintenance company who will be undertake the work under the SMS of the accredited RIM and the risk management procedures adopted must comply with the RIM's SMS. The contractor will be responsible for duplicating track, upgrading signalling and building a new platform. The section of track to be upgraded will be closed for the works however nearby track will be operational and carry additional passenger and freight services. The platform construction is not near the live tracks. The contractor's Project Leader and Safety Manager work with the accredited RIM to document the operating conditions and varying work requirements for the project. RSWs tasks are identified and grouped to align with project delivery tasks in order to inform the fatigue risk management process.
Step 2 Identify fatigue factors	In order to build on previous work done in-house, the Project Leader asks the Safety Manager to use a RSW fatigue risk assessment developed for a past track work upgrade project to help compile a list of fatigue factors for the upcoming project. Other information sources used to assess the factors listed in regulation 29 of the National Regulations include the RIM and contractor's risk registers as well as monitoring hours of work reports (planned vs. actual) and incident reports for similar projects. The Safety Manager also considers that a previous project carried out over bushfire season resulted in delays due to extreme heat and poor air quality. Identified fatigue factors include: • *Environmental conditions* Daytime work means that workers will be exposed to the hottest part of the day which in recent years has been from mid-afternoon to early evening. The year previous, air quality was particularly bad in the early to mid-morning. • *Scheduling of work* Daytime shifts in the heat of the day will require more scheduled work-related rest breaks. Early waketime (during the circadian low period) will be required for the duration of the project. • *Rest environment* Being a regional project, the project team is required to relocate to the area and must be provided with accommodation for the duration of the project.

	• *Food and drink* The nearest township offering food and drink is 30mins away so workers will need to be provided with food and drink at the worksite. • *Commuting* Most workers will have to travel between 2-3 hours prior to the start of their first shift and will travel 30mins to and from the worksite daily. • *Work schedule irregularity* Project timeframes may require additional people to be called in at particular points to meet various construction deadlines. Once a complete list of fatigue factors is identified, the Safety Manager groups these factors by RSW tasks and the relevant work context in order to inform Step 3.
Step 3 Analyse the impact of fatigue factors on rail safety risks: *Analyse the errors, non-compliance with procedures and rail safety risks that may arise if an RSW is impaired by fatigue* *Analyse the effectiveness of existing controls and determine current level of risk*	Using the information gathered in Steps 1 and 2, the Safety Manager begins to develop a RSW fatigue risk assessment specific to the project. This includes working with the Project Leader and other key project staff to develop a series of "what if" scenarios to identify errors, short cuts or procedural variations that could occur if RSWs are fatigued. Example "what if" scenarios include: • Task completed incorrectly results in latent defect that leads to significant rail safety incidents (e.g. track failure leading to the derailment of rolling stock). • Protection boards are set in the wrong area and workers find themselves in the path of the oncoming train. • Error by excavator operator leads to breach of the live track and collision with train. • Communication error leads to worker struck by track machine. At the end of the process both high and low risk tasks are identified: • High risk tasks include wiring and electrics, testing, commissioning and certification, worksite protection and managerial decision making. • Low risk tasks include those the simple tasks performed frequently with well-defined procedures where the likelihood of error is low, and the consequences of error are low. These include construction work on the new platform. The Safety Manager then uses the information gathered as part of Step 2 to determine the likelihood of fatigue risk associated with these high and low risk tasks. This allows the Safety Manager to categorise the RSWs according to fatigue related risk. The Safety Manager analyses the effectiveness of existing controls to reduce fatigue likelihood or reduce risk arising from errors, examples include:

	• *Worksite protection practices* Protection officers have made errors in handovers on previous projects which has resulted in incidents causing project delays and safety risks. • *Scheduled rest breaks* Most projects are required to have rest breaks of 15mins taken every 4 hours which is generally adequate outside of summer but in the first two months may not be adequate and may need to occur more frequently. • *Commuting policy* Commuting to a regional worksite is always scheduled for the day before first shift to allow workers to have an opportunity to settle in and rest prior to commencing a project. Commuting policy does not consider day to day travel to and from worksite. • *Rest environments* On past projects some workers have bunked in together in caravans and cabins that are not air-conditioned. This resulted in poor quality sleep during the peak of summer when overnight temperatures were above 30 degrees.
Step 4 Evaluate options for reducing fatigue-related risk: *Evaluate work scheduling practices and procedures* *Consider and evaluate any other measures to eliminate or mitigate the risk of RSW fatigue*	Following an assessment of the impact of fatigue factors on rail safety risks and existing controls to manage fatigue risk, the Safety Manager identifies some options for improvement to existing work scheduling practices and procedures that will help reduce risk. These required improvements are analysed according to the cost and safety benefit. Those that are recommended for adoption are discussed with the Project Management team and approval is gained for the following changes to be adopted and implemented: • Updating the commuting policy to reflect day to day travel to and from worksite and ensure this travel is taken into account during scheduling and rostering. • Increasing the frequency of work-related rest breaks during hot weather. • Provision of food and drink at the worksite. • New handover procedure and checklist is developed for Protection Officers to use in relation to confirmation of worksite projection arrangements. • The skill mix on-site is reviewed twice a day to ensure people operating track machines or doing manual tasks in hot conditions can rotate and take breaks. • Where possible, workers operating air-conditioned track machinery can be rotated more with those on the ground to break the monotony of track machine operation and reduce heat stress for those on the ground. Additional measures are also implemented: • *Commuting* Local bus company is scheduled to take workers to and from the worksite. The bus will depart accommodation at 5am.

	• *Scheduled rest breaks* To provide respite from the heat, 15min rest breaks are scheduled every 3 hours. • *Improving rest environments* Two air-conditioned caravans are brought in to allow for workers to take their scheduled work-related rest breaks away from the heat. • *Food and drink* Food van is brought into the worksite daily providing a range of morning and afternoon snacks, lunch and hydration. • *Air-quality* P2 masks are supplied to workers during periods where air quality is an issue and tasks are reviewed, scaled back or rescheduled on days where the air quality index rating is 'very poor' and where possible all works are ceased if the rating is 'hazardous'.
Step 5 Treat fatigue related risks	The Project Leader and Safety Manager complete the risk register, assigning accountability and responsibilities for new and amended controls to key project staff including consulting with affected people regarding changes that affect them. Prior to implementation an email is sent to relevant workers with a link to updated procedures which have been uploaded to the online SMS. The information is then reinforced at the project induction and pre-work briefings for the project, and fatigue risk management is regularly discussed during Toolbox Talks.
Step 6 Record, report, monitor and review fatigue-related risk.	The Project Leader and Safety Manager have documented the risk assessment process including the decision-making and risk acceptance process to show that risks are managed SFAIRP. This documentation will form the basis for future risk reviews. Following the completion of the project, the Project Leader hosts a project debrief with senior project staff to discuss what worked well and identify areas for improvement. The Safety Manager presents on the fatigue risk management process and key lessons learned including: • The importance of increasing the frequency of work-related rest breaks during hot weather. • Ensuring that the skill mix on-site is reviewed accordingly to ensure people operating track machines or doing manual tasks in hot conditions can rotate and take breaks. • Where possible, workers operating air-conditioned track machinery should be rotated with workers on the ground to break the monotony of track machine operation and reduce heat stress for those on the ground. The lessons learned are then implemented into project planning for future track upgrade projects.

Scenario 3 - Medium sized tourist and heritage operator

Fatigue risk management process	Example approach
Step 1 Establish the context	A medium sized tourist and heritage operator operates on weekends and public holidays throughout the year. The operator is in a regional area and relies heavily on volunteer staff, many of whom have full-time employment elsewhere and several of which travel over 2 hours to volunteer. Although services are run from 10am until 4:30pm, most of the staff start at 8am and finish at 6pm. Two firemen arrive at 4am each day of operation to prepare the boiler. The operator's Safety Manager begins to document the operating conditions and varying work requirements for its operations. RSWs tasks are identified and grouped in order to inform the fatigue risk management process.
Step 2 Identify fatigue factors	Using the factors listed in regulation 29 of the National Regulations, the Safety Manager begins to compile a list of fatigue factors for its operations. Key information sources include the operator's risk register and work schedules. Identified fatigue factors include: • *Scheduling of work* Staff work up to 10 hour shifts and more than half the volunteer staff hold full-time employment elsewhere. • *Relief practices* On a number of occasions, Illness of a volunteer has resulted in a other volunteers agreeing to work at short notice without enough consideration of their recent work pattern. In one case, after completing their substantive job shift at 1am, a volunteer was phoned at 6am and asked to cover a shift starting at 8am with the heritage railway. • *Commuting* Several workers travel over 2 hours to work, some of whom travel 4 hours plus. • *Rest environments* The staff breakout area on site needs an upgrade; some of the furniture is damaged and not suitable to allow rest. • *Circadian effects, extended wakefulness and sleep inertia* Firemen can be rostered to commence work at 4am and throughout the day. Fireman rostered for a 4am start will require very early waketime (during the circadian low period). Once a complete list of fatigue factors is identified, the Safety Manager groups these factors by RSW task and the relevant work context in order to inform Step 3.

Step 3 Analyse the impact of fatigue factors on rail safety risks: *Analyse the errors, non-compliance with procedures and rail safety risks that may arise if an RSW is impaired by fatigue* *Analyse the effectiveness of existing controls and determine current level of risk*	Using the information gathered in Steps 1 and 2, the Safety Manager works with key organisational staff to create a series of "what if" scenarios to identify errors, short cuts or procedural variations that could occur if RSWs are fatigued. The task analysis that was undertaken to develop RSW categories for the health assessment standards is used as a starting point. Example "what if" scenarios include: • Track patrol inspector fails to identify component failure leading to a derailment. • Driver is fatigued from the long commute and exceeds a proceed authority. • Breakdown of communication during coupling/uncoupling of carriages leads to a crush injury. • Error in applying handbrakes leads to runaway train. These "what if" scenarios are then used to identify existing controls and analyse their effectiveness in order to look for improvements that could be more effective and reasonably practical: • *Commuting policy* Workers who travel more than 2 hours before signing on are required to travel the day before when the combined travel and work time is more than 12 hours. This has generally worked well but the cost for local motels is considerable. • *Rotating tasks* Where possible, tasks are rotated across regular staff. This is considered effective in breaking the monotony of certain tasks that may lead to fatigue. Irregular staff are not rotated to ensure they maintain competence and familiarity with the particular tasks but are checked on regularly by a supervisor. • *Rest opportunities* Drivers and firemen have natural rest breaks built into the shift as the turnaround of passengers between services takes at least 20 minutes. This is considered effective in maintaining alertness during the service. • *Shift scheduling* Firemen rostered on to commence work at 4am alternate every weekend. Firemen who commence at 4am are only rostered on until 12pm and do not run service on those days. It is noted that this has created logistical problems in the past. Firemen who are required to commute more than 1 hour are not rostered on for the 4am start unless they have local accommodation for the night before. A number of volunteer firemen have longer travel times so are having to stay in motels but have indicated that this is not financially sustainable in the long term.

Step 4 Evaluate options for reducing fatigue-related risk: *Evaluate work scheduling practices and procedures* *Consider and evaluate any other measures to eliminate or mitigate the risk of RSW fatigue*	Following an assessment of the impact of fatigue factors on rail safety risks and existing controls to manage fatigue risk, the Safety Manager identifies some required improvements to existing work scheduling practices and procedures that will help reduce RSW exposure to fatigue. The following changes are implemented: • The expectations regarding individual management of fatigue are strengthened with more specific requirements for recovery between jobs (including minimum time off) on occasions when previous shifts have involved working at night. • A formal fatigue check-in with workers is implemented prior to shift commencement. • On days of disruption the team will consider changes to rostered roles provided that planned shift lengths are not exceeded. The following additional measures are implemented: • *Upskilling of maintenance workers* An additional two maintenance workers are trained to obtain a high-risk work licence and a boiler ticket. This will enable them to prepare the engine so that there is an increased pool of fireman to manage the 4am shift. • *Rest environment – on-site* New furniture is sourced for the staff breakout area and blankets are provided to promote daytime rest. A sleeper car is also repurposed and airconditioned to provide overnight accommodation for firemen who need to be accommodated overnight. • *Rest environment – overnight* Some of the local volunteers offer spare rooms at their houses to allow volunteers who travel long distances to stay for the weekend. Volunteers are also provided with an updated list of local motels that have been vetted as quiet and comfortable. • *Commuting* Workers who commute longer distances are encouraged to carpool. Information is shared amongst staff.
Step 5 Treat fatigue related risks	The Safety Manager completes the risk register, assigning accountability and responsibilities for new and amended controls to management staff. Changes are communicated to workers via email and a special briefing is scheduled for the next weekend of operations.
Step 6 Record, report, monitor and review fatigue-related risk.	The Safety Manager then sets up a monthly monitoring schedule, speaking with workers to understand what is and isn't working well. Findings are then used to inform the next update of the Operator's FRMP.

Scenario 4 - Inhouse track maintenance

Fatigue risk management process	Example approach
Step 1 Establish the context	An accredited rail transport operator has inhouse track maintenance teams to carry out routine maintenance of their network. According to demand, some of the work may be contracted out to independent contractors, and labour hire companies are also used to source various skilled rail safety workers. The operator commences a review of the FRMP as part of an annual review of the SMS. The purpose of the review is to assess the effectiveness of current controls for rail maintenance projects undertaken during the year and develop additional controls in response to a significant forward program of projects. The operator's Safety Manager convenes a risk assessment team, which includes technical advisors and workers representing the different areas of maintenance, to undertake the review. The context is set by documenting the varying work requirements including types of projects, locations and operating conditions and identifying all internal and external requirements. RSW tasks are identified and grouped by type of maintenance activity, including track repair, resurfacing, track inspections, rail grinding, and trackside systems, to inform the fatigue risk management process.
Step 2 Identify fatigue factors	Using the factors listed in regulation 29 of the National Regulations, the risk assessment team begins to compile a list of fatigue factors for its operations. Key information sources include the operator's risk register and work schedules. Identified fatigue factors include: • *Environmental conditions* Projects are scheduled across a range of environmental conditions including periods of extreme heat and cold, and high rainfall. Extreme weather events can place additional demand on inhouse resources, particularly when track damage occurs. • *Scheduling of work* Varying work schedule requirements including days, nights, weekends, on-call and periods of maintenance task overlap. Some maintenance work can only be done at night due to the availability of infrastructure, such as track, or to reduce fire risk, and sometimes workers are working long sequences of nights. There can be higher fatigue likelihood on the first night shift due to extended time awake and where workers have worked consecutive night shifts, they have also reported difficulty recovering on days off. • *Rest environments* Project teams are often required to travel for work and accommodation is required as close to site as can be located. Where works are scheduled at night, over a number of days and/or in regional locations crib rooms and or meal facilities are also required. • *Travel and commuting* Workers are split between two regional offices and travel and commuting is dependent on the location of the work. Where work is scheduled in more remote locations, workers must travel the night before commencement of the closedown to assist with managing fatigue risk. Some of the workers have pointed out

	that travel the night before reduces time at home and they prefer to get up early and travel before the first day of shut down, rather than travelling the night before. • *Work schedule irregularity* Although maintenance work would generally occur as planned, where unexpected issues occur, on call technical specialists can be required to travel to a worksite or make technical decisions over the phone sometimes at night. Scheduling deadlines may also require staff who are generally office-based to be called out to worksites without much notice. • *Contingency for multiple work packages* Work packages are often scheduled back-to-back and any overrun can result in staff being split across two worksites. This is manageable for short closedowns but overruns for larger work packages with night work that require overtime can reduce opportunity for recovery sleep between jobs. • *Use of technical specialist sub-contractors* The pool of technical specialist sub-contractors used by the operator are highly sought after and may be working on multiple projects including work for other operators. Technical specialists such as overhead and signalling are in demand and many work long hours as independent contractors. Small mistakes by these contractors on past projects have caused delays and minor incidents. It has been difficult to assess if fatigue contributed as their work history is unknown. Some subcontractors such as welders do rail work on weekends on top of work in general construction during the week.
Step 3 Analyse the impact of fatigue factors on rail safety risks: *Analyse the errors, non-compliance with procedures and rail safety risks that may arise if an RSW is impaired by fatigue* *Analyse the effectiveness of existing controls and determine current level of risk*	Using the information gathered in Steps 1 and 2, the risk assessment team develops a series of "what if" scenarios to identify errors, short cuts or procedural variations that could occur if RSWs are fatigued. The process is informed by information from an occurrence database, investigations as well as input from participants on site conditions, situations or close calls that may not necessarily have been formally recorded. Example "what if" scenarios include: • Task completed incorrectly results in latent defect that leads to significant rail safety incidents (e.g. track failure leading to the derailment of rolling stock). • Rail safety track protection, such as protection boards are set in the wrong area and workers find themselves in the path of the oncoming train. • Track machine exceeds a proceed authority putting workers at risk of collision. • Communication error leads to worker struck by track machine. At the end of the process both high and low risk tasks are identified: • High risk tasks include signalling works, track welding, ultrasonic testing, worksite protection, fault rectification, commissioning and testing. • Low risk tasks include those the simple tasks performed frequently with well-defined procedures where the likelihood of error is low, and the consequences of error are low.

	The risk assessment team analyses the effectiveness of existing controls to reduce fatigue likelihood or reduce risk arising from errors, examples include: • *Worksite protection practices* Safeworking checklists are paper based and considered outdated by some of the risk assessment team. On two occasions in the past six months the incorrect placement of track protection boards has resulted in incidents causing project delays and safety risks. • *Rest environments* On past projects workers have complained of excessive noise affecting their opportunity for sleep. Accommodation is usually booked centrally by head office and the risk assessment team identifies there is no process for determining the suitability of rest accommodation. • *Subcontractors* Subcontractor errors can be costly and current contractual arrangements for fatigue risk management are limited for this group of workers. • *Resource sufficiency* Retaining on job competencies of office-based managers has been used to meet staffing shortfalls for short notice or late running projects. However, managers have sometimes worked a full day in the office prior to travel to site resulting in extended time awake and extended time driving. There is scope for better logistical management to reduce these fatigue factors. • *Resource management and planning* Existing rostering practices don't adequately take into account extended travel impacts on task related fatigue and extended time awake for the first night shift.
Step 4 Evaluate options for reducing fatigue-related risk: *Evaluate work scheduling practices and procedures* *Consider and evaluate any other measures to eliminate or mitigate the risk of RSW fatigue*	Following an assessment of the impact of fatigue factors on rail safety risks and existing controls to manage fatigue risk, the risk assessment team identifies some options for improvement to existing work scheduling practices and procedures that will help reduce risk. The Safety Manager discusses controls recommended for adoption with the senior management team and approval is gained for the following changes to be adopted and implemented: • Extended travel time to site included in shift time for first and last shift where travel is on the same day will reduce task related fatigue. A later pre-work briefing can be accommodated in project plan. • Night shifts limited to 8-10 hours where workers are driving themselves to and from the site. • If consecutive night shifts are longer than 10 hours the sequence is limited to four after which a reset break of at least two full nights off is provided. • Formal process to optimise suitability of rest accommodation is implemented, this includes minimum requirements that must be met in order for accommodation allowances to be paid and, where practical, company booked accommodation is provided.

	• New electronic handover procedure and checklist is developed for Protection Officers to use in relation to confirmation of worksite projection arrangements. • Managers who are usually office based but sometimes required to work on site at night, are required to leave the office early to ensure minimum time off and a nap opportunity prior to working a night shift. If they are called out at short notice, consideration is given to the length of time awake and time of day in determining how long they can work.. • Minimum fatigue requirements are developed for inclusion in contracts for subcontractors and labour hire. • On call checklist is developed for technical specialists. Additional measures are also implemented: • *Fatigue App* An off the shelf fatigue management app is being trialled for the next 12 months to assist the organisation in determining work before a sub-contractor signs-on to a worksite. • *Commuting* When projects are based in regional areas and accommodation is provided, where possible, taxis/minibuses will be engaged to take workers to and from a worksite. Workers who require their own vehicle because of tools will have travel time to site included as part of the shift time for fatigue management purposes.
Step 5 Treat fatigue related risks	The Safety Manager completes the risk register, assigning accountability and responsibilities for new and amended controls to key project staff including consulting with affected people regarding changes that affect them. Fatigue risk management is then reinforced as part of project induction, pre-work briefings and regularly discussed during toolbox talks.
Step 6 Record, report, monitor and review fatigue-related risk.	The Safety Manager has documented the risk assessment process including the decision-making and risk acceptance process to show that risks are managed SFAIRP. This documentation will form the basis for future risk reviews. The Safety Manager is responsible for monitoring hours of work for fatigue purposes and reports on the results of monitoring to executive at monthly intervals. Fatigue is also included as a specific topic as part of the regular post closedown debrief process. This includes speaking with workers to understand what is and isn't working well. Findings are then used to inform the next update of the operator's FRMP.