NSW Resources Regulator

GUIDE

Fatigue management

Guidance for the NSW mining and petroleum industries

NSW GOVERNMENT

Document control

Published by NSW Department of Planning and Environment, NSW Resources Regulator

Title: Fatigue management guide

First published: April 2018

Authorised by: Chief Compliance Officer

CM9 reference: PUB18/141

Amendment schedule		
Date	Version	Amendment
Aug 2018	1.1	Minor typographical amendments

Contents

Glossary of terms

Term	Definition
Actual sleep	Time spent in the state of rest afforded by suspension of voluntary functions and the natural suspension, complete or partial, of consciousness.
Breaks between blocks of shifts	Time between when a worker has finished a series of shifts and commences the next series of shifts.
Breaks between shifts	The time between when a worker has finished work and is next rostered to commence work.
Circadian	Noting or pertaining to rhythmic biological cycles recurring at approximately 24-hour intervals, even in the absence of light fluctuations.
BIBO	Bus in Bus Out (to a workplace).
DIDO	Drive in Drive Out (to a workplace).
FIFO	Fly in Fly Out (to a workplace).
Micro-sleep	A temporary episode of sleep which may last for a fraction of a second or up to 30 seconds.
Operator	A PCBU nominated under the *Work Health and Safety (Mines and Petroleum Sites) Act 2013* to be the operator of the mine or petroleum site. Operators include coal mines, metal mines, quarries and petroleum sites.
PCBU	A person conducting a business or undertaking. This is a broad term used in the work health and safety laws for individuals, businesses or organisations that are conducting business or not for profit entities involved in work.
Performance impairment	The state of being diminished or weakened in the execution or accomplishment of work or a task.
Prior sleep wake factoring	The process of estimating the likelihood of fatigue based on sleep obtained in the last 24 and 48 hours and hours awake.
Shared responsibility	A particular burden or obligation shared with another person or thing.

Term	Definition
Sleep	To take rest afforded by a suspension of voluntary bodily functions and the natural suspension, complete or partial, of consciousness; cease being awake.
Sleep debt	The gap between the amount of sleep needed and the amount of sleep obtained.
Sleep opportunity	The time available to get sleep.
WHS	Work health and safety.
WHS Act	*Work Health and Safety Act 2011*.
WHS Reg	Work Health and Safety Regulation 2011.
WHS(MPS) Act	*Work Health and Safety (Mines and Petroleum Sites) Act 2013*.
WHS(MPS) Reg	Work Health and Safety (Mines and Petroleum Sites) Regulation 2014.
WHS laws	The *WHS Act*, WHS Reg, *WHS (MPS) Act* and WHS (MPS) Reg
Worker	A person who performs work for a PCBU in any capacity is considered a worker.

1. Introduction

This document provides guidance on how to prevent worker fatigue and its associated risks. The document outlines how to provide workers with the opportunity to have between seven and eight hours sleep daily and provide them with opportunity to recover between blocks of shifts. It is intended for use by the NSW mining, extractives and quarrying and petroleum sectors. It draws upon current thinking, reflects good practice and will assist operators and other PCBUs to manage the risks associated with fatigue in the workplace.

The guide is not prescriptive, which means that operators and other PCBUs may develop fatigue management arrangements that are specific to eliminating or, where elimination is not possible, minimise the risks identified in their work activities. However, operators and other PCBUs should address each of the main areas identified in this document.

Site operators must address fatigue management as part of their safety management system, including contractor management arrangements. Control measures to be implemented to prevent and manage risks associated with fatigue form part of the health control plan.

What is fatigue?

Fatigue may be defined as a decreased capability to perform mental or physical work, produced as a function of inadequate sleep, circadian disruption, or time on task (Brown, 1994).

Performance impairments increase risks to workers in the short term (acute = safety consequences) and in the long term (chronic = health effects). Unmanaged fatigue related impairment is both an organisational and individual hazard.

Why is fatigue a problem?

Fatigue presents both safety and health risks to workers and others. Under the legislation, operators and other PCBUs are required to eliminate or, where elimination is not possible, minimise the risks identified in their work activities.

Safety risks

Workers impaired by fatigue are less able to respond effectively to changing circumstances, leading to an increased likelihood of incidents due to human error.

Fatigue impairment includes:

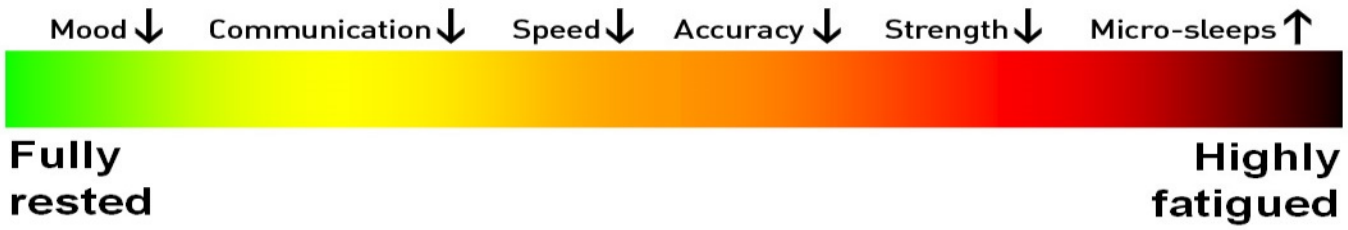
- → reduced capacity to communicate effectively
- → reduced reaction time
- → reduced coordination and alertness
- → short term memory and concentration difficulties
- → impaired judgement and decision making
- → micro sleeps.

What causes fatigue?

The primary cause of fatigue is long periods of wakefulness without adequate sleep (prior sleep wake model), e.g. long shifts or night shifts without adequate sleep. Ongoing sleep disruption may lead to sleep debt and chronic sleep deprivation, placing individuals in a state of increased risk to themselves and to others (Fatigue Fact Sheet 'Why we need sleep').

Figure 1: Fatigue impairment continuum

The continuum below indicates the cumulative impairments that are likely as a result of increasing levels of fatigue.



Health risks

Fatigue may also result in long-term health problems. The health control plan must eliminate health risks or, where elimination is not possible, minimise the risks identified in work activities. There is evidence suggesting that shift work and fatigue can contribute to a number of health issues that may include:

- → diabetes
- → digestive problems
- → high blood pressure
- → heart disease
- → lowered fertility
- → harmful drug and alcohol use, and
- → anxiety and depression.

Explanation

There are health, safety, performance and wellbeing advantages from having adequate sleep. Aim for seven to eight hours sleep within a 24-hour period.

While the focus on managing hours of work and rest is useful, a better understanding of why we sleep and how sleep affects the safety, health and productivity of everybody could be beneficial. Fatigue can affect everyone and it is often insufficient sleep that is the main cause.

Sleep is a homeostatic response to being awake. Basically, the longer you are awake, the more you need to sleep. Researchers at the University of Rochester Medical Center for Translational Neuromedicine found the brain has a unique “waste disposal system” during sleep. Called the “glymphatic system”, researchers saw that certain glial cells have channels that open up when people are asleep and remove chemicals and toxins that have built up in the brain during wakefulness.

Adenosine triphosphate (ATP) is a substance released by glial cells within the brain and can help with neurotransmission (communication from one brain cell to the next). Glial ATP is rapidly broken down to adenosine, which acts on adenosine receptors to depress neuronal activity. Basically, a build-up of adenosine in the brain serves as a sleep-promoting drive. As long as a person is awake, they are creating a drive to sleep slowly over the day, through the build-up of adenosine.

Figure 2 shows how the chemical might build up during wakefulness. When a lot of this is built up, the brain will have reduced function and a drive for sleep will soon begin. During sleep, the cleanout begins. By pumping cerebrospinal fluid through your brain’s tissues, the glymphatic system flushes waste from your brain, back into your body’s circulatory system. From there, the waste eventually reaches your liver, where it is eliminated.

During sleep, the glymphatic system becomes 10 times more active than during wakefulness. Simultaneously, brain cells are reduced in size by about 60%. Some of these toxins may be responsible for diseases such as Alzheimer’s.

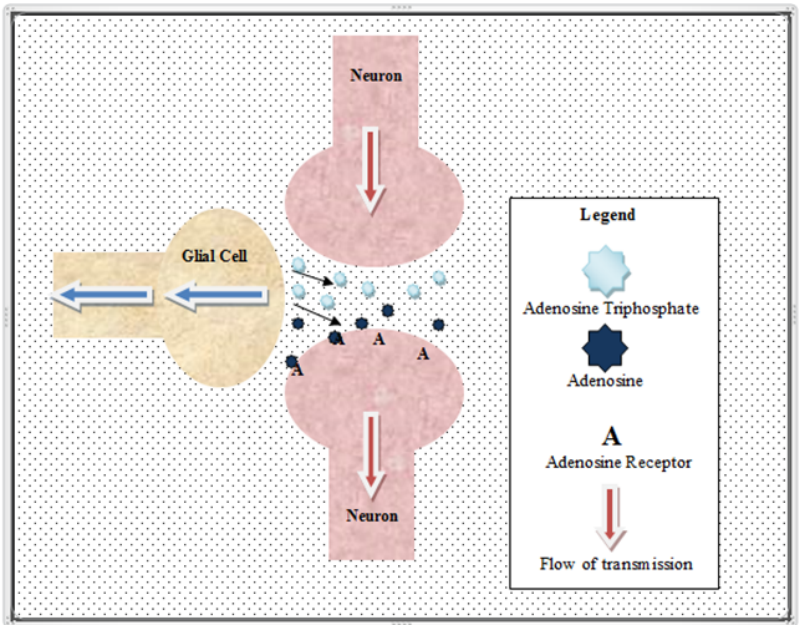


Figure 2. Transformation of adenosine triphosphate to adenosine between neurons and removal of toxins. From Beyond Midnight Consulting “Comprehensive Fatigue Resource Book 2nd Ed (2015).

Do job and environmental factors cause fatigue?

The primary cause of fatigue is the wake-to-sleep ratio but job and environmental factors may contribute to performance impairment. Mental demands such as the need to be vigilant for long periods or tasks requiring complex mental activity may contribute to the onset of fatigue. Other job and environmental factors, whilst not direct causes, may interact with fatigue and result in performance impairment. For example, monotonous work may decrease alertness, poor equipment design and other environmental factors such as heat/cold, noise and vibration may have a negative impact and contribute to fatigue related impairment.

Sleep opportunity, time in bed and actual sleep

Sleep opportunity refers to the 'window' available for an individual to sleep. Both work and non-work activities determine the amount of time an individual is awake and therefore has sleep opportunity. Studies[1] indicate actual hours spent in a state of sleep are always less than a person's sleep opportunity. Work-related impacts on sleep opportunity should be addressed and managed by the operator and other PCBUs. For example, the operator and other PCBUs should ensure minimum hours between shifts (including unplanned overtime or callouts) provide opportunity for workers to obtain 7 to 8 hours actual sleep. It should be noted that fatigue management is a shared responsibility and workers also have a responsibility to present fit for work. Non- work-related activities which reduce actual sleep obtained should be managed by the worker.

Work-related impact on sleep opportunity

Examples of work arrangements that have a direct impact on an individual's opportunity for sleep include:

- → roster design (e.g. the number of consecutive night shifts)
- → unplanned work, overtime, emergencies, breakdowns and call-outs
- → planned shutdown and maintenance
- → commuting times.

Non- work-related impact on sleep opportunity and actual sleep obtained

An individual's family, community and social arrangements also impact sleep opportunity. Everyone needs a certain amount of time before and after work to fulfil personal health and fitness needs (mental and physical) as well as family responsibilities. Home location and volunteering (e.g. emergency services, coaching children's sport) are examples of non-work activities that could reduce sleep opportunity.

In addition to the amount of sleep obtained, the quality of sleep is a factor in the development of fatigue. Impacts on sleep quality include:

- → sleep disorders (e.g. sleep apnoea)
- → alcohol and drugs

[1] Drew Dawson, Kirsty McCulloch (2005). Managing fatigue – It's about sleep. *Sleep Medicine Reviews 9, 365 -380.*

- depression and anxiety
- external stressors (e.g. financial or domestic difficulties)
- physical fitness.

How may you tell if someone is fatigued?

Fatigued individuals are not good at recognising that their function is becoming impaired. In workplaces where fatigue is an issue, often it is a worker's colleagues who identify they may be experiencing fatigue. Symptom checklists are available (Some examples are in Appendix 3).

Typical symptoms include:

- excessive or increased yawning
- falling asleep (different to micro-sleeping)
- headaches
- dizziness
- blurred vision
- poor concentration
- impaired decision making
- slow reflexes.

Other indicators that a worker may be fatigued include:

- increased rates of unplanned absences
- regularly arriving later for shift start
- regularly sleeping longer than ‘normal’ on days off.

2. Fatigue risk management overview

Who has a duty?

Everyone at a workplace has a duty to ensure fatigue does not create a health and safety risk at work. Duty holders include:

- → PCBUs including the site operator
- → Workers (including contractors, apprentices, students, labour hire workers, volunteers).

The PCBU (s19 *WHS Act 2011*) has the primary duty to ensure the health and safety of workers. Officers (s27 *WHS Act 2011*) such as company directors must exercise due diligence to ensure that the operation complies with its WHS duties including ensuring there are appropriate resources and processes for managing fatigue risks.

In addition, site operators have a specific duty under clause 43 WHS (MPS) Reg to manage risks to health and safety associated with worker fatigue. The control measures used to ensure that people working at the site are fit to carry out that work without causing a risk to their own or others' safety must be set out in the health control plan.

WHS (MPS) Reg 26(3) Health control plan: The operator of a mine or petroleum site must prepare a health control plan for the mine or petroleum site that sets out the means by which the operator will manage the risks to health associated with mining operations or petroleum operations at the mine or petroleum site in accordance with clause 9.

Specifically, under Schedule 2 Principal control plans—matters to be addressed

1. A health control plan for a mine or petroleum site must address the following:

(b) the control measures to ensure that persons working at the mine or petroleum site are fit to carry out that work without causing a risk to their own or others' safety including the control measures for minimising the risk that a worker will be impaired by fatigue, extremes of temperature, moisture content of air or intoxication by alcohol or drugs

Workers (s28 *WHS Act 2011*) must comply with any reasonable instructions and cooperate with any reasonable measure in place to minimise or manage fatigue risks. Workers (including supervisors, managers and technical/professional staff) should report to their supervisors or managers when they are fatigued and avoid undertaking safety critical or high-risk tasks, including monotonous work such as driving haul trucks.

Operators and PCBUs cannot control what workers do when they are not working. Workers are often best placed to know whether they are fatigued and, as such, they play a critical role in managing fatigue. Engaging with workers to help them understand fatigue risks can be an effective part of managing fatigue risks.

Resources needed

Operators and other PCBUs responsible for managing fatigue risks must ensure that appropriate resources are made available. These resources include a competent person to conduct the risk assessment, worker representatives (including contractors) and other relevant people who are informed about fatigue and can participate in the risk management process in a meaningful way.

Other resources may include:

- → training to inform managers and workers about the nature of fatigue including factors which contribute to fatigue and types of control measures
- → industry information on fatigue related incidents
- → up to date knowledge about fatigue, fatigue factors or expert advice
- → roster analysis tools
- → tools or technology for identifying fatigue symptoms or impairment
- → supervisor training on identifying and responding to worker fatigue.

Further advice is found in Appendix 9: Further resources and references.

3. Consultation

Consultation involves sharing information and giving another party, such as workers, the opportunity to express their views and taking those views into account before making decisions on health and safety matters.

Consulting with workers

Operators and other PCBUs must consult with workers when developing and implementing strategies to manage fatigue. If the workers are represented by a health and safety representative (HSR), the consultation must involve that HSR. At coal mines, this includes the mine safety and health representative (MSHR). Consulting workers at each step of the risk management process encourages everyone to work together to identify fatigue risk factors and implement effective control measures. Consultation also helps to raise awareness about the risks of fatigue.

Communication and consultation with those who work outside ‘normal’ business hours e.g. nights and weekends may require different communication strategies. In addition, these strategies should include consultation arrangements for vulnerable workers, such as inexperienced workers or contractor workers.

Refer to WHS consultation, cooperation and coordination code of practice.

s47 *WHS Act*: A person conducting a business or undertaking must consult, so far as reasonable practicable, with workers who carry out work for the business or undertaking who are (or likely to be) directly affected by a work health and safety matter.

s48 *WHS Act*: If the workers are represented by a health and safety representative, the consultation must involve that representative.

Consulting with other PCBU's

Sometimes more than one person conducting a business or undertaking may have responsibility for health and safety because they are involved in the same activities or share the same workplace. In these situations, they must communicate with each other to identify and assess health and safety risks associated with fatigue and work together in a co-operative and co-ordinated way so these risks are eliminated or minimised so far as is reasonably practicable.

For example, if a contractor provides labour hire workers who carry out shift work for an operator, both PCBUs have a duty of care to the workers. The PCBU will need to discuss whether fatigue may be a potential hazard and consider issues such as rosters, working hours and the mental and physical demands of the job. The contractor PCBU will need to consider the cumulative effect of fatigue arising from all the different workplaces the worker is sent to and agree on arrangements to manage the risks of fatigue with each PCBU. (SafeWork Australia - Guide for managing the risk of fatigue at work 2013).

See also Contractors and other businesses at mines and petroleum sites factsheet for specific requirements under the WHS (MPS) Reg for operators and contractors at mine and petroleum sites.

s46 *WHS Act*: A person conducting a business or undertaking must consult, co-operate and co-ordinate activities with all other persons who have a work health and safety duty in relation to the same matter, so far as reasonably practicable.

For more details on additional risk factors associated with contractor fatigue see Appendix 2.

When to consult

The legislation requires that workers be consulted when:

- → assessments are made of risks to health and safety
- → decisions are made on measures to control or eliminate those risks
- → changes are made to premises, systems or methods of work, or to plant or substances used for work, that may affect health, safety or welfare at work
- → decisions are made about the consultation arrangements.

The Work Health and Safety Consultation Code of Practice available from SafeWork NSW provides guidance as to how and when to consult.

4. Fatigue risk management

Operators and other PCBUs are required to manage fatigue risks as set out by the risk management provisions in both the WHS Reg and the WHS (MPS) Reg and document risk assessments and control measures. Site operators are required to integrate fatigue risk management measures into the safety management system.

Fatigue risk management encompasses:

- hazard identification - identifying foreseeable factors that give rise to fatigue risks
- risk assessment - evaluating the likelihood of these factors contributing to impaired performance and the potential consequences given the nature of the work being performed
- risk control - selecting and implementing reasonably practicable measures to eliminate or minimise risk
- control maintenance - ensuring the continued effectiveness and implementation of selected measures.

Identifying factors that may contribute to fatigue

Fatigue is often caused by a number of inter-related factors which may be cumulative.

Hazard identification requires operators and other PCBUs to consider the extent to which hazards are present. Work related hazards that affect hours awake and sleep opportunity should be considered first as these are the primary contributors of fatigue and are factors which the operator and other PCBUs has control over such as where they work, when they work and how they work.

Factors which may contribute to performance impairment that should be identified may include; mental and physical demands of work e.g. monotonous work (high vigilance tasks), work environment conditions (e.g. heat, noise, vibration and lighting).

Individual and non-work hazards that impact sleep opportunity, quantity and quality of sleep should also be considered. These hazards may be identified in a variety of ways including talking with workers (including contractors); and surveying workers to gauge the impact of work arrangements and find out about workforce characteristics (e.g. volunteering, secondary employment) and worker concerns or preferences.

All the hazards identified may be compared against the SafeWork Australia example presented in Appendix 8.

In addition, examining records to look at fatigue related hazard reports, incidents and health impacts provides a source of information about fatigue risks.

Work scheduling and planning

How work is planned and scheduled, the time at which work is performed and the amount of time worked, may increase the fatigue risk load. Workers require reasonable time to commute and meet living responsibilities (e.g. bathe, eat, meet family obligations, sleep). Work arrangement design should enable sufficient sleep and home-life opportunities. Performing work at times when workers are biologically programmed to sleep (11:00pm – 5:30am) and/or working for long periods of time (being awake longer) may increase fatigue risk. Work scheduling and planning should consider:

- night shifts (particularly consecutive night shifts)
- length of shifts, and/or length of shift cycle (roster) until days off
- length of break between shifts
- impacts of planned (shutdowns, overtime, on call etc.) or unplanned (emergencies etc.) extra work hours on workers
- extra fatigue risk loading of commute times on top of work hours
- recovery break length (between shift blocks)
- shift start/finish times
- high risk work during night shifts.

Commuting

Having to travel long distances before or after work increases wake time, reduces sleep opportunity and increases the wake to sleep ratio. Commuting may occur daily, reducing sleep opportunity between shifts or in isolated areas workers may only commute at the end of the roster (drive-in, drive-out).

Drive-in, drive-out (DIDO) arrangements of workers may place both the worker and others at risk as workers may drive anywhere between an hour and up to 10 hours pre- and post-roster at NSW mines. The commute issue can arise due to the high cost of air travel, lack of convenient airports and lack of, or minimal transport opportunities between airports and mine sites.

Workers may choose to commute from home rather than fly to reduce travel costs. In many cases, workers may travel to site the afternoon prior to roster commencement and stay in accommodation overnight. However, if the cost of overnight accommodation is borne by the worker, they may be discouraged from utilising this option.

How do long commutes contribute to fatigue?

Residential commutes

Workers regularly commuting long distances to work face significant health and safety risks due to:

- acute sleep debt from a short sleep and an early awakening
- driving throughout a period when a worker normally sleeps (low point in the circadian rhythm) and in the dark, where the worker is more likely to fall asleep.

If catching up on sleep does not occur, fatigue may continue for the duration of the working roster and then for the drive back home.

Individual and non-work factors

In addition to the work-related factors it is important to identify other non-work factors that reduce sleep opportunity. Things to consider include:

- lifestyle issues such as caring or child-care responsibilities, social and recreational pursuits, voluntary work, secondary employment
- factors which affect quality of either daytime or night time sleep such as children, noisy neighbours or a bedroom that is too hot or not dark enough for day-time sleep
- health conditions or pre-existing medical conditions such as insomnia, sleep apnoea, or alcohol or drug dependence or level of fitness and diet.

Demands of work

Demands of work including prolonged vigilance, complex or monotonous tasks which may interact with sleep/wake causes of fatigue and contribute to impairment.

Work environment conditions

Working in adverse and/or uncomfortable work environments may affect worker performance in many ways. Extreme heat/cold, hazardous noise and vibration are some of the environmental conditions that may tire workers more quickly and impair performance.

Effect of exposure for longer periods

When taking a risk management approach to fatigue, it is very important to look at how long working hours may interact with other workplace hazards and increase exposures to other health hazards e.g. manual tasks, hazardous chemicals, dust and noise.

Risk assessment

Risk assessment must involve consultation between PCBUs and workers at a workplace. Workers' practical knowledge of the tasks, as well as non-work fatigue risk factors, informs the risk assessment process. As fatigue is a complex multi-factor hazard, a formal risk assessment should be facilitated by a trained and competent person and should also involve a subject matter expert. This may require external resources.

Fatigue risk assessment has two aspects:

- how likely is it that workers could become fatigued?
- the severity of the consequences that may be expected because of fatigue impairment.

This assessment allows control activities and monitoring to be prioritised. Priority should be given to factors that directly affect sleep opportunity and sleep obtained.

Minimising fatigue by maximising opportunity for workers to gain 7-8 hours' sleep

Work scheduling and non-work factors outlined above should be examined in detail to determine their impact on sleep opportunity, actual sleep, sleep quality and the length of time awake. The risk assessment team needs to:

- understand what sleep opportunity the work roster provides for workers (including contractors) based on work hours including overtime and call outs, travel times/distances
- recovery time available between blocks of shifts taking commuting into account
- estimates of actual sleep (on average), sleep quality given workforce characteristics (family, social and health profiles) (see Appendix 3: Fatigue assessment tools).

Information on hours worked, including non-compliance with maximum hours' policy, frequency of unplanned overtime and call outs and roles that regularly work longer hours (e.g. supervisors) helps develop an understanding of how work scheduling and planning is affecting sleep opportunity and recovery between rostered shift blocks.

Managing the consequences of fatigue impairment

If workers are not regularly getting 7-8 hours good quality restorative sleep it is possible that they are working/operating in an impaired state. The fatigue risk assessment must examine WHS records to consider if fatigue impairment is affecting safety performance and/or worker health. This should involve the following:

- review of fatigue reports, errors, near misses and incidents to determine if fatigue is affecting safety outcomes
- assessing whether job and environmental factors may contribute to impaired performance
- the use of relevant information such as safety alerts, investigation reports and any industry level data on fatigue related incidents.

Reputable information and advice from experts in the field should be used to inform the risk assessment (see Appendix 9 for list of resources). Important fatigue risk factors are detailed in the Safe Work Australia Guidance on fatigue[2] and operators and other PCBU's should refer to its current guidance material.

The following dot points (based on SWA Guide) outline some relevant factors. As different operations have different needs there is no single optimal shift system which suits everyone. However, a planned and systematic approach to managing the risks of shift work may improve the health and safety of workers.

Key risk factors which should be considered in shift schedule design are the workload, the work activity, shift timing and duration, direction of rotation and the number and length of breaks during and between shifts. Other features of the workplace such as the physical environment may also contribute to the risks associated with shift work.

[2] SafeWork Australia (2013). Guide for managing the risk of fatigue at work. *Appendix B – Guidelines for Shift Design* p14

Shift design

- Plan an appropriate and varied workload.
- Offer a choice of permanent roster or rotating shifts.
- Limit shifts to 12 hours including overtime, or to 8 hours if they are night shifts and/or the work is demanding, monotonous, dangerous and/or safety critical.

Night shifts

- Restrict number of successive night shifts (no more than 3 to 4.
- Allow for at least 2 full night's sleeps after the last night shift.
- Avoid keeping workers on permanent night shifts.
- Arrange shifts so day sleep is not restricted.
- Except in case of emergency, provide at least 24 hours' notice before night work.

Early starts

- Avoid early morning starts and move early shift starts before 6:00 am forward (e.g. 7:00 am not 6:00 am start).
- Limit the number of successive early starts (to 4 maximum).
- Shifts involving an early start should be shorter in length to counter the impact of fatigue later in the shift.

Shift length

- If 12-hour shifts worked then no overtime worked in addition.
- Avoid long working hours.
- If 8/10 hour shifts then no more than 4/2 hours extra overtime to be worked.
- Limit consecutive work days to a maximum of 5-7 days.

Rest periods

- Allow minimum of 12 hours between shifts and avoid 'quick return' of 8 hours if possible. (Rest period between shifts should permit enough time for commuting, meals and sleep.)
- Build regular free weekends into the shift schedule, advisably at least every 3 weeks.

Rotation

- Use a rapid rotation of shifts (a select number of days) or a slow rotation of shifts (a select number of weeks). A shift design should consider individual differences and preferences as far as possible.
- Use forward rotation (morning/afternoon/night).

Other considerations

- Arrange start/finish times of the shift to be convenient for public transport, social and domestic activities.
- Account for travelling time of workforce.
- Allow individual choice where possible to accommodate family commitments and offer alternatives where workers have difficulty adjusting to shift times.
- Keep the timing of shifts predictable.

The information in Appendix 8 provides an example of how to assess the risk associated with each major risk factor.

Risk control

Control measures identified through the risk assessment must be implemented so that hazards that pose risk to workers or to others are properly controlled. If unable to eliminate the hazard (and associated risks) control measures must attempt to minimise the risks as per the 'Hierarchy of Control'.

Cl 36 (3 a-c) Part 3.1 WHS Reg: (if risk cannot be eliminated it should be minimised) by doing one or more of the following (so far as reasonably practicable):

(a) substituting (wholly or partly) the hazard giving rise to the risk with something that gives rise to a lesser risk,

(b) isolating the hazard from any person exposed to it,

(c) implementing engineering controls

Applying the hierarchy of controls

It is a legislated requirement to apply the hierarchy of control to all hazards including fatigue.

The hierarchy of control requires that worker fatigue be eliminated (WHS Reg 2017 clause 36). If this is not reasonably practicable then an operator and other PCBU must minimise or manage risks to safety from fatigue related impairment.

The aim in selecting control measures is to:

1. prevent or reduce the likelihood of a worker becoming fatigued (increase sleep opportunity)

If this is not achieved and workers are working/operating in an impaired state then the second aim is to:

2. mitigate the severity and likelihood of safety incidents.

Whilst the descriptors used to define the hierarchy of controls may not accurately describe fatigue control measures a hierarchy must be applied.

Note: Only prevention addresses the health impacts known to be associated with fatigue and shift work.

Prevention - Minimise the likelihood of a worker becoming fatigued

To minimise fatigue, control measures must address factors which determine time awake, sleep opportunity and actual sleep obtained. Examples of higher to lower order controls designed to reduce the likelihood of a worker becoming fatigued are listed below:

- redesign roster, reduce shift length, and increase the opportunity to sleep between shifts
- increasing the break between shift blocks
- provide on-site accommodation (or implement policies on residential location) to increase sleep opportunity by reducing commute times and time spent doing other non-work-related activities
- provide longer breaks within a shift
- engage and educate the workforce on the importance of sleep, creating a conducive sleep environment and how they may report being fatigued or making errors because of fatigue impairment.

A list of tips for individuals on how to help avoid fatigue is provided in Appendix 4 and a Fatigue likelihood calculation is provided in Appendix 3.

Mitigation - Reduce the likelihood and severity of safety incidents

If a worker does become fatigued then control measures should remove impaired workers from high risk work or reduce the consequences of fatigue related error. Examples of higher to lower order controls to reduce the severity and likelihood of safety incidents include:

- not scheduling high risk work during high risk points in the shift (circadian lows) or high-risk points in the roster cycle
- using technology which isolates workers/stops operation when fatigue signs are detected
- establishing arrangements for workers and supervisors to identify worker fatigue and taking appropriate action to remove the worker from work where a fatigue related error could result in an incident
- rotate workers to lower risk tasks when symptoms of fatigue are identified.

Example controls for the most common fatigue risk factors are shown Appendix 8.

Applying the ‘bow tie’ method to controlling fatigue

A bow tie may be used to help identify control measures to reduce the likelihood that workers will become fatigued or mitigate the likelihood and severity of an incident occurring due to a worker undertaking tasks while impaired.

To develop a bowtie for fatigue control measures, the ‘loss of control’ happening to be prevented (the centre of the bowtie) and threats to control maintenance both need to be defined. One suggested description of ‘loss of control’ is defined below, but a workplace may define the event in a way that is more relevant to their operation.

Example loss of control event - “***Worker operating in an impaired state”***

The preventative controls for each of the identified threats should then be selected to prevent a worker operating when impaired. If these controls fail to do this then mitigating controls need to be identified to reduce the likelihood and consequences of an incident.

Some suggested threats include:

- roster does not provide the recommended amount of sleep opportunity
- worker does not present fit for work
- worker becomes impaired during the shift as wake time increases
- work design, job demands or environmental conditions contribute to worker impairment
- work scheduling does not consider times of circadian low or high-risk points in the roster cycle.

See Appendix 5: *Bow tie example*.

Testing individual performance impairment

Individual testing may be a tool for managing risk. It may involve a variety of different types of tests, ranging from cognitive psychomotor tests (e.g. hand-eye coordination) to central nervous system tests. But testing is not a preventive control measure. It is a tool for assessing impairment and, on its own, may not give enough information to manage risk. These tests are not infallible. The fact that an individual employee has passed a fatigue test does not provide any guarantee of fitness for work for the remainder of the shift, particularly in the absence of proper risk control measures. Also, testing needs to be clearly related to the job tasks of the worker.

Do multiple controls work best?

Fatigue controls are most effective and straightforward to implement when ‘layered’ upon one another. A fatigue management model that reflects this is called the ‘defence in depth’ approach. This model is growing in popularity because it does not merely rely upon mandated hours of work but rather it builds upon maturity and commitment from managers and workers to achieve reduced levels or instances of workplace fatigue. For a fuller description of this approach see Appendix 6: *Defence in depth*.

Some risk controls may need to be trialled before being introduced

Some control measures should be tested before they are permanently put into place. For example, if a roster is re-designed, it could be piloted with one work group before the final arrangements are made. A trial may identify unexpected problems.

Monitoring the effectiveness of controls

The PCBU should monitor the effectiveness of the control measures put in place to ensure they are appropriately maintained. Some examples of useful measures are listed below:

- Hours worked over shifts, weeks, months
- Workers not presenting fit for work due to fatigue
- Assessment of an individual's impairment due to fatigue
- Changes in shift patterns, including novel events, e.g. shutdowns
- Outcomes of investigations that identify fatigue as a factor
- Current information on fatigue hazards and risks
- Actual breaks between shifts and blocks of shifts
- Commuting/travel times
- Training records

Regularly review control measures

Reviewing fatigue control measures to ensure that they remain effective is an important part of risk management. This is not only good practice but a legislative requirement (WHS Reg 2017 clause 38 and WHS(MPS) Reg 2014 clause 10). The following occurrences must trigger a review of measures:

- a control failure (indicated by an incident or near miss)
- before a change at the workplace. Some examples include:
  - a business expansion or contraction
  - changes in the workforce (e.g. introduction of new contractors)
  - changes to work schedules (roster changes)
- at the request of a HSR or SHR/ISHR in the case of a coal mine (*WHS Act* s38)
- as a result of audit findings.

Arrangements to support fatigue control measures

Identify where the risk of fatigue may impose potential harm to workers and then communicate what really matters. It is critical that workers understand the critical control and supporting controls and know what they have to do to ensure the controls are implemented.

- Roles and responsibilities - fatigue management arrangements should set out the shared responsibilities of the organisation and workers with respect to managing fatigue. Specific fatigue risk management responsibilities should be outlined for managers, supervisors and workers, including contractors.

- Accountabilities - outline any accountability that may be imposed upon workers/contractors.

- Consultation with workers needs to identify the important issues to be discussed including the roles of the operator, other PCBUs and workers.

- Information and training - fatigue management arrangements should identify skills and knowledge workers require in meeting their fatigue risk management responsibilities.

- Supervision - ensure workers and supervisors are competent to identify, report and manage fatigue risks. Fatigue management arrangements should identify skills and training required by workers to carry out their roles and responsibilities under the fatigue management arrangements.

- Specialist help may be required when undertaking risk assessments and selection controls

An example of how operators and PCBUs can implement their fatigue management arrangements is found in Appendix 1.

5. Appendices

Appendix 1: Fatigue and the safety management system

A site operator must establish a safety management system (SMS). This provides an integrated way of controlling all the health and safety risks arising from the operation of the mine or petroleum site. The SMS content must be documented in a manner which reflects this structure but may be set out in one or more documents.

Fatigue management adopts a risk based approach that outlines processes to manage and control operational fatigue risks, and processes to verify that these risks are being controlled. If fatigue is addressed in a separate plan (or document) it is sufficient that the SMS refers to that plan or document. Fatigue management arrangements should be developed, implemented and reviewed in consultation with workers.

The four major elements that fatigue management arrangements should address are outlined below.

Policy

The operator and other PCBUs must have a sound knowledge and understanding of fatigue safety risks. Whilst a fatigue policy is not mandatory, it may be useful to communicate the management's commitment to fatigue risk management. The policy should clearly outline the roles of managers, supervisors and workers, and be developed in consultation with workers.

Implementation

Operators and other PCBUs should identify which control is critical to preventing fatigue related incidents at their operation. A critical control (CC) is one which is crucial to preventing an unwanted event or mitigating the consequences of that event. The absence or failure of a CC would significantly increase the risk despite the existence of the other controls.

As well as the roster, control measures specific to the work may be required e.g. additional rest breaks or increased supervision. For operating vehicles on haul roads, roadway and intersection design may be critical for mitigating the consequences of a fatigue related incident.

The fatigue management arrangements should be customised to reflect the nature, size and complexity of the operations and organisational arrangements in place at the site for which it is developed.

Communicate what really matters

Identify where the risk of fatigue may impose potential harm to workers and then communicate what really matters. Workers must understand the critical control and supporting controls and know what they have to do to ensure the controls are implemented.

→ Roles and responsibilities - fatigue management arrangements should set out the shared responsibilities of the organisation and workers with respect to managing fatigue. Specific

fatigue risk management responsibilities should be outlined for managers, supervisors and workers, including contractors.

- → Accountabilities - outline any accountability that may be imposed upon workers/contractors.
- → Information and training - fatigue management arrangements should identify skills and knowledge workers require in meeting their fatigue risk management responsibilities.
- → Supervision - ensure workers and supervisors are competent to identify, report and manage fatigue risks. Fatigue management arrangements should identity skills and training required by workers to carry out their roles and responsibilities under the fatigue management arrangements.
- → Specialist help - the plan should address how and when to seek specialist advice and who has the authority to seek this advice.
- → Consultation - outline how and when workers and contractors will be consulted e.g. risk assessment, change in working arrangements, after an incident where fatigue could have been a contributing factor.

Monitoring

Fatigue management arrangements should address types of monitoring and how, when and why it should be undertaken.

- → Select the right measures - consider what performance indicators could be monitored to measure the control's effectiveness e.g. actual hours worked including overtime and call outs (including supervisors and managers), number of workers reporting fatigue at the commencement or during a shift and fatigue related incidents.
- → Frequency - determine monitoring schedule for each performance indicator.
- → Identify how monitoring will be done - monitoring procedures and who is responsible.
- → Investigate issues of concern - a reporting system and procedure for workers, supervisors and managers to raise issues of concern including who is responsible for investigating and giving feedback.

Audit and review

Fatigue management arrangements require periodic audit and review to assess their effectiveness and to achieve continuous improvement. They should be audited at least annually, or in accordance with an existing audit schedule for other parts of the safety management system. The purpose is to identify potential improvements and changes to fatigue management arrangements that may need to be made to reflect organisational developments and to ensure that fatigue management arrangements align with latest industry good practice.

Auditing should also verify the accuracy of monitoring results as well as the effectiveness of controls.

Managers should review monitoring and audit results and consider actions that need to be taken to improve fatigue management arrangements.

- → Reviewing performance - performance indicators should be assessed on a regular basis to determine whether the controls are fully implemented, functioning correctly and effective.

- → Learning lessons - are the lessons from the incidents reviewed and incorporated into the fatigue management arrangements if appropriate.
- → Worker consultation and involvement - have workers been consulted at appropriate times? Should additional consultation be included in the fatigue management arrangements?
- → Change management - the plan should be reviewed when circumstances at the site change e.g. when rostering patterns change or when there is any indication that fatigue risks are not being controlled.
- → Human factors - address any human factors not previously identified that may contribute to fatigue risk.
- → Revisit fatigue management arrangements and take action.

Appendix 2: Additional risk factors associated with contractors and fatigue

Contractors play an important part of the NSW mining and petroleum industries and as such they often undertake safety critical tasks (SCT) sometimes as specialists (shot firers, crane operators etc.) or often as hire labour. They often travel long distances and may work on a number of sites before taking a break. The length of a commute has the potential to impact the sleep opportunity of contractors and this risk should be considered.

Examples of such SCT include driving a vehicle (particularly on the road) or operating high risk plant, working at heights, working with flammable or explosive substances and other types of work identified as hazardous, for example electrical work.

Mining, extractives and quarrying and petroleum operations in NSW involve a number of safety critical tasks (SCT) as part of 'day to day' activities. These include tasks or activities where the consequences of a mistake or error in judgment could cause serious injury. When the risks associated with these activities is managed effectively then the risks are either eliminated or reduced to an acceptable level.

Shut-Downs and mobilising large maintenance groups

A shutdown is when an organisation has an organised date to shut down a plant or production facility to undergo maintenance, upgrades or repairs. The shutdown is organised to take as little time as is needed and is carefully planned to reduce down-time as much as possible. The shutdown may run from a few days to several weeks and may require anything from a couple of workers to large crews of a hundred or more. When a site organises a shutdown, an employment agency or "for hire" group is often called upon. Many such groups provide specialised services and have a number of employees ready to mobilise.

This instant mobilisation of a work group may come at a price. It is well known that people who work on shutdown crews go from shutdown to shutdown and may work for several weeks before taking time off for rest and recuperation. This places companies at risk of fatigue incidents, not only with the shutdown workforce but also the company employees required to work with or beside the shutdown crew (including shutdown supervisors, etc.).

Service and support contractors

Operations use service and support contractors that are not permanently based at the site. These contractors may service a number of sites each day (including after-hours call outs). These contractors may only be at one site once or twice a week however operators and other PCBU's should include these types of contractors in their fatigue management arrangements.

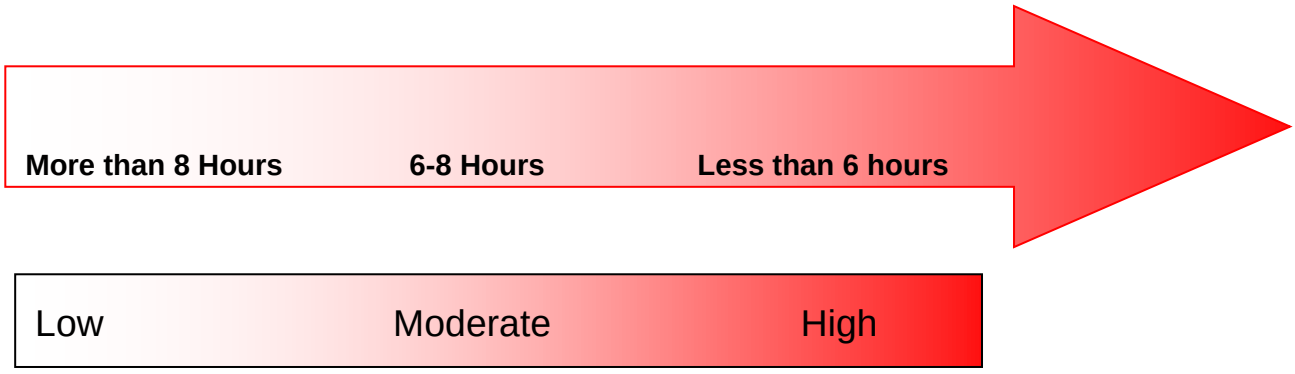
An example of the considerations in planning around the use of workers (this includes contractors and all other employees who are exposed to these risks) that commute long distances is provided in the table below. It should be noted that consideration needs to be given to commute length at the beginning and end of a shift block and also commuting within the shift block.

Commute Length	Possible Matched Controls
1) Less than 1-hour drive or no drive required	1) Comprehensive fatigue education for all workers.
2) 1 to 2 hours' drive or no drive e.g. BIBO/ FIFO	2) The above plus – journey management/commute management plan for those workers with longer commutes. Journey management/commute management plan for BIBO or FIFO situations. Comprehensive supervisor fatigue training. Review of safety critical tasks.
3) More than 2 hours' drive	3) The above plus – review of site arrangements for length of first and last shift. Review of site arrangements for residential accommodation usage before and after shift.

Appendix 3: Example fatigue assessment tools

Sleep opportunity calculator

Determining time awake		
How much time, are you awake for prior to leaving for work?	p	
How much time does it take for you to get to and from work?	c	
How much time do you spend at work?	w	
How much time do you spend awake after you have finished work (not including commuting home from work) prior to going to bed?	a	
Add p+c+w+a to work out Time Awake	TA	
Calculating sleep opportunity		
24 – TA = Sleep Opportunity	SO	
Use the risk rating graph below to risk assess your individual sleep opportunity		



Fatigue likelihood calculator

Developed by Drew Dawson, Sleep research centre

A: Prior 24 hours sleep								
Sleep:	0 Hours	1 Hours	2 Hours	3 Hours	4 Hours	5 Hours	5> Hours	**A**
Points:	20 Points	16 Points	12 Points	8 Points	4 Points	0 Points	0 Points	?
B: Prior 48 hours sleep								
Sleep:	<7 Hours	8 Hours	9 Hours	10 Hours	11 Hours	12 Hours	12> Hours	**B**
Points:	10 Points	8 Points	6 Points	4 Points	2 Points	0 Points	0 Points	?
C: Fatigue Impairment Likelihood at shift start								
					Number of hours awake at start			? = **C**
Total: A+B+C= Fatigue Impairment Likelihood at start of shift								
D: Fatigue Impairment Likelihood by shift end								
					Number of hours awake at end			? = **D**
Total: A+B+D= Fatigue impairment likelihood by end of shift								

Ref: (http://w3.unisa.edu.au/news/2009/081209.asp)

Potential impairment

The table below compares the fatigue likelihood score from the table on the previous page and aims to estimate the potential negative effects of fatigue impairment.

12	• Struggling to stay focused on any task. • Difficulty staying awake at times. • Micro-sleeps likely.
10	• Clear loss of motivation. • Significant loss of situational awareness. • Task performance impaired.
8	• Clear evidence of behavioural impairment. • Difficulty sustaining attention on simple tasks.
6	• Difficulty concentrating. • Occasional lapses of attention. • Poor judgement on complex task.
4	• Difficulty in maintaining extended concentration for complex tasks.
2	• Slowed cognition. • Occasional minor fatigue behaviours. • Minor mood changes observable.
0	• Not fully alert but able to perform tasks safely. • Few external signs of fatigue.

Individual alertness self-assessment

The following table may be used by individuals to determine their level of alertness:

- before the start of a shift as a routine assessment
- during a shift
- when fatigue has been reported
- when on call, and
- at the time of an incident.

The self-assessment may assist supervisors and managers in determining an individual's level of fatigue

Determining Individual Fatigue

1	Fully Alert
2	Very lively
3	Okay

4	A little tired
5	Moderately Tired
6	Extremely Tired
7	Completely Exhausted

The following table provides some example control responses using the previous tables' rating criteria.

Samn-Perelli Fatigue Checklist[3]	Risk level	Controls (suggested examples only)
1 - 3	Low	• No specific controls necessary (except in the presence of other indicators i.e. symptoms, errors or incidents).
4 - 5	Moderate	• Prior sleep/wake and behavioural assessment. • Individual controls such as work break. • Increase supervision or team-based monitoring.
6	High	• Document with shift supervisor. • Prior sleep/wake and behavioural assessment. • Individual controls such as work break. • Task re-assignment. • Team-based controls. • Support napping and safe-home policies.
7	Extreme	• Intolerable risk - no individual rostered beyond this threshold. • Any proposed exceptions to be escalated to the group management for approval.

Note: The above tools cannot provide **definitive** measurements of fatigue levels or a precise prediction of fatigue and so an overreliance on these to make accurate decisions would be inappropriate, without considering other factors and individual differences.

[3] Samn S.W, Perelli L.P Estimating aircrew fatigue: a technique with application to airlift operations: Brooks AFB, USAF School of Aerospace Medicine; 1982. Report No.: SAM-TR-82-

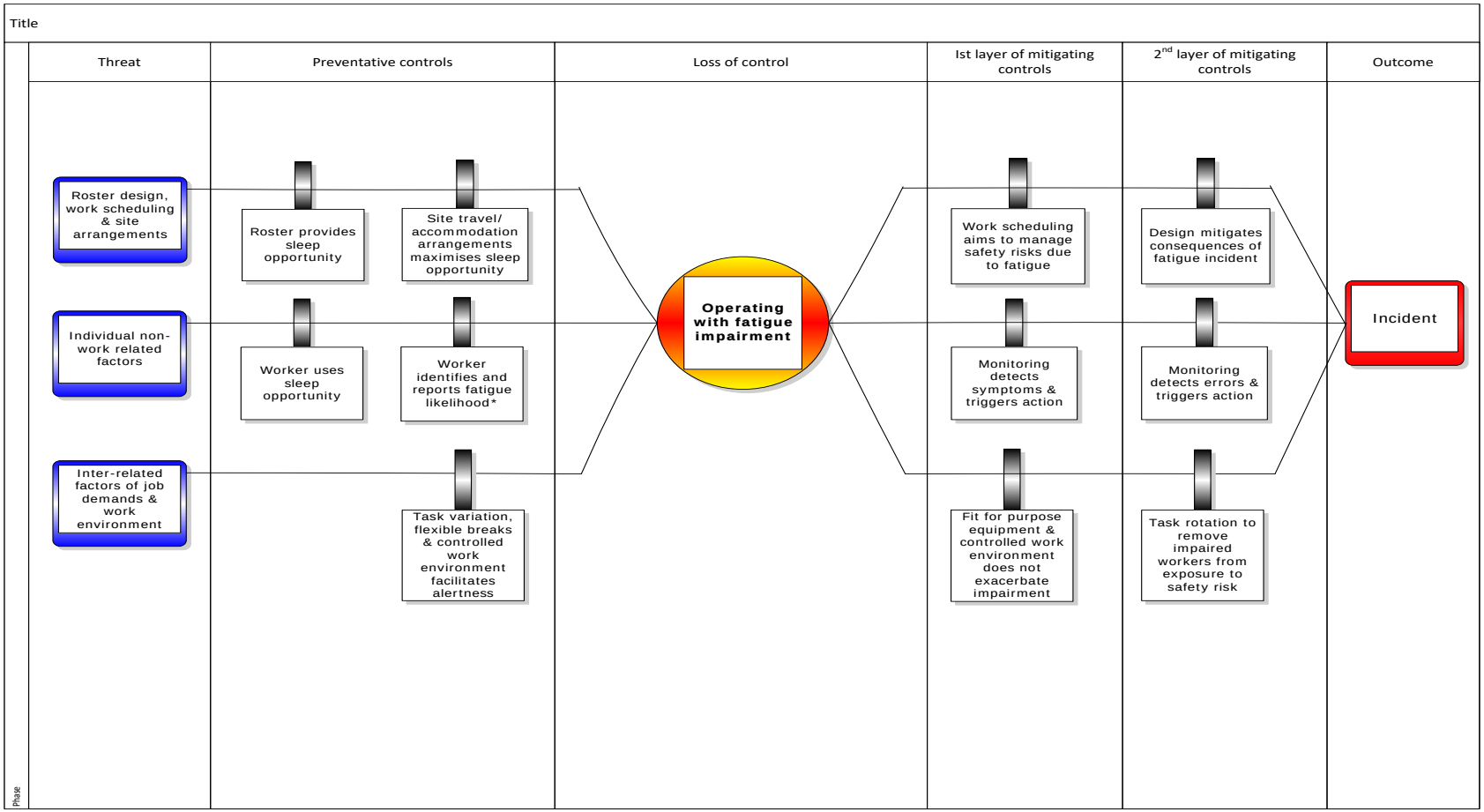
Appendix 4: Tips for individuals on avoiding fatigue

These tips are meant for workers who may be subject to fatigue.

Sleep	• The best sleep is night sleep • If sleeping during the day, darken the room and allow more time than normal to fall asleep • Choose a quiet, peaceful place to sleep and adhere to a routine • Seven to eight hours uninterrupted sleep is adequate • Seek medical advice for excessive snoring, irregular breathing, difficulty sleeping and insomnia
Drugs and alcohol	• Avoid excessive consumption of alcohol – it affects quality of sleep • Avoid stimulants – they delay the need for sleep • Do not consume coffee or tea before going to bed
Medical conditions	• If you have a medical condition, you should seek advice from your doctor if you are in a job that involves shift work or long working hours • Tell your employer about any medical conditions that may limit your ability to work or make you susceptible to fatigue • Ask your doctor for an alternative medication if it causes you drowsiness when you need to be awake
Fitness	• Maintain a basic level of fitness • Exercise regularly • Keep your weight in check – obesity contributes to sleeping disorders
Commuting	• Live close to work • Arrange temporary accommodation close to work • Share driving • Work shorter shifts • Minimise overtime

Modified from the WorkSafe Victoria and NSW WorkCover report: Fatigue prevention in the workplace. 2008.

Appendix 5: Bow tie example



Fatigue likelihood can be calculated using the 'Fatigue likelihood calculator' included in Appendix 3 – based on hours awake in the last 24 and 48 hours together with hours awake or projected hours awake as the shift progresses likely level of fatigue impairment can be determined.

Appendix 6: Fatigue – A defence in depth example

The 'defence in depth' example encompasses the following 'levels' or 'layers';

LEVEL 1 – Involves a work schedule or roster pattern design that enables workers adequate opportunity to rest and recover. Understanding the correlation of roster demands (day/night, length, start and finish times etc.) to the average hours of sleep obtained, is the crucial factor here.

LEVEL 2 – Involves actual sleep obtained by appropriately utilising the sleep opportunity afforded by LEVEL 1 planning and design. This includes fitness for work (FFW) and involves a ***shared responsibility*** by workers.

- → This level further involves measures like setting minimum sleep hours and maximum time awake. Prior sleep and wake calculations to determine fatigue likelihood levels, should form part of this level.

LEVEL 3 – Involves self-monitoring for behavioural symptoms of fatigue or monitoring symptoms in a workmate. Mood changes, yawning, slow reactions are potential indicators typically monitored for.

- → This level should include procedures (and 'no blame' style climate), so as to encourage early reporting.

Note: Illness and undetected health conditions may impact upon an individuals' restorative sleep, regardless of work pattern and attempts to sleep. This level is therefore an important layer to the fatigue risk management system (FRMS).

LEVEL 4 – Involves recognition or detection of fatigue related errors. Early and reliable detection combined with procedural measures to account for increased likelihood of errors, are the key to this layer of defence.

- → Double/triple checks, decision challenging, counter signing, verbal confirmation of instructions and supervisory oversight, are all typical measures at this level.

LEVEL 5 – Investigation into fatigue contribution in incidents. This affords an organisation learning opportunities by reflecting on outcomes so as to initiate improvements. If the previous layers are effectively implemented and well-designed, reporting, analysis and trending is possible.

This approach requires the development of a procedural framework for fatigue management arrangements such as:

- → organisational understanding and planning in the development of suitable work patterns that provide adequate sleep opportunities, as well as the commitment of workers to get enough sleep.
- → early reporting and mitigation strategies (including awareness training).
- → error detection and planning around reduction measures (see above) need to be designed into the fatigue management arrangement.

- → reviewing and monitoring effectiveness of fatigue management arrangements by investigating for fatigue causes in incidents.

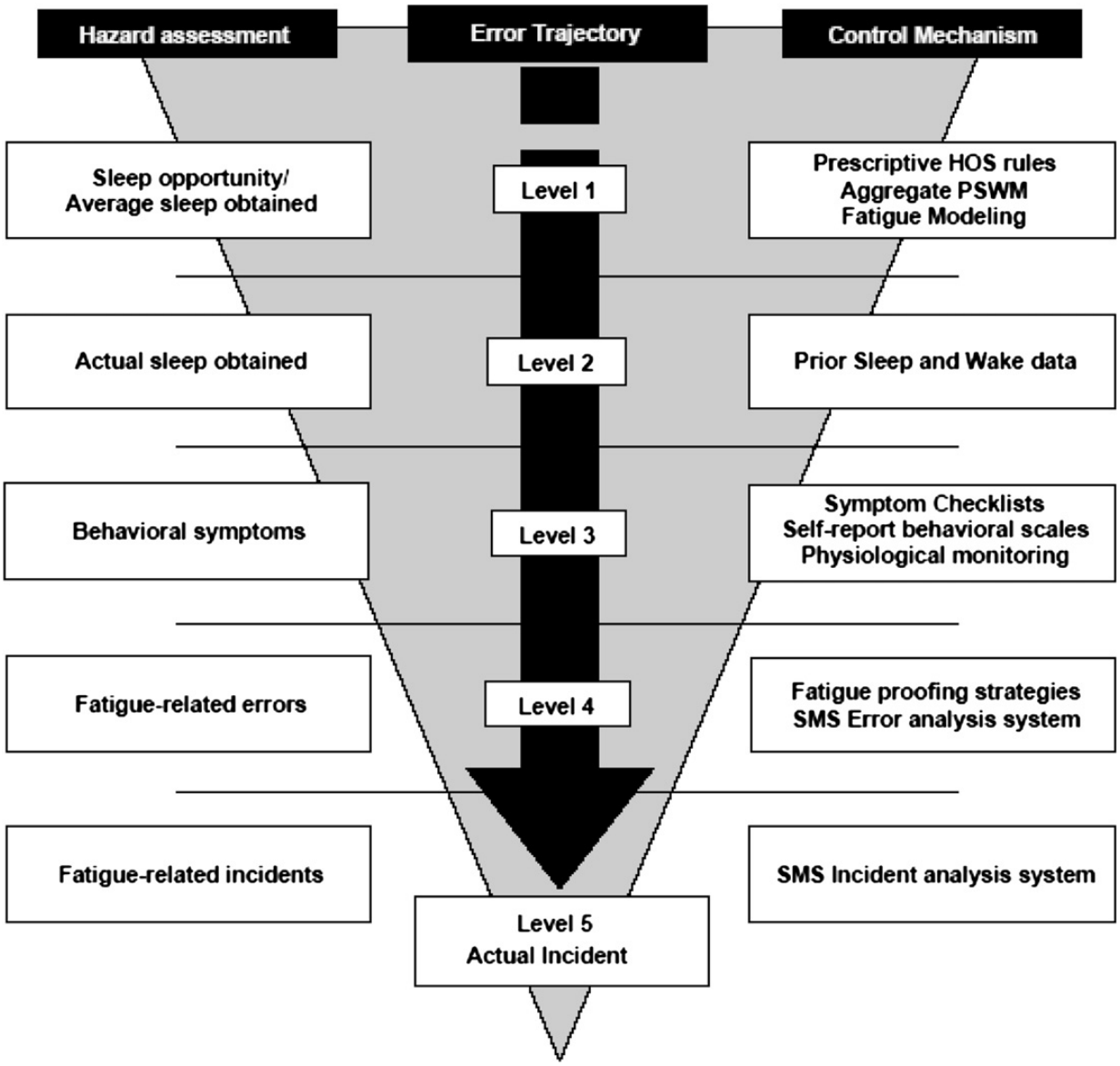
Fatigue management arrangements require periodic audit and review to assess their effectiveness and to achieve continuous improvement. They should be audited at least annually, or in accordance with an existing audit schedule for other parts of the safety management system. The purpose is to identify potential improvements and changes to fatigue management arrangements that may need to be made to reflect organisational developments and to ensure that fatigue management arrangements align with latest industry good practice.

Auditing should also verify the accuracy of monitoring results as well as the effectiveness of controls.

Managers should review monitoring and audit results and consider actions that need to be taken to improve fatigue management arrangements.

- → Reviewing performance - performance indicators should be assessed on a regular basis to determine whether the controls are fully implemented, functioning correctly and effective.
- → Learning lessons - are the lessons from the incidents reviewed and incorporated into the fatigue management arrangements if appropriate.
- → Worker consultation and involvement - have workers been consulted at appropriate times? Should additional consultation be included in the fatigue management arrangements?
- → Change management - the plan should be reviewed when circumstances at the site change e.g. when rostering patterns change or when there is any indication that fatigue risks are not being controlled.
- → Human factors - address any human factors not previously identified that may contribute to fatigue risk.
- → Revisit fatigue management arrangements and take action.

Figure 1. Defence in depth fatigue risk management model



Source - Dawson D, et al., Fatigue-proofing: A new approach to reducing fatigue-related risk using the principles of error management, Sleep Medicine Reviews (2011), doi:10.1016/j.smrv.2011.05.004

Appendix 7: Examples of roles and responsibilities for fatigue management

Managers	Supervisors	Workers
• Understand what fatigue is and what causes it; why do we need sleep; what effects may fatigue have on safety.	• Understand what fatigue is and what causes it; why do we need sleep; what effects may fatigue have on safety.	• Understand what fatigue is and what causes it; why do we need sleep; what effects may fatigue have on safety.
• Recognise and understand the operational risks that fatigue presents at their site.	• Recognise and understand the operational risks that fatigue presents at their site.	• Recognise and understand the operational risks that fatigue presents at their site.
• Ability to develop and implement fatigue management arrangements, including roster development, management of overtime; identifying and implementing other controls commensurate to the risks and training. • If a technological control is used it needs to be understood and its effectiveness monitored. The usefulness and effectiveness needs to be communicated to supervisors and workers.	• Ability to apply fatigue management arrangements at work group level; know and understand roles and responsibilities referred to in the arrangements – and be able to clearly communicate those to workers. • Understand how the technological control works and understands their role.	• Understand the tools in fatigue management arrangements that apply to an individual. • Understand how the technological control works and understands their role.
• Identify and monitor fatigue in an individual during a shift – able to identify specific and general symptoms of fatigue and able to develop and implement processes.	• Identify and monitor fatigue in an individual during a shift – able to identify specific and general symptoms of fatigue and able to apply processes.	• Identify and monitor fatigue in self during a shift – able to identify specific and general symptoms of fatigue and report.
• Ability to lead fatigue risk assessments and know when expert advice may be required. Knowledge that fatigue management arrangements should focus not on just rules of rostering (and the industrial area) but also ensure focus on the safety management principles.	• Ability to participate in risk assessments; ability to assess whether a worker presents fit for work or becomes fatigued during a shift. Report suspected related incidents and issues.	• Ability to participate in risk assessments; know how to carry out a self-assessment to identify fatigue; understand how to present fit for work and report when feeling fatigued at work and report if suspect others are fatigued.
• Review organisational fatigue risk information and statistics and systematically evaluate the performance and effectiveness of fatigue management arrangements.	• Monitor organisational fatigue risk information.	• Be consulted and be informed of the monitoring of organisational fatigue risk.
• Appropriate consultation is undertaken in the development, implementation and review of fatigue management arrangements.	• Facilitate worker involvement in consultation.	• Participate in consultation.

Managers	Supervisors	Workers
• Analyse the performance data associated with the fatigue management arrangements and be able to communicate its meaning to supervisors and workers.	• Understand the meaning of the outcomes from the performance measures data.	• Understand the meaning of the outcomes from the performance measures data.
• Review investigations of incidents to identify possible fatigue related causal factors to prevent reoccurrence and take action.	• Lead investigations of incidents to identify possible fatigue related causal factors to prevent reoccurrence.	• Participate in investigations.
• Lead review and improvement of fatigue management arrangements.	• Participate in the review and improvement of fatigue management arrangements.	• Be consulted.

Appendix 8: SafeWork Australia risk management chart

(SafeWork Australia 2013 Appendix C p16)

Step 1: Hazard identification	Step 2: Risk Assessment	Step 3 Risk Control
Identify potential hazards and risks at the workplace. Examples of some factors that contribute to fatigue are listed below. Consider these factors in the context of your specific workplace or industry.	To assist risk assessment, a general level of risk for each hazard is indicated along arrow guides. In assessing risk consider interaction between hazard factors that could influence the level of risk. Also take into account specific workplace/industry circumstances that may influence it.	Where a hazard is assessed as medium/higher risk, consider implementing control measures, such as those outlined in section 2 of this code.

Factors that contribute to Fatigue	General Risk indicator for factors that contribute to fatigue			Control measures
Work Scheduling and planning **Hours**	Lower Risk → Higher risk			**The most appropriate control measures should be implemented for the identified risk factor. Control measures may include:**
Average weekly hours (other than FIFO)	35-40 hours (working week)	48 hours (working Week	56 hours (working week)	• Scheduling safety critical work outside low body clock periods (i.e. between 2am and 6am) • Structure shifts and work plans so that demands are highest towards the middle of the shift and decrease towards the end. • Use forward rotation roster systems (day-evening-night) • Designing working hours and rosters to provide for adequate sleep opportunity
Total hours over a three-month period (other than FIFO)		624 working hours		
Daily work hours	9 working hours	12 working hours		
Daily work hours and work-related travel, including commute		10 working hours	13 working hours	

Factors that contribute to Fatigue	General Risk indicator for factors that contribute to fatigue			Control measures
Scheduling of work	Regular, predictable hours	Irregular and unpredictable hours, short notice of schedule, extended overtime, on call across shift cycle		(considering time for eating, washing, personal commitments etc.) • Monitor actual time worked against the allocated roster and identify if excessive hours are being worked
Shift work	Lower Risk → Higher risk			**Additional control measures should be implemented for special work arrangements and include:**
Length of shift (other than FIFO)		10 hours	13 hours	• Considering sleep opportunity and recovery in instances where workers are required to work on call after a normal shift or on days off • Avoiding quick shift changeovers such as finishing at 11am and starting again at 7am • Use forward rotation roster systems (day-evening-night) • Allocate shift and night workers consecutive days off to allow for at least two full nights rest including some weekends
Time of Shift	Day Shift	Afternoon shift	Night shift	
Speed and direction of shift	Forward rotation (morning/afternoon/night)	Backward rotation (night / evening / morning)	Slower rotation (i.e. weekly / 3-4 weekly rotation)	
Split shifts and variable Shifts			13-hour period	
Night Work	Lower Risk → Higher risk			**The most appropriate control measures should be implemented for the identified risk factor. Control measures may include:**
Shift end (for those working 8 hrs or more between 10pm and 6am			After 10pm and before 6am	• Planning into work schedules enough workers and other resources to do the job without placing excessive demands on workers • Keeping sequential night shifts to a minimum • Avoiding overtime allocations after afternoon or night shifts
Sequential night shifts	8 hours	10 hours	12 hours	
		6 or more 8 hour shifts 5 or more 10 hour shifts 4 or more 12 hour shifts		

Factors that contribute to Fatigue	General Risk indicator for factors that contribute to fatigue		Control measures
Breaks	Lower Risk → Higher risk		The most appropriate control measures should be implemented for the identified risk factor. Control measures may include:
Period of non-working following a sequence of night shifts	48 hours	Less than 48 hours	• Ensuring that workers have and take adequate and regular breaks so that they can rest, eat and rehydrate • Including rest periods in the work schedule and allow time for controlled sleeping and napping if necessary • Designing working hours and rosters to allow for good quality sleep and enough recovery time between work days or shifts for travelling, eating, washing and sleeping
Frequency of breaks during work	Adequate and regular breaks	Infrequent of no breaks	
Recovery time / sleep opportunity between work periods	Adequate time for sleep, travel, meals, etc.	Inadequate time for sleep, travel, meals etc.	
Job demands	Lower Risk → Higher risk		The most appropriate control measures should be implemented for the identified risk factor. Control measures may include:
Repetition (physical and/or mental)	Varying task demands	Highly repetitive work and or high concentration work, with high demands over an extended period of time	• Install fit for purpose plant machinery and equipment for use at the workplace • Redesign jobs to limit periods of excessive mental or physical demands • Introduce job rotation to limit build-up of mental and physical fatigue
Physical and mental	Minimal physically or mentally demanding work	Highly physically demanding work that results in muscle fatigue	
Environmental Conditions	Lower Risk → Higher risk		The most appropriate control measures should be implemented for the identified risk factor. Control measures may include:
Exposure to hazardous substances and atmospheric contaminants	Hazardous substances, low risk calculated using relevant exposure standard	For hazardous substances, high risk calculated using relevant exposure standard	• Avoid working during periods of extreme temperature

Factors that contribute to Fatigue	General Risk indicator for factors that contribute to fatigue		Control measures
Exposure to noise	- exposure for short duration - low noise levels	- exposure for long duration - high noise levels	• Install heating devices in cold work environments or provide access to cooled areas • Install fit for purpose machinery (low noise) • Install cooling devices in hot work environments like truck cabins and ensure shelters for shade are available in hot work environments • installation of adjustable, low vibration seats in appropriate machinery and vehicles and provide low vibration hand held equipment • Taking reasonable steps to ensure the workplace and surroundings are well lit, safe and secure
Exposure to extreme temperatures	Short period of exposure	Long period of exposure	
Exposure to vibration	Short period of exposure	Long period of exposure	
Individual and lifestyle	Lower Risk → Higher risk		The most appropriate control measures should be implemented for the identified risk factor. Control measures may include:
Sleep (amount and quality)	Night sleep 8 hours sleep in 24 hours	Day sleep 6 hours sleep in 24 hours	Consulting with workers and designing shift rosters that enable workers to meet work and personal commitments Develop a fitness for work policy and consider implementing health and fitness programs
Health and wellbeing		Poor diet Recent illness/injury	
Social life		Influence of alcohol drugs or amount of sleep	
Family responsibilities	Adequate time to fulfil family responsibilities	Inadequate time to fulfil family responsibilities	
other work commitments (for example having a second job)	No other work commitments	Additional work commitments (second job)	

Appendix 9: Further resources and references

Some enterprises or mine sites may not have the internal resources that are required to develop, implement, maintain and review an effective fatigue management plan. Instead, operators and other PCBUs may need to identify qualified specialists in various areas to help with certain aspects of the plan. The web sites of some of the organisations likely to be of most use, and some useful references, are listed below.

Resources

WHS organisations:

- NSW Resources Regulator - http://www.resourcesandenergy.nsw.gov.au/regulation
- Coal Services Pty Ltd - http://www.coalservices.com.au/
- SafeWork NSW - http://www.safework.nsw.gov.au/
- Australasian Faculty of Occupational and Environmental Medicine - https://www.racp.edu.au/about/racps-structure/australasian-faculty-of-occupational-and-environmental-medicine
- Human Factors and Ergonomics Society of Australia - https://www.ergonomics.org.au/

Other sources:

- Construction, Forestry, Mining and Energy Union – Mining and Energy Division - https://me.cfmeu.org.au/
- Australian Workers Union - https://nsw.awu.net.au/
- Minerals Industry Safety and Health Centre - http://www.mishc.uq.edu.au/
- New South Wales Minerals Council - http://www.nswmining.com.au/
- National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) – incident and dangerous occurrence investigation – example from other jurisdiction - https://www.nopsema.gov.au/assets/Guidance-notes/A392817.pdf

References

NSW Mine Safety Advisory Council. Guide to the development and implementation of a health management plan for the New South Wales mining industry. See - http://www.resourcesandenergy.nsw.gov.au/__data/assets/pdf_file/0015/303063/Guide-to-the-development-and-implementation-of-a-Health-Management-Plan.pdf

Safe Work Australia and SafeWork NSW Guide for managing the risk of fatigue at work (2013). See https://www.safeworkaustralia.gov.au/system/files/documents/1702/fatigue-management-a-workers-guide.pdf

WorkSafe Victoria. Fatigue in mines. WorkSafe Victoria: Melbourne, 2017. See https://www.worksafe.vic.gov.au/__data/assets/pdf_file/0018/211284/ISBN-Fatigue-in-mines-handbook-2017-06.pdf

Western Australian Government, Department of Industry and Resources. Fatigue management for the Western Australian mining industry. See http://www.dmp.wa.gov.au/Safety/Guidance-about-preventing-and-7034.aspx

Queensland Government, Department of Natural Resources and Mines. QGN16 (2013). See - https://www.dnrm.qld.gov.au/__data/assets/pdf_file/0004/240358/qld-guidance-note-16.pdf