NOPSEMA
Australia's offshore energy regulator

GUIDANCE NOTE

Avoiding Fatigue

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Core concepts

- The Commonwealth *Offshore Petroleum and Greenhouse Gas Storage (Safety) Regulations 2009* stipulate that a person must not allow, or require, a member of the workforce, who is under the person's control, to work for a continuous or successive period of time that could reasonably be expected to have an adverse effect on the health or safety of that member of the workforce or other people at or near the facility.
- Reducing the exposure of the offshore workforce to the hazards of fatigue and shift work is in line with the Australian Work Health and Safety Strategy 2012-2022.
- Fatigue is understood as an occupational health and safety hazard, and also as a potential contributing factor to accident and dangerous occurrence causation.
- The implementation of a fatigue risk management system is a possible means by which ***dutyholders*** can effectively prevent and mitigate the presence and impact of fatigue in their workforce.
- The National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) has developed this guidance note to assist ***dutyholders*** to achieve legislative compliance by reducing fatigue risk to a level that is as low as reasonably practicable (ALARP).

Contents

Abbreviations/Acronyms

ADO	Accident or dangerous occurrence
ALARP	As low as reasonably practicable
FRMS	Fatigue Risk Management System
LTI	Lost Time Injury
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
OHS	Occupational health and safety
OPGGSA	*Offshore Petroleum and Greenhouse Gas Storage Act 2006*
OPGGS(S)R	*Offshore Petroleum and Greenhouse Gas Storage (Safety) Regulations 2009*
SMS	Safety Management System

Definitions

Accident	An occurrence at or near a facility resulting in the death or serious injury of any individual, or which causes a member of the workforce to be incapacitated from performing work for 3 or more days [OPGGSA Schedule 3 Clause 82(1)(a); OPGGS(S)R Regulation 2.41(1)].
Circadian rhythm	The internal body clock that regulates the approximately 24 hour cycle of biological processes in humans, driving regular variations in body and mental functions such as sleeping patterns, body temperature and heart rate**.**
Dangerous Occurrence	(1) An occurrence at a facility that did not cause, but could reasonably have caused: (a) the death of, or serious personal injury to, a person; or (b) a member of the workforce to be incapacitated from performing work for a period of 3 or more days (2) A fire or explosion (3) A collision of a marine vessel with the facility (4) An uncontrolled release of hydrocarbon vapour exceeding 1 kilogram (5) An uncontrolled release of petroleum liquids exceeding 80 litres (6) A well kick exceeding 8 cubic metres (or 50 barrels) (7) An unplanned event that required the emergency response plan to be implemented (8) Damage to safety-critical equipment (9) An occurrence to which items 1 to 8 do not apply that: (a) results in significant damage to a pipeline (for example, reducing the capacity of the pipeline to contain petroleum or greenhouse gas substance flowing through it); or

(b) is likely to have a result of a kind mentioned in paragraph (a); or

(c) is of a kind that a reasonable pipeline licensee would consider to require immediate investigation

(10) Any other occurrence of a kind that a reasonable operator would consider to require an immediate investigation

[OPGGS(S)R Regulation 2.41(2)].

Dutyholder	For the purpose of this guidance note a ***dutyholder*** includes an operator of a facility, a person who is in control of any part of a facility, or of any particular work carried out at a facility and an employer.
Error	The failure of a planned action to achieve a desired outcome.
Fatigue	A workplace hazard which prevents an individual from functioning at a desired level due to incomplete recovery from the demands of prior work and other waking activities.
Performance shaping factor	A variable which influences the likelihood that an error will occur during task completion.
Psychomotor performance	The coordination of a sensory or cognitive process and a motor activity (U.S. National Library of Medicine).
Sleep homeostasis	The principle of sleep regulation, where the drive for sleep increases according to the length of time spent awake.
Sleep inertia	The experience of impaired cognition, grogginess and disorientation felt immediately upon waking from sleep.

1. Introduction

1.1. Intent and purpose of this guidance note

This document provides guidance on fatigue avoidance and management in the context of the Commonwealth *Offshore Petroleum and Greenhouse Gas Storage (Safety) Regulations 2009* [OPGGS(S) Regulations]. During routine inspections at offshore facilities, the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) has identified some members of the workforce at risk of experiencing fatigue, which can lead to accidents and other adverse health effects, and can contribute to dangerous occurrences. NOPSEMA has also found that fatigue management plans and the risks associated with shift work are not always clearly understood, identified or controlled by ***dutyholders*** to ensure risks are reduced to a level that is as low as reasonably practicable (ALARP).

The purpose of this Guidance Note is to provide ***dutyholders*** with information on how to manage the risk posed by fatigue in the workplace, thus facilitating compliance to their legislative obligations. This Guidance Note provides information about how ***dutyholders*** can apply controls to effectively demonstrate the reduction of fatigue risk to a level that is ALARP.

Guidance notes indicate what is explicitly required by the regulations, discuss good practice and suggest possible approaches. An explicit regulatory requirement is indicated by the word must, while other cases are indicated by the words should, may, etc. NOPSEMA acknowledges that what is good practice and what approaches are valid and viable may vary according to the nature of different offshore facilities and the hazards existing at those facilities.

2. Legislative requirements

OPGGS(S) Regulations – Avoiding Fatigue

Reg 3.1(1) *This regulation applies to:*

a) an operator; and

b) an employer; and

c) another person in control of:

i) a facility; or

ii) a part of a facility; or

iii) particular work carried out at a facility.

(2) *The person must not allow, or require, a member of the workforce who is under the person's control, to work for:*

a) a continuous period; or

b) successive continuous periods;

of a duration that could reasonably be expected to have an adverse effect on the health or safety of the member of the workforce or other persons at or near the facility.

The OPGGS(S) Regulations 2009 identify fatigue as a hazard with the potential to adversely affect the occupational health and safety (OHS) of members of the workforce and other persons.

OPGGSA – Duties relating to occupational health and safety

Cl. 9(2) The operator of a facility is taken to be subject, under subclause (1) to each of the following requirements:

d) to take all reasonably practicable steps to implement and maintain systems of work at the facility that are safe and without risk to health.

Cl. 10(2) A person who is in control of any part of a facility, or of any particular work carried out at a facility is taken to be subject, under subclause (1) to each of the following requirements:

d) to take all reasonably practicable steps to implement and maintain systems of work at the facility that are safe and without risk to health.

Cl. 11(2) An employer is taken to be subject, under subclause (1) to each of the following requirements:

d) to take all reasonably practicable steps to implement and maintain systems of work at the facility that are safe and without risk to health.

The OPGGS Act requires that ***dutyholders*** implement and maintain systems of work that are safe and without risk to health. To the extent that fatigue is a hazard with the potential to adversely affect the health or safety of members of the workforce or other persons at or near the facility, ***dutyholders*** must take all reasonably practicable steps to ensure that their systems of work appropriately and effectively address the hazard of fatigue.

3. Fatigue

Fatigue is a hazard that, when not managed effectively, can lead to occupational injury and other adverse health outcomes. Fatigue is a performance shaping factor, it increases the likelihood that a member of the workforce will experience error which can contribute to accident and dangerous occurrence (ADO) causation. Fatigue can be experienced physically and mentally, is caused by many factors both work-related and not, and can accumulate over time. Fatigue impacts the ability of individuals to work safely and effectively.

3.1. The effects of fatigue

The body's physiological processes are not constant throughout the day, but are rhythmical and cyclical. Circadian rhythms influence cognitive and psychomotor performance, physiological activities, alertness and mood. Sleep homeostasis and circadian rhythms regulate when we feel alert and when we feel tired and fatigued, and are the strongest influences on our state of alertness. A related factor is the cumulative effect of suboptimal periods of sleep over extended periods of time, known as sleep debt. Periods of recovery sleep are needed to satisfy a sleep debt and return to normal levels of alertness. Additionally, individuals may also be able to sleep bank in advance of short periods of extended work, provided sufficient notice is given (e.g. prior to commencing a regular swing of night shift, to have a daytime sleep before the first shift).

Fatigue increases the likelihood of error. Research suggests that performance impairment after 17-19 hours without sleep is similar to that of a blood alcohol concentration of 0.05% (Williamson, Feyer, Friswell & Finlay-Brown, 2000). In particular, increasing levels of fatigue are associated with diminished cognitive function and impaired task performance, increased error and accident rates, and reduced safety outcomes. For example, control panel operators experiencing mental fatigue may misread control panel information and fail to respond appropriately to alarm information, resulting in loss of containment and the potential for a fire or explosion. Similarly, mentally fatigued maintenance personnel may forget to perform a mechanical isolation prior to commencing work, resulting in the activation of moving parts and subsequent crushing or amputation injuries. Alternatively, physically fatigued personnel working on the drill floor may experience damage to muscle and tissue, either during a particularly strenuous activity or as 'wear and tear' over time.

The final report of the US Chemical Safety Board (2007) into the BP Texas City refinery explosion highlights the consequences of fatigue in the workforce. A summary of the fatigue-related findings detailed within the report is presented below.

On March 23, 2005, the restarting of a hydrocarbon isomerisation unit resulted in a series of explosions. Fifteen people were killed and a further 180 were injured. The Chemical Safety Board (CSB) found that the isomerisation unit operators were affected by fatigue, including the following observations:

- Operators had worked excessive consecutive days, ranging from 29 to 37 days without a break.
- Scheduled rest breaks within 12 hour shifts were rarely taken.
- Operators and maintenance personnel worked an average of 27% overtime.
- Some personnel worked up to 68% overtime.
- These overtime rates were excessive, likely to compromise safety, and indicative of understaffing.
- The unit operators displayed behaviour consistent with impaired judgement and slow reaction time, typical performance outcomes associated with fatigue. This diminished their ability to recognise that the raffinate splitter tower was overfilling.
- The unit operators displayed behaviour consistent with cognitive fixation, a typical performance effect of fatigue. Operators focused on the symptom of the problem (pressure spikes) rather than seeking to diagnose the actual problem (tower overfill).

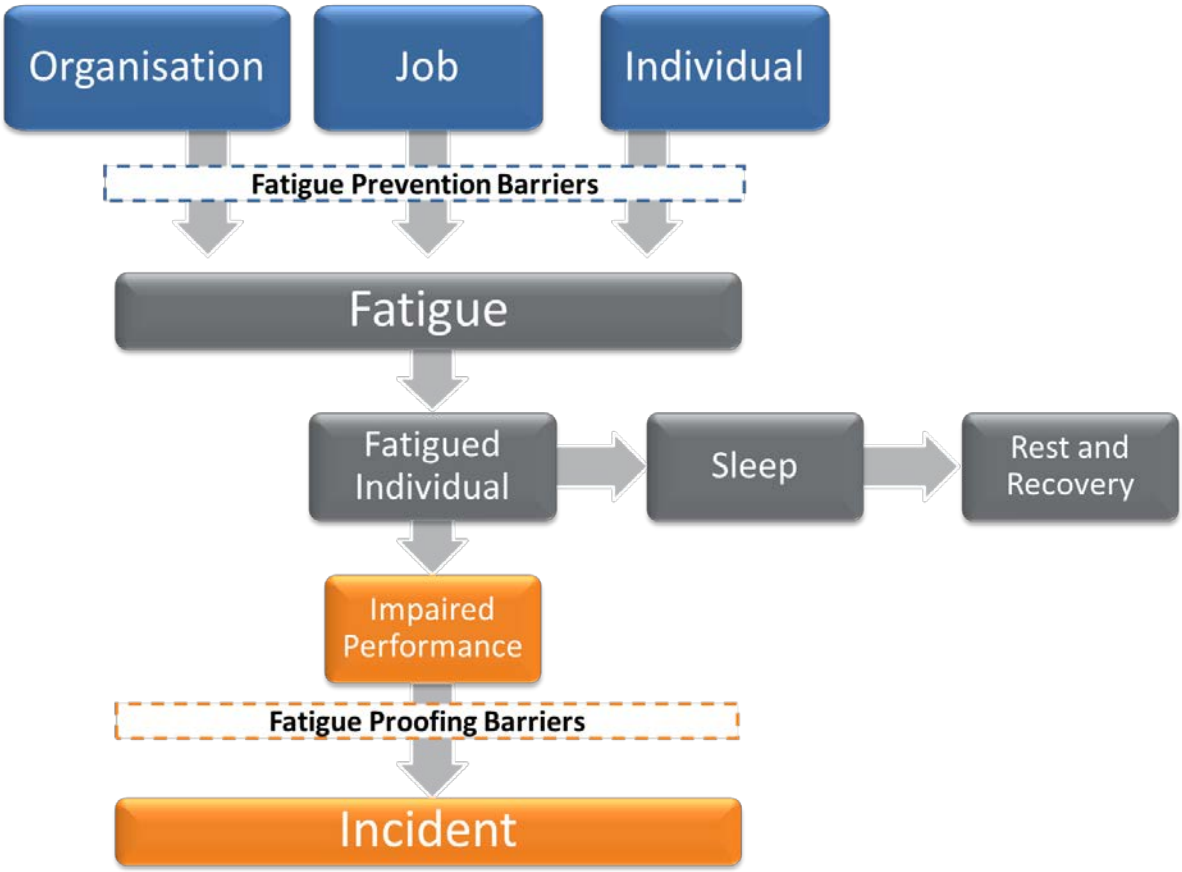
CSB investigators concluded that operator performance was impaired by fatigue, a likely contributing factor to the overfilling of the raffinate splitter tower.

4. Fatigue Risk Management Systems

The offshore petroleum industry in Australia increasingly utilises an evidence-based risk management approach for preventing fatigue and mitigating its influence. Such an approach forms a rational position from which a ***dutyholder*** is able to demonstrate effective management of fatigue related risk. Comprehensive fatigue risk management should include controls to prevent members of the workforce experiencing fatigue while at work (fatigue prevention), and controls to mitigate the risk presented by fatigue impaired individuals in the workplace (fatigue proofing).

Dutyholders may wish to implement a Fatigue Risk Management System (FRMS) and incorporate this within their SMS. A FRMS is an evidence-based and systematic approach to preventing fatigue and mitigating its effects within the workforce, taking a layered-defence approach to fatigue risk management. Compared to other more prescriptive approaches to fatigue management, such an approach allows for greater operational flexibility while also arguably providing stronger controls against fatigue. A layered-defence approach includes both preventative and mitigating barriers, as presented in Figure *1*. Such an approach serves to reduce the likelihood of the occurrence of fatigue, and to mitigate the risk of fatigue in those situations where preventative barriers may be insufficient.

Figure 1 - A multilayered model of fatigue risk management



The model demonstrates that fatigue is created through a variety of factors which can be grouped together at organisation, job, and individual levels of influence. These levels of influence are expanded upon in the following sections.

4.1. Individual factors influencing fatigue

Individual (within-person) factors can influence the degree of fatigue experienced by members of the workforce. Individual level factors interact with job and organisational factors and should not be considered in isolation. Individual level fatigue-influencing factors include, but are not limited to:

- The amount of **time spent awake**. Longer periods of wakefulness will result in a greater need for sleep.

- The **quality and duration of past sleep**, both in the short-term (the last period of sleep) and long-term (sleep over the past week/s). This can be influenced by work-related factors (see Section 4.2), and also by personal factors, such as sleep disorders, alcohol and drug use, stress, and family factors such as young children or illnesses.
- **Individual differences in sleep requirements**. Some individuals may require as few as six hours of sleep in any 24 hour period while others may require nine or ten hours to achieve the rest and recovery necessary for normal performance.
- **Individual circadian rhythms**. Feelings of alertness and sleepiness throughout a 24 hour period can vary between individuals. Unique circadian rhythms can influence task performance at different times of the day due to peaks and troughs in alertness, and may also determine the success of different individuals in achieving sufficient sleep during scheduled rest periods.

4.2. Job factors influencing fatigue

Workplace factors can influence the likelihood that members of the workforce will experience fatigue. Job level fatigue-influencing factors interact with individual and organisational factors and include, but are not limited to:

- **Shift work and roster design**. The nature of shift work inherently includes an increased risk of fatigue however this can be exacerbated by the design of the roster. Working consecutive nights with insufficient recovery time, alternating between days and nights, and mid-swing rotations can all increase the likelihood that members of the workforce will experience fatigue.
- **Unplanned work events** such as overtime or over-cycle, emergency musters and drills, breakdown maintenance, and callouts can cut into the rest and recovery time available to members of the workforce. Such events are more likely to lead to fatigue when sleep is interrupted.
- **The task being completed**. Increased workload within a standard shift, duties with a high physical or cognitive demand, and tasks with low demand which are monotonous can all result in decreased levels of alertness and increased feelings of fatigue.
- **Features of the offshore working environment**, such as physical stress, temperature extremes, noise, vibration, and low light.
- **Features of the offshore resting environment**, such as the confined nature of the living/sleeping environment, levels of ambient noise and light in allocated sleeping quarters, and the behaviours of 'room-mates'. Short-term recovery from work related fatigue may be impaired in these conditions, which are often cramped, with little capacity for personal space.
- **Long-distance commuting**. During swing changeover, some members of the workforce may travel from interstate or overseas, drive from rural locations, or experience multiple stop-overs or delays. In addition, early morning wake-ups required for fixed wing flights to align with helicopter departure times are also likely to increase levels of fatigue experienced by all members of the workforce during their first shift.
- The **time of day** during which the work is being conducted and the number of hours since the individual has last slept will influence the experience of fatigue. The risk of a person being involved in an accident

is substantially increased if they are performing work when they would normally be asleep, or if it has been some time since they last slept.

4.3. Organisational factors influencing fatigue

Organisational factors can affect both the likelihood that members of the workforce will experience fatigue, and the consequences of fatigue induced errors. Organisation level fatigue-influencing factors interact with individual and job level factors and include, but are not limited to:

- **Formal recognition of fatigue** as a hazard through inclusion in the SMS.
- **Formal processes for fatigue management**. Attempts to delegate responsibility for fatigue management to individual members of the workforce (i.e. "manage your own fatigue") are inappropriate and unlikely to assist in avoiding or mitigating fatigue-related risk on a facility.
- **Company policies for minimum personnel requirements**. Policies which aim to reduce or eliminate workforce redundancy can lead to increases in the need for overtime and over-cycle. Such policies will limit the success of lower-level fatigue prevention and mitigation strategies.
- **Training and support** for offshore managers, supervisors, and members of the workforce about fatigue risk and consequence, fatigue avoidance strategies, identifying fatigue in self and others, and mitigation strategies where fatigue is identified.
- Effective **health screening** conducted regularly can identify potential risk factors such as sleep disorders, medication and drug use, stressors at work or at home, and psychological challenges associated with offshore living arrangements. Where at-risk personnel are identified, appropriate treatment should be sought.

4.4. Core elements of a successful FRMS

The design of a successful FRMS should be based upon the following characteristics (Moore-Ede, 2010):

- **Evidence-based**, and supported by published peer-reviewed science.
- **Data driven**, with decisions based on the objective analysis of collected data. In the case of insufficient data, a **risk-based** approach is appropriate.
- Cooperative, with **all stakeholders involved** in the design of the system.
- **Fully implemented**, where tools, systems, policies and procedures are adopted throughout the organisation.
- **Integrated**, contained within the overall **Safety Management System**.
- Subject to **continuous improvement**, where feedback is collected, evaluated and used to drive system modification.
- Appropriately **budgeted** with a justifiable business case.
- Owned by the **executive and senior leaders**, who support and **take responsibility** for the system.

5. Fatigue prevention barriers

Fatigue prevention barriers should be designed with the intention of reducing the likelihood that members of the workforce will experience fatigue. The following sections provide information about some of the fatigue prevention barriers that ***dutyholders*** may wish to include within their FRMS.

5.1. Appropriate staffing

Attempts to increase individual productivity through 'lean' approaches to business management can lead to a reduction of personnel levels to a point that is insufficient to appropriately support business requirements. This may result in members of the workforce, including management, becoming overloaded and working longer or more strenuous hours to meet prescribed targets. **Appropriate levels of workforce, including contingency capacity, are necessary** to ensure that personnel are not required to work while fatigued. Insufficient staffing can increase the likelihood of errors occurring at all levels of the workforce. Errors are likely to increase when personnel experience time-pressure, when they are mentally fatigued, and when they are physically fatigued. Such **errors may lead to ADOs**. Long term OHS consequences associated with insufficient staffing can include burnout, anxiety, insomnia, heart disease, and other **adverse physical and psychological health outcomes**.

Where numbers of available personnel are insufficient to meet planned targets, these targets should be adjusted. Where a team has experienced turnover, remaining personnel may be capable of increasing their productivity **for a short time** while additional personnel are sourced. However this should not be viewed as proof that a smaller workforce is capable of delivering the same outcomes **in the long term**. The additional effort required to meet unchanged targets can only be sustained for **a relatively short period of time** before personnel will begin to experience fatigue and consequent adverse health effects. Following such periods of increased effort a **reduced workload or extended leave** period may be necessary to allow personnel sufficient **opportunity to recover**.

5.2. Appropriate rostering

Roster patterns have a significant role in the creation or avoidance of fatigue in the workforce, such that a significant correlation between roster patterns and injury exists. In the offshore petroleum industry, certain roster factors have been found to influence the likelihood of serious lost time injuries (LTIs) and fatalities (Parkes, 2007). When designing roster patterns, the following factors should be taken into consideration:

- **Swing changeover.** Members of the workforce who have been booked on early morning fixed wing flights or who have had to commute from interstate or rural locations will be likely to experience fatigue on the first day of their swing.
- **Direction and speed of shift rotation.** A forward rotation (morning to evening to night) produces less fatigue than a reverse rotation (night to evening to morning). Speed of rotation can vary from fixed shifts, slowly rotating over two to three weeks, or rapidly over two to three days.
- **Time of shift change over.** A later start to the morning shift is better to maximise the hours of sleep (6:00am is better than 5:00am). Conversely, an earlier end to the night shift is preferable to increase the hours of sleep that occur during night time. The conflict between these two requirements can be seen where a favourable pattern for one shift will have a negative effect on the other.

- **Time off between shifts.** Adequate time off for rest and recovery during a break onshore is important, as well as time between shifts while at work to enable the employee to allocate sufficient time to sleep as well as eating, socialising and personal care.
- **Shift duration.** Overtime should only be permitted in exceptional circumstances and not without prior approval. Adequate records are essential to monitor hours worked and overtime. Where personnel are required to perform overtime, additional mitigations should be implemented to manage the increased risk of fatigue both during the actual overtime worked and after the shift is completed. For example, prescribing a later start to the shift where overtime is required to provide an opportunity to sleep bank.

A variety of tools are available to assess the fatigue implications of different shift patterns. A reputable tool should be used for assessment across the organisation, with adequate training and support for those personnel involved in its use. The assessment should focus on **identifying the potential for fatigue**, and the analysis of **likely fatigue patterns** across the roster.

Analyses may include:

- the point of time during the shift/swing at which members of the workforce are likely to become fatigued
- the specific members of the workforce who are at risk of becoming fatigued
- the task/s which are most likely to occur while members of the workforce are experiencing fatigue
- the number of personnel (including contractors) likely to be at risk of becoming fatigued
- how often the risk of fatigue is likely to occur
- the potential risk that fatigue poses to personnel, the facility, and those around it.

Such analyses deliver evidence-based data which should then be used to **drive improvements** in staffing levels and roster design, with the aim of **eliminating fatigue wherever practicable**. Where elimination is not possible, during periods of high fatigue risk emphasis should be placed on the **utilisation of relevant fatigue-proofing barriers** (see Section 6).

5.3. Sleep

Sleep is the **only effective long term strategy** to prevent and manage fatigue. The most beneficial sleep is **night time sleep in a continuous period**. There is no research evidence to support the claim that people can train themselves to need less sleep through constant sleep deprivation. Although people may be able to function on less than their usual amount of sleep for a couple of nights, **when sleep debt accumulates there is a linear degradation in performance**. The following strategies can help members of the workforce to achieve sufficient sleep during their rest periods:

- **Appropriate welfare facilities.** Sleeping quarters should be designed to facilitate sleep. Night shift workers in particular should be placed in rooms where noise, light, temperature, and vibration are minimised. Room sharing should be avoided where practicable, however where it is necessary, facilities should be provided which minimise the disruption caused by the activities of one person to another.

- **Employee health monitoring, treatment and compliance.** Members of the workforce should be screened for sleep disorders such as obstructive sleep apnoea and insomnia. Where such disorders are identified, appropriate treatment should be sought. Regular checks should be conducted to verify that the treatment is effective, and that affected individuals are complying with the prescribed treatment.
- **Employee training.** Education and training can assist members of the workforce to identify sleep problems and improve the quality and duration of their sleep both at work and at home. Such training should include information about fatigue risk, human physiology, circadian cycles, sleep hygiene, sleep disorders, the use of stimulants and other drugs, and strategies to facilitate good quality sleep.

6. Fatigue proofing barriers

The nature of offshore work is such that 24 hour operations are largely unavoidable. On most normally manned offshore facilities a proportion of the workforce will be **required to work during the low point in their circadian cycle**. Even when sufficient restful sleep is obtained in the preceding rest period, it is likely that these individuals will experience feelings of drowsiness and lethargy at some point during their shift. In addition to planned night work, **emergency situations** such as musters, drills and callouts for breakdowns or events can occur during scheduled rest periods. In these situations fatigued personnel will be required to act and make decisions, possibly while feeling the effects of sleep inertia. Similarly, some members of the workforce **may not obtain sufficient sleep** in the rest period preceding every shift, particularly when that rest period has been disturbed. In these situations, where preventative barriers have not or cannot prevent the experience of fatigue, **mitigating barriers are necessary** to ensure that fatigue does not lead to ADOs.

Fatigue proofing barriers should be designed to increase the likelihood that fatigue in members of the workforce is identified, and that **appropriate strategies are implemented to detect and mitigate errors** occurring as a result of that fatigued state. The following sections provide information about some of the fatigue proofing barriers that ***dutyholders*** may wish to include within their FRMS.

6.1. Task scheduling

To minimise the risk associated with fatigue, night shift work should be **limited where practicable** to that which is required to maintain production, and for emergency response as needed. Night shift work should be scheduled with consideration given where practicable to the likely attentional peaks and troughs within a typical circadian cycle. That is, tasks that are highly monotonous and tasks that are considered safety-critical should be **avoided during troughs in the circadian cycle**, typically between the hours of 2:00am and 4:00am.

Targets for night shift work should be adjusted to allow a greater amount of time for task completion than would normally be allocated for work conducted during the day. Time pressure is a known performance shaping factor which can increase the likelihood of error. The combined presence of fatigue and time pressure has a **magnifying effect on error probability**, increasing the likelihood that night shift workers will experience error, potentially contributing to an ADO.

6.2. Work environment

The **design of the working environment** can significantly affect levels of alertness, particularly during night shift work. The following elements of the workplace should be controlled where practicable to **minimise feelings of drowsiness and lethargy**:

- light intensity and wavelength
- sound levels
- temperature
- humidity
- vibration.

6.3. Behaviour monitoring and response

All personnel should be trained in how to identify signs of fatigue in themselves and others. Such training should include **appropriate responses and mitigations** once fatigue is recognised. Formal fatigue response strategies should be developed and communicated to personnel. Supervisors and managers should initiate the use of these formal strategies to demonstrate to personnel that the organisation is serious about managing fatigue.

The following tools and strategies may assist in the identification of fatigue risk:

- Sleep and wake data for the preceding 48 hours
- Symptoms checklists
- Physical monitoring
- Fitness for duty testing
- Self- and peer-monitoring and communication.

It should be noted that personnel experiencing fatigue **may be unaware of or unable to assess their own state of impairment**. Typically, people are able to identify when they feel tired, but **are not good judges of the corresponding level of risk** associated with their impaired state. Similarly, personnel influenced by fatigue may be **less likely to identify errors** when they do occur. In these instances the error may not be identified until further along an event trajectory where a greater response is required to prevent an event from occurring, or to mitigate the consequences of an event. As such, once a member of the workforce has been identified as being impaired by fatigue, it becomes necessary for the other, non-fatigued members of the work group to **increase their vigilance** in seeking, identifying and responding to fatigue-induced error. The nature of such strategies will necessarily vary depending on the type of work being conducted and the structure of the work group. Examples of such strategies include:

- verbal verification and/or repetition of information
- written aides
- task reassignment
- increased time for task completion

- independent checking of work to ensure completion of all steps.

For example, during swing and shift changes, some members of the workforce are required to participate in handovers with their 'back-to-backs'. **Fatigue may adversely impact how well oncoming personnel understand, process, and remember the handover information**. Formal strategies can assist in comprehension and accurate recollection, such as using **handover notes**, having oncoming personnel **answer questions** about the handover information and **paraphrasing information** to demonstrate their understanding. The use of notes provides oncoming personnel with a point of reference so that they can **refresh their memory** or confirm their understanding of any points discussed during handover. The use of verbal strategies provides departing personnel with the opportunity to **verify** that oncoming personnel have **accurately interpreted** the handover information, to **identify any gaps or misunderstandings** and to correct these immediately.

6.4. Emergency response and callouts

Fatigue is likely to pose a problem for members of the workforce whose sleep is interrupted for emergency response, musters and drills, callouts for breakdown maintenance, and similar requirements. Such personnel will be likely to experience fatigue both during the task itself, and during their next rostered shift. Personnel in these situations may experience sleep inertia, and so may experience greater cognitive and physical impairment during the period **immediately following their waking**. Any decision to wake personnel for these types of situations should first be subject to appropriate **risk assessment and approval** processes. Following a decision to wake personnel, the strategies outlined in Section 6.3 should be applied to help **mitigate the immediate influence** of fatigue. To prevent the **accumulation of sleep debt** following interrupted sleep, additional opportunity for sleep should be provided. Where practicable, personnel should be instructed to **delay the start of their next shift** to a time which will allow them a sufficient period of uninterrupted sleep.

7. System monitoring and improvement

7.1. Accident and dangerous occurrence investigation

Despite multiple levels of risk controls in place, fatigue risk management systems have the potential to fail and the outcome in the offshore environment can be catastrophic. When properly investigated, ADOs where fatigue is identified as a contributing factor can provide the organisation with a **learning opportunity** and lessons in how to **prevent further occurrences**. ***Dutyholders*** may wish to include the following fatigue-related questions in their internal reporting template to facilitate the **capture and tracking of data**:

- What **time of the day** did the event occur?
- Where personnel were involved:
  - at how many **hours since waking** did the event occur?
  - at how many **hours into the shift** did the event occur?
  - at how many **hours/minutes into the task** did the event occur?
  - at how many **days into the swing** did the event occur?

Accurate recording and tracking of such information can provide information about incident patterns which can potentially be used to **improve fatigue-influencing factors** such as manning levels, roster arrangements and task scheduling.

When an investigation into an **accident or dangerous occurrence** has identified fatigue as a contributing factor, ***dutyholders*** may wish to explore this in greater detail as a means of **improving their FRMS**. The following questions may facilitate this process, but should not be considered an exhaustive list:

- Had the involved person been required to work **overtime or over cycle** in the 48 hours prior to the ADO?
- Did the involved person have an **accumulated sleep debt** at the time of the ADO?
- Had the involved person been screened for **sleep disorders**?
- Of what quality were the **welfare facilities** provided to the involved person? (e.g. cabin quality and facilities, number and type of personnel allocated to the cabin, etc.)
- Were the **physical workplace conditions** likely to enhance feelings of fatigue? (e.g. temperature, lighting, etc.)
- Did the ADO occur at a time when the involved person had been **roused from sleep**?
    - Was a **risk assessment** conducted regarding the need to wake the involved person?
    - Were appropriate **behaviour monitoring and response strategies** implemented given that the person had been roused from sleep?
- Did the ADO occur during **night shift**?
    - Was the task scheduled between the hours of **2:00am and 4:00am**?
    - Was the task **necessary to maintain operations**?
    - Was the task considered **safety-critical**?
    - Was the task **monotonous**?
- Had personnel been **trained in identification of fatigue** signs and symptoms?
- Had personnel been **trained in appropriate behaviour monitoring and response** strategies?
- Did the **involved person recognise** that fatigue was presenting a risk?
    - Did the involved person **disclose the fatigue** to team members or a supervisor?
- Did other **team members identify** signs and symptoms of fatigue in the involved person?
    - Did the team members discuss their observations with the involved person?
    - Did the team members discuss their observations with a supervisor?
- Did the **supervisor identify** signs and symptoms of fatigue in the involved person?
    - Did the supervisor **discuss these observations** with the involved person and the other team members?
- Were appropriate **behaviour monitoring and response** strategies implemented?

The intention of such an investigation should not be to apportion blame to the involved person, the team or the supervisor. Rather, **such an investigation should focus on system improvement**. That is, identifying

which barriers within the FRMS failed, why they failed, how such failures can be prevented in the future, and whether additional barriers may improve the integrity of the FRMS.

7.2. Performance indicators

As with any internal system, the effectiveness of the FRMS should be **audited and reviewed** at regular intervals to ensure continuing suitability, adequacy and effectiveness of the controls for eliminating risk in relation to fatigue in the workplace. **Lead and lag indicators** should be developed for each barrier, and should be subject to regular monitoring. Where indicators suggest that certain barriers are ineffective, **further investigation** is warranted to ensure that appropriate steps are taken to **maintain the integrity** of the FRMS.

Table *1* contains examples of lead and lag indicators that ***dutyholders*** may wish to use to monitor their FRMS. Note that this is not an exhaustive list.

Table 1 – Lead and lag indicators for a FRMS

Lead indicators	Lag indicators
Average number of hours worked per shift/swing	Any instance of **falling asleep at work**
Planned versus actual hours worked per shift/swing	Number of **complaints about welfare facilities** in relation to sleep quality/duration
Percentage of overtime or over cycle per shift/swing	Number of reports of **insufficient sleep**
Number of consecutive shifts/swings worked by individuals	Number of reports of **drowsiness or inattention**
Number of non-compliances with a documented shift pattern	Number of reports of **fatigue-related errors**
Percentage of personnel who have completed health screening	Number of **'near misses'** where fatigue is identified as a contributing factor
Percentage of work breaks missed (sampling/interview)	Number of **ADOs** where fatigue is identified as a contributing factor

8. Example – practicable fatigue management during emergency maintenance

A production platform has identified the need for emergency maintenance to be conducted. The extent of the problem is such that production has been stopped until the maintenance work is completed. A service team is to be sent to the facility via the first helicopter of the following morning. The tight scheduling requirement means that the ***dutyholder*** is unable to provide 12 hours of notice to the maintenance crew prior to mobilisation. This notice period may be insufficient for some crew members to achieve sufficient sleep prior to mobilising for work the following day, so a potential fatigue risk is identified.

To minimise the risk of fatigue, crew members are selected in accordance with the following preferences:

- those with the shortest travel time to get to the helicopter departure point

- those with the most days off since last swing
- those with the lowest percentage of overtime during last swing
- those with the lowest percentage of on-call time during off-swing
- those with no known medical sleep conditions or relevant health concerns.

The scheduled arrival times for maintenance crew members are staggered to allow for continuous operation while minimising fatigue risk. Cabins and beds are allocated with the aim of minimising disruptions during scheduled rest periods. Internal guidelines regarding maximum hours worked are reviewed with supervisors and crew members prior to work commencing. Supervisors and crew members are reminded that any hours worked beyond this maximum are first to be subjected to further risk assessment and approval. Supervisors and crews review and discuss behavioural indicators of fatigue, and agree on appropriate mitigations where fatigue is identified in crew members.

9. References, Acknowledgements & Notes

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Note: Further information relating to fatigue risk assessment and management has been published by the ***Energy Institute***, the ***Health and Safety Executive***, ***OGP/IPIECA***, and ***Safe Work Australia***.

Note: All regulatory references contained within this Guidance Note are from the Commonwealth *Offshore Petroleum and Greenhouse Gas Storage Act 2006* and the associated Commonwealth regulations. For facilities located in designated coastal waters, please refer to the relevant corresponding laws of each State and of the Northern Territory.
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