# Managing fatigue using a fatigue risk management plan (FRMP)

energy institute

# MANAGING FATIGUE USING A FATIGUE RISK MANAGEMENT PLAN (FRMP)

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# FOREWORD

Employee fatigue can present risks to health, safety and productivity. In 2006, the Energy Institute's (EI) Human and organisational factors committee (HOFCOM) developed and published *Improving alertness through effective fatigue management,* which explored strategies to manage fatigue. Traditional strategies for managing fatigue, such as limits on hours of work or fatigue awareness training, are – if used in isolation – now recognised as providing limited protection against fatigue risk. Consequently, many stakeholders now recommend a more comprehensive approach to fatigue management. This approach involves the implementation of a fatigue risk management plan (FRMP), which manages fatigue in a risk-based and systematic manner, and fosters shared responsibility between the organisation and its employees.

Reflecting current good practice, *Managing fatigue using a fatigue risk management plan* (FRMP) (1st edition) supersedes *Improving alertness through effective fatigue management*, and:

- Provides a source of reference for site-level managers directly responsible for managing fatigue in the energy and allied industries.
- Defines and describes the general elements that can be expected in an FRMP that complies with industry good practice.
- Provides managers with practical step-by-step guidance on how to build, implement and maintain an FRMP.

*Managing fatigue using a fatigue risk management plan* (FRMP) is composed of two parts. Part I provides introductory information on the causes of fatigue and its management. Part II provides guidance to managers on the design and implementation of an FRMP. A number of supporting resources are provided in the annexes.

This guidance is particularly directed at organisations that are in the early stages of FRMP implementation. However, operators who already have an FRMP in place should also find the document useful as a summary of good practice against which to compare their existing FRMP. The document is relevant for all major hazard industries, including onshore and offshore operations. Due to the nature of offshore work, where practical, additional guidance for offshore and remote operations has been provided.



The EI welcomes feedback on its publications. Feedback or suggested revisions should be submitted to:

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# PART I – UNDERSTANDING FATIGUE AND ITS MANAGEMENT

# 1 INTRODUCTION

## 1.1 WHAT IS FATIGUE?

Definitions of fatigue vary between industries, regions and also according to professional perspectives. Confusion over the terminology relating to fatigue, and the causes of fatigue can pose a challenge to managing the associated risk. Therefore a single definition of fatigue should be identified and used consistently. The definition of fatigue used in this document, and proposed for broader use in industry, is that provided in ANSI/API RP 755:

> Reduced mental and physical functioning caused by sleep deprivation and/or being awake during normal sleep hours. This may result from extended work hours, insufficient opportunities for sleep, failure to use available sleep opportunities, or the effects of sleep disorders, medical conditions or pharmaceuticals which reduce sleep or increase sleepiness.
>
> (API, 2010)

This definition first states the adverse effects fatigue can have on performance (these are described in 1.2) and then considers the main causes of fatigue (these are discussed further in 1.3).

## 1.2 WHAT ARE THE CONSEQUENCES OF FATIGUE?

### 1.2.1 Accidents

The UK Health and Safety Executive (HSE) has identified the fatigue associated with shift work and overtime as one of the 'top 10' human factors issues facing onshore major hazards industries, based on research, consultation with industry and intermediaries and inspection experience. Managing human fatigue was also on the US National Transportation Safety Board's (NTSB) 'most wanted' for 20 years between 1990 and 2012.

Awareness of the safety risk posed by human fatigue has been elevated by industrial disasters such as the Exxon Valdez oil spill and the explosion at the Texas City refinery. Research has also identified links between fatigue and accidents across various other industries, in road transport and mining (Williamson et al, 2011, Jackson et al, 2011, Halvani et al, 2009).

### 1.2.2 Performance decrements

Fatigue can contribute to the risk of accidents by impairing performance in many different ways:

- Diminished ability to perform certain tasks (e.g. slowed reaction times; periods of delayed response or no response (lapses) during vigilance-based tasks; increased errors of omission (forgetting to do something); impaired selective attention; reduced accuracy of short-term memory).
- Changes in emotional state and willingness to apply effort (e.g. being more quiet or withdrawn than usual, lacking in energy, lacking in motivation and being irritable and grumpy).
- Changes in the way we communicate (e.g. diminished ability to communicate effectively).

Table 1 provides examples of how fatigue-related decrements in performance might manifest for four types of employee roles.

**Table 1 Examples of the effects of fatigue on performance for four employee roles**

| Control room operator | Shift supervisor | Tanker driver | Emergency response manager |
|---|---|---|---|
| Loss of 'big picture' situation awareness | Failing to anticipate events or actions | Zigzagging within the lane | Progressive degradation in multi-tasking ability |
| Loss of attention across displays | Failing to communicate important information | Crossing the centre line | Deterioration of higher-order functions such as judgement |
| Difficulty concentrating on tasks | More likely to be irritable | Impaired judgement, increased risk taking | Impaired selective attention |
| Lapses in attention | More likely to delay or not complete additional tasks | Falling asleep at the wheel | Significant decreases in the ability to hold in mind and make use of a visual image after a very brief distraction has been introduced |

Observable signs of fatigue include fidgeting, rubbing eyes, yawning, frequent blinking, staring blankly, long blinks, difficulty keeping eyes open and head nodding. Head nodding and difficulty keeping eyes open are associated with extreme levels of fatigue and are symptoms of what are termed 'micro-sleeps': short-periods of time (seconds) when the brain disengages from the environment (by ceasing to process visual information and sounds) and we slip uncontrollably into light sleep for a short time. The characteristic head nodding associated with micro-sleeps is caused by the muscles in the neck relaxing as we enter light sleep (see section 2 for more information about the stages of sleep)[1].

### 1.2.3 Health

The relationship between fatigue and health is complex. Whilst the causal mechanisms are not clear and evidence for causal associations is limited, recent systematic reviews suggest that shift work (and specifically, working at night over a long period of time) may increase the risk for:

- breast cancer (Straif et al, 2007; Kolstad, 2008; Pesch et al, 2010);
- ischaemic heart disease (Frost et al, 2009), and
- gastrointestinal diseases (Knutsson et al, 2010).

1 A similar effect is seen in drivers falling asleep at the wheel, whereby the driver's leg muscles relax, causing the driver to take pressure off the accelerator, resulting in a fluctuation in speed as (s)he slips in and out of micro-sleeps.

Although the causal mechanisms are not clear, lack of sleep has, in some studies, been found to be associated with medical conditions including:
- diabetes (Gottlieb et al, 2005);
- hypertension (Gangwisch et al, 2006);
- cardiovascular disease (Scheer et al, 2009; Puttonen et al, 2010);
- adverse reproductive outcomes (Frazier et al, 2003; Harrington et al, 2001);
- obesity (Marshall et al, 2008);
- increased cholesterol levels (Suwazono et al, 2010), and
- metabolic diseases (Lowden et al, 2010).

Shift work may impact on health via several mechanisms: psychosocial, bio-chemical and physiological. As yet, it is unclear which of these is more significant for elevating shift work-related health risks and it is probable that any impact is the result of a combination of these mechanisms. It is also unclear to what extent each of the many features of shift work is responsible for any observed effects: do health problems arise as a result of sleep loss associated with daytime sleep, or the frequent circadian disruption caused by switching between day and night shifts, or are they due to the melatonin suppression that results from nocturnal exposure to light?

Whilst there is still debate regarding the extent and nature of the effects of shift work on health, the general relationship between a lifestyle that includes significant lengths of time working shifts which require frequent disruption to circadian rhythms and health outcomes seems clearer: 'Shift work is probably bad for the heart, almost certainly bad for the head and definitely bad for the gut' (Monk and Folkard, 1992).

## 1.3 WHAT ARE THE CAUSES OF FATIGUE?

### 1.3.1 Performance shaping/influencing factors

Fatigue is determined by a multitude of work-related and individual factors, some of which are listed in Table 2[2]. In order to provide comprehensive protection from the impaired performance caused by fatigue, an organisation's fatigue management procedures should give due consideration to all of these factors.

**Table 2 Work-related and individual performance/influence shaping factors related to fatigue**

| Work-related | Individual |
|---|---|
| Shift schedule design | Sleep environment |
| Overtime and on-call arrangements | Sleep disorders |
| Commute | Health |
| Environmental conditions | Domestic commitments |
| Access to food and water | Social commitments |

2 Effective fatigue risk managment therefore recognises that fatigue is the joint responsiblity of both management and employees and that communication, consultation and commitment on both parts are essential.

| **Work-related** | **Individual** |
|---|---|
| Type of work | Commute |
| Task design | Knowledge and application of FRM strategies |
| Staffing levels | Commitment to sleep hygiene |
| Breaks within shifts | Age |
| Safety culture | Secondary employment |
| Pay structures* | |
| Commitment to fatigue risk management | |
| Sleep environment | |
| * Payment which is linked to results can provide an incentive for employees to work longer hours, thus inadvertently contributing to fatigue (for more information see NRTC (2001) and HSE (2006)). | |

### 1.3.2 Work-related factors

For the energy and allied industries, one of the most significant contributors to fatigue is the necessity of 24-hour or extended hour operations and the need for employees to work shift work, including stand-by and long duties. Shift work can be defined as any system of work that involves working, or waking, during the normal night-time sleep hours[3]. It has been estimated in industrialised countries approximately 20 % of wage and salary workers work a shift other than a regular daytime shift (McMenamin, 2007)[4].

There are an enormous range of potential shift work patterns, but some schedules disrupt the natural sleep/wake cycle and promote fatigue more than others. Annex C provides a summary of good practice guidelines for shift scheduling.

The most challenging shifts include:

- night shifts;
- shifts that start/finish very early;
- shifts that start/finish very late;
- unpredictable shifts (i.e. shifts with start or end times, or total durations, that vary at short notice);
- long shifts, and
- long runs of consecutive shifts without days off.

The level of fatigue associated with a shift schedule is, in part, dependent on how diligently employees use their time off for sleep, as well as quality of sleeping quarters, behaviour of others living in camps, disturbances from operational noise and vibrations, etc. However, poorly designed schedules may mean that even diligent employees are unsuccessful in their attempts to obtain adequate sleep.

Night work can be particularly problematic and is very often associated by increased subjective and objective sleepiness. Multiple studies report full-blown sleep occurring during night shift working, particularly in the early morning (Hobson, 2004) during the window of circadian low (WOCL) see 2.3. Working at night requires us to remain awake and alert when the body is anticipating sleep, and to sleep during the day, when alertness and arousal are naturally highest. Consequently, night work can induce increased fatigue, mood deterioration

3 Although see the glossary (Annex B) for a more detailed definition.
4 For recent studies on the changing patterns of shift work in the UK and Europe see HSE (2011) and Eurofound (2012, 2012a).

and performance decrements. Night workers also typically have problems trying to sleep soundly during the daytime because the bedroom is likely to be brighter, noisier and hotter than at night, and they sacrifice sleep in order to attend to personal, domestic and social responsibilities.

### 1.3.3 Individual factors

A variety of everyday individual factors may contribute to fatigue, such as long commutes, the presence of a new baby in the home, emotional difficulties such as stress and grief, a poor sleep environment and social/recreational activities or secondary employment.

Excessive sleepiness can be symptomatic of healthy physiological changes, for example intense physical training or pregnancy, as well as being indicative of a variety of health and emotional problems. Fatigue can occur as the direct result of disease (for example flu, depression), as a side-effect of the sleep loss caused by other symptoms (for example chronic pain), or as the primary presenting complaint (for example chronic fatigue syndrome).

Sleep disorders are notoriously under-diagnosed and under-treated:

- In the USA, it has been estimated that sleep disorders cost employers $60 billion per year in lost productivity, industrial accidents and medical expenses (Hillman et al, 2006).
- Around 40 million Americans have been estimated to suffer from one of the 85 sleep disorders that have been identified (Thorpy, 2010). Some of the more common disorders include insomnia, obstructive sleep apnoea-hypopnoea syndrome, narcolepsy, periodic limb movement disorder and restless legs syndrome.

Many prescription and over-the-counter medicines can disrupt sleep, cause excessive daytime drowsiness, or impact judgement and the ability to perform complicated tasks. Medications identified as having these unwanted side effects include those typically used to treat conditions such as depression, anxiety, heart disease, vertigo, nasal congestion, colds, flu, hay fever and travel sickness. Over-the-counter medications that have the most severe sedative side effect are those that contain sedating antihistamines[5], a group of substances commonly found in cold, flu and hay fever treatments (for a review, see Barrett and Horne, 2001). Some of these substances have such a profoundly sedating effect that they are also marketed specifically as sleep aids.

Emerging research is beginning to suggest genetically determined individual differences with regard to sleep need, tolerance to fatigue and our preferences for rising early/staying up late (see, for example, Goel and Dinges (2011)). However, the science is still in its infancy. Whatever the research shows, it is almost certain that genetics are only one determinant of fatigue and other factors, such as commute and living arrangements, will remain influential.

5 Chlorpheniramine, Diphenhydramine, Promethazine and Triprolidine

# 2 THE PHYSIOLOGY OF FATIGUE, SLEEP AND CIRCADIAN RHYTHMS

## 2.1 SLEEP DURATION AND STAGES

Sleep is as essential as food and water and we cannot reduce the amount of time we spend asleep without suffering adverse consequences. The relationship between sleep and fatigue is quite straightforward: the less sleep we have and the longer we are awake the more fatigued we become. We all differ in the amount of sleep we need to perform optimally, but most of us regularly need between seven and nine hours per day.

During sleep we alternate between two distinct states: rapid eye movement (REM) and non-REM (NREM) sleep. NREM sleep can be further sub-divided into four stages of progressively deeper sleep called stages 1, 2 (light sleep), 3 and 4 (deep sleep).

As shown in Figure 1, when we are asleep we progress through all of the sleep stages in cycles of approximately 90 – 120 minutes. The exact duration of cycles, amount of time we spend in each sleep stage and the number of cycles we go through in a sleep period depends on many factors including how long we have been awake, age and the time of day or night we are sleeping.

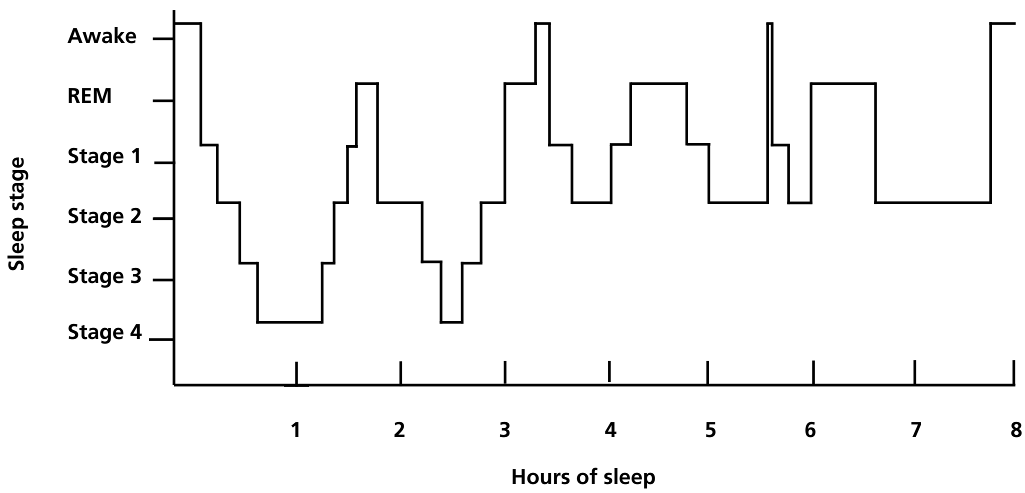


**Figure 1 Hypnogram showing the stages of sleep**

## 2.2 ACUTE AND CUMULATIVE SLEEP LOSS

Sleep loss can be acute or cumulative. Acute sleep loss involves not obtaining our required sleep for a single night, for example remaining awake for 24 hours. Cumulative sleep loss, sometimes referred to as the accumulation of a sleep debt, occurs when we do not obtain our ideal sleep duration for multiple consecutive days. For example, if an individual with a daily sleep need of seven hours works a block of five night shifts, and only obtains six hours of sleep each day, a cumulative sleep debt of five hours is accrued. Many people assume that they can recover from cumulative sleep loss by having one long sleep; however, depending on the severity of sleep loss, it can take more than three nights of unrestricted recovery sleep for people to return to their normal level of waking function (Belenky et al, 2003; van Dongen et al, 2003).

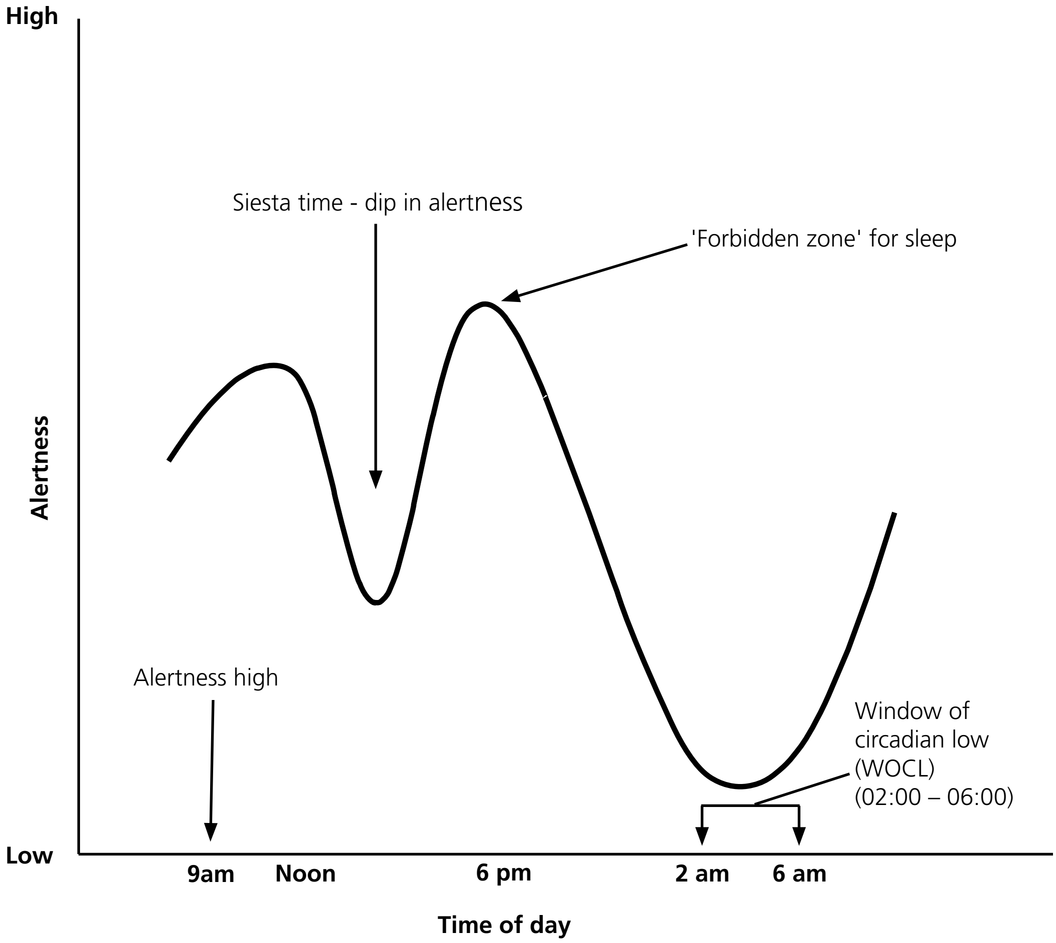


**Figure 2 The circadian rhythm in alertness**

## 2.3 CIRCADIAN RHYTHMS

Compared to the role that sleep loss plays in determining fatigue, the role of circadian rhythms is more complex and less widely recognised. Circadian rhythms exhibit a regular pattern over each 24-hour period and can be found in most physiological functions, such as body temperature, hormone production, sleepiness and alertness. The most prominent rhythm is the sleep-wake cycle: humans are in effect 'programmed' to be asleep during the hours of darkness and to be awake and active during the hours of daylight.

The body clock, a small cluster of cells called the suprachiasmatic nucleus located in a part of the brain called the hypothalamus, sets the timing for all circadian rhythms. The body clock is extremely sensitive to light. When we cross multiple time-zones and are exposed to a new schedule of light exposure, the timing of our circadian rhythms gradually adjusts and adapts. Adjustment to a shift schedule, for example a week of night shifts, is harder because, except at extreme latitudes during winter, we are exposed to light both during the night-time and the daytime, for example during the drive home in the morning. In practical terms it is extremely difficult to fully adapt to being awake at night and to sleep during the day.

It has long been known that there is a circadian variation in alertness and performance. Alertness and performance reach minima in the early hours of the morning (c.02:00 – 06:00, a period sometimes referred to as the 'window of circadian low' (WOCL), see Figure 2). There is another, smaller dip in alertness in the afternoon, between approximately 14:00 and 16:00, which some cultures have traditionally utilised to take a siesta (Dijk and Czeisler, 1994). Studies have identified two daily peaks for fatigue accident risk, consistent with these circadian lows, i.e. during the WOCL and the afternoon (siesta time) (Brown, 1994; Pack et al, 1995; Eskandarian et al, 2007).

There are also certain times of the 24-hour day when our circadian rhythm alertness is high. Two peaks in alertness occur: in the mid-morning and in the early hours of the evening (sometimes called the 'forbidden zone' for sleep). These can cause problems for those who have to try to sleep at these times.

## 2.4 SLEEP INERTIA

Sleep inertia is the feeling of grogginess and disorientation that can come with awakening from a sleep. This state usually lasts for a few minutes to a half-hour and can be problematic for those who must perform safety-critical tasks, such as driving or making critical decisions, immediately after waking from sleep. Sleep inertia is more severe, and can last longer, when we wake out of deep sleep (stages 3 and 4), are already sleep-deprived or woken during the WOCL.

# 3 MANAGING FATIGUE – MOVING FROM COMPLIANCE TO RISK MANAGEMENT

## 3.1 PRESCRIPTIVE VERSUS RISK-BASED APPROACHES TO FATIGUE MANAGEMENT

Traditionally, the most common operational strategy for managing fatigue has been via compliance with prescriptive limits on the number of hours that employees can work, and the number of hours that are free from work and available for sleep, rest and leisure activities (e.g. European working time directive (2003/88/EC)), which historically were designed to improve worker welfare, not to specifically control fatigue.

Whilst hours of work limits are valuable in that they provide unambiguous upper limits within which organisations must work, as far as managing risk from fatigue is concerned, they are increasingly seen as an overly simplistic solution to a complex problem. By their nature, prescriptive limits take a 'one size fits all' approach that does not consider the different conditions in which operators work or the risks that are encountered. Most importantly, limits do not usually consider when the hours are worked, and therefore when sleep opportunities are available. Working at night and having to sleep during the day can be significantly more fatiguing than working during the day and sleeping at night, due mainly to the human circadian rhythm in alertness, but also to environmental factors such as heat, light and noise that disturb individuals trying to sleep during the daytime.

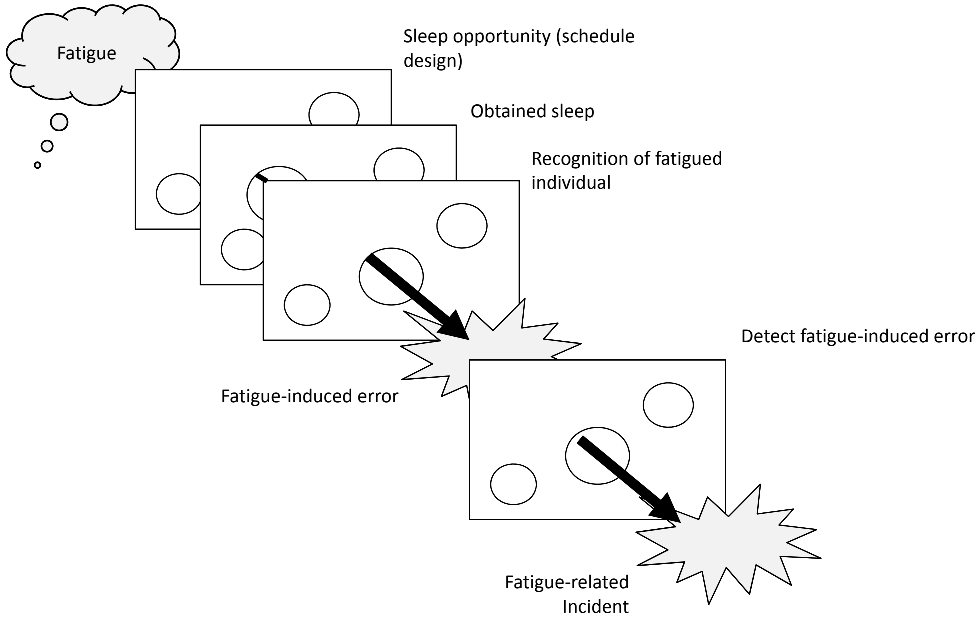


**Figure 3 Swiss cheese model illustrating several example layers of protection against fatigue-induced errors**

To use James Reason's 'Swiss cheese' model of incident causation (Reason, 1990), limitations on hours of work provide only a single imperfect layer of defence against fatigue-related incidents (see Figure 3). Fatigue-related incidents are usually preceded by a fatigue-related error, which in turn will be preceded by behavioural symptoms of fatigue, and an individual work/sleep history that has led to fatigue. Each of the levels of the fatigue-related error trajectory provides an additional opportunity to detect and measure fatigue and to implement a layer of defence against fatigue risk (Dawson and McCulloch, 2005). Accordingly, hours of work limits should be supported by additional layers of defence, relating to each of the subsequent layers within the incident trajectory.

The most effective strategy for managing fatigue is therefore likely to be multiple layers of imperfect controls, rather than one set of work and rest limits. Risk management is at the heart of this approach. A fatigue risk assessment seeks to identify the specific aspects of an operation that pose a fatigue risk, the risk is quantified and a variety of different controls are considered for implementation.

To provide additional protection from fatigue risk, operators have long implemented fatigue management training programmes, redesigned shift-schedules and developed employee fatigue reporting schemes. However, rather than having in place a range of sporadically applied and disconnected controls, it is now generally accepted that fatigue risk should be integrated into a management system and considered and controlled in much the same way as other risks (e.g. by using a likelihood and consequence risk matrix). This system-based approach enables different controls to be evaluated and facilitates continuous monitoring and improvement.

## 3.2 THE FATIGUE RISK MANAGEMENT PLAN (FRMP) – A MORE EFFECTIVE WAY TO MANAGE FATIGUE

Managing fatigue involves managing all of the various causes of fatigue using a range of independent layers of control. The various controls and strategies are brought together in the form of a fatigue risk management plan (FRMP).

### 3.2.1 Definition of an FRMP

An FRMP is a risk-based plan or system of controls that identifies, monitors and manages fatigue risk, with the aim of ensuring that, so far as reasonably practicable, employees are performing with an adequate level of alertness. An FRMP should be risk and evidence-based, but grounded by operational experience and practicalities. It should also be integrated into existing corporate safety and health management systems.

### 3.2.2 Four principles that underpin an FRMP

There are four principles that an effective FRMP should be built upon:

1) **The FRMP should be customised to the operation for which it is developed**
An FRMP is not an off-the-shelf product; rather, for it to be effective, it 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. For example, for a site that works only during daylight hours, does not employ any long-distance commuters and involves relatively small amounts of safety-critical work, a relatively small and simple FRMP may be sufficient. In contrast, a more substantial FRMP may be required to effectively manage the fatigue risk associated with a 24-hour continuous operation, where employees work multiple consecutive night shifts.
Some organisations have formalised this concept and distinguish between a 'lite FRMP' and a 'full FRMP'. The lite FRMP is appropriate for assets with some, but

limited, risk exposure, and the full FRMP is applied where assets have significant risk exposure. The scope and principles of each FRMP are the same, but the degree of formality and rigour, and extent of controls needed, might vary.

Section 4 provides guidance on how to develop an FRMP that reflects the size and nature of an individual operation and its fatigue risk profile.

2) **The FRMP should be based on assessed risk and evidence**

As with many of the other hazards encountered in the industry, fatigue should be managed based on evidence and experience. There should be evidence and experience underpinning risk assessments, the selection of controls and the ongoing monitoring of fatigue risk exposure. Experience comes in the form of the operational experience and judgement of those familiar with the operation and the experience of subject matter experts who may have encountered similar challenges elsewhere. Evidence is provided by operational data streams that may provide an indication of fatigue levels; for example, absenteeism rates or devices that measure employee fatigue-related performance decrements.

In industries with day-to-day access to operational data on fatigue, such as aviation, an FRMP can be largely data-driven. It is sometimes suggested that the energy industry does not have ready access to the fatigue-related operational data required to manage fatigue. However, there are a number of sources of fatigue data that may provide an evidence base to inform the design and implementation of an FRMP and ongoing fatigue management, for example: employee fatigue report forms; shift schedule statistics pertaining to fatigue, and fatigue-related accident investigation findings.

As an FRMP considers all sources of fatigue risk, not just the fatigue associated with work hours, data should be collected on factors that may not previously have been considered, such as the incidence of sleep disorders and the impact that commuting is having on sleep and fatigue. Section 4.6.4 provides more information on sources of data on fatigue.

Fatigue risk management involves the identification of fatigue hazards, the assessment of the associated risk and the identification and implementation of the necessary mitigation strategies. Once mitigators have been put in place, performance indicators should be used to monitor their effectiveness. OGP/IPIECA (2013) contains examples of leading and lagging indicators that can be used for this purpose.

3) **The FRMP should be built on the principle of shared responsibility**

Another fundamental principle underpinning an FRMP is that of shared responsibility; the recognition that all parties within the organisation have a role to play in managing fatigue. In particular, fatigue risk management is a shared responsibility between employers – to provide adequate opportunity for recuperative sleep – and employees – to make lifestyle choices that allow them to actually get the sleep they need. The success of an FRMP is dependent on the extent to which everyone within the organisation recognises the importance of workplace fatigue risk mitigation and actively works to support the goals of the FRMP. It is therefore essential to engage with the workforce from the outset, explaining the intent and objectives of the FRMP, involving them in its development and implementation, and providing the training necessary to enable all to manage fatigue risk effectively. Section 4.5 provides guidance on the contents of fatigue training programmes for employees and management.

4) **The FRMP should be integrated into existing management systems**

An FRMP should be integrated into a site's existing systems for managing health and safety, including, for example, the employee assistance programme (EAP) and contractor management arrangements. There are two reasons why an FRMP should be integrated:

1) The existing systems already provide, or could be adjusted to provide, some of the functions of an FRMP. For example the company's EAP could be adjusted to better consider sleep disorders, while existing reporting systems could be modified to consider fatigue. Rather than creating parallel systems it makes good sense to make use of existing systems and resources, where possible.
2) Fatigue usually occurs as the result of a complex interaction of individual and organisational factors and has consequences for many aspects of work performance and personal life. For example, an individual involved in a fatigue-related incident may have been experiencing elevated levels of fatigue because they were on-call for many consecutive days prior to the incident. This may have been compounded by their sleep being disrupted by back pain. In addition, perhaps they were not well trained in the task or they were not wearing the appropriate personal protection equipment. In order to prevent this complex adverse interaction of factors, there clearly needs to be close integration between the FRMP, EAP and the safety management systems (SMS).

## 3.3 WHAT ARE THE BENEFITS OF AN FRMP?

The primary benefit of an FRMP is enhanced safety levels and the prevention of fatigue-related incidents and accidents. Compared to prescriptive limits on work hours and other isolated strategies for managing fatigue, the implementation of an FRMP also has a number of other advantages:

- It is a systematic and documented approach to fatigue management.
- The many different causes of fatigue are considered.
- Fatigue management is risk-based, rather than involving reliance on 'one size fits all' fatigue management strategies.
- It involves both proactive and reactive risk management.
- The unique set of fatigue controls available at a site are recognised and utilised.
- Fatigue management is tailored to the site, rather than relying on 'generic' fatigue management strategies.
- Responsibility for managing the risk of fatigue rests with operating companies, not the regulator.

Employee, production and regulatory benefits:

- Employee benefits include improved health, work-satisfaction, and well-being.
- Improved employee morale, increased staff retention and a reduction in absenteeism and training, which may lead to reduced operating costs.
- Managing the adverse impact fatigue has on human performance can improve operational reliability and ultimately productivity.
- In some regions, an FRMP may facilitate compliance with local regulatory requirements regarding the management of health and safety or hours of work.
- If the pre-existing controls are overly restrictive, operational flexibility can be enhanced.

**Further reading**

Dawson, D. and K. McCulloch (2005) *Managing fatigue: it's about sleep*. In Sleep medicine reviews, 9(5), 365-80.

Fourie, C, Holmes, A, Hilditch, C, Bourgeois-Bougrine, S. and P. Jackson (2010) *Fatigue risk management systems: a review of the literature*, Road safety research report 110, London, Department for Transport.

Fourie, C, Holmes, A, Hilditch, C, Bourgeois-Bougrine, S. and P. Jackson (2010a) *Interviews with operators, regulators and researchers with experience of implementing fatigue risk management systems*. Road safety research report 120, London, Department for Transport.

OGP-IPIECA (2012) *Performance indicators for fatigue risk management systems. Guidance document for the oil and gas industry*, OGP report number 488, OGP-IPIECA. London

Although originally developed for the mining industry, the following guide to developing and implementing a fatigue management plan provides useful information of relevance to the energy industry:

New South Wales Mine Safety Advisory Council, *Fatigue management plan: a practical guide to developing and implementing a fatigue management plan for the NSW mining and extractives industry*. NSW Government,

http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0017/302804/Guide-to-the-Development-of-a-Fatigue-Management-Plan-Amended-17-6-10.pdf

# PART II – IMPLEMENTING AN FRMP

# 4 THE ELEMENTS OF AN FRMP

An FRMP for a site or facility should contain at least the following:

1) A documented commitment to managing fatigue risk in a systematic manner.
2) A statement of the scope of application of the plan.
3) A clear description of the roles and responsibilities of the various stakeholders within the organisation who have a part to play in managing fatigue.
4) A statement of working hours and overtime limits, setting out the procedures to be followed when employees are required to work beyond standard hours.
5) Fatigue risk management promotion: training, awareness and communications.
6) Fatigue risk management processes: including hazard identification, risk assessment, risk control and evaluation.
7) A procedure for employees to self-report fatigue.
8) A commitment to ensure fatigue is properly considered in incident investigations.
9) Management of health issues that can influence fatigue.
10) A process for the audit and continuous improvement of the FRMP.

The following sub-sections discuss each of these 10 elements in turn.

## 4.1 A DOCUMENTED COMMITMENT TO MANAGING FATIGUE RISK IN A SYSTEMATIC MANNER

An FRMP is underpinned by a clear statement of the organisation's commitment to fatigue risk management, which is usually referred to as a fatigue risk management policy, standard or recommended practice. For the purposes of this guidance document, the term policy will be used. Whilst terminology may differ, the intent is the same; this is a clear and concise statement of the organisation's commitment to formally manage the health and safety risks associated with fatigue. The policy should be developed in consultation with employees and should be signed and committed to by an accountable manager.

For information on how a fatigue policy and all of the elements of an FRMP should be documented, see section 5, stage 4. An example of a fatigue risk management policy can be found in the FRMP toolkit (Annex F).

## 4.2 A STATEMENT OF THE SCOPE OF APPLICATION OF THE PLAN

In addition to a fatigue risk management policy, a FRMP should include a clear statement of scope; in other words, a statement of the roles/tasks/operations/sites to which the FRMP applies. Some organisations have an all-encompassing FRMP, whereas in others it may be restricted to those employees undertaking safety-critical tasks or working in particularly demanding environments. The FRMP should also make it clear which normal operations it covers, and how the fatigue associated with activities such as emergency response, shutdowns and turnarounds will be managed.

## 4.3 A CLEAR DESCRIPTION OF ROLES AND RESPONSIBILITIES

The FRMP also sets out the shared responsibilities of the organisation and of employees with respect to managing fatigue. The organisation is responsible for providing employees with a safe system of work and this includes adequate time off to obtain sufficient sleep. Employees are responsible for being fit for duty and this includes using their time off to obtain adequate sleep and informing management when they have had inadequate sleep or feel excessively tired at work.

Specific fatigue risk management responsibilities should be outlined for the roles listed here:

- senior management;
- immediate supervisors;
- individual employees;
- contract companies and their employees, and
- key support functions (e.g. medical, HR, safety, training, workforce planning and scheduling).

For example, senior management may be responsible for ensuring the FRMP is adequately resourced, implemented and regularly audited.

## 4.4 A STATEMENT OF WORKING HOURS AND OVERTIME LIMITS

The FRMP should include a statement of what the organisation deems to be acceptable limits for:

- the maximum number of hours of work for a standard day;
- maximum overtime/extended hours limits;
- weekly and monthly work hours;
- the maximum number of consecutive day and night duties;
- minimum durations of rest periods between duties, and
- the maximum number of hours of work before a break should be taken.

While there may be industry and/or national regulations that must be adhered to, it may be appropriate and desirable to impose more stringent limits for specific parts of the operation, or roles associated with a high level of risk.

Some organisations also utilise an 'extended hours approval procedure', for situations where operational demands make it necessary for an individual to work longer than the standard hours, or to work more than the maximum number of consecutive duties. This procedure requires the authorising manager to document the controls and mitigations that have been implemented to manage the additional fatigue risk.

## 4.5 FATIGUE RISK MANAGEMENT PROMOTION: TRAINING, AWARENESS AND COMMUNICATIONS

The purpose of safety promotion is to ensure that all those with a role to play in the FRMP understand its function, any new procedures being introduced, and the responsibilities and duties that apply to their position. Safety promotion is achieved on a day-to-day basis via communication and at longer intervals via education and training.

### 4.5.1 Communication

Ongoing communication about fatigue risk management is necessary to keep employees engaged and informed. Examples of communication methods include electronic media (emails, websites, company intranet), safety newsletters, seminars and periodic poster campaigns. Effective communication also involves providing timely feedback to individuals who submit fatigue report forms or identify fatigue hazards.

### 4.5.2 Fatigue risk management training

A fatigue risk management training programme should equip individuals with the skills and knowledge required to meet their FRMP responsibilities. For a fatigue training programme to be effective it should be tailored to reflect the organisation's unique fatigue risks and the controls that are available to employees. The training should motivate and encourage employees to think about fatigue and how it affects them, their families, their work colleagues and the organisation they work for, and how to make good choices about how they prioritise sleep in their lifestyles. Training should aim to instigate a change of attitude within the workforce, from viewing fatigue as an inevitable and relatively benign consequence of work, to recognising that it is a safety risk that they and the organisation must work together to manage.

**Training syllabus and format**

Suggested syllabuses for fatigue risk management training programmes for employees and managers can be found in the FRMP toolkit (Annex F). Some organisations have already developed in-house fatigue risk management training materials that are delivered to their workforce either online, via the company intranet, on CD-ROM/DVD, or in classrooms. Ideally, the training should conclude with an assessment of the learner's competency to manage fatigue risk. The effectiveness of the training programme could be evaluated using Kirkpatrick's four levels of evaluation model (Kirkpatrick, 1994).

**Training for different roles**

The training that an individual receives should be determined by their role and responsibilities within the FRMP. Table 3 provides an example of the types of training that one organisation introducing an FRMP provides to its existing employees, management and support staff.

**Table 3 Example of fatigue risk management training provided to different individuals in one organisation**

| | **Initial training** | **Refresher training** | **Fatigue risk management for managers** | **Fatigue management workshops and conferences** |
|---|---|---|---|---|
| Format | CBT* or classroom** | In-house classroom | In-house classroom | External |
| Duration | ½ day | ¼ day | ½ day | 2 days |
| Frequency | Once | Annually | Once | Annually |
| Employees<br>Safety officers<br>Scheduling officers | ✓ | ✓ | | |
| Operations managers<br>Shift managers<br>Safety managers | ✓ | | ✓ | |
| Occupational health | ✓ | | | |
| Fatigue risk management system (FRMS) leaders<br>Subject matter experts | | | | ✓ |

* computer-based training (CBT)

** Depending on the number of employees to be trained, a computer-based solution may be more practical.

**Training resources**

EI *Human Factors Awareness: web-based training course*. Module on fatigue http://www.eihoflearning.org

HSE (2001) *An intervention using a self-help guide to improve the coping behaviour of nightshift workers and its evaluation*, HSE CRR 365/2001, HSE Books http://www.hse.gov.uk/research/crr_pdf/2001/crr01365.pdf

Minerals industry risk management gateway (MIRMgate), *Fatigue management for the Western Australian mining industry* http://www.dmp.wa.gov.au/documents/Guidelines/MSH_G_FatigueManagement.pdf

AEA-TECDOC-1358 (2003) *Means of evaluating and improving the effectiveness of training of nuclear power plant personnel* http://www-pub.iaea.org/MTCD/publications/PDF/te_1358_web.pdf

**Training resources continued...**

*Minerals industry risk management gateway (MIRMgate)* website
http://www.mirmgate.com/index.php?coreId=212

The New South Wales Mine Safety Advisory Council has developed a suite of tools to enable industry to deliver their own Fatigue Management Plan workshop. This is available at: http://www.resources.nsw.gov.au/safety/world-leading-ohs/fatigue

## 4.6 FATIGUE RISK MANAGEMENT PROCESSES

'The FRMS implementation process first identifies all sources of fatigue risk in the business operation, then introduces mitigating policies, technologies, and procedures to reduce the risk, and most importantly then maintains them in a proactively-managed continuous improvement system.' (Technical Support document for API RP 755, 2010).

This section describes how each of the standard elements of risk management listed here is applied specifically to the management of fatigue risk:

- **Fatigue hazard identification** involves identifying the tasks, work schedules, work practices and individuals that may pose a significant fatigue risk.
- **Fatigue risk assessment** describes the process of evaluating the extent of the fatigue risk arising from exposure to the hazard, and determining the tolerability of that risk in light of existing controls, and whether the risk can be reduced by introducing new controls.
- **Fatigue risk control** is the process of addressing the risk by eliminating or minimising its effect.
- **Evaluation** is the process of identifying safety performance indicators to check the extent to which the control measures have been successful, and that the FRMP is working effectively.

### 4.6.1 Fatigue hazard identification and risk assessment

'A risk assessment is nothing more than a careful examination of what, in your work, could cause harm to people, so that you can weigh up whether you have taken enough precautions or should do more to prevent harm.' HSE (2011)

The key objectives of the initial fatigue hazard identification and risk assessment are to identify which parts of the organisation to include in the FRMP, and where the highest risks are that should be addressed first.

The HSE has developed a guide outlining a simple five-step approach to risk assessment (HSE, 2011):

1) identify the hazard;
2) decide who might be harmed and how;
3) evaluate the risks and decide on precautions;
4) record and implement findings, and
5) review and update if necessary.

Section 6 contains a case study of a fatigue risk site assessment.

**Utilising operational expertise to identify fatigue hazards and assess the risk**

Hazard identification and risk assessment take many different forms, but in the early stages of building an FRMP, a structured workshop can be helpful. A workshop enables the FRMP manager to draw on the wealth of knowledge and experience of the people working in different parts of the organisation and to quickly identify and evaluate fatigue risks.

Employees have the knowledge and experience of day-to-day working practices that enable them to evaluate risks, and propose controls, that managers may be less aware of. Other operational experts that could be involved in the fatigue risk assessment include operational management, HR and medical professionals.

**Who should undertake the risk assessment?**

Undertaking and documenting a fatigue risk assessment can be a demanding task calling on skill, experience and judgement, as well as a familiarity with the science of fatigue. Organisations exposed to significant fatigue risks should seek to develop individuals in-house who have the knowledge and experience to carry out fatigue risk assessments and make informed judgements on the risks and necessary controls. Ideally, there will be someone within the organisation who has been assessed as being competent to complete this undertaking. Alternatively, it may be preferable to engage an external specialist with risk assessment and specialist fatigue management expertise to conduct the initial risk assessment. This individual can provide training to an in-house team, so that future risk assessments can be conducted in-house with minimal assistance.

**What risk assessment tools should be used?**

The organisation may already use a standardised risk assessment process (very commonly based on a risk matrix) with recognised risk grades, and have in place a method for documenting the results of risk assessments. Utilising the existing risk assessment process is one way of integrating the FRMP into the safety management system.

The FRMP toolkit (Annex F) provides a table to assist in the identification of fatigue hazards and risk assessment. The table lists the fatigue hazards that can be present in operations, provides questions that can be asked to evaluate the associated risk and suggests a range of controls that can be considered.

**What information should a risk assessment consider?**

In addition to utilising the knowledge of in-house specialists (e.g. company medics, occupational health, rostering and safety departments) risk assessments should ideally consider operational data, such as the occurrence of overtime, the amount of work undertaken at night, or knowledge of commute arrangements, such as the home locations of the workforce and the modes of transport employed to get to and from work. As an FRMP develops, more sources of data on fatigue are usually collected and fatigue risk assessments become more informed. Table 4 summarises some of the different types of data on fatigue that could be considered.

**Where should the results of fatigue risk assessments be documented?**

Details of the fatigue risk assessments that have been undertaken and the risk controls that are, and will be in place, along with an implementation strategy and timelines, should be formally recorded and available for review. Many organisations already have a safety database where risk assessment records are stored.

**Further reading**

The following sources provide more information on how to undertake a risk assessment. For a simple assessment:

HSE (2011) *Five steps to risk assessment*, HSE leaflet INDG163 (rev3)
http://www.hse.gov.uk/pubns/indg163.pdf

For guidance on health risk assessments:

OGP/IPIECA (2006) *Controlling health risks at work: a roadmap to health risk assessment in the oil and gas Industry*
http://www.ogp.org.uk/pubs/384.pdf

### 4.6.2 Fatigue risk control

The more effective fatigue controls usually address the primary cause of fatigue – lack of sleep – by improving the sleep opportunity and the amount/quality of sleep employees obtain. Controls for fatigue risk vary widely in their effectiveness. For example, eliminating certain safety-critical tasks from the night shift is likely to be more effective than ensuring that the tasks are undertaken in a well-lit environment or putting up posters reminding employees that fatigue is elevated when working at night[6]. Examples of such controls include:

- delaying the start time of early shifts;
- medical screening for and treatment of sleep disorders;
- increasing the frequency with which employee buses run between company-provided accommodation and the work site, and
- providing a napping opportunity and appropriate napping facility during the night shift.

There are situations where fatigue is inevitable and it is not possible or practical to implement fatigue-reducing measures without increasing the overall risk profile of the operation. For example, in emergency situations or during long processes, introducing a shift changeover can pose even more of a risk due to the loss of continuity and possible miscommunication of information. In situations where a degree of fatigue is unavoidable, 'fatigue proofing' strategies, which reduce the risks of operating in a fatigued state, can be explored. Examples of these strategies include:

- increasing the role technology plays in completing the task;
- the use of checklists, and
- replacing lone workers with teams of two or more people.

Fatigue proofing can also be utilised to manage fatigue risk on a day-to-day basis. However, priority should usually be given to improving employee sleep duration. Fatigue proofing can contribute to reducing safety risks associated with fatigue, but the only way to effectively control the risks over the long term is to ensure employees obtain adequate sleep on a regular basis.

The FRMP toolkit (Annex F) includes examples of controls that can be applied to manage fatigue risk.

6 Some safety-critical tasks (e.g. maintenance activities) are planned to occur during the night shift, specifically because there are fewer personnel around and thus present a lower risk. Where this is the case it is recommended that additional measures are identified to mitigate the additional fatigue risk associated with working during the WOCL.

**Further reading**

The following documents are recommended as sources of more detail on fatigue risk controls. Whilst these guides provide examples of effective controls, it is critical that each operation implements controls that are both effective for the nature of their operation and organisation, and do not impact on controls against other risks.

HSE (2006) *Managing shift work – health and safety guidance*, HSE Publication HSG256

OGP-IPIECA (2007) *Managing fatigue in the workplace, a guide for oil and gas industry supervisors and occupational health advisors*, OGP-IPIECA Health Committee, OGP report number 392, OGP-IPIECA. London

ACOEM Task Force (2012) *ACOEM guidance statement: fatigue risk management in the workplace,* In Journal of occupational and environmental medicine, 54 (2): 231-258

American Petroleum Institute (2010) *ANSI/API recommended practice RP755 fatigue risk management systems for personnel in the refining and petrochemical industries*, Washington, DC: American Petroleum Institute

### 4.6.3 Evaluation: key performance indicators for monitoring fatigue controls, fatigue risk and FRMP performance

Each control should be allocated to an accountable manager for implementation and a performance indicator identified and set to measure the control's effectiveness, i.e. the extent to which fatigue risk has been effectively controlled. The accountable manager and performance indicator could be recorded in the risk assessment documentation.

OGP-IPIECA (2012) proposes a comprehensive range of performance indicators to support data-driven fatigue risk management. The proposed indicators enable the monitoring of controls, risk exposure and the effectiveness of the elements of the FRMP. The OGP-IPIECA guidance proposes two forms of indicators:

1) Leading indicators are forward-facing and proactive, and are used to highlight areas of system weakness, e.g. 'percentage of shifts that comply with the rostered work hours'.
2) Lagging indicators are retrospective and reactive, and use learnings from the occurrence of incidents and near-misses, e.g. 'percentage of incidents or near misses that occur during or following deviations from the roster'.

Performance indicators should be assessed on a regular basis to determine whether the controls are appropriately applied, function correctly, or need to be changed, thus enabling continuous improvement.

### 4.6.4 Sources of data on fatigue

As the FRMP evolves it may be necessary to identify more detailed information on fatigue in order to enable more effective risk management. This section briefly describes the more important sources of fatigue data that can be considered in subsequent risk assessments, or to enable day-to-day fatigue risk management.

There is no single, comprehensive measure of fatigue. Instead, fatigue could be evaluated using a combination of different subjective and objective data measures. Table 4 suggests possible methods for collecting these data, some of which may already be collected within the organisation (for example absenteeism rates), whereas other data may require existing tools (such as incident investigation tools) to be adapted. Other fatigue data may require the implementation of new procedures, or even the purchase of new systems, for example fatigue monitoring devices.

The decision as to which fatigue data should be collected should be based on the organisations needs, the level of fatigue risk, the sources of fatigue identified during the risk assessment process and the level of investment required to manage the issue. Before investing heavily in data collection tools or systems, consider the value of the data that they will produce and whether other sources of information that might be simpler to collect might be equally valid.

**Further reading**

HSE (2006) *The development of a fatigue/risk index for shift workers*, Research report RR446 http://www.hse.gov.uk/research/rrhtm/rr446.htm (site also includes a guidance document and the fatigue/risk index)

CASA (2010) *Biomathematical fatigue modelling in civil aviation fatigue risk management – application guidance*, Civil Aviation Safety Authority (CASA) Human Factors Section. http://www.casa.gov.au/wcmswr/_assets/main/aoc/fatigue/fatigue_modelling.pdf

**Table 4 Examples of possible sources of operational data on fatigue**

| Subjective data | Objective data |
|---|---|
| Use the awareness consideration tool (ACT) provided in Annex F to collect alertness data from employees. | Analyse HR data, e.g. absenteeism, sickness, turnover, overtime and compare incidence of these measures across different functional groups and roster patterns to identify trends. |
| Ask employees to rate their alertness at different times during their shift using a standardised alertness scale (e.g. Samn-Perelli Scale*) and collect subjective sleep data using a sleep and activity diary. | Use a biomathematical fatigue model to objectively assess different rosters. Biomathematical fatigue models widely used include:<br>– fatigue audit interdyne (FAID);<br>– fatigue avoidance scheduling tool (FAST), and<br>– HSE fatigue/risk index. |
| Administer an annual online or paper-based fatigue survey of employees. | Conduct scientific studies – use actigraphy to collect objective sleep data. |
| Analyse data collected via a fatigue reporting system (see 4.7). Compile monthly statistics to track seasonal variations. Annex F includes an example of a fatigue report form. | Implement fatigue detection technologies to monitor fatigue and its effect on performance. |
| Analyse data collected via investigations of the role of fatigue in incidents (see 4.8) | |
| * Samn, S.W and L.P Perelli (1982) | |

## 4.7 A PROCEDURE FOR EMPLOYEES TO SELF-REPORT FATIGUE

An effective fatigue reporting procedure is critical to the successful management of fatigue risk. The open and honest reporting of information by employees enables immediate fatigue risks to be addressed and systematic fatigue risks to be identified.

### 4.7.1 What are the components of an effective fatigue reporting procedure?

The EI publication *Viability of using sleep contracts as a potential measure of fatigue management* (Energy Institute, 2006) provides detailed practical information on how to build an effective system for reporting fatigue. To summarise:

- There should be a clear definition of fatigue and how it should be identified.
- Employees should be made aware that if they are not fit for work due to fatigue they have a responsibility to inform their immediate supervisor or manager.
- Employees should be made aware that if their state deteriorates during work, that is, they become fatigued whilst at work, they should inform their immediate supervisor or manager.
- Supervisors and managers should be made aware that they have a responsibility to address the employee's reported fatigue in a formal manner utilising the potential actions/outcomes that have been previously agreed and documented.
- The fatigue event and how it is managed should be recorded to enable trends to be mapped within the company.

### 4.7.2 A fatigue reporting procedure enables current fatigue risks to be addressed

When an individual reports fatigue to their supervisor, both parties should respond in a formal and structured manner to manage the risk for the remainder of the shift and where relevant on an ongoing basis. Providing supervisors with a checklist to assess the condition of individuals reporting fatigue is one way to ensure that the assessment is conducted in a structured way. Annex F contains examples of such checklists and links to other fatigue risk assessment tools. In the event of any indication of medical drugs or related issues being associated with causing the fatigue, supervisors should seek support from a suitably qualified health professional. Supervisors should not attempt to make any form of clinical judgement on their own.

### 4.7.3 A fatigue reporting procedure enables systematic fatigue risks to be identified

The data collected on the incidence of fatigue may also be utilised to track trends and to identify systematic fatigue risks. For example, specific shifts, crews or times of day where fatigue is repeatedly reported. In turn, this information can be used to refine the controls that are in place and/or to inform the introduction of further controls.

### 4.7.4 Factors that determine the effectiveness of a fatigue reporting system

For the reporting system to be effective, all stakeholders should be committed to the management of fatigue risk and feel comfortable that the reporting system is a tool that they can use to achieve this aim. This means ensuring that a supportive work culture exists between management and employees; that any actions taken following a report of fatigue have been agreed via a consultation process and communicated to the workforce before the system goes live, and that responses are structured, reasonable and consistent. Access should also be provided to appropriate support, such as an employee assistance programme.

If employees have taken the trouble to submit a report of fatigue, management should first acknowledge the report, and then inform the individual of any steps they have taken to address the issue. In order to encourage employees to submit forms it is important that they see that positive outcomes can result from doing so. For this reason management should provide regular feedback to the workforce regarding the issues that have been raised and the actions taken.

> **Further reading**
>
> Section 4.6 (page 18 – 23) of American Petroleum Institute (2010) *ANSI/API recommended practice RP755 fatigue risk management systems for personnel in the refining and petrochemical industries* includes detailed information on factors to consider when designing a fatigue reporting system.
>
> Alertness consideration tool (ACT), published by the Civil Aviation Safety Authority (CASA) of Australia in 2012, is a simple tool designed to assist aircrew to identify whether they are fit to fly, or should report fatigue. Although originally designed for aircrew, the tool could be readily adapted to suit personnel working in the energy industry. A copy can be found in Annex F.

## 4.8 FATIGUE INCIDENT INVESTIGATION

Fatigue-related incidents usually occur as the result of a combination of factors, rather than due to fatigue alone. Often fatigue contributes to incidents by exacerbating an otherwise manageable situation. A combination of events (e.g. equipment breakdown) and states (e.g. inadequate training) may produce a demanding work situation. However, due to their fatigued state the employee may make errors of judgement that make the situation worse.

Aggregate analysis of incident investigations may identify trends (e.g. time of day, number of hours worked within a shift or number of consecutive shifts worked prior to the incident) that suggest that fatigue is contributing to these incidents.

### 4.8.1 Key questions for investigating the role of fatigue in incidents

For an organisation to gain a true understanding of the impact of fatigue on safety, it is essential that the incident investigation procedure gives sufficient consideration to the contributory role played by fatigue. In order to do this, the procedure should collect data to answer the following questions:

1) At the time of the incident had the individual been given sufficient time off to obtain adequate sleep?
2) Had the individual actually obtained sufficient sleep in this rest period?
3) Was the individual exhibiting any of the primary signs of fatigue in the time leading up to the incident?
4) Are the errors that caused the incident indicative of fatigue?

   Where it is established that the individual was suffering from fatigue at the time of the incident, the investigation should proceed to determine whether the error that caused the incident was actually fatigue-related. To help answer these questions, the American College of Occupational and Environmental Medicine (ACOEM) has provided two checklists (see Annex F), adapted from versions originally developed for the Federal Transit Administration (Gertler et al, 2002). Note that these are included as examples only; the actual content would need to be customised for use in any specific energy industry operation.

5) What are the possible reasons for the individual's fatigue?
Where the individual can be considered to have been suffering from fatigue and the incident can be considered to have been caused by a fatigue-related error, the investigation process should now seek to identify possible reasons for the fatigue or tiredness that caused the incident, so that appropriate countermeasures can be implemented to help prevent future similar incidents occurring.

It is also important to rule out other possible causes of the impairment that the individual may have been experiencing. For example, consider the role that prior medical conditions, prescription and over-the-counter medicines, illicit drugs or alcohol may have played in the incident. If indicated, the individual should be reviewed by a specialist in sleep medicine.

For practical guidance on incident investigation see the Energy Institute (2006) *Guidance on investigating and analysing human and organisational factors aspects of incidents and accidents*.

## 4.9 MANAGEMENT OF HEALTH ISSUES THAT CAN INFLUENCE FATIGUE

How the relationship between fatigue, health, fitness and wellbeing is managed will be different between organisations, and possibly between sites within an organisation. Some sites have a dedicated company medical and occupational health team that are engaged in proactive and reactive fatigue risk management. Other sites have an employee assistance programme that employees can access if they need medical or personal support or guidance. Whatever arrangements are in place, the following guidance on the role and objectives of the individuals responsible for managing fatigue in relation to health may be useful:

- Design health assessment, screening and disease management programmes that consider the unique health risk profile of shift workers. For example, enhance medical surveillance for night workers.
- Ensure that night shift workers have the same access opportunities to training, employee assistance programme and health assessment and promotion programmes as their dayshift-working colleagues.
- The various personal reasons for fatigue require professional, careful and sometimes confidential management.
- Employees should also be able to access support, for example the EAP, through the fatigue reporting system.
- Provide education for employees' families on the importance of sleep for shift workers, how to protect shift workers' daytime sleep opportunity and the symptoms of sleep disorders.
- Utilise unidentified health-related performance indicators, for example on the number of days off employees are taking due to fatigue, within the FRMP.

**Further reading**

A guide aimed at assisting oil and gas industry supervisors and occupational health practitioners to understand, recognise and manage fatigue in the workplace.

OGP-IPIECA (2007) *Managing fatigue in the workplace, a guide for oil and gas industry supervisors and occupational health advisors*, OGP-IPIECA Health Committee, OGP report number 392, OGP-IPIECA. London.

This document provides current, detailed and comprehensive guidance for occupational and environmental physicians on how to enhance health and safety via an FRMS.

ACOEM Task Force (2012) *ACOEM guidance statement: fatigue risk management in the workplace*. In Journal of occupational and environmental medicine, 54 (2): 231 – 258.

## 4.10 A PROCESS FOR THE AUDIT AND CONTINUOUS IMPROVEMENT OF THE FRMP

As with any management system, an FRMP requires periodic audit to assess its effectiveness and to achieve continuous improvement. An FRMP is usually audited annually, or in accordance with the existing audit schedule for other safety management systems. The purpose is to identify potential improvements to the FRMP (such as streamlining procedures) and changes to the FRMP that may need to be made to reflect organisational developments, and to ensure that the FRMP is still in line with latest industry best practice.

An FRMP audit seeks to establish whether fatigue risk is being effectively managed and the FRMP is actually working successfully. The audit is specifically designed to assess:

- Whether the FRMP is functioning in accordance with the documented FRMP policy and procedures.
- Whether the targets linked to performance indicators (for fatigue management and FRMP performance) are being met.
- The extent to which the FRMP is effectively managing fatigue risk and, ideally, continuously enhancing the management of fatigue risk.

The OGP-IPIECA document *Performance indicators for fatigue risk management systems. Guidance document for the oil and gas industry* provides a range of performance indicators for monitoring these points.

The audit findings should detail any deficiencies, each of which is allocated a responsible person, rectification plan and a deadline for rectification. The audit schedule should deliver corrective actions through a continuous improvement process.

**Further reading**

OGP-IPIECA (2012) *Performance indicatiors for fatigue management systems. Guidance document for the oil and gas industry,* OGP report number 488, OGP-IPIECA, London

# 5 PREPARING FOR FRMP IMPLEMENTATION

It typically takes between one and two years for a site to develop a fully-functional FRMP that contains all of the elements of an FRMP listed in section 4.

The development and implementation of an FRMP requires hard work, commitment and dedication, but when it is well-designed and has been tailored to address the specific circumstances of a particular site, the benefits that it can bring to the organisation and to the workforce can be significant.

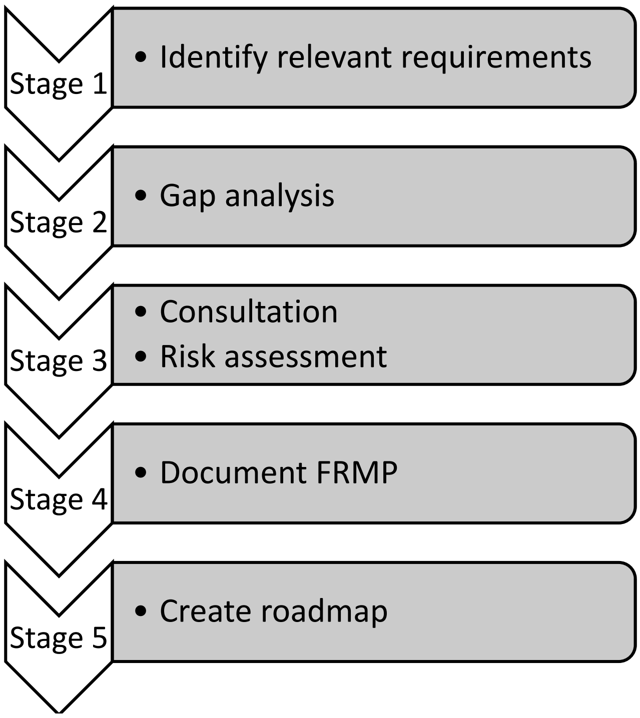


**Figure 4: Five-stage process for preparing an FRMP implementation**

This section is intended to assist managers to take a structured approach towards preparing for and commencing the development of an FRMP for their site. A five-stage process is suggested, but the stages are not intended to be prescriptive. As noted earlier, an effective FRMP should reflect the size, nature and risk profile of each individual site. Therefore, much of the FRMP development process involves gaining an in-depth understanding of the unique fatigue risk associated with the operation and building an FRMP to match.

**Stage 1: Identify relevant requirements and recommendations for fatigue risk management**

The first step towards building an FRMP is to identify all relevant organisational, legislative, and regulatory requirements and guidelines. Depending on the location, local health and safety laws may require that occupational risks, including fatigue risk, are eliminated or controlled. In addition, the site may need to comply with regulations that limit the maximum number of hours that workers can work and the minimum number of hours that must be available for rest (for example, the EU Working Time Directive). There may also be more specific legislation and regulations or work agreements pertaining to the management of fatigue risk and the implementation of FRMP that should be adhered to.

**Stage 2: Gap analysis – Evaluate compliance with existing requirements and recommendations**

Where an organisation has established company-wide standards for fatigue management, a gap analysis should be completed against these. Where there are no company standards, there are a number of industry best practice guidance documents on FRMP, such as this one, which may be found useful.

Some organisations have an in-house fatigue specialist who can assist in providing specialist input regarding the science of fatigue and sleep. Alternatively, it may be necessary to contract an external specialist to fulfil this role.

**Stage 3: Consult with employees to develop policy and undertake risk assessment**

Consultation with employees is an integral part of the initial and ongoing development of an FRMP. Not only are employees the most likely to be exposed to the health and safety risks associated with fatigue, but they are often best able to identify fatigue risks and suggest practical controls. Initial consultations with employees should aim to develop the fatigue risk management policy and undertake the initial fatigue risk assessment. Consultation usually involves meetings of a specially convened FRMP committee or the addition of fatigue risk management to the agenda of existing health and safety committee meetings.

**Stage 4: Document FRMP actions**

The FRMP should be fully documented, including a description of how each of the standard elements of an FRMP is constructed at the site. The FRMP should be clearly described, include measurable objectives and should be made available to all personnel, as well as for review and audit, both internally and by regulatory authorities, if required. The first step in writing an FRMP document is to establish what additional resources might be required to undertake and maintain this documentation. It is often recommended that an FRMP should form a distinct part of an organisation's existing safety management system manual. For example, the FRMP may be added as a chapter to an existing safety management system manual and made available on the company intranet.

Writing a complete FRMP takes time, but the initial version might include:

- A broad statement of the company's policy on fatigue management.
- The results of an initial risk assessment identifying parts of the operation that are associated with an elevated fatigue risk and those employees who are to be covered by the FRMP.
- An agenda for a planned training programme to be developed over the coming 12 months.
- Documentation of existing arrangements for controlling working hours.

Having begun the process, the FRMP can then be refined and added to as new fatigue risk management activities are introduced. For example:

- Records of fatigue training conducted, including dates, personnel trained, who trained them and the results of any end-of-training exams taken.
- Records and details of the fatigue risk assessments that have been undertaken and details of the risk controls that are/will be in place.
- The performance indicators that have been identified for tracking how well fatigue is being managed.

**Stage 5: FRMP implementation road-map**

The final stage of FRMP implementation planning involves constructing a road-map for the implementation. When constructing the road-map the following key issues should be considered:

- Who will have overall responsibility for the FRMP?
- Who will administer the FRMP on a day-to-day basis?
- Which other departments will need to be involved, for example as part of a fatigue steering committee or working group?
- How should the workforce be involved in the development of the FRMP?
- Once the FRMP is in development how will the workforce be informed about new procedures being introduced?
- What training will be required for those responsible for the management and administration of the FRMP, for management and for the workforce as a whole?
- What additional resources might be required? Resources include having competent people available to run fatigue risk management training sessions, lead fatigue risk assessments and undertake FRMP audits.

Once the initial hard work has been completed, the challenge for the FRMP manager is to keep the momentum going. It is important to provide regular feedback to the workforce and to management on improvements and developments that will bring tangible benefits to the organisation and to individuals. A good starting point is to survey the workforce to identify 'quick wins': simple cost-effective changes that can be made that will demonstrate the value of the FRMP.

**Sources of further information**

1) Gap Analysis tools
   The International Civil Aviation Organisation (ICAO) has developed comprehensive guidance to assist airline safety managers to implement an FRMS, much of which is of relevance to safety managers in other industries. In addition, the transport regulatory authority of Canada, Transport Canada, has a comprehensive library of resources for transport managers. These include information on conducting a gap analysis. Links to both organisations follows:
   http://www2.icao.int/en/FatigueManagement/Pages/FatigueManagementTools.aspx
   http://www.tc.gc.ca/eng/civilaviation/standards/sms-frms-menu-634.htm
2) Guidance on consultation
   HSE (2008) *Involving your workforce in health and safety: good practice for all workplaces*. HSE books http://www.hse.gov.uk/pubns/books/hsg263.htm
3) WorkCover, New South Wales (2001) Occupational health and safety consultation code of practice.
   http://www.aeromech.usyd.edu.au/ohsrm/workcover/Code%20of%20Practice%20for%20OHS%20Consultation%20(cop_ohsconsultation).pdf
4) Further reading
   To learn from the experiences of others who have already implemented FRMPs, or similar, see Department of Transport (2010) *Interviews with operators, regulators and researchers with experience of implementing fatigue risk management systems*. Road safety research report no. 120
   http://assets.dft.gov.uk/publications/fatigue-risk-management-systems-a-review-of-the-literature-road-safety-research-report-110/rsrr120.pdf

# ANNEX A
# REFERENCES AND BIBLIOGRAPHY

## A.1 REFERENCES

**America College of Occupational and Environmental Medicine (ACOEM) (http://www.acoem.org)**

Task Force (2012) *ACOEM guidance statement: fatigue risk management in the workplace,* Journal of occupational and environmental medicine, 54 (2): 231 – 258

**American Petroleum Institute (API) (http://www.api.org)**

*ANSI/API recommended practice RP755 Fatigue risk management systems for personnel in the refining and petrochemical industries* (2010)

*Technical support document for ANSI/API recommended practice RP755 Fatigue risk management systems for personnel in the refining and petrochemical industries* (2010)

**CS Energy (http://www.csenergy.com.au)**

CS Energy, *Procedure for fatigue management CS-OHS-12*
http://www.csenergy.com.au/userfiles/Fatigue%20management%20procedure.pdf

**Energy Institute (EI) (http://www.energyinst.org)**

*Guidance on investigating and analysing human and organisational factors aspects of incidents and accidents* (2008)

*Viability of using sleep contracts as a potential measure of fatigue management* (2006)

**Eurofound (http://www.eurofound.europa.eu)**

*Fifth European working conditions survey*, Publications office of the European Union, Luxembourg (2012)

*Health and well-being at work: a report based on the fifth European working conditions survey*, Dublin (2012a)

**Health and Safety Executive (HSE) (http://www.hse.gov.uk)**

*Effect of shift schedule on offshore shift workers' circadian rhythms and health* (2005)

*Five steps to risk assessment*, HSE Leaflet INDG163 (rev3) (2011)

*Managing shift work – health and safety guidance,* HSE Publication HSG256 (2006)

*Offshore working time in relation to performance, health and safety – A review of current practice and evidence* (2010)

*Psychosocial aspects of work and health in the North Sea oil and gas industry*, Summaries of reports published 1996 – 2001

**National Road Transport Commission (NRTC) (http://www.ntc.gov.au)**

*CR 202: Fatigue expert group: Options for regulatory approach to fatigue in drivers of heavy vehicles in Australia and New Zealand*, Melbourne: National road transport commission law courts (2001)

**New South Wales Mine Safety Advisory Council (http://www.nswminesafety.com.au)**

*Fatigue management plan: a practical guide to developing and implementing a fatigue management plan for the NSW mining and extractives industry* (2009) http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0017/302804/Guide-to-the-Development-of-a-Fatigue-Management-Plan-Amended-17-6-10.pdf

**International Association of Oil and Gas Producers (OGP) (http://www.ogp.org.uk)**

*Managing fatigue in the workplace, a guide for oil and gas industry supervisors and occupational health advisors*, OGP-IPIECA Health committee, OGP report number 392 (2007)

*Performance indicators for fatigue risk management systems. Guidance document for the oil and gas industry*, OGP report number 488 (2013)

**Worksafe Victoria (http://www.worksafe.vic.gov.au)**

*Fatigue: Prevention in the workplace*, http://www.worksafe.vic.gov.au/__data/assets/pdf_file/0008/9197/vwa_fatigue_handbook.pdf

**Other citations**

Barrett, P. and J.A. Horne (2001) *Over-the-counter medicines and the potential for unwanted sleepiness in drivers: a review*, Road safety research report no. 24. London: Department for Transport, Local Government and the Regions

Belenky, G, Wesensten, N.J, Thorne, D.R, Thomas, M.L, Sing, H.C, Redmond, D.P, Russo, M.B. and T.J. Balkin (2003) *Patterns of performance degradation and restoration during sleep restriction and subsequent recovery: a sleep dose-response study*, Journal of sleep research, 12(1), 1 – 12

Brown, I.D. (1994) *Driver fatigue*, Human factors, 36(2): 298 – 314

Dawson, J, Chapman, J and Thomas, J.W (2011) *Fatigue-proofing: A new approach to reducing fatigue-related risk using the principles of error management*, Sleep medicine reviews (2011): 1 – 9

Dawson, D. and K. McCulloch (2005) *Managing fatigue: it's about sleep*, Sleep medicine reviews, 9(5): 365 – 80

Dijk, D-J. and C.A. Czeisler (1994) *Paradoxical timing of the circadian rhythm of sleep propensity serves to consolidate sleep and wakefulness in humans*, Neuroscience letters, 166(1): pp. 63 – 68

Eskandarian, A, Sayed, R, Delaigue, P, Blum, J, and A. Mortazavi (2007) *Advanced driver fatigue research*, Final Report 09.2003 – 12.2005, Federal Motor Carrier Safety Administration, Washington D.C

Ferguson, S.A, Kennaway, D.J, Baker, A, Lamond, N. and D. Dawson (2012) *Sleep and circadian rhythms in mining operators: limited evidence of adaptation to night shifts*, Applied ergonomics, 43(4): 695 – 701

Folkard, S. and P. Tucker (2003) *Shift work, safety and productivity*, Occupational medicine, 53(2): 95 – 101

Fourie, C, Holmes, A, Hilditch, C, Bourgeois-Bougrine, S. and P. Jackson (2010) *Fatigue risk management systems: a review of the literature*, Road safety research report 110, London, Department for Transport

Fourie, C, Holmes, A, Hilditch, C, Bourgeois-Bougrine, S. and P. Jackson (2010a) *Interviews with operators, regulators and researchers with experience of implementing fatigue risk management systems*, Road safety research report 120, London, Department for Transport

Frazier, L.M. and D.A. Grainger (2003) *Shift work and adverse reproductive outcomes among men and women*, Clinical occupational environmental medicine, 3: 279 – 292

Frost, P, Kolstad, H.A, and J.P. Bonde (2009) *Shift work and the risk of ischemic heart disease – a systematic review of the epidemiologic evidence*, Scandinavian journal of work, environment and health, 35(3): 163 – 179

Gangwisch, J.E, Heymsfield, S.B, Boden-Albala, B, Buijs, R.M, Kreier, F, Pickering, T.G, Rundle, A.G, Zammit, G.K. and D. Malaspina (2006) *Short sleep duration as a risk factor for hypertension: analyses of the first national health and nutrition examination survey*, Hypertension, 47: 833 – 839

Gertler, J, Popkin, S, Nelson D. and K. O'Neil (2002) Transportation Research Board for the Federal Transit Administration, *Toolbox for transit operator fatigue*, TCRP report 81. Washington, DC: National academies press

Goel, N. and D.F. Dinges (2011) *Behavioral and genetic markers of sleepiness,* Journal of clinical sleep medicine 7(5): S19 – S21

Gottlieb, D.J, Punjabi, N.M, Newman, A.B, Resnick, H.E, Redline, S, Baldwin, C.M. and F.J. Nieto (2005), *Association of sleep time with diabetes mellitus and impaired glucose tolerance*, Arch Intern Med, 2005 165: 863 – 867

Halvani, G.H, Zare, M. and S.J. Mirmohammadi (2009) *The relation between shift work, sleepiness, fatigue and accidents in Iranian industrial mining group workers*, Industrial health, 47(2): 134 – 8

Harrington, J.M. (2001), *Health effects of shift work and extended hours of work*, Occupational and environmental medicine, 58: 68 – 72

Hillman, D.R, Murphy, A.S, Antic, R. and L. Pezzullo (2006) *The economic cost of sleep disorders,* Sleep, 29: 299 – 305

Hobson, J. (2004) *Shift work and doctors' health*,
http://careers.bmj.com/careers/advice/view-article.html?id=468

Jackson, P, Holmes, A, Hilditch, C, Reed, N. Smith, L. and N. Merat (2011) *Fatigue and road safety: An evidence-based review,* Research report. London: Department for Transport

Kirkpatrick, D.L. (1994) *Evaluating training programs*, San Francisco: Berrett-Koehler Publishers, Inc.

Knutsson, A. and H. Bøggild (2010) *Gastrointestinal disorders among shift workers*, Scandinavian journal of work, environment and health, 36(2): 85 – 95

Kolstad, H.A. (2008) *Nightshift work and risk of breast cancer and other cancers – a critical review of the epidemiologic evidence,* Scandinavian journal of work, environment and health, 34(1): 5 – 22

Lowden, A, Moreno, C, Holmbåck, U, Lennernås, M. and P. Tucker (2010) *Eating and shift work – effects on habits, metabolism and performance*, Scandinavian journal of work, environment and health, 36(2): 150 – 162

Marshall N.S, Glozier N. and R.R. Grunstein (2008) *Is sleep duration related to obesity? A critical review of the epidemiological evidence*, Sleep medicine reviews, 12: 289 – 298

McMenamin T.M. (2007) *A time to work: recent trends in shift work and flexible schedules*, Monthly labour review, 130: 3 – 15

Miller, J.C. (2006) *Fundamentals of shiftwork scheduling*, US Air Force research laboratory publication AFRL-HE-BR-TR-2006-0011, Brooks City-Base, Texas, USA

Monk T.H. and S. Folkard (1992) *Making shift work tolerable*, CRC Press Inc.

Pack A.I, Pack A.M, Rodgman E, Cucchiara A, Dinges D.F. and C.W. Schwab (1995) *Characteristics of crashes attributed to the driver having fallen asleep*, Accident analysis and prevention, 27(6): 769 – 775

Pesch, B, Harth, V, Rabstein, S, Baisch, C, Schiffermann, M, Pallapies, D, Bonberg, N, Heinze, E, Spickenheurer A, Justenhoven, C, Brauch, H, Hamann, U, Ko, Y, Straif, K. and T. Brüning (2010) *Night work and breast cancer – results from the German GENICA study*, Scandinavian journal of work, environment and health, 36(2): 134 – 141

Puttonen, S, Härmä, M, C Hublin (2010) *Shift work and cardiovascular disease – pathways from circadian stress to morbidity*, Scandinavian journal of work, environment and health, 36(2): 96 – 108

Reason, J. (1990) *Human error*, New York, Cambridge University Press

Samn, S.W. and L.P. Perelli (1982) *Estimating aircrew fatigue: a technique with application to airlift operations*, Technical report SAM-TR-82-21, Brooks AFB, TX: USAF School of Aerospace Medicine

Scheer F.A, Hilton M.F, Mantzoros C.S. and S.A. Shea (2009) *Adverse metabolic and cardiovascular consequences of circadian misalignment,* Proceedings of the National Academy of Science USA. 106(11): 4453 – 4458

Straif, K, Baan, R. Grosse, Y, Secretan, B.E, Ghissassi, F.E, Bouvard, V, Altieri, A, Benbrahim-Tallaa, L. and V. Cogliano (2007) *Carcinogenicity of shift-work, painting and fire-fighting*, Lancet oncology, 8: 1065 – 6

Suwazono, Y, Uetani, M, Oishi, M, Tanaka, K, Morimoto, H, Nakada, S, K Sakata (2010) *Estimation of the benchmark duration of alternating shift work associated with increased total cholesterol levels among male Japanese workers*, Scandinavian journal of work, environment and health, 36(2): 142 – 149

Thorpy M. (2010) *Classification of sleep disorders,* Meir H, Kryger M.H, Roth T. and W.C. Dement (Eds.) Principles and practice of sleep medicine, 5th ed. St Louis, MO: Elsevier (Saunders): 680 – 693

Van Dongen, H.P, Maislin, G, Mullington, J.M. and D.F. Dinges (2003) *The cumulative cost of additional wakefulness: dose-response effects on neurobehavioral functions and sleep physiology from chronic sleep restriction and total sleep deprivation*, Sleep, 26(2): 117 – 126

Williamson A, Lombardi D.A, Folkard S, Stutts J, Courtney T.K. and J.L. Connor (2011) *The link between fatigue and safety*, Accident analysis and prevention 43(2): 498 – 515

## A.2 BIBLIOGRAPHY

**Chemical Safety and Hazard Investigation Board (CSB) (http://www.csb.gov)**

*Investigation report. Refinery explosion and fire: BP, Texas City, Texas, March 23, 2005*, No. 2005-04-I-TX (2007)

**Civil Aviation Safety Authority (CASA) (http://www.casa.gov.uk)**

*Biomathematical fatigue modelling in civil aviation fatigue risk management – application guidance*, Civil Aviation Safety Authority (CASA) Human Factors Section (2010)

*Fatigue management for flight crew members*
http://www.casa.gov.au/wcmswr/_assets/main/download/caaps/ops/48_1.pdf

*Proposed civil aviation advisory publication – CAAP 48-1(0) – Fatigue management for flight crew members*, Annex C (2012)
http://www.casa.gov.au/wcmswr/_assets/main/newrules/ops/nprm/nprm1202os-annexc.pdf

**Department of Transport (DTP) (https://www.gov.uk/government/organisations/department-for-transport)**

*Interviews with operators, regulators and researchers with experience of implementing fatigue risk management systems*, Road safety research report no. 120, (2010) http://assets.dft.gov.uk/publications/fatigue-risk-management-systems-a-review-of-the-literature-road-safety-research-report-110/rsrr120.pdf

**Energy Institute (EI) (http://www.energyinst.org)**

*Human Factors Awareness: web-based training course*, Module on fatigue, http://www.eihoflearning.org

*Human factors – top 10 issues*
http://www.energyinst.org/technical/human-and-organisational-factors/human-factors-top-ten

**Health and Safety Executive (HSE) (https://www.hse.gov.uk)**

*An intervention using a self-help guide to improve the coping behaviour of nightshift workers and its evaluation*, HSE CRR 365/2001, HSE Books (2001)
http://www.hse.gov.uk/research/crr_pdf/2001/crr01365.pdf

*Effect of shift schedule on offshore shift workers' circadian rhythms and health*, HSE RR 318, (2005)

*Five steps to risk assessment*, HSE Leaflet INDG163 (rev3), revised 06/11 (2011)
http://www.hse.gov.uk/pubns/indg163.pdf

*Guidance for managing shift work and fatigue offshore*, offshore information sheet No. 7/2008 (2008)
http://www.hse.gov.uk/offshore/infosheets/is7-2008.htm

*Human factors strategy*, Hazardous installations division human factors team
http://www.hse.gov.uk/offshore/humanfactorsstrategy.pdf

*Involving your workforce in health and safety: good practice for all workplaces*, HSE books, (2008)

http://www.hse.gov.uk/pubns/books/hsg263.htm

*Psychosocial aspects of work and health in the North Sea oil and gas industry: summaries of reports published 1996-2001*, HSE RR 002, HSE Books (2002)

*The development of a fatigue/risk index for shift workers*, Research report RR446, (2006)

http://www.hse.gov.uk/research/rrhtm/rr446.htm

**International Agency for Research on Cancer (IARC) (http://www.iarc.fr)**

*Painting, firefighting, and shift work*, IARC monographs on the evaluation of carcinogenic risks to humans. vol 98. Geneva, Switzerland: World Health Organization Press; (2010)

http://monographs.iarc.fr/ENG/Monographs/vol98/mono98.pdf

**International Atomic Energy Agency (IAEA) (http://www.iaea.org)**

AEA-TECDOC-1358 *Means of evaluating and improving the effectiveness of training of nuclear power plant personnel* (2003)
http://www-pub.iaea.org/MTCD/publications/PDF/te_1358_web.pdf

**International Civil Aviation Organization (ICAO) (http://www.icao.int)**

*FRMS implementation guide for operators*, ICAO / IATA / IFALPA, 1st Ed. (2011)

*FRMS manual for regulators*, 2011 Edition (Doc 9966), ICAO (2011)

**IPIECA (https://www.ipieca.org)**

*Controlling health risks at work: a roadmap to health risk assessment in the oil and gas Industry*, http://www.ogp.org.uk/pubs/384.pdf

**Minerals industry risk management gateway (MIRMgate) (https://www/mirmgate.com)**

*Fatigue management for the Western Australian mining industry*
http://www.mirmgate.com/index.php?coreId=212

**National Sleep Foundation (https://www.sleepfoundation.org)**

*Sleep in America poll*
http://www.sleepfoundation.org/sites/default/files/2002SleepInAmericaPoll.pdf

**New South Wales Mine Safety Advisory Council (http://www.nswminesafety.com.au)**

http://www.resources.nsw.gov.au/safety/world-leading-ohs/fatigue

**Transport Canada (https://www.tc.gc.ca)**

*Fatigue risk management system for the Canadian aviation industry. Developing and implementing a fatigue risk management system*, TP 1457E,
http://www.tc.gc.ca/eng/civilaviation/standards/sms-frms-menu-634.htm

**United States Nuclear Regulatory Commission (https://www.nrc.gov)**

*Assessment of the NRC's 'Policy on factors causing fatigue of operating personnel at nuclear reactors'*, report forming part of COMSECY-04-0014 – Status of 10 CFR Part 26 Rulemaking activities for drug testing and fatigue

**WorkCover, New South Wales (https://workcover.nsw.gov.au)**

*Occupational health and safety consultation code of practice* (2001)
http://www.aeromech.usyd.edu.au/ohsrm/workcover/Code%20of%20Practice%20for%20OHS%20Consultation%20(cop_ohsconsultation).pdf

**Other citations**

Dawson, D, etal (2011) *Fatigue-proofing: A new approach to reducing fatigue-related risk using the principles of error management*, Sleep medicine reviews (2011): 1 – 9

Dinges, D.F. (1995) *An overview of sleepiness and accidents*, Journal of sleep research, 4(S2): pp.4 – 14

# ANNEX B
# GLOSSARY OF TERMS, ABBREVIATIONS AND ACRONYMS

## B.1 TERMS

| | |
|---|---|
| accident/incident investigation | A formal method of examining evidence following an incident or accident to determine the immediate and underlying ('root') causes. |
| actigraphy | A non-invasive method of measuring activity and rest cycles. Data are collected via a wrist-worn device containing an accelerometer that measures movement, which is used to calculate the wearer's activity / sleep state. |
| alertness | The state of being attentive and watchful and ready to respond to a stimulus. |
| Antihistamine | A chemical substance found in common medicines, e.g. hay fever preparations, some of which can cause drowsiness. |
| backward rotating shift [backward-rotation] | A shift system where the shift changes to an earlier shift period at each shift change, thus from morning to nights to afternoons. |
| circadian rhythm | A predictable and regular 24-hour pattern seen in many bodily processes such as body temperature, hormone production and sleepiness. Circadian rhythms are generated by a cluster of cells in the brain referred to as the body clock. |
| fatigue | Reduced mental and physical functioning caused by sleep deprivation and/or being awake during normal sleep hours. This may result from extended work hours, insufficient opportunities for sleep, failure to use available sleep opportunities, or the effects of sleep disorders, medical conditions or pharmaceuticals which reduce sleep or increase sleepiness. |
| fatigue risk management plan (FRMP) | An FRMP is a risk-based plan or system of controls, that identifies, monitors and manages fatigue risk, with the aim of ensuring that, so far as reasonably practicable, employees are performing with an adequate level of alertness. |
| fitness for duty | The state of having adequate mental and physical ability and readiness to work safely. Someone who is fit for work will not be impaired by illness: fatigue; drugs; medicines; alcohol, or personal problems. |
| forbidden zone for sleep | A period of the circadian rhythms in alertness and sleep propensity, which usually occurs in the early evening, when alertness is high and sleep is unlikely. |
| forward rotating shifts | A shift system where the shift changes to a later shift period at each shift change, thus from morning to afternoon to night shifts. |

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| hazard | Anything with the potential to cause harm. It could be an obvious feature of the workplace such as moving machinery, sharp tools, corrosive or toxic chemicals, or it could be less immediately obvious, such as a poor organisational safety culture or lack of safety training. |
| hazard identification | The process used to identify things with the potential to cause harm and the first step in the risk management process. |
| human factors | Refers to environmental, organisational and job factors, and human and individual characteristics which influence behaviour at work in a way which can affect health and safety. A simple way to view human factors is to think about three aspects: the job, the individual and the organisation and how they impact people's health and safety-related behaviour. |
| insomnia | A disorder of too little or poor-quality sleep, usually either in the form of (1) difficulty falling asleep, (2) sleeping lightly and restlessly, waking often, lying awake in the middle of the night and/or (3) waking early and being unable to get back to sleep. |
| lapse | A type of human error in which a person has a brief loss of memory (forgets something) or attention (is distracted or loses concentration). |
| micro-sleeps | Brief (usually <15 seconds) episodes of sleep during which there is complete failure to respond to a task, accompanied by droopy eyes, slow eye-closures and head nodding. |
| naps | short (intentional) periods of sleep that can be taken during break periods within a shift as a strategy for improving alertness. May be used as an emergency countermeasure where alertness is required to enable the completion of a task or to get to a place where proper sleep can be obtained (e.g. during a long drive). |
| narcolepsy | A sleep disorder, the main characteristic of which is excessive and irresistible daytime sleepiness. Leads to very rapid falling asleep, and the rapid onset of REM sleep whilst napping. |
| night work | Work taking place at any time during the period between midnight and 0500, according to the International Labour Organisation (ILO) convention on night work. |
| periodic limb movement disorder | A sleep disorder characterised by twitching, jerking or bending of the limbs (usually the feet or toes) during sleep; or movements that occur every 5 to 90 seconds and last between c.0.5 and 10 seconds. Can range from small toe twitches to kicking and flailing of the arms and legs. Can momentarily awaken the individual, and significantly affect sleep quality. |

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| rapid eye movement (REM) | A natural stage of sleep, characterised by the eyes moving rapidly and randomly. Although considered to be the stage of lightest sleep, during which dreams are most likely to be remembered, REM sleep is nevertheless important for sleep to be of maximal benefit and is thought to play an important role in memory consolidation. |
| restless leg syndrome | Discomfort in the legs whilst awake causing uncontrollable urges to move them in order to relieve the discomfort. It can be reported as tingling, prickly or like having insects crawling inside your legs. The urge to move to relieve discomfort delays or interrupts the process of going to sleep and so it is commonly associated with sleep loss. |
| risk | The likelihood that a hazard will cause a specified harm to someone or something. |
| risk assessment | A formal and systematic method for examining the hazards in the workplace and assessing the risk of those hazards causing harm. The second step in the risk management process. |
| risk assessment tool | A framework that allows hazards to be examined and the risks quantified. |
| risk matrix | A system whereby the acceptability of a risk is determined through combining the severity of the risk with the probability of its occurrence. These two factors are taken into consideration to allow the risk to be defined as acceptable, acceptable with mitigation, or unacceptable. |
| rollover shift | see *split shift* |
| shift work | Any regularly taken employment outside the day working window, defined arbitrarily as the hours between 0700 and 1800. Shiftwork often involves organising work in shifts whereby workers succeed each other at the same work stations according to a certain pattern, including a rotating pattern, and which may be continuous or discontinuous, entailing the need for workers to work at different times over a given period of days or weeks. |
| sleepiness | Difficulty in maintaining the wakeful state associated with an increased likelihood of falling asleep. |
| obstructive sleep apnoea hypopnoea syndrome (OSAHS): | A sleep disorder in which a person has irregular breathing at night and is excessively sleepy during the day. The upper airway (pharynx) collapses repeatedly, at irregular intervals, during sleep. Apnoea occurs when the airway collapses and is blocked completely, cutting off the flow of air. Hypopnoea occurs when the collapse is only partial. Risk factors for sleep apnoea include obesity and a large neck circumference (>17 inches). More common in men, particularly those aged over 50. |
| sleep debt | The cumulative effect of not getting enough sleep over multiple days. |

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| sleep hygiene | Sleep promoting habits, such as keeping the bedroom dark, cool, quiet and work-free, and establishing a consistent pre-bedtime routine. |
| sleep inertia | The groggy feeling and cognitive impairment associated with waking from sleep that can last for five minutes to longer than 30 minutes. Particularly severe when waking from deep sleep, in the early morning or when sleep-deprived. |
| sleep loss | Occurs when an individual does not obtain sufficient sleep to be fully alert and refreshed in the morning. Can be acute or cumulative. |
| acute | A short period of sleep loss, occurring over a period of only one or two nights. |
| cumulative | Sleep loss (often a small amount each night) which is accrued over a number of nights/weeks, which can be due to factors relating to working or commuting hours. |
| sleep need | The amount of sleep an individual requires in order to feel refreshed and fully alert. |
| sleep/wake cycle | The pattern of sleep and wake undertaken by an individual. Generally linked to outside time clues such as light and dark. May get out-of-synch with the body's circadian mechanisms after time-zone transition. |
| slip | A type of human error in which a person performing a physical act (operating a control, looking at a display) fails to perform the task correctly (operates the wrong control, operates the right control but in the wrong direction, looks at the wrong display or misreads the right display etc). |
| split shift | Synonymous with swing shift and rollover shift. A shift pattern in which a long period of days is followed by a long period of nights (or vice versa). A typical offshore split shift is a 14-day tour starting with night shifts of 12 hours for the first half of the tour then changing to day shifts for the second half. |
| swing shift | see *split shift* |
| Swiss cheese model | A model of accident causation first proposed by Professor James Reason (Reason, 1990). From this perspective high technology systems are considered to have many defensive layers whose function is to protect people and assets from hazards. Ideally these layers would all be intact, but in reality each layer may contain 'holes' (hence the Swiss cheese analogy) that are continually opening, closing and moving. These holes result from active failures (unsafe acts committed by those in direct contact with the system) or latent conditions (arising from decisions made by management, system designers and others), which may lie dormant before combining with active failures to create an accident opportunity. |
| tiredness | Temporary loss of strength and energy resulting from sleep loss or demanding mental or physical activity . |

## B.2 ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| ACOEM | American College of Occupational and Environmental Medicine |
| ACT | alertness consideration tool |
| ANSI | American National Standards Institute |
| API | American Petroleum Institute |
| CBT | computer-based training |
| DfT | UK Department for Transport |
| EAP | employee assistance programme |
| EI | Energy Institute |
| FRMP | fatigue risk management plan |
| FRMS | fatigue risk management system |
| HOFCOM | Human and Organisational Factors Committee |
| HoW | hours of work |
| HSE | UK Health and Safety Executive |
| ICAO | International Civil Aviation Authority |
| ICMM | International Council on Mining and Metals |
| IPIECA | International Petroleum Industry Environmental Conservation Association |
| MSAC | Mine Safety Advisory Council |
| NRC | US Nuclear Regulatory Commission |
| NREM | non-rapid eye movement |
| NTSB | US National Transportation Safety Board |
| OGP | International Association of Oil and Gas Producers |
| PPE | personal protective equipment |
| REM | rapid eye movement |
| RP | recommended practice |
| SMS | safety management system |
| WOCL | window of circadian low |

# ANNEX C
# GUIDELINES FOR SHIFT SCHEDULE DESIGN

Humans have evolved to be asleep at night, so any shift schedule involving work in the evening, night or early morning will usually be associated with a degree of sleep loss and a consequent increase in fatigue. However, by adhering to some basic scheduling principles it is possible to minimise the fatigue associated with shift schedules. The following nine principles for good practice in shift scheduling have been proposed by Miller (2006). It is acknowledged that it will not always be possible or practicable to adhere to all of the principles, and in these circumstances it is recommended that additional fatigue mitigations are identified and documented. These additional mitigations could include task rotation, increased communication, establishing a buddy system or assigning additional personnel to a task during the night, caffeine consumption and a napping schedule.

**Principle 1 – Adopt a shift plan that maintains circadian stability**
Ideally, the shift schedule should enable workers to maintain the natural human sleep/wake pattern; that is, to be awake during the day and asleep at night. In reality this will not always be possible and so it is recommended that efforts are made to minimise exposure to night work, with a maximum of three consecutive night duties being acceptable.

An alternative approach is to work only nights and to attempt to invert the circadian rhythm, such that one becomes entrained to be awake at night and asleep during the day. This requires the individual to take steps to prevent morning sunlight from resetting the body clock to the norm; thus, avoiding all exposure to bright light and morning sunlight upon finishing the night duty (e.g. by wearing sunglasses and a peaked hat), sleeping early in the day in a very dark environment, and being exposed to bright light during the first part of the night shift.

**Principle 2 – Keep shift duration to no more than eight hours**
A study bringing together the findings from three field studies conducted with companies involved in 24/7 shift work (Folkard and Tucker, 2003) showed that, for these companies, the risk of injury or accident in the 12th hour of work was more than double that during the first eight hours. As a result it has been suggested that shift durations should be limited to eight hours, except where the work is low stress and does not involve high vigilance activities. Where shift duration does exceed eight hours it is recommended that additional fatigue mitigation strategies are implemented towards the end of duties, that safety-critical or monotonous activities are scheduled to occur during the first part of the shift, and that supervisors and employees receive training to help them spot the signs of fatigue in themselves and in others.

**Principle 3 – Minimise the number of consecutive night shifts**
Folkard and Tucker (2003) also looked at the increased risk associated with working consecutive night shifts in seven companies and found that risk of injury or accident was 6 % higher on the second night, 17 % higher on the third night, and 36 % higher on the fourth night shift. (Consecutive day shifts in the same companies were associated with increases of 2 %, 7 % and 17 % respectively).

**Principle 4 – Ensure that adequate time off for recovery is provided after night shifts**
To ensure that a worker has sufficient time to recover from the fatigue accrued when working at night, best practice recommends that each night shift should be followed by 24 hours off. In reality, 12-hour breaks between consecutive night duties are more typical within the oil and gas industry, with workers being compensated by an equal amount of time off at the end of a block of duties (e.g. seven nights/seven off).

In addressing this principle, the day immediately after a night shift should properly be treated as a recovery day, as the worker will need to use that day to recover from the fatigue accrued on the night duty. Hence, the schedule DDNN/OOOO should be treated as DDNN/ROOO, where D = day, N= night, O = off and R = recovery.

In remote locations, or where the workforce is housed in a camp, attention should be given to the quality of time off. First, do workers' accommodation areas provide the best opportunity for good quality, restful sleep (particularly for those who have to sleep during the day)? Second, where workers have a rest day (as opposed to a 12-hour break between duties) are there adequate rest and recreational facilities available?

**Principle 5 – Maximise the number of free days on weekends**

A weekday-only worker receives 104 weekend days off per year. For shift workers, this figure may be considerably less, depending on the shift schedule being worked. One of the challenges for the scheduler, therefore, is to address shift workers' concerns over the perceived inequity with their weekday-only colleagues. In many organisations the solution to this problem is to compress the working week into fewer, longer duties (e.g. 12 hours rather than eight). However, given that 12-hour duties are associated with an elevated level of fatigue, some job functions may not be well suited to longer durations.

One approach for addressing this principle is to align the schedule with the working week, by using a shift plan with a cycle length that is a multiple of seven days, then aligning the plan in such a way that good quality rest days (as opposed to recovery days) fall on the weekend. Alternatively, a shift plan cycle length that is not a multiple of seven days can be adopted, such that the alignment of the shift plan with the days of the week changes from week to week, but in a predictable manner. For more information see Miller (2006).

**Principle 6 – Provide a minimum of 104 days off per year**

A shift worker working a combination of day and night duties is exposed repeatedly to circadian disruption and the resulting cumulative fatigue. As a consequence, whereas 104 weekend days is sufficient for recovery for a weekday only worker, shift workers need more rest days to ensure that they are fully recovered before returning to work. Moreover, one also needs to consider the social and wellbeing aspects of a shift schedule: for the workforce to be content to work a roster other than the standard Monday – Friday pattern there needs to be some compensation for the hardships of working at non-standard times. The roster mentioned in principle 4 (DDNNOOOO) – when worked by a four-crew panel provides 182 days off per year. However, following principle 4, one of these days off each week should be treated as a recovery day, resulting in 136 good quality rest days off.

**Principle 7 – Equity**

As well as ensuring equity with other (weekday only) workers, ensure that all shift workers within a workforce are treated equally with regard to the schedules to which they are assigned. For example, where there is an occasional requirement to work extended duties, multiple consecutive duties, nights and weekend work, care is required to ensure that these duties are shared equally amongst the workforce.

In addition, when choosing from one of a number of scheduling options, it is recommended that the workforce (or representatives thereof) is involved in the design and selection of a preferred schedule, to encourage buy-in for the chosen option.

**Principle 8 – Predictability**

For shift workers with families or social commitments, roster predictability can be a significant issue. Being able to predict work-days and rest-days far into the future enables the individual shift worker to plan family and social occasions around their work schedule. A shift schedule that is unpredictable or prone to last-minute alterations may cause family stress and have a damaging effect on workforce morale.

**Principle 9 – Quality of time off**

Principle 4 shows that the quality of time off could be a major concern for those in remote locations. However, even for those who are not working in remote locations, the quality of time off may also be a significant issue. Compressed work schedules (e.g. working four consecutive 12-hour duties: DDNNOOOO) offer the potential for an extended period of rest which may be perceived as being of higher value than two weekends (depending on the personal circumstances of the individual).

However, in creating schedules that provide an opportunity for extended rest breaks, one needs also to consider the potential for 'moonlighting' that arises when a worker has several consecutive days off. If a worker is provided with an extended rest period to enable them to recover from the rigours of a particular shift schedule, then it is important that they use this opportunity to obtain adequate rest, rather than to work a second job. A company's fitness for duty policy should make it clear that employees have a responsibility to use time off for recovery and to ensure that they are fit for subsequent duties.

# ANNEX D
# GUIDANCE ON FATIGUE RISK MANAGEMENT AT OFFSHORE AND REMOTE SITES

There are many reasons why fatigue risk can be elevated onshore and why an FRMP can be particularly beneficial in this environment. An FRMP can also be implemented offshore; however, there are important differences between typical refineries/chemical plants and offshore platforms, which mean that the guidance provided in this document may not always be directly applicable offshore. Working at remote onshore facilities shares many characteristics with working on offshore platforms, and also requires special consideration.

The remainder of this annex provides information relevant for FRMP implementation offshore, including some of the key differences between the typical onshore and offshore work environments.

**Work hours are long and shift patterns can promote fatigue**

– Offshore daily work hours and tours are long: typical shifts are 12 hours long for a period of 14 to 21 days (tour), sometimes with overtime, followed by long periods of time off of a similar duration.
– Offshore shift patterns involve weeks of working the same shift: there are different methods of arranging the shift patterns on the 14 or 21-day tour, i.e. all days, all nights or split shifts (rollover or swing shifts) where a mid-tour shift change takes place at the end of the first week.
– A typical offshore split shift is a 14-day tour starting with night shifts of 12 hours for the first half of the tour then changing to day shifts for the second half. This pattern is often the workforce's preferred option because at the end of the pattern they return onshore acclimatised to normal daylight hours. However, the disadvantage is that the elevated risk associated with the fatigue that accumulates across the night shifts is experienced while the individual is at work, thus elevating the risk to the operation. Research has clearly shown that the pattern is amongst the most fatiguing and there are other patterns that are preferable from a health and safety perspective.
– Research shows that, compared to working onshore, offshore crew experience more and quicker circadian adaptation to the shift they are working (usually dayshift or nightshift). This is largely because they are isolated from social or domestic responsibilities that interfere with sleep, can avoid exposure to light, and do not have a commute.
– It is common for managers to work significantly longer than scheduled hours.

**The offshore environment usually promotes sleep**

– The offshore environment has some particular advantages for sleep, the primary one being that living in company-provided accommodation, and being isolated from normal daily family and social responsibilities, can enable offshore workers to convert a relatively high amount of time off into sleep. Employees are also isolated from normal household noise and interruptions (telephone, visitors to the home, light). A second advantage offshore for sleep is that sleep facilities, for example cabins or bunk rooms, are generally well designed for sleep (e.g. cool, dark, quiet and comfortable). The sleeping, working and recreation environment offshore can be more carefully controlled than in onshore operations.
– Offshore workers can, however, experience disrupted sleep due to noise associated with continuous production offshore, as well as cabin sharing. Other workers on board are generally sympathetic to their co-workers' need for sleep; however, it is not

uncommon for workers to complain of sleep disruption on shift changeover days, when workers about to leave the rig are less sensitive to the sleep needs of other workers.

**Long commutes and jet lag can pose a fatigue risk**

- The offshore worker may have a long, difficult journey, which could involve crossing multiple time zones, to and from the workplace at the start and end of the tour. Individuals working in remote FIFO (fly-in-fly-out) operations can also travel internationally to get to work and then remain in camp for typically 28 days. It is common for offshore and FIFO workers to be expected to commence work soon after arriving, when they may be tired and suffering the effects of jet lag. Some organisations, mindful of the risks associated with such a situation, roster a shorter first day (either a late start or an early finish) and minimise safety-critical activities during the first 24 hours on site.
- Other strategies for managing the fatigue risk associated with commuting include providing employee bus transport (rather than employees self-driving to/from work) and providing accommodation to enable employees to sleep before/after commuting.
- To limit jetlag and encourage acclimatisation to a new time zone the following strategies are recommended:
  - On arrival, try to match the timing of sleep and wake, meals and exercise to the new time zone.
  - Use caffeine to help you to remain awake during the day (avoid caffeine in the evening).
  - Avoid exposure to light at night time. If you wake during the night and can't get back to sleep, try reading a book in low light and don't use your computer.
  - After a westward flight, it is important to stay awake during daylight hours at the new destination and sleep only after it gets dark.
  - After an eastward flight, it is important to remain awake in the morning but to avoid bright morning light. It is also recommended to be outdoors as much as possible in the afternoon at the new destination.
  - For both directions, some moderate exercise when bright light exposure is advised may reinforce the acclimatisation process.

**Contingency planning is essential offshore**

As offshore installations are in a remote environment, shift and staffing arrangements have to include contingency for unusual circumstances that might require additional working hours or additional personnel. Such circumstances include: injuries/incapacitation of personnel, or tasks taking longer than anticipated owing, for example, to poor weather conditions. Contingency arrangements may include the need to rearrange tasks or reschedule work; having available a multi-skilled workforce, or slightly increasing staffing levels with personnel able to deploy additional skills.

**Summary of the HSE research into offshore fatigue**

The HSE has published a series of reports relating to fatigue and shift work in offshore environments. Table D.1 summarises the key findings from these reports.

**Table D.1 Summary of HSE research into offshore fatigue**

| Title of publication | Main findings |
|---|---|
| HSE (2010) *Offshore working time in relation to performance, health and safety – A review of current practice and evidence* | Fixed shifts (e.g. 14 nights) work better as they minimise circadian disruption.<br>Rollover/mid shift changes are preferred by personnel.<br>Evidence suggests circadian disruption associated with night work and rollover patterns leads to increased injury rates.<br>Construction and maintenance workers found more likely to be at risk of injury during night work.<br>Gastric problems and sleep disturbances more likely to be experienced by night/shift workers.<br>Small UK study found no clear evidence of ill effects of three weeks offshore, three weeks onshore rotation on alertness, mood or sleep, although there were markedly lower satisfaction ratings for 3-3 schedules relative to 2-2 schedules. |
| HSE (2002) *Psychosocial aspects of work and health in the North Sea oil and gas industry, Summaries of reports published 1996-2001* | Night shift workers more likely to have gastric problems and sleep disturbances than day-shift workers.<br>Injuries occurring during the night shift were more likely to be severe (fatality or serious injury) than during the day shift.<br>Night shift workers more likely to visit sick bay than day shift workers, especially due to accidents.<br>The offshore environment facilitates circadian adjustments arising from shift work changes from days to nights (and vice versa).<br>Fixed shift patterns are less detrimental to sleep, alertness and performance.<br>The majority of personnel would prefer a rollover shift comprising seven nights followed by seven days.<br>Rollover shift patterns such as this present a greater risk of adverse outcomes.<br>Fixed shift patterns halve the number of circadian adjustments required compared to rollover shifts (seven days and seven nights) |
| HSE (2005) *Effect of shift schedule on offshore shift workers' circadian rhythms and health* | Mid shift changing schedule (seven nights and seven days) causes the greatest amount of desynchrony, promotes cumulative fatigue and jeopardises alertness.<br>A fixed schedule of 14 days or 14 nights represents the lowest amount of desynchrony, with the most favourable schedule being from 06:00 – 18:00 or vice versa for the 14 consecutive duties. |

**Further reading**

HSE (2008) *Guidance for managing shift work and fatigue offshore*, offshore information sheet No. 7/2008,
http://www.hse.gov.uk/offshore/infosheets/is7-2008.htm

# ANNEX E
# COMMON OPERATIONAL QUESTIONS

**What is the difference between fatigue, tiredness and sleepiness?**

In the operational environment, the term fatigue is more commonly used than the terms tiredness and sleepiness. The three terms tend to be used interchangeably, or as synonyms; however, this is not the only way the terms are used and some people understand there to be a clear distinction between fatigue, tiredness and sleepiness. One of the more frequently cited differences between tiredness and fatigue relates to duration. Some people view tiredness as being relatively short-term (for example as the result of remaining awake for 24 hours) and fatigue as more long-term or chronic (for example the result of inadequate sleep over a month). The term 'sleepiness' tends to be used more specifically, particularly in scientific literature, to refer to the likelihood that someone will fall asleep.

Before commencing the development of an FRMP, speaking with employees to gain an insight into their existing understanding of the terms fatigue, tiredness and sleepiness is recommended. This will enable the organisation to ensure there is a common understanding of the terms used, which can be crucial for effective communication, education and ultimately employee buy-in to the FRMP.

**Are there differences between the management of physical and mental fatigue?**

Compared to mental fatigue, physical fatigue is typically better understood and the strategies for managing physical fatigue are more obvious. Physical fatigue, for example due to manual labour or working in challenging environmental conditions, simply increases the longer someone is engaged in the task, or is exposed to the source of fatigue. The solutions to physical fatigue usually involve taking a break, changing or redesigning tasks. Sleep is not required – at least in the short term.

The organisation may already have effective processes in place for managing physical fatigue, for example: limits on the amount of time employees can spend underground or, in very hot climates, outside; rest procedures, and ensuring that fresh drinking water is always available.

In contrast, the accumulation and management of mental fatigue is more complex. In addition to increasing the longer someone is engaged in a task, mental fatigue is powerfully influenced by the amount of sleep the individual has obtained and the circadian rhythm in alertness.

To manage mental fatigue, the strategies for managing physical fatigue are usually of limited or no benefit. For example, taking a break will be of minimal value if an individual is working in a sleep-deprived state during the early hours of the morning. Fundamentally, to prevent and recover from mental fatigue the only strategy is to obtain adequate sleep.

An FRMP considers both physical and mental fatigue, but the key benefit of the plan is typically the effective management of mental fatigue; while many organisations may have effective measures in place to manage physical fatigue, mental fatigue has not been comprehensively addressed. Furthermore, as tasks become more automated and employees move from being operators to observers primarily involved in monitoring tasks, there is an increased need to manage mental fatigue.

**Are some tasks more sensitive to fatigue?**

Those familiar with other definitions of fatigue may note that the definition provided at the start of the document does not consider the various 'contributors' to fatigue that are associated with the task being undertaken. For example:

– the fatigue that accumulates due to time-on-task (for example during a long driving task);

- tasks undertaken in challenging environmental work conditions (for example hot conditions);
- physically demanding tasks (for example heavy lifting tasks);
- high workload tasks (for example complex tasks requiring divided or intense concentration);
- tasks involving proactive planning, and
- unstimulating or monotonous tasks.

Rather than classifying these task-related factors as 'causes' of fatigue[7], the definition acknowledges them as modulating factors that determine how susceptible a task is to fatigue . In other words, the consequences of fatigue for performance depend on the task being performed. While some tasks are susceptible to fatigue, others are more resilient. When we are fatigued, tasks that are susceptible or sensitive to fatigue are particularly likely to be performed erroneously, whereas tasks that are less susceptible (sometimes referred to as 'fatigue resilient') are more likely to be able to be performed adequately.

For example, a control panel operator who has only had four hours of sleep before starting a night shift, and who undertakes a long, monotonous monitoring task in poorly lit conditions, is relatively likely to commit fatigue-related errors. In contrast, if the task involved brief periods of work with regular breaks, was designed in such as a way as to sustain the operator's interest and was undertaken in a well-lit environment, the same fatigued operator may be more likely to perform adequately.

The task of driving is especially susceptible to fatigue because it requires constant vigilance for extended periods of time, often in monotonous conditions. In addition, a brief lapse in attention whilst driving can have catastrophic consequences.

Tasks that are more resilient to fatigue tend to be self-paced, interesting to the operator, involve some physical activity and a moderate amount of workload. Giving consideration to the susceptibility of a task to fatigue, and the steps that can be taken to reduce this susceptibility, can be a useful starting point for managing fatigue risk. Tasks can sometimes be made more resilient to fatigue via redesign, for example having a task completed by pairs rather than individual workers, or scheduling safety-critical tasks for times of day when employee alertness levels are high (and avoiding times of day when alertness is at a minimum). Section 4.6.2 provides more information on fatigue proofing, while the table of hazards and controls in Annex F.5 provides further examples of adjustments that can be made to tasks to make them more resistant or resilient to fatigue.

**Do people adapt to night work?**

When more than three consecutive night shifts are scheduled the timing of the body's circadian clock begins to change, or adapt. In the same way that after crossing multiple time-zones we gradually adapt to the new time-zone of our destination (jet-lag), we also slowly adapt to night work over many shifts (shift-lag). While adaptation sounds positive and some sites schedule long periods of consecutive nightshifts to promote adaptation, in reality there is limited evidence of complete adaptation to night work (see for example Ferguson et al, 2012).

The reason shift workers do not fully adapt is largely because the timing of the circadian rhythm is influenced by light. When working at night, shift workers are exposed to light at night but also during the day, for example during the drive home and in the afternoon. In addition, any adaption is undone during days off when employees return to their normal daytime activities and sleep at night.

7 Another defining feature of task-related 'contributors' to fatigue is that they can be well managed by simply taking adequate breaks from the task i.e. rest. In contrast, a break is of limited benefit for the fatigue associated with sleep loss or a sleep disorder.

An alternative strategy for scheduling night work is to only work a small number of consecutive night shifts and avoid adaptation. This approach is usually considered to be preferable in Europe.

It should be noted that, in the offshore working environment, it may be possible to provide an environment that is more conducive to adaptation, as long as strict guidelines are adhered to.

**How long should employees nap for: emergency naps versus scheduled rest?**
Research has established that – aside from the possible negative effects of sleep inertia – a fatigued individual will benefit more from a longer sleep than they will from a shorter nap. For this reason, where longer sleep is possible, it is recommended that fatigued employees should have the opportunity for a 90-minute sleep, sometimes referred to as 'scheduled rest'. Some organisations allow employees experiencing fatigue to take an emergency nap of around 30 minutes. Naps are most beneficial in time-critical operations where a longer sleep period is not possible. Naps certainly improve alertness in the short-term and because they are so short the individual is less likely to fall into deep sleep and wake with significant sleep inertia.

A scheduled rest period of 90 minutes will in theory enable an individual to progress through a single sleep cycle. During sleep we move from light to deep sleep and back into light sleep and it takes approximately 90 minutes to go through one full sleep cycle. At the end of a cycle (i.e. after c.90 minutes) the individual should be in a light stage of sleep, during which they can readily be woken and should experience minimal sleep inertia.

It should be noted that the figure of 90 minutes is only a guide. There are a number of variables which can influence sleep cycles and sleep inertia; 90 minutes is recognised as the sleep cycle length of the 'average' person, but factors such as time of day, how fatigued the individual is and how readily they are able to fall asleep, can all influence the timing and duration of sleep cycles and the extent of sleep inertia they experience upon wakening.

Therefore, it is recommended that employees returning to the workplace after completing their scheduled rest should not engage in safety-critical tasks such as driving for 30 minutes, to allow them to fully recover from the sleep. During this 30-minute recovery period it is recommended that they engage in activities that may help to refresh them before recommencing work (e.g. moderate exercise, use of caffeine, splashing cold water on the face).

# ANNEX F
# FRMP TOOLKIT

The materials in this toolkit are provided as examples only and should be adapted to suit the organisation's particular operational practices and risks.

## F.1 EXAMPLE FATIGUE RISK MANAGEMENT POLICY STATEMENT

___________ Company is committed to providing a safe work system and a safe and productive workplace by eliminating conditions and work practices that could lead to personal injury, equipment and other property damage.

Fatigue can impair fitness to work and may have negative impacts in the areas of health, safety, security and the environment (HSSE). _________Company's objective is that all employees recognise this threat and manage and minimise the associated risks.

In support of ___________Company's commitment [*asset name*] will:

- Create a safe working environment by managing the risks associated with fatigue using science-based risk assessment approaches, in combination with appropriate outcome measures, such as accidents and injuries, regularly review the results, and then take actions to reduce the risks.
- Strive to ensure off-duty time is sufficient to achieve eight hours of continuous sleep.
- Identify and manage work-related fatigue issues.
- Manage fairly and constructively people who are deemed unfit for work as a result of fatigue.
- Manage training and education related to fatigue management.

Underpinning this policy, individuals in HSSE critical positions are accountable for:

- Complying with the [*asset name*] FRMP.
- Striving to obtain the required sleep between shifts in order to minimise the risks associated with fatigue.
- Raising concerns about their own level of fatigue with their supervisor.
- Raising concerns about another operator's level of fatigue with that person and their supervisor.
- Notifying their supervisor of any situation where there has been a breach of policy.

## F.2 EXAMPLE OF A FATIGUE REPORT FORM

| **Fatigue report form** | | | | For office use only:<br>FRF No:_____ |
|---|---|---|---|---|
| **If you wish the contents of this form to remain confidential please tick here ☐** | | | | |
| **Name** | Date of birth<br>(DD/MM/YY): | Site | Job title | Today's date |
| **When did it happen?** | Date (DD/MM/YY)<br>____/____/____ | Time of incident<br>_____:_____ | How long have you been awake?<br>________ hours ________ mins | |
| **What happened?** | Describe the incident or your concern | | | |
| **What were you doing?** | At work<br>☐ | Driving to work<br>☐ | Driving home<br>☐ | Other ☐<br>_______ |
| **If at work, what task were you performing?** | | | | |

| **Shift details** | | |
|---|---|---|
| | Please describe your shift pattern (e.g. 3D/3N/3off) __________________________ | |
| | On which shift did the incident occur (e.g. 1st night) _________________________ | |
| | How many days in row had you worked?<br>____________________________________ | How many rest days had you worked in the previous four weeks?<br>____________________________ |
| | Scheduled work start time ____:____<br>Actual work start time ____:____ | Scheduled work start time ___:___<br>Actual work start time ____:_____ |

| **Why did it happen?**<br>Tick all factors that contributed to the incident/your general concern | | **Commute** | **Sleep history** |
|---|---|---|---|
| ☐ Early start time<br>☐ Late finish time<br>☐ Night shift<br>☐ Long shift<br>☐ Workload<br>☐ Schedule changes<br>☐ Commute<br>☐ Work stress | ☐ Problems at home<br>☐ Health<br>☐ Long-term fatigue<br>☐ Poor daytime sleep<br>☐ Poor night-time sleep<br>☐ Don't know<br>☐ Other (please add details)<br>_______________<br>_______________ | Not applicable (offshore)<br>☐<br>Average commute duration from home to work:<br>____HRS _____MIN<br>Average commute duration from work to home:<br>____HRS ____MIN | For the 48 hours prior to the incident, record start and finish times of all sleep (including naps): |

| | Date | Time |
|---|---|---|
| Start | / / | : |
| End | / / | : |
| Start | / / | : |
| End | / / | : |
| Start | / / | : |
| End | / / | : |
| Start | / / | : |
| End | / / | : |

<table>
<tr><th colspan="8">Tick all signs of fatigue you noticed in the two hours before the incident and any countermeasures used</th></tr>
<tr><th>Physical signs</th><th colspan="4">Cognitive signs</th><th colspan="3">Countermeasures</th></tr>
<tr><td>☐ NO PHYSICAL SIGNS WERE NOTED<br>☐ Rubbing eyes<br>☐ Yawning<br>☐ Frequent blinking<br>☐ Staring blankly<br>☐ Long blinks<br>☐ Difficulty keeping eyes open<br>☐ Head nodding<br>☐ OTHER: ___________</td><td colspan="4">☐ NO COGNITIVE SIGNS WERE NOTED<br>☐ Impaired attention<br>☐ Impaired memory<br>☐ Negative mood<br>☐ Reduced communication<br>☐ Impaired problem-solving<br>☐ Increased risk-taking<br>☐ OTHER: ______________</td><td colspan="3">☐ Advised colleague of fatigue risk<br>☐ Shared or coordinated workload<br>☐ Increased communication<br>☐ Had some caffeine<br>☐ Had something to eat<br>☐ Drank some water<br>☐ Had a nap<br>☐ OTHER: ________________</td></tr>
<tr><td>Describe how you felt immediately before the incident?</td><td>1<br>☐<br>Fully alert, wide awake</td><td>2<br>☐<br>Very lively but not at peak</td><td>3<br>☐<br>OK, somewhat fresh</td><td>4<br>☐<br>A little tired, less than fresh</td><td>5<br>☐<br>Moderately tired, let down</td><td>6<br>☐<br>Extremely tired, very difficult to concentrate</td><td>7<br>☐<br>Completely exhaused</td></tr>
<tr><td>Filing instructions</td><td colspan="7"></td></tr>
</table>

## F.3 FATIGUE INVESTIGATION CHECKLISTS

(Source: ACOEM Task Force (2012))

| Investigating procedure checklist 1 – Establishing the fatigued state | | |
|---|---|---|
| **Issue** | **Probes** | **Desirable response** |
| Quantity of sleep | What was the length of the last consolidated sleep period?<br>Start time?<br>Awake time?<br>Was sleep interrupted (for how long)?<br>Have you had any naps since your last consolidated sleep?<br>Duration of naps? | 7,5 - 8,5 hours<br>Normal circadian rhythm, late evening<br>Normal circadian rhythm, early morning<br>No<br>Yes<br>Had opportunity for restorative (1,5 – 2 hours) or strategic (20 minutes) nap prior to start of late shift. |
| Summary – establish whether or not there was a sleep debt | Describe your sleep patterns in the last 72 hours (apply sleep credit system). | Two credits for each hour of sleep; loss of one credit for each hour awake – should be positive value. |
| Quality of sleep | How did the sleep period relate to the individual's normal sleep cycle i.e. start/finish time? (See 'Quantity of sleep').<br>Sleep disruptions?<br>Sleep environment? | Normal circadian rhythm, late evening/early morning<br>No awakenings<br>Proper environmental conditions (quiet, comfortable temperature, fresh air, own bed, dark room). |
| Summary – establish whether or not the sleep was restorative. | Sleep pathologies? | None |
| Work history | Hours on duty and/ or on call prior to the occurrence? | Situation dependent – hours on duty and/or on call and type of duty that ensure appropriate level of alertness for the task. |

| | | |
|---|---|---|
| Summary – establish whether the hours worked and the type of duty or activities involved had an impact on quantity and quality of sleep. | Work history in preceding week? | Number of hours on duty and/or on call and type of duty that do not lead to a cumulative fatigue effect. |
| **Issue** | **Probes** | **Desirable response** |
| Irregular schedules | Was he/she a shift worker? | No. (Shift worker never fully adept in terms of sleep quantity). |
| | If yes, was it a permanent shift? | Yes – day shifts. |
| | If no, was it rotating (vs. irregular) shift work? | Yes – Rotating clockwise, rotation slow (1 day for each hour advanced), night shift shorter, and at the end of cycle. |
| | How are overtime or double shifts scheduled? | Scheduled when operator will be most alert in the context of their circadian rhythm. |
| | Scheduling of critical safety tasks? | Scheduled when operators will be most alert in the context of their circadian rhythm. |
| Summary – establish whether scheduling was problematic with regard to its impact on quantity and quality of sleep. | Is there a fatigue countermeasure programme in place? | Yes |

| **Investigation procedure checklist 2 – Establishing a link between fatigue and unsafe act/decision** | |
|---|---|
| **Performance impairment** | **Indicators** |
| **Attention** | Overlooked sequential task element<br>Incorrectly ordered sequential task element<br>Preoccupied with single tasks or elements<br>Exhibited lack of awareness of poor performance<br>Reverted to old habits<br>Focused on a minor problem despite risk of major one<br>Did not appreciate gravity of situation<br>Did not anticipate danger<br>Displayed decreased vigilance<br>Did not observe warning signs |

| | |
|---|---|
| **Memory** | Forgot a task or elements of a task<br>Forgot the sequence of tasks or task elements<br>Inaccurately recalled operational events |
| **Alertness** | Succumbed to uncontrollable sleep in form of micro-sleep, nap, or long sleep episode<br>Displayed automatic behaviour syndrome |
| **Performance impairment** | **Indicators** |
| **Reaction time** | Responded slowly to normal, abnormal, or emergency stimuli<br>Failed to respond altogether to normal, abnormal, or emergency stimuli |
| **Problem-solving ability** | Displayed flawed logic<br>Displayed problems with arithmetic, geometric or other cognitive processing tasks<br>Applied inappropriate corrective action<br>Did not accurately interpret situation<br>Displayed poor judgement of distance, speed, and/or time |
| **Mood** | Was less conversant than normal<br>Did not perform low-demand tasks<br>Was irritable<br>Distracted by discomfort |
| **Attitude** | Displayed a willingness to take risks<br>Ignored normal checks or procedures<br>Displayed a 'don't care' attitude |
| **Physiological effects** | Exhibited speech effects – slurred, rate, content<br>Exhibited reduced manual dexterity – key-punch entry errors, switch selection |

**See also:**

Worksafe Victoria, *Fatigue: Prevention in the workplace*
http://www.worksafe.vic.gov.au/__data/assets/pdf_file/0008/9197/vwa_fatigue_handbook.pdf

CS Energy, *CS Energy Procedure for fatigue management CS-OHS-12*
http://www.csenergy.com.au/userfiles/Fatigue%20management%20procedure.pdf

## F.4 TRAINING SYLLABUSES

This section provides two high-level training syllabuses for fatigue risk management training for both the workforce and managers. In addition to syllabus A, managers should also complete syllabus B.

### F.4.1 Syllabus A: fatigue risk management training for the workforce

**Background**

- The potential health and safety consequences of fatigue for the organisation and the individual.
- The unique challenges and fatigue risks confronting the company due to the specific nature of operations.

**FRMP**

- The advantages of an FRMP over prescriptive fatigue management regulations.
- The objectives and structure of the site FRMP including the company FRM policy.
- Management and employee responsibilities with regard to fatigue.

**The science of fatigue**

- The science of sleep and fatigue including sleep homeostasis, the daily cycle of the circadian body clock, jet lag and sleep inertia.

**Personal fatigue management**

- Sleep hygiene: strategies for achieving good quality, restorative sleep.
- How to manage the domestic and social challenges associated with shift work.
- Tested fatigue countermeasures – what works and what doesn't.
- Recognising symptoms of sleep disorders and how to obtain appropriate medical advice and treatment.

**Fatigue risk management procedures**

- How to identify the early warning signs of fatigue in oneself and in others.
- How to assess personal fatigue risk.
- Procedures that are to be followed when fatigue risk is identified, including napping, the process for reporting fatigue-related concerns and how these will be responded to.
- Awareness and application of fatigue countermeasure strategies.

### F.4.2 Syllabus B: fatigue risk management training for managers (ANSI/API RP755, 2010)

- The influence of staffing levels on employee fatigue.
- The effects of work and rest scheduling on employee fatigue, and how to schedule work to minimise the risk.
- How to manage a team of employees to minimise fatigue risk within the group.
- How to detect when employees are excessively fatigued.
- Understanding policies and procedures for times when employees or contractors should be removed from duty due to fatigue.
- The continuous improvement process for assessing, updating, and increasing the effectiveness of the FRMS through a data-driven (risk-based) process.

## F.5 FATIGUE HAZARDS, EXAMPLES OF QUESTIONS TO ASK WHEN ASSESSING THE ASSOCIATED RISK AND EXAMPLES OF POSSIBLE CONTROL MEASURES[8]

For each question, answering 'no' suggests that the level of risk is low. Where the answer is 'yes', the hazard is more likely to pose a significant level of fatigue risk.

| Fatigue hazards | Examples of risk assessment questions | Control measures to consider implementing where feasible |
|---|---|---|
| **Work schedule** | | |
| Sleep opportunity (time off between shifts) | – Taking into consideration commute times, and making reasonable allowance for social and family activities, is there insufficient time off between shifts to enable employees to obtain adequate sleep?<br>– Do some employees fail to use the opportunity available to them to obtain adequate sleep (e.g. second jobs, other commitments)?<br>– Do employees ever receive less than the opportunity for two full sleep periods after seven days of work? | – Design rosters that provide employees with adequate time to obtain eight hours of sleep per day. The roster should consider the time involved in travelling to/from work, meals, family, domestic and social responsibilities.<br>– Every seven days, provide an extended recovery period of at least 48 hours off.<br>– For good practice guidance on shift schedule design see the HSE publication *Managing shift work–health and safety guidance* http://www.hse.gov.uk/pubns/books/hsg256.htm |
| Shift start/finish times | – Do shifts start or finish between 22:00 or 07:00?<br>– If yes, are monotonous, complex, difficult or strenuous tasks undertaken at the start and end of these shifts?<br>– Are split shifts worked? | – Avoid or limit shifts that start or finish between 22:00 and 07:00.<br>– If these cannot be avoided, do not schedule tasks that are high risk or susceptible to fatigue at the start and end of these shifts.<br>– Avoid multiple consecutive challenging duties, for example more than four consecutive early or night duties. |

8 Based on a similar table published b the NSW Mine Safety Advisory Council and the NSW Government (2009).

| Fatigue hazards | Examples of risk assessment questions | Control measures to consider implementing where feasible |
|---|---|---|
| Shift start/finish times continued... | | – Forward-rotating shift schedules (i.e. morning to afternoon, afternoon to night) are normally preferable to backward-rotations.<br>– Match shift times to the availability of public transport.<br>– Avoid or limit split shifts.<br>– Where split shifts must be worked, adjust the timing of the shifts so that employees are provided with the best sleep opportunity. |
| Night shifts | – Are multiple consecutive night shifts worked?<br>– Are night shifts longer than eight hours?<br>– Are monotonous tasks, tasks requiring sustained physical or mental effort or complex tasks, undertaken on night shift? | – Eliminate or limit night work.<br>– Limit the number of consecutive night duties to no more than three in a row.<br>– Reduce night shift duration to 10 hours or less.<br>– Schedule tasks that are high risk or susceptible to fatigue (monotonous tasks, tasks requiring sustained physical or mental effort, or complex tasks) during the day.<br>– If tasks that are high risk or susceptible to fatigue must be completed at night, avoid the WOCL (02:00 – 06:00).<br>– Avoid scheduling tasks that are high risk or susceptible to fatigue on the first night shift. If unavoidable, when planning the task consider additional controls such as task rotation, a delayed start time or early finish, or additional rest breaks.<br>– Minimise or redesign routine administrative tasks to ensure employees can focus on their core duties during the night shift. |

| Fatigue hazards | Examples of risk assessment questions | Control measures to consider implementing where feasible |
| --- | --- | --- |
| Night shifts continued... | | – Provide employees who often work night shifts with periods of time off that enable them to sleep at night and recover from their sleep debt.<br>– After the last night shift, employees should have at least two nights of unrestricted recovery sleep.<br>– Except for emergencies, provide at least 24 hours notice before night work.<br>– Provide a napping opportunity and appropriate napping facility. See Annex E for guidance on nap duration. |
| Long shift duration | – Are shifts longer than 10 hours? | – Avoid or limit shifts longer than 10 hours.<br>– Reduce shift duration to less than 10 hours.<br>– During long shifts, avoid or limit tasks that are high risk or susceptible to fatigue.<br>– On long shifts, limit the use of overtime, particularly unscheduled overtime.<br>– If employees drive to/from work, after long shifts or overtime, provide them with transport to reduce the risk of being involved in a fatigue-related road accident.<br>– Offer alternatives to employees who have particular difficulties coping with night work.<br>– Defer non-urgent work to prevent long work hours.<br>– Record and monitor hours of work. |
| Long hours of work across a roster cycle | – Do actual hours of work (including overtime) exceed 48 hours in any seven days, or 624 hours over a three-month (13 week) period? | – Avoid or limit long hours of work across a roster cycle.<br>– Agree limits on daily work hours, maximum average weekly hours, total hours over a three-month period and work-related travel. |

| Fatigue hazards | Examples of risk assessment questions | Control measures to consider implementing where feasible |
|---|---|---|
| Long hours of work across a roster cycle continued... | | – Avoid working arrangements, for example high overtime pay rates, that incentivise employees to work excessive hours.<br>– Avoid or limit working four consecutive duties that are longer than 10 hours in duration.<br>– Every seven days, provide an extended recovery period of at least 48 hours off.<br>– Control overtime, shift-swapping and on-call duties. |
| Breaks within shifts | – Are there insufficient break opportunities (duration and frequency) for employees to rest, refresh and nourish themselves? | – Provide adequate break opportunities (duration and frequency) for employees to rest, refresh and nourish themselves.<br>– Ensure sufficient employees are available to provide cover during breaks.<br>– Provide a safe and comfortable environment for napping. |
| On-call | – As the result of call-outs, are there irregular and unplanned schedules?<br>– Are there situations where the working day or working week can be extended beyond 12 hours in a single day, 48 hours in any seven days or 624 hours over a three-month (13 week) period? | – Avoid or limit the use of standby or on-call duties.<br>– Reduce the duration of standby or on-call duties.<br>– After a call-out, provide employees with adequate time off to recover before returning to work. |
| Predictability (influenced by overtime, call-outs, roster changes etc.) | – Is the difference between planned and actual work hours unknown?<br>– Do actual work hours ever exceed planned work hours? If so, how often and by how much?<br>– Are roster changes ever made with only minimal notice given to employees working these rosters (i.e. last minute changes)? | – Avoid or limit roster unpredictability.<br>– Monitor and manage the difference between planned and actual work hours.<br>– Provide employees with as much prior notice as possible of their schedule and any schedule changes. |

| Fatigue hazards | Examples of risk assessment questions | Control measures to consider implementing where feasible |
|---|---|---|
| Predictability (influenced by overtime, call-outs, roster changes etc.) continued... | – Are overtime, call-outs or roster changes made without managing the potential fatigue risk? | – Manage the possible increased fatigue risk associated with overtime, call-outs or roster changes, for example by using fatigue proofing strategies.<br>– Manage the workload and change in work-rate caused, for example, by machinery breakdowns and planned and unplanned absences. |
| **Amount of sleep obtained by employees** | | |
| | – Are workers not informed of their personal responsibility to obtain sufficient sleep to be fit for work?<br>– Are workers uneducated about sleep hygiene and how to obtain sufficient sleep?<br>– Are workers unlikely to notify their supervisor if they have obtained inadequate sleep?<br>– Are workers involved in activities outside of work that reduce the amount of sleep they obtain (e.g. second jobs)?<br>– Does the alertness consideration tool (ACT) provided in F.6 suggest employees are obtaining inadequate sleep?<br>– Do workers have responsibilities outside of work that reduce the amount of sleep they obtain (e.g. domestic, child or elder care responsibilities)? | – Ensure that workers are well-informed of their personal responsibility to obtain sufficient sleep to be fit for work.<br>– Educate workers about sleep hygiene and how to obtain sufficient sleep.<br>– Introduce a fatigue reporting system that employees actually use.<br>– Encourage workers to discuss personal or health issues that may be disrupting their sleep with an appropriate person, for example the occupational health team or line manager.<br>– Foster a company and site culture in which employees feel comfortable to report instances of fatigue. |
| **Mental and physical demands of work** | | |
| Repetitive or monotonous work | – Do employees undertake monotonous tasks for extended periods, for example long distance driving? | – Re-design tasks to reduce or eliminate repetitive or monotonous work, sustained mental or physical effort, or overly complex tasks. |

| Fatigue hazards | Examples of risk assessment questions | Control measures to consider implementing where feasible |
|---|---|---|
| Sustained mental or physical effort | – Is the work mentally demanding, for example does it require sustained attention?<br>– Is the work physically demanding?<br>– Is the work fast-paced?<br>– Is the timing and pace of tasks out of the employees' control? | – Improve communication between employees undertaking these tasks.<br>– Provide training to allow for multi-skilling and effective job rotation.<br>– Use alarms and monitors, particularly for solo work (e.g. driving vehicles).<br>– Ensure there are sufficient employees and other resources to complete the task, particularly during peak times, without placing excessive demands on individuals.<br>– Ensure adequate breaks during shifts to allow recovery.<br>– Allow supervisors and employees some control over the scheduling of tasks and the pace at which they are completed.<br>– Ensure that sufficient time is allowed to enable safe and efficient shift hand-over. |
| Complex mental or physical tasks | – Are high levels of concentration required?<br>– Are there multiple demands that can be difficult to combine? | |
| **Work environment** | | |
| | – Does the work environment promote drowsiness (i.e. is it warm, quiet, low light and lacking stimulation)?<br>– Do employees work in adverse environmental conditions, in terms of exposure to:<br>  – temperature?<br>  – noise?<br>  – hazardous substances?<br>  – dust? | – Avoid or limit work in adverse environmental conditions – consider temperature, noise, vibration, hazardous substances and dust.<br>– Ensure the workplace and surroundings are well lit and secure.<br>– Provide adequate work and rest facilities, for example for meals and napping.<br>– Improve work environments that promote drowsiness (i.e. warm, quiet, low light and lacking stimulation). |

| Fatigue hazards | Examples of risk assessment questions | Control measures to consider implementing where feasible |
|---|---|---|
| | – Do exposure standards remain the same for extended shifts (they may need to be adjusted)?<br>– Is there a plan for managing safety-critical tasks during periods of extreme environmental conditions? | – Consider whether different types of clothing and equipment are required for different shifts, for example sunglasses during the day and reflectors at night.<br>– Monitor exposure standards and consider adjusting them for long or extended shifts. For example, exposure during a 10-hour shift may not equate to 1,25 times the exposure experienced during an eight-hour shift. |
| **Sleep environment** | – Where sleep facilities are provided for employees, do they promote good quality sleep (i.e. are they cool, dark, quiet, secure and comfortable)?<br>– Is the quality of the sleep facilities formally assessed and managed on an on-going basis? | – Where sleep facilities are provided for employees, they should promote good quality sleep and be cool, dark, quiet, secure and comfortable.<br>– The quality of sleep facilities should be formally assessed and managed on an on-going basis.<br>– Subsidise modifications in private homes to improve sleeping conditions, for example through the provision of blackout blinds and air-conditioning. |
| **Commuting** | – Is significant travel to and from work necessary each day so that time available for sleep is reduced?<br>– Are long-distance commutes undertaken at the start or end of a work cycle?<br>– Do long distance commutes involve employees travelling across multiple time zones?<br>– Do employees drive to/from work? | – Co-ordinate shift start and finish times with the availability of public transport.<br>– Provide transport, for example employee buses to/from local towns, to reduce the need for employees to drive to/from work.<br>– At sites where employees have a long distance commute and live on site for multiple days, start work on the day after arrival and start travel home on the day after the shift cycle is finished.<br>– Alternatively, have a delayed start on the first duty and/or early finish on the last duty.<br>– Adjust the shift schedule to take account of commuting.<br>– Promote sleep during commutes, for example by air, by providing comfortable seats. |

| Fatigue hazards | Examples of risk assessment questions | Control measures to consider implementing where feasible |
|---|---|---|
| **Health** | – Are employees uninformed regarding the impact that prescription medicines, over-the-counter medications, drugs and alcohol can have on sleep and alertness?<br>– Are employees uninformed regarding sleep disorders?<br>– When fitness for duty issues linked to health arise, are procedures in place to evaluate and manage the consequences this could have for fatigue-related safety? | – Educate workers on the impact that medicines, drugs and alcohol can have on sleep, alertness and safety.<br>– Educate employees and their families about sleep disorders.<br>– Consider fatigue-related safety when evaluating and managing fitness for duty issues linked to health.<br>– Encourage workers to discuss personal or health issues that may be disrupting their sleep with an appropriate person, for example the occupational health team or line manager.<br>– Provide access to professional advice, for example an employee assistance programme, or sleep disorder clinic. |

## F.6 ALERTNESS CONSIDERATION TOOL (ACT)

The ACT was originally designed for the aviation industry to enable crew to consider fatigue risk when assessing their fitness for a duty. Originally produced by the Civil Aviation Safety Authority (Australia) the ACT is provided as an example of a tool that possibly could be amended to fit the energy, and other, industries. In addition to assisting individuals to assess their fitness for work it also has other uses; for example, to assist in incident investigations or to provide a structured framework for discussions between a supervisor and an employee reporting being fatigued.

Figure F.1 summarises the assessment process embodied within the ACT. The assessment involves answering four questions relating to alertness, sleep, duty timing and duty risk. The answers to the questions are coded and combined to enable the employee to determine what steps they need to take in order to manage fatigue risk.

The ACT is provided on the next page and instructions for using the ACT to evaluate alertness prior to a duty are provided on the subsequent pages.

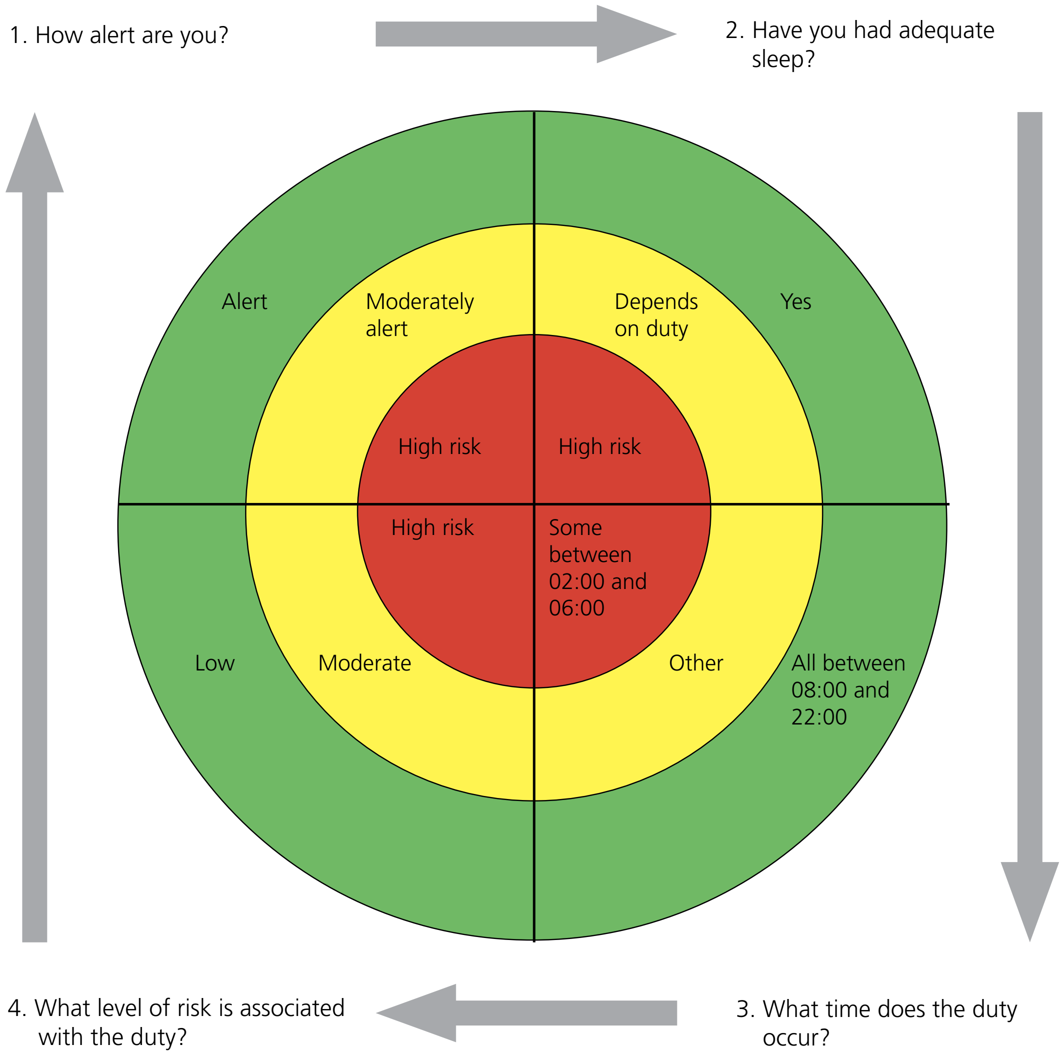


**Figure F.1 Summary of the assessment process embodied within the ACT**

**Instructions for using the ACT prior to a duty**

**Q1. How alert are you feeling?**

Question 1 involves the individual rating their current alertness (ideally close to their report time) using one of the seven options on the alertness scale. The result falls into one of three bands of risk – low, moderate, or high.

If high risk, the individual should consider discussing this with team members or his/her supervisor and may need to address the risk through applying previously defined risk control measures, such as extended rest periods or task rotation. If a decision is made to continue with the duty, proceed to question 2.

**Q2. Have you had adequate sleep?**

Whilst it is easy to understand that adequate sleep is a prerequisite for an alert airline crew member, the notion of what adequate sleep consists of is subject to individual variability and this is further complicated by how easy it is to overestimate the amount and quality of sleep we actually get. As a general guide an individual who was previously well rested prior to the 48 hour window requires at least six hours' sleep in 24 hours, and 13 hours in 48 hours.

Question 2 involves the individual using accruing points based on their sleep in the prior 24 hours, 48 hours, and hours wake at the end of the duty. The points sum to produce a final score, which is categorised in terms of risk as low, moderate, or high.

If the result is high risk, the individual should consider discussing this with team members or his/her supervisor and may need to address the risk through applying previously defined risk control measures, such as extended rest periods or task rotation. If a decision is made to continue with the duty, proceed to question 3.

**Q3. What time does the duty occur?**

Question 3 involves the individual classifying their duty based on the time of day that the duty occurs. The result falls into one of three bands of risk – low, moderate, or high.

They then continue to question 4.

**Q4. What level of operational risk is associated with the duty?**

Question 4 involves classifying the level of operational risk associated with the duty. Table F.1 provides an example of the types of risks that should be considered and can be adapted to reflect the operational risks inherent in your operations. Note that the examples are from the aviation sector.

**Table F.1 Examples of low, moderate and high risk operational factors**

| Factor | Low risk | Moderate risk | High risk |
|---|---|---|---|
| Route | Familiar, low workload route | Unfamiliar low workload route or familiar high workload route | Unfamiliar high workload |
| Airports | Familiar primary airports | Secondary airports or unfamiliar primary airport | Unfamiliar secondary airport |
| Airspace? | Quiet airspace | Moderately busy airspace | Very busy airspace |
| Level of employees' experience | All employees are highly experienced | Employees moderately experienced or combination of employees with low and high experience | Employees with low experience |
| Aircraft | Well-equipped aircraft | Moderately equipped aircraft | Poorly equipped aircraft |
| Serviceability | Fully serviceable aircraft | Minor unserviceable items | Major unserviceable items requiring work arounds. |
| Weather | Good conditions | Moderate conditions | Poor conditions |

**Determine the fatigue risk level and what may need to be considered when determining whether to undertake this duty.**

Based on the results for questions 1 – 4, the individual can use the table provided to determine whether a fatigue risk may be present during the duty and take steps to manage the risk.

## Table F.2 ACT questionnaire

| 1. How alert are you? (rate just prior to the start of duty) | | Result ① |
|---|---|---|
| 1 | Fully alert wide awake | Low |
| 2 | Very lively responsive but not at peak | |
| 3 | OK, somewhat fresh | |
| 4 | A little tired, less than fresh | Moderate |
| 5 | Moderately tired, let down | |
| 6 | Extremely tired, very difficult to concentrate | High |
| 7 | Completely exhausted, unable to function effectively | |

If 'high risk' is indicated consider risk controls, such as napping, task rotation or advising the operator you are not fit for duty.

| 2. Have you had adequate sleep? | | Points |
|---|---|---|
| 1) At start of duty how much sleep will you have had in last 24 hours? (this is value 'x')<br>x = ______hours ———> x: ≤ 3h 4h 5h 6+h<br>Points: 12 8 4 0 | Enter points in box ——> | |
| 2) At start of duty how much sleep will you have had in last 48 hours? (this is value 'y')<br>y = ____hours ——> y: ≤ 8h 9h 10h 11h 12h 13+h<br>Points: 10 8 6 4 2 0 | Enter points in box ——> | |
| 3) At end of planned duty how many hours will you have been awake? (this is value 'z') z = ______hours | | |
| 4) If y < z, subtract hours of sleep obtained in last 48 hours (y) from hours awake (z) (z – y). Convert the resulting figure to points (1 hour = 1 point).<br>Enter points in box ———> | | |
| **Add points above to determine your score ———>** | | |

| Score | Result ② |
|---|---|
| 1 – 4 | Low |
| 5 – 8 | Moderate |
| 9+ | High |

If 'high risk' is indicated consider risk controls, such as napping, task rotation or advising the operator you are not fit for duty.

| 3. What time does the duty occur? | Result ③ |
|---|---|
| All hours of the duty occur between 08:00 – 22:00 | Low |
| Other | Moderate |
| Part of the duty occurs between 02:00 – 06:00 | High |

| 4. What level of generic risk is associated with the duty?<br>(Consider role, activities, environmental conditions, level of employee experience, the site features and any equipment being operated). | Result ④ |
|---|---|
| Description | |
| All factors rated low risk | Low |
| At least one factor rated moderate risk | Moderate |
| At least one factor rated high risk | High |

**5. Based on the results for ① ② ③ and ④ use the table below to determine what you may need to consider when determining whether to undertake this duty.**

| Results | Example ① | Example ② | Example ③ | Example ④ | Adequate alertness for duty? |
|---|---|---|---|---|---|
| High for Q1 or Q2 | | | | | **High risk:** Discuss with your supervisor why your alertness level may not be sufficient for this duty and consider a rostering alternative to manage the risk (e.g., augmented crew, longer rest periods). |
| All moderate and high | | | | | |
| Any combination of low, moderate and high | | | | | **Moderate risk:** Discuss with your supervisor whether your alertness level is suitable for this duty and consider the use of additional mitigation strategies (e.g. napping, task rotation). |
| 2 low, 2 high | | | | | |
| All moderate | | | | | |
| Any combination of low and moderate | | | | | **Low risk:** Discuss with your supervisor whether your alertness level is suitable for this duty and consider beneficial fatigue risk controls for this duty (e.g. caffeine use). |
| 3 low and 1 high | | | | | |
| All low | | | | | |

# ANNEX G
# CASE STUDY: INTRODUCING AN FRMP AND ASSESSING COMPLIANCE AGAINST A COMPANY FATIGUE RISK MANAGEMENT STANDARD

This case study illustrates how one organisation implemented an FRMP. It does not necessarily reflect the only way or even the most appropriate way, to implement an FRMP.

Company A has significant assets and operations in Africa, Asia, Australasia, South America and the United States. The company employs approximately 43 000 employees and contractors at approximately 30 sites around the world.

Company A sites operate 24 hours a day, seven days a week, 365 days a year, and the company has a large, distributed workforce, many of them shift workers engaged in safety-critical work and in hazardous environments. As such, the company is acutely aware of the need to manage fatigue risk. In 2010 the company began the process of introducing a comprehensive approach to fatigue risk management.

Company A's fatigue management journey began with the collection of data to help the management team understand the extent of the fatigue issue within the organisation. These data were presented and discussed at a global meeting of site managers, to ensure the senior management team was engaged and understood the new direction the company was intending to take.

Following the global meeting a 'cross-functional team' was established, with the mission to develop a fatigue risk management standard to be applied to all facilities and operations. Subject matter experts were also engaged to provide guidance on scientific and industry best practice, including the fatigue management methods employed in other industries.

The Company A fatigue risk management standard is built on four pillars:

1) education and training;
2) prevention;
3) detection, and
4) mitigation strategies.

Underpinning these pillars is the concept of shared responsibility: the recognition that all parties have a role to play in the management of fatigue. The fatigue risk management standard includes tools designed to assist site health and safety managers to measure, monitor and manage fatigue.

Since the beginning of 2012, site assessments have been completed at the majority of Company A's sites. Each assessment culminates in the development of a site-specific FRMP, including recommendations for how to achieve greater compliance with the Company A fatigue risk management standard.

To support the launch of the fatigue risk management standard and to raise employee awareness of their responsibilities within the standard (and the effective strategies they and their supervisors can employ to minimise fatigue), Company A produced an online fatigue training programme. This modular training has now been launched globally, with Spanish and Bahasa Indonesian versions now available. The online training is supported by local fatigue campaigns and activities, including toolbox talks, family open days and training for fatigue champions.

To assist individual sites to develop their site-specific FRMPs, site assessments were conducted at the company's sites. The following is a summary of a site assessment conducted at a site in Australia.

**Pre-visit data analysis**
Prior to visiting the site all roster patterns worked at the site were analysed using fatigue analysis software. The results were then used to identify the groups to be interviewed during the site assessment. Groups were selected based on their roster (i.e. those associated with highest predicted levels of fatigue took precedence), the number of employees working that roster, and the nature of their work (those involved in safety-critical work being priority).

**Site assessment – data collection**
The site visit began with an opening presentation to management, outlining the purpose of the visit and agreeing the itinerary (i.e. which groups would be seen on which days). The team then conducted semi-structured interviews with managers, supervisors and groups of up to six employees. A total of 118 individuals were interviewed, out of an active site workforce of c.560[9].

Discussions with employees focused on their experience of working the roster, their sleep patterns when working days and nights, their home situation, lifestyle and out-of-work activities that may impact on fatigue, as well as their understanding and experience of fatigue. Data collected on actual sleep patterns are used to refine the fatigue analysis of rosters.

Interviews with management focused on their understanding of fatigue and their role with respect to fatigue management, and the controls they have put in place to manage the fatigue of their workforce.

**Data analysis**
A site assessment questionnaire was used to assess the main contributors to fatigue, the controls in place, and the site's compliance with the standard. Once complete, this was discussed with the site management team and a final version agreed. This was used to generate the site's FRMP, which detailed the steps the site needed to take to better manage fatigue, and to achieve a greater degree of compliance with the standard. Finally, the FRMP was presented at a meeting with the site leadership team, during which actions were assigned to responsible persons and a timescale for completion was agreed.

**Summary of findings**
Overall compliance with the fatigue risk management standard at this site was 43 %, with the main weakness being in the education and training provided to employees regarding fatigue.

**Main contributors to fatigue**

1) Roster-related contributors:
   - Multiple consecutive night duties.
   - Insufficient recovery time for some rosters (e.g. seven days/four off/seven nights/three off).
2) 'Lifestyle' related contributors:
   - Disrupted sleep when working nights.
   - Commute causes extended wakefulness on first duty.
   - Driving home after seventh night.
   - Workforce wellbeing.
   - Sedentary role.
   - Dining hall opening times make it difficult to visit the gym after work and go to mess.
   - Effects on physical condition, wellbeing, obesity, sleep disorders.

9 Total workforce for the site is 1 600, split across four panels. At any one time there are approximately 560 personnel active on site.

3) Work-related contributors
   - Safety-critical activities undertaken between 02:00 – 04:00.
   - Some groups do not take breaks/breaks not protected.

**Existing controls**

The site has in place a range of formal controls for managing fatigue, including an equal time roster (seven nights/seven days), a 14-hour door-to-door policy and fatigue rooms for long distance commuters to use before setting off after their last duty. However, awareness and use of some of the fatigue controls could be improved. While training has been conducted in the past, this was generic and not tailored to suit the operation. The training was delivered more than 12 months ago and a number of new controls have since been introduced and many new employees have joined the company.

**Recommendations**

The research team provided a set of recommendations for the site management to implement to improve the management of fatigue and to achieve greater compliance with the fatigue risk management standard. These included:

1) Provide feedback on the results of the fatigue risk assessment.
2) Establish a fatigue-training programme tailored to the operation.
3) Extend dry mess opening time (evening) to enable employees to visit the gym.
4) Revise current system of allocating breaks, emphasise role of breaks to maintain performance.

This publication has been produced as a result of work carried out within the Technical Team of the Energy Institute (EI), funded by the EI's Technical Partners and other stakeholders. The EI's Technical Work Programme provides industry with cost effective, value adding knowledge on key current and future issues affecting those operating in the energy sector, both in the UK and beyond.

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