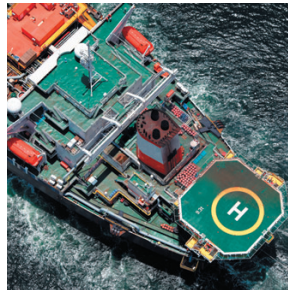




# Performance indicators for fatigue risk management systems

Guidance document for the oil and gas industry

Health  
2012





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# Performance indicators for fatigue risk management systems

Guidance document for the oil and gas industry

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## Contents

<b>Introduction</b>	<b>1</b>
Fatigue risk management systems	1
<b>An approach to developing performance indicators for a fatigue risk management system (FRMS)</b>	<b>2</b>
<b>Structure of proposed FRMS performance indicators</b>	<b>2</b>
<b>Proposed FRMS performance indicators for fatigue contributors</b>	<b>3</b>
1. Rostered work hours	3
2. Actual work hours	4
3. Types of work tasks	5
4. Working environment	6
5. Amount of sleep obtained	7
6. Sleeping environment	8
7. Sleep disorders	9
8. Other health issues	10
<b>Proposed FRMS performance indicators for system components</b>	<b>11</b>
1. Roles and responsibilities	11
2. Training and competence	12
3. Risk assessment	13
4. Risk reduction	14
5. Health issues including the management of sleep disorders	15
6. Incident investigation	16
7. Monitoring and processes for the internal and external assesment of the FRMS	17
<b>Glossary</b>	<b>18</b>
<b>Source documents and references</b>	<b>19</b>

## Introduction

Science demonstrates that fatigue associated with extended hours, night shifts and rotating shifts can have a negative impact on human performance (such as impaired cognitive function, reaction time and increased error rates). This can present increased safety risk to industries that involve safety-critical work.

Historically, the risk associated with fatigue was largely managed by limiting the number of hours worked. However, there is increasing understanding that hours-of-service limits by themselves may not achieve the objective of managing risk from fatigue. This, together with the restrictive impact on operations, has led industry and regulators to move away from using rules based solely on hours of work, and instead adopt a more comprehensive style of fatigue risk management using fatigue risk management systems (FRMS).

An FRMS is a scientifically- and risk-based approach to managing risk from fatigue, and is based on the well-established 'layered defence' approach to managing safety risk (Dawson and McCulloch, 2005). As well as providing stronger controls against fatigue, the FRMS approach provides greater operational flexibility, rather than adhering to strict hours-of-work restrictions.

While there are many benefits to a more flexible, risk-based FRMS approach, the performance of the system must be monitored. This was highlighted during the IPIECA/OGP/ICMM Fatigue Management Workshop in Johannesburg, South Africa in August 2011. This document contains proposals for possible performance indicators that could be used to monitor the effectiveness of an FRMS.

### Fatigue risk management systems

A number of authors have outlined the core elements of an FRMS, but the concepts defined by Moore-Ede (2009) are generally considered essential to the success of FRMS implementation:

1. **Science based:** supported by established peer-reviewed science.
2. **Data driven:** decisions based on the collection and objective analysis of data.
3. **Cooperative:** designed through a participative approach by all stakeholders.
4. **Fully Implemented:** system-wide use of tools, systems, policies and procedures.
5. **Integrated:** built into the corporate safety and health management systems.
6. **Continuously improved:** progressively reduces risk using feedback, evaluation and modification.
7. **Budgeted:** justified by the business case for an accurate return on investment.
8. **Owned:** responsibility accepted by senior corporate leadership.

While data-driven decision making is clearly a desirable aspiration, the reality for many companies is that hard data on fatigue are difficult to come by. In most cases, where data are not available, decisions are risk based. An FRMS therefore needs to be properly grounded in assessment of the risks facing the operation or organization.

There are several ways to structure an effective FRMS. One method was proposed by the American College of Occupational and Environmental Medicine (ACOEM) in their *Guidance Statement on Fatigue Risk Management in the Workplace* (ACOEM, 2012) and also in the ANSI/API Recommended Practice RP755, *Fatigue Risk Management Systems for Personnel in the Refining and Petrochemical Industries* (ANSI/API, 2010). According to these documents, the core components of an effective FRMS should include:

- roles and responsibilities;
- training;
- risk assessment;
- risk reduction;
- health issues including the management of sleep disorders;
- monitoring and processes for the internal and external assessment of the FRMS; and
- incident investigation.

## An approach to developing performance indicators for a fatigue risk management system (FRMS)

FRMS performance indicators should focus both on:

- direct contributors to fatigue-related impairment; and
- the individual components of an effective FRMS.

Direct contributors to fatigue-related impairment can be either work related or non-work related (see box below).

Performance indicators should also include a mix of *leading* and *lagging* indicators:

- **Leading** indicators are used to highlight areas of system weakness, without relying on the occurrence of an incident or near miss (i.e. they are proactive).
- **Lagging** indicators, on the other hand, use learnings from the occurrence of incidents and near misses to identify weakness in the system (i.e. they are reactive).

Work-related and non-work-related contributors to performance impairment	
Work-related contributors	Non-work-related contributors
<ul style="list-style-type: none"> <li>• Rostered work hours</li> <li>• Actual work hours (including overtime, extra shifts, etc.)</li> <li>• Types of work tasks (e.g. repetitive, mundane, physically strenuous, safety critical)</li> <li>• Working environment (e.g. hot environments)</li> </ul>	<ul style="list-style-type: none"> <li>• Amount of sleep obtained</li> <li>• Sufficient quality sleep obtained</li> <li>• Sleeping environment</li> <li>• Sleep disorders</li> <li>• Other health issues</li> </ul>

### Structure of proposed FRMS performance indicators

The following pages contain proposals for performance indicators based on fatigue contributors and on the typical components of an FRMS. The proposals are based on current scientific understanding and have been compiled to assist companies to manage fatigue in a practical manner. Companies are likely to choose and adapt metrics which reflect their organizational culture and systems, and for that reason no single metric is necessarily more important than another. Because it is not possible to compartmentalize components of an FRMS in a rigid way, similar possible metrics appear in the different parts of the document. Each part provides the following information:

- **A summary of the item:** fatigue contributor or FRMS component.
- **The desired outcome:** the impact of effective management of the item.

- **Critical elements:** the processes or inputs required to ensure the desired safety outcome.
- **Assessment questions:** potential audit-type questions to determine whether necessary management systems are in place.
- **Possible leading indicators:** indicators of weaknesses in processes or inputs essential to maintain the item.
- **Possible lagging indicators:** indicators of weaknesses in the risk control system based on feedback from incidents or adverse events.
- **Possible supporting leading metrics:** provide a measure of degree of performance of leading indicators.
- **Possible supporting lagging metrics:** provide a measure of degree of performance of lagging indicators.

## Proposed FRMS performance indicators for fatigue contributors

1. Rostered work hours	
<p>Work hours should be rostered to:</p> <ul style="list-style-type: none"> <li>• provide as much sleep opportunity between shifts as possible;</li> <li>• minimize the amount of work performed during ‘fatigue hot spots’ (e.g. 24:00–06:00); and</li> <li>• minimize consecutive extended shifts that may cause cumulative sleep debt.</li> </ul>	
<p><b>Desired outcomes</b></p> <ul style="list-style-type: none"> <li>• Workers are well rested and fit to begin and complete each shift.</li> </ul>	<p><b>Critical elements</b></p> <ul style="list-style-type: none"> <li>• Rostered work hours provide sufficient time for sleep and recovery between shifts.</li> </ul>
<p><b>Possible leading indicators</b></p> <ul style="list-style-type: none"> <li>• Planned rosters have been adequately risk assessed for fatigue.</li> </ul>	<p><b>Possible lagging indicators</b></p> <ul style="list-style-type: none"> <li>• Evidence of incidents or near misses occurring within periods of the roster, where the likelihood of fatigue-related impairment is increased.</li> </ul>
<p><b>Possible assessment questions</b></p> <ul style="list-style-type: none"> <li>• Taking account of travel time to and from the place of work, and of reasonable domestic and social activities during the planned work period, do the planned rosters allow reasonable likelihood of an opportunity for at least 7 hours’ sleep in every 24-hour period?</li> <li>• Has the cumulative impact of sleep debt been considered?</li> <li>• What processes are in place to facilitate a periodic review of the effectiveness of rosters in managing fatigue?</li> <li>• Is there a participative approach to the development of rosters involving stakeholders, e.g. workers and management?</li> <li>• Is worker feedback received on whether they believe the roster provides sufficient opportunity for sleep and recovery?</li> </ul>	
<p><b>Possible supporting leading metrics</b></p> <ul style="list-style-type: none"> <li>• Percentage of rosters that have elevated predicted levels of fatigue (as identified by the organization’s risk assessment).</li> <li>• Percentage of each shift that exceeds an action level (as defined by the organization’s fatigue risk assessment).</li> <li>• Percentage of shifts where shift swaps have taken place to minimize the adverse impact of fatigue.</li> <li>• The number of workers reporting having a sleep opportunity of less than 6 hours in any 24-hour period.</li> </ul>	
<p><b>Possible supporting lagging metrics</b></p> <ul style="list-style-type: none"> <li>• Percentage of incidents or near misses that occur during periods of the roster where there is an elevated risk of fatigue.</li> <li>• Number of fatigue-related incidents occurring while travelling to or from work, involving employees working rosters associated with elevated predicted levels of fatigue.</li> </ul>	

## Proposed FRMS performance indicators for fatigue contributors (continued)

2. Actual work hours	
<p>Actual work hours reflect deviations from rostered work hours, such as overtime, call-outs, working additional shifts and the potential effects of jet lag (relevant for business travellers, 'fly-in, fly-out' operations, rotators, etc.). It is important to ensure that actual work hours, as well as rostered work hours, provide sufficient opportunity for sleep and recovery between shifts.</p>	
<p><b>Desired outcomes</b></p> <ul style="list-style-type: none"> <li>Workers are well rested and fit to begin and complete each shift.</li> </ul>	<p><b>Critical elements</b></p> <ul style="list-style-type: none"> <li>Actual work hours provide sufficient time for sleep and recovery between shifts.</li> </ul>
<p><b>Possible leading indicators</b></p> <ul style="list-style-type: none"> <li>Assessment of actual work hours indicates whether sufficient sleep and recovery opportunity is being provided.</li> <li>The distribution of additional work hours across the workforce.</li> <li>Assessment of the number of 'open' shifts.</li> </ul>	<p><b>Possible lagging indicators</b></p> <ul style="list-style-type: none"> <li>Evidence that overtime, call-outs or additional shifts have contributed to reduced sleep or recovery, and to an incident or near miss.</li> </ul>
<p><b>Possible assessment questions</b></p> <ul style="list-style-type: none"> <li>Does the site have records that show the difference between planned and actual work hours?</li> <li>Do actual work hours regularly exceed rostered work hours for individuals performing safety-critical activities and if so, by how much?</li> <li>By how much do actual work hours exceed rostered work hours for the individuals working the most overtime among those performing safety-critical activities?</li> <li>Does the process for managing additional work hours or jet lag include an assessment of potential fatigue risk?</li> <li>Is worker feedback received on whether they believe the actual hours worked provide sufficient opportunity for sleep and recovery?</li> </ul>	
<p><b>Possible supporting leading metrics</b></p> <ul style="list-style-type: none"> <li>Percentage of shifts that comply with rostered work hours.</li> <li>Percentage of actual work hours that are likely to produce an elevated risk of fatigue based on a fatigue risk assessment.</li> <li>Percentage of unfilled positions.</li> </ul>	
<p><b>Possible supporting lagging metrics</b></p> <ul style="list-style-type: none"> <li>Percentage of incidents or near misses that occur during or following deviations from the roster, particularly during periods where there is a high likelihood of fatigue-related impairment.</li> </ul>	



*Proposed FRMS performance indicators for fatigue contributors (continued)*

<b>3. Types of work tasks</b>	
<p>Some types of tasks are more sensitive to fatigue-induced impairment than others. Fatigue-sensitive tasks tend to require sustained concentration and attention, are mundane and boring, repetitive or mentally demanding. Tasks that rely on communication can also be impaired by fatigue. Interaction with others may heighten alertness. As a result, lone working should be considered as a potential risk factor.</p>	
<p><b>Desired outcomes</b></p> <ul style="list-style-type: none"> <li>• Workers remain focused and perform their work tasks safely throughout each shift.</li> </ul>	<p><b>Critical elements</b></p> <ul style="list-style-type: none"> <li>• Work tasks are structured to maximize worker productivity, and minimize the effect of fatigue.</li> </ul>
<p><b>Possible leading indicators</b></p> <ul style="list-style-type: none"> <li>• Work tasks are planned to maximize alertness, and minimize the effect of fatigue.</li> <li>• A degree of task variation across a typical shift.</li> <li>• Evidence that workers have elected to change or 'swap' tasks to self-manage fatigue.</li> </ul>	<p><b>Possible lagging indicators</b></p> <ul style="list-style-type: none"> <li>• Recognition from incident investigation that performance of a task was impaired due to fatigue.</li> </ul>
<p><b>Possible assessment questions</b></p> <ul style="list-style-type: none"> <li>• Does the planning of tasks that are known to be sensitive to fatigue take account of times of heightened fatigue risk?</li> <li>• To what extent are work tasks varied for each worker within a shift?</li> <li>• To what extent can workers change tasks or take a break if they start to feel fatigued or experience a lack of focus?</li> <li>• Is there a plan for managing safety-critical tasks during periods of increased levels of fatigue?</li> <li>• To what extent are work tasks structured to keep workers focused throughout the shift?</li> <li>• To what extent are tasks undertaken by lone workers?</li> <li>• Is there a plan to minimize the number of safety-critical tasks performed by lone workers?</li> </ul>	
<p><b>Possible supporting leading metrics</b></p> <ul style="list-style-type: none"> <li>• Percentage of employees who report that they change tasks or take a break if they start to feel fatigued.</li> <li>• Percentage of safety-critical tasks scheduled outside the window of circadian low.</li> </ul>	
<p><b>Possible supporting lagging metrics</b></p> <ul style="list-style-type: none"> <li>• None currently proposed.</li> </ul>	

## Proposed FRMS performance indicators for fatigue contributors (continued)

4. Working environment	
<p>The working environment can exacerbate the effects of fatigue. Environments that are warm, quiet, have low lighting levels and lack stimulation are particularly likely to induce drowsiness in personnel who are subject to fatigue.</p>	
<p><b>Desired outcomes</b></p> <ul style="list-style-type: none"> <li>Workers remain focused and perform their work tasks safely throughout each shift.</li> </ul>	<p><b>Critical elements</b></p> <ul style="list-style-type: none"> <li>The work environment is managed to minimize the effect of fatigue.</li> </ul>
<p><b>Possible leading indicators</b></p> <ul style="list-style-type: none"> <li>Environmental conditions are managed to minimize the impact on worker performance.</li> </ul>	<p><b>Possible lagging indicators</b></p> <ul style="list-style-type: none"> <li>Evidence that fatigue-inducing environmental conditions had been experienced leading up to, or during, an incident or near miss.</li> </ul>
<p><b>Possible assessment questions</b></p> <ul style="list-style-type: none"> <li>What environmental conditions have been identified as a potential risk factor for impacting worker performance?</li> <li>How are those environmental conditions managed?</li> <li>Is there a plan for managing safety-critical tasks during periods of extreme environmental conditions?</li> </ul>	
<p><b>Possible supporting leading metrics</b></p> <ul style="list-style-type: none"> <li>Percentage of shifts exposed to environmental conditions that induce fatigue.</li> <li>Percentage of shifts that have management strategies in place, or for which alternative duties are allocated.</li> <li>Percentage of sites that have facilities in place for managing working conditions (e.g. air-conditioned rooms for hot days).</li> </ul>	
<p><b>Possible supporting lagging metrics</b></p> <ul style="list-style-type: none"> <li>Percentage of incidents or near misses that occur in environmental conditions known to exacerbate or cause fatigue.</li> </ul>	

*Proposed FRMS performance indicators for fatigue contributors (continued)*

<b>5. Amount of sleep obtained</b>	
<p>Science shows that obtaining insufficient sleep in every 24 hours can result in fatigue-related impairment. It may be difficult to obtain reliable data from workers on sleep obtained, even if sufficient sleep opportunity has been provided. The considerable physiological variation between individuals means that what constitutes ‘sufficient sleep’ will also vary significantly.</p>	
<p><b>Desired outcomes</b></p> <ul style="list-style-type: none"> <li>• Workers obtain sufficient quality sleep to be fit for work.</li> </ul>	<p><b>Critical elements</b></p> <ul style="list-style-type: none"> <li>• Workers understand the requirement to obtain sufficient quality sleep, when provided with the opportunity to obtain it.</li> </ul>
<p><b>Possible leading indicators</b></p> <ul style="list-style-type: none"> <li>• Workers understand the importance of obtaining sufficient quality sleep.</li> <li>• Workers are aware of the elements of good sleep hygiene.</li> <li>• Procedures exist to report and manage instances of insufficient sleep.</li> </ul>	<p><b>Possible lagging indicators</b></p> <ul style="list-style-type: none"> <li>• Evidence that insufficient sleep has contributed to an incident or near miss.</li> </ul>
<p><b>Possible assessment questions</b></p> <ul style="list-style-type: none"> <li>• How are workers informed of their personal responsibility to obtain sufficient sleep to be fit for work?</li> <li>• Are workers educated about the basis of good sleep hygiene?</li> <li>• How do workers notify their supervisor if they have received insufficient sleep, and how are they managed?</li> </ul>	
<p><b>Possible supporting leading metrics</b></p> <ul style="list-style-type: none"> <li>• Frequency of workers reporting insufficient sleep before a work shift.</li> <li>• Frequency of workers reporting less than an average of 7 hours’ sleep per 24 hours.</li> <li>• Any occurrence of workers reporting less than five hours’ sleep over more than three consecutive work days.</li> </ul>	
<p><b>Possible supporting lagging metrics</b></p> <ul style="list-style-type: none"> <li>• Percentage of incidents or near misses that have occurred where the individual involved has obtained less than 7 hours’ sleep in the prior 24 hours.</li> </ul>	

## Proposed FRMS performance indicators for fatigue contributors (continued)

6. Sleeping environment	
<p>Where the work arrangement is 'fly-in, fly-out', camp based, or involves split shifts where workers sleep in facilities or camps provided by the employer, it is important to ensure that the facilities promote good quality sleep. This includes consideration of light, noise, temperature and bedding.</p>	
<p><b>Desired outcomes</b></p> <ul style="list-style-type: none"> <li>The sleeping accommodation provided is suitable for obtaining good quality sleep.</li> </ul>	<p><b>Critical elements</b></p> <ul style="list-style-type: none"> <li>The sleeping accommodation has been designed to minimize noise, and control temperature and light sources, and is fitted with comfortable bedding.</li> </ul>
<p><b>Possible leading indicators</b></p> <ul style="list-style-type: none"> <li>Worker reports of disturbed sleep due to aspects of the sleeping accommodation.</li> </ul>	<p><b>Possible lagging indicators</b></p> <ul style="list-style-type: none"> <li>Evidence that insufficient sleep caused by sleeping accommodation disturbances has contributed to an incident or near miss.</li> </ul>
<p><b>Possible assessment questions</b></p> <ul style="list-style-type: none"> <li>How is camp-based accommodation assessed/managed to ensure that sufficient good quality sleep is obtained?</li> <li>Who is responsible for improving camp facilities where they are deemed inadequate?</li> </ul>	
<p><b>Possible supporting leading metrics</b></p> <ul style="list-style-type: none"> <li>Percentage of camp rooms that comply with requirements following a sleep hygiene assessment.</li> <li>Percentage of camp rooms that have been reported as having levels of noise, light, vibration, etc. sufficient to disrupt sleep.</li> <li>Percentage of camp rooms that have been reported as having inadequate bedding or climate control, etc. sufficient to promote sleep.</li> <li>Percentage of camp rooms that have been upgraded to improve sleeping conditions.</li> </ul>	
<p><b>Possible supporting lagging metrics</b></p> <ul style="list-style-type: none"> <li>Percentage of incidents or near misses that have occurred where the individual involved has obtained less than 6 hours sleep in the prior 24 hours, which has been caused by sleeping accommodation disturbances.</li> </ul>	

*Proposed FRMS performance indicators for fatigue contributors (continued)*

<b>7. Sleep disorders</b>	
Sleep disorders can affect sleep quality and/or sleep quantity, and can have a significant impact on performance and safety.	
<p><b>Desired outcomes</b></p> <ul style="list-style-type: none"> <li>• Sleep disorders are understood, diagnosed and treated.</li> </ul>	<p><b>Critical elements</b></p> <ul style="list-style-type: none"> <li>• Workers understand the requirement to obtain sufficient quality sleep, when provided with the opportunity to obtain it.</li> </ul>
<p><b>Possible leading indicators</b></p> <ul style="list-style-type: none"> <li>• Training provided to workers on the symptoms and treatment for common sleep disorders.</li> <li>• Sleep disorder screening offered to workers.</li> <li>• Procedure to manage potential impairment of workers diagnosed with sleep disorders.</li> </ul>	<p><b>Possible lagging indicators</b></p> <ul style="list-style-type: none"> <li>• Evidence that a diagnosed sleep disorder contributed to an incident or near miss.</li> <li>• Consideration of a non-diagnosed sleep disorder as a contributor to an incident or near miss.</li> </ul>
<p><b>Possible assessment questions</b></p> <ul style="list-style-type: none"> <li>• What training is provided to inform workers of symptoms, risks and treatment of sleep disorders?</li> <li>• Is there a requirement for workers to inform appropriate persons (e.g. occupational health/medical, supervisor, managers, etc.) when diagnosed with a sleep disorder?</li> <li>• What management strategies are implemented to facilitate workers being screened, diagnosed and treated for sleep disorders?</li> </ul>	
<p><b>Possible supporting leading metrics</b></p> <ul style="list-style-type: none"> <li>• Percentage of workers performing safety-sensitive work who have been trained to understand the symptoms, consequences and treatment of sleep disorders.</li> <li>• Percentage of workers performing safety-sensitive work who have been screened for sleep disorders.</li> <li>• Percentage of workers performing safety-sensitive work who have been screened for sleep disorders that obtain diagnostic testing.</li> <li>• Percentage of workers diagnosed with a sleep disorder, and who are being actively managed.</li> </ul>	
<p><b>Possible supporting lagging metrics</b></p> <ul style="list-style-type: none"> <li>• Percentage of incidents or near misses that have occurred, involving an individual who has, or is at risk of having, a sleep disorder.</li> </ul>	

## Proposed FRMS performance indicators for fatigue contributors (continued)

8. Other health issues	
<p><b>Amount of sleep obtained</b></p> <p>Many health issues, such as chronic pain, viruses, flu-like illnesses and medications can have an impact on sleep and fatigue. This, in turn, can have an impact on fitness for work, performance and safety.</p>	
<p><b>Desired outcomes</b></p> <ul style="list-style-type: none"> <li>Workers manage their personal health to minimize fatigue, and be fit for work.</li> </ul>	<p><b>Critical elements</b></p> <ul style="list-style-type: none"> <li>Workers understand the relationship between fatigue and other health issues, and report any potential fitness-for-work issues to their supervisor.</li> </ul>
<p><b>Possible leading indicators</b></p> <ul style="list-style-type: none"> <li>Workers understand the relationship between general health issues and the impact on alertness and fatigue.</li> <li>Procedures exist to report and manage health issues where fitness for work may be compromised.</li> </ul>	<p><b>Possible lagging indicators</b></p> <ul style="list-style-type: none"> <li>Evidence that a person's general health or medication has contributed to an incident or near miss.</li> </ul>
<p><b>Possible assessment questions</b></p> <ul style="list-style-type: none"> <li>How are workers informed of their personal responsibility to manage their health and any prescribed or over-the-counter medications?</li> <li>Are workers required to declare personal health issues before engaging in safety-critical tasks? How is data privacy maintained?</li> <li>What procedures exist to notify appropriate persons (e.g. occupational health/medical practitioners, supervisor, managers, etc.) of potential fitness-for-duty issues due to other health concerns?</li> <li>When potential fitness-for-duty issues arise, what processes are in place to assess the potential impact on safety-sensitive duty (related specifically to fatigue) and to issue appropriate work restrictions?</li> </ul>	
<p><b>Possible supporting leading metrics</b></p> <ul style="list-style-type: none"> <li>Percentage of random drug and alcohol screening that indicates drugs known to have an impact on sleep/fatigue.</li> <li>Percentage of random drug and alcohol screening that indicates drugs known to promote alertness.</li> <li>Percentage of workers that have reported personal health issues impacting on alertness at work.</li> </ul>	
<p><b>Possible supporting lagging metrics</b></p> <ul style="list-style-type: none"> <li>Percentage of incidents or near misses that have occurred where the individual had taken medications, or was experiencing health issues known to have an impact on sleep or fatigue.</li> </ul>	

## Proposed FRMS performance indicators for system components

1. Roles and responsibilities	
<p>A fatigue risk management system requires key roles and responsibilities to be identified for its development, introduction and ongoing maintenance.</p>	
<p><b>Desired outcomes</b></p> <ul style="list-style-type: none"> <li>Roles and responsibilities for implementing the constituent elements of an FRMS are in place and followed.</li> </ul>	<p><b>Critical elements</b></p> <ul style="list-style-type: none"> <li>A senior member of the site management has clear responsibility and accountability for implementation and compliance with the site FRMS.</li> </ul>
<p><b>Possible leading indicators</b></p> <ul style="list-style-type: none"> <li>A single point of accountability for programme introduction and management.</li> <li>Evidence that performance against the FRMS is reviewed and discussed in senior management meetings.</li> </ul>	<p><b>Possible lagging indicators</b></p> <ul style="list-style-type: none"> <li>Incident investigations identify the lack of management control or responsibility for fatigue management as a contributing factor.</li> </ul>
<p><b>Possible assessment questions</b></p> <ul style="list-style-type: none"> <li>Are roles and responsibilities (board members, management, supervisors, employees, etc.) for the management and monitoring of the FRMS clearly defined?</li> <li>Has a single point of accountability for programme introduction and management been identified?</li> <li>Has a 'fatigue management working group' been convened, recognizing the importance of key stakeholder involvement?</li> <li>Has a deficiency in roles and responsibilities been identified during an internal or regulatory audit?</li> <li>Is the requirement for an FRMS specified in contracts?</li> </ul>	
<p><b>Possible supporting leading metrics</b></p> <ul style="list-style-type: none"> <li>Percentage of sites that have convened a 'fatigue management working group' recognizing the importance of key stakeholder involvement.</li> <li>Percentage of sites where supervisor responsibilities about fatigue are clearly defined and documented (e.g. in the job description).</li> <li>Percentage of job descriptions that include clearly defined and documented employee responsibilities concerning fatigue (e.g. in the job description).</li> <li>Percentage of relevant external contracts that have a requirement for an FRMS.</li> <li>Percentage of contractors who have an FRMS in place.</li> <li>Percentage of audit findings where a deficiency in roles and responsibilities has been identified.</li> <li>Percentage of audit findings where a deficiency in stakeholder engagement has been identified.</li> </ul>	
<p><b>Possible supporting lagging metrics</b></p> <ul style="list-style-type: none"> <li>Percentage of incident investigations in which a lack of clear roles and responsibilities for fatigue management is identified.</li> </ul>	

## Proposed FRMS performance indicators for system components (continued)

<b>2. Training and competence</b>	
<p>Training provides personnel with new knowledge and skills, but people need to apply and practise these to become competent. Competence is a combination of practical thinking skills, knowledge and experience.</p>	
<p><b>Desired outcomes</b></p> <ul style="list-style-type: none"> <li>• Personnel are able to recognize the effects of fatigue and to use alertness strategies effectively to enable them to maintain fitness for work/duty.</li> </ul>	<p><b>Critical elements</b></p> <ul style="list-style-type: none"> <li>• Personnel are able to recognize fatigue in themselves and others.</li> <li>• Personnel are able to use alertness strategies effectively to overcome the effects of fatigue associated with extended hours of work or continuous operations involving shift changes.</li> </ul>
<p><b>Possible leading indicators</b></p> <ul style="list-style-type: none"> <li>• Existence of a competency-based fatigue management training programme for relevant target employee groups.</li> <li>• Evidence of application of the learning in the workplace.</li> </ul>	<p><b>Possible lagging indicators</b></p> <ul style="list-style-type: none"> <li>• Incident investigations identify lack of awareness of the risks of fatigue in the workforce as a contributing factor leading to:               <ul style="list-style-type: none"> <li>- people involved in incidents being in a significantly fatigued state; and/or</li> <li>- failure to intervene to prevent a seriously fatigued individual performing safety-critical work.</li> </ul> </li> </ul>
<p><b>Possible assessment questions</b></p> <ul style="list-style-type: none"> <li>• Are processes in place for training and periodic assessment of employees?</li> <li>• Are employees aware of measures to improve sleep?</li> <li>• Are training programmes updated to reflect lessons learned from incidents?</li> <li>• Do systems exist for additional training for those employees and supervisors who require it?</li> <li>• Is the training 'fit for purpose' (is it the right type of training for the organization's needs, including practical management strategies)?</li> <li>• Is the training validated (did it deliver what it was supposed to)?</li> <li>• Are training records available?</li> <li>• How is the impact of training on worker performance evaluated?</li> </ul>	
<p><b>Possible supporting leading metrics</b></p> <ul style="list-style-type: none"> <li>• Percentage of employees trained per period as compared with schedule.</li> <li>• Percentage of supervisors who have received additional specific training regarding their responsibilities per period as compared with schedule.</li> <li>• Percentage of occupational drivers who have received additional specific training per period as compared with schedule.</li> <li>• Percentage of employees completing refresher training per period as compared with schedule.</li> <li>• Percentage of training records completed.</li> <li>• Percentage of employees assessed to be competent in the application of their knowledge of fatigue and its application in the workplace based on post-training knowledge/competency tests.</li> </ul>	
<p><b>Possible supporting lagging metrics</b></p> <ul style="list-style-type: none"> <li>• Percentage of incident investigations in which a lack of adequate training in fatigue management is identified.</li> <li>• Percentage of incident investigations in which a lack of competence in the management of fatigue is identified.</li> <li>• Percentage of incident investigations in which recognized alertness strategies were not used effectively.</li> </ul>	



*Proposed FRMS performance indicators for system components (continued)*

<b>3. Risk assessment</b>	
<p>A risk assessment is a process designed to assess whether a site needs to implement controls to reduce the risk from fatigue to an acceptable level. It involves recognizing the hazard, evaluating the associated risk, assessing the effectiveness of existing controls, and identifying whether additional controls are needed.</p> <p>Fatigue risk assessment can take many forms and can be applied at different levels of detail. At the most detailed level, it may assess the impact of fatigue on worker performance, the probability that employees will experience fatigue while performing their roles, and the associated hazards and risks to operating performance.</p>	
<p><b>Desired outcomes</b></p> <ul style="list-style-type: none"> <li>• A process is in place to identify, assess and record the risks to health and safety arising from fatigue.</li> </ul>	<p><b>Critical elements</b></p> <ul style="list-style-type: none"> <li>• Risk assessment is carried out competently, is properly scoped, and under effective quality and technical assurance.</li> </ul>
<p><b>Possible leading indicators</b></p> <ul style="list-style-type: none"> <li>• Evidence that the site has assessed the risk from fatigue and the effectiveness of existing controls.</li> <li>• Evidence that, where necessary, the site has implemented additional controls to reduce fatigue-related risk to ALARP (as low as reasonably practicable).</li> </ul>	<p><b>Possible lagging indicators</b></p> <ul style="list-style-type: none"> <li>• Incident investigations find no evidence that risk associated with fatigue had been assessed prior to the incident.</li> </ul>
<p><b>Possible assessment questions</b></p> <ul style="list-style-type: none"> <li>• Is an effective FRMS in place?                             <ul style="list-style-type: none"> <li>- What is the process?</li> <li>- Who is responsible?</li> </ul> </li> <li>• Do affected employees understand the fatigue risk reduction/control measures that have been put in place in their work areas?</li> <li>• Is there a process to ensure that contractor organizations have undertaken adequate and appropriate fatigue risk assessments?</li> <li>• Do affected employees understand the significant findings of the risk assessment?</li> </ul>	
<p><b>Possible supporting leading metrics</b></p> <ul style="list-style-type: none"> <li>• Percentage of sites that have undertaken a fatigue risk assessment.</li> <li>• Percentage of employees who have completed a personal fatigue risk assessment (including both work and personal factors).</li> <li>• Percentage of fatigue risk assessments per period as compared with schedule.</li> <li>• Percentage of existing fatigue risk assessments reviewed per period as compared with schedule.</li> <li>• Percentage of fatigue risk assessments relating to contractor activities or personnel.</li> <li>• Percentage of fatigue risk assessments that have considered the work environment.</li> <li>• Number of ad hoc operational fatigue risk assessments triggered by deviations from scheduled hours of work.</li> <li>• Number of ad hoc operational fatigue risk assessments triggered as a result of fatigue-related behaviour by employees that has been observed in the workplace.</li> </ul>	
<p><b>Possible supporting lagging metrics</b></p> <ul style="list-style-type: none"> <li>• Percentage of assessments and incident investigations in which the lack of fatigue risk assessment is identified.</li> </ul>	

## Proposed FRMS performance indicators for system components (continued)

4. Risk reduction	
<p>If an organization has identified risks to health and safety arising from fatigue, it should also identify and assess risk reduction measures, which may include implementing additional controls to manage fatigue risk.</p>	
<p><b>Desired outcomes</b></p> <ul style="list-style-type: none"> <li>• Appropriate controls are in place to mitigate known fatigue-related risk.</li> </ul>	<p><b>Critical elements</b></p> <ul style="list-style-type: none"> <li>• Fatigue control measures should consider the following elements:               <ul style="list-style-type: none"> <li>- Fatigue reduction.</li> <li>- Fatigue prevention (sometimes known as fatigue proofing).</li> </ul> </li> <li>• Fatigue should be included in fitness-for-work assessments for relevant positions.</li> <li>• The reporting of fatigue is encouraged and not penalized (the presence of a 'just' culture).</li> </ul>
<p><b>Possible leading indicators</b></p> <ul style="list-style-type: none"> <li>• Evidence of fatigue reduction and/or fatigue proofing controls within the FRMS.</li> </ul>	<p><b>Possible lagging indicators</b></p> <ul style="list-style-type: none"> <li>• Incident investigations find no evidence of attempts to implement fatigue mitigation measures or to assure that they are effective.</li> </ul>
<p><b>Possible assessment questions</b></p> <ul style="list-style-type: none"> <li>• Is an effective risk reduction process in place?           <ul style="list-style-type: none"> <li>- What is the process?</li> <li>- Who is responsible?</li> </ul> </li> <li>• Are affected employees aware of, and do they understand, the fatigue risk reduction/control measures that have been put in place in their work areas?</li> <li>• Is there a system in place to manage the fatigue-related behaviour of employees that has been observed in the workplace?</li> <li>• Do the organizational arrangements for fatigue management enable workers to change shifts or swap tasks to self-manage fatigue and its impacts?</li> <li>• Is there a process to ensure that contractor organizations have implemented risk reduction/control measures?</li> <li>• Are employees aware of the benefits of the strategic use of caffeine and/or naps?</li> <li>• Do employees and contractors have a mechanism to suggest improvements/raise concerns?</li> </ul>	
<p><b>Possible supporting leading metrics</b></p> <ul style="list-style-type: none"> <li>• Percentage of 'open' shifts per rolling period.</li> <li>• Percentage of unfilled positions.</li> <li>• Percentage of hours worked that are overtime.</li> <li>• Percentage of employees who have exceeded the maximum number of consecutive working days/hours before taking a rest day.</li> <li>• Percentage of single rest days between shift cycles per rolling period.</li> <li>• Percentage of task swaps intended to reduce the adverse impact of fatigue on employee performance.</li> <li>• Percentage of shifts worked following shift swaps (measure of stability of shift patterns).</li> <li>• Percentage of safety-critical activities performed during the window of circadian low (24:00–06:00).</li> <li>• Percentage of control room watches exceeding six hours.</li> <li>• Maximum length of time between breaks on shift.</li> <li>• Percentage of sites that have dedicated facilities or arrangements to enable workers to practise alertness strategies.</li> </ul>	
<p><b>Possible supporting lagging metrics</b></p> <ul style="list-style-type: none"> <li>• Percentage of incident investigations in which a lack of fatigue risk reduction measures is identified as a contributor to the incident.</li> <li>• Percentage of incident investigations which cite ineffective fatigue risk reduction measures as a contributor to the incident.</li> </ul>	

*Proposed FRMS performance indicators for system components (continued)*

<b>5. Health issues including the management of sleep disorders</b>	
Health issues may cause employee fatigue, or may be aggravated by extended hours of work or continuous operations involving shift changes.	
<p><b>Desired outcomes</b></p> <ul style="list-style-type: none"> <li>• Health issues which may cause employee fatigue, or which may be aggravated by extended hours of work or continuous operations involving shift changes are addressed by the organization’s fitness for work programme and fatigue risk management system.</li> </ul>	<p><b>Critical elements</b></p> <ul style="list-style-type: none"> <li>• Reduction of health issues which may cause employee fatigue, or which may be aggravated by extended hours of work or continuous operations involving shift changes.</li> <li>• Health promotion programmes.</li> <li>• Screening for relevant health problems.</li> <li>• Assessment of potential health problems.</li> <li>• Management of health problems.</li> </ul>
<p><b>Possible leading indicators</b></p> <ul style="list-style-type: none"> <li>• Evidence that the impact on health of extended hours of work or continuous operations involving shift changes is addressed by the site.</li> <li>• Evidence that the impact of health on working extended hours of work or continuous operations involving shift changes is addressed by the site.</li> </ul>	<p><b>Possible lagging indicators</b></p> <ul style="list-style-type: none"> <li>• Incident investigations identify underlying health issues affecting sleep as contributing to fatigue associated with incidents.</li> </ul>
<p><b>Possible assessment questions</b></p> <ul style="list-style-type: none"> <li>• Is a system for screening of sleep disorders in place?                             <ul style="list-style-type: none"> <li>- Self-assessment?</li> <li>- Specialist referral?</li> </ul> </li> <li>• Are employees offered a pre-placement assessment before commencing extended hours of work or continuous operations?</li> <li>• Is a system in place for informing affected employees about risk reduction measures?</li> <li>• Are findings (numbers) documented and reported, and do they form part of the basis for continuous improvement of the FRMS?</li> </ul>	
<p><b>Possible supporting leading metrics</b></p> <ul style="list-style-type: none"> <li>• Percentage of employees working extended hours or working on continuous operations involving shift changes, and who were offered a fitness-for-duty assessment which included questions relating to fatigue.</li> <li>• Percentage of employees working extended hours or working on continuous operations involving shift changes, and who completed a fitness-for-duty assessment which included questions relating to fatigue.</li> <li>• Percentage of employees identified as being ‘at risk’ with regard to sleep disorders on initial screening.</li> <li>• Percentage of ‘at risk’ employees who were diagnosed with a sleep disorder.</li> </ul>	
<p><b>Possible supporting lagging metrics</b></p> <ul style="list-style-type: none"> <li>• Percentage of incident investigations in which a health-related fatigue issue was identified.</li> </ul>	

## Proposed FRMS performance indicators for system components (continued)

6. Incident investigation	
<p>After an incident, an investigation should be conducted which considers whether fatigue or a failure of the FRMS was a contributor. This enables lessons to be learned and, where necessary, changes to processes and procedures can be adopted to reduce the risk of fatigue-related incidents in the future.</p>	
<p><b>Desired outcomes</b></p> <ul style="list-style-type: none"> <li>All incident investigations will explicitly include an assessment of the role that fatigue may have played in the incident.</li> </ul>	<p><b>Critical elements</b></p> <ul style="list-style-type: none"> <li>Incident investigation procedures include specific reference to the assessment of fatigue.</li> <li>The investigation of fatigue takes account of the prior sleep history and time awake of the individuals involved.</li> <li>The fatigue investigation goes beyond the actors directly involved in the incident, and considers others who may have created errors due to fatigue-related performance decrement.</li> <li>Incident investigators are trained in the assessment of fatigue.</li> <li>The incident investigation report includes a reference to fatigue (having been assessed and any findings documented).</li> </ul>
<p><b>Possible leading indicators</b></p> <ul style="list-style-type: none"> <li>The possibility that fatigue could be a contributing factor is included in all incident investigations.</li> <li>Completeness of the process for assessing the possible role of fatigue.</li> </ul>	<p><b>Possible lagging indicators</b></p> <ul style="list-style-type: none"> <li>The role of fatigue is included in all incident investigations.</li> </ul>
<p><b>Possible assessment questions</b></p> <ul style="list-style-type: none"> <li>Does the documentation and process used for 'incident investigation' include reference to fatigue?</li> <li>Do incident investigators receive the necessary training to enable them to assess the relevance of fatigue when an investigation is conducted?</li> </ul>	
<p><b>Possible supporting leading metrics</b></p> <ul style="list-style-type: none"> <li>Percentage of incident investigation reports that contain an assessment of the contribution of fatigue.</li> <li>Percentage of cumulative incident investigation summaries (e.g. quarterly or year end) that include a section on fatigue.</li> <li>Percentage of near miss reports (i.e. not just incidents that led to an injury) that make reference to fatigue.</li> <li>Percentage of incident investigators who have received additional training in fatigue.</li> <li>Percentage of investigation reports that provide data on the prior sleep/wake history of both direct actors in the incident and those who may have created latent errors.</li> </ul>	
<p><b>Possible supporting lagging metrics</b></p> <ul style="list-style-type: none"> <li>Percentage of incident investigations that do not address fatigue (or any references that are deemed to be incomplete).</li> <li>If fatigue is relevant to an incident, it is only discovered by chance (i.e. not through a systematic assessment of the incident).</li> </ul>	

*Proposed FRMS performance indicators for system components (continued)*

<b>7. Monitoring and processes for the internal and external assessment of the FRMS</b>	
Monitoring is undertaken and a process is in place for the internal and external assessment of the FRMS which delivers corrective actions through a continuous improvement process.	
<p><b>Desired outcomes</b></p> <ul style="list-style-type: none"> <li>• A system is in place to monitor and review the effectiveness of the FRMS and implement corrective actions as required, for continuous improvement.</li> </ul>	<p><b>Critical elements</b></p> <ul style="list-style-type: none"> <li>• The presence of an internal and/or external assessment process to determine alignment with the published FRMS.</li> <li>• Leading and lagging indicators are identified.</li> <li>• Findings from the assessment are used to undertake corrective actions.</li> <li>• Findings from the assessment are used to drive continuous improvement.</li> </ul>
<p><b>Possible leading indicators</b></p> <ul style="list-style-type: none"> <li>• Number of internal/external FRMS audits.</li> </ul>	<p><b>Possible lagging indicators</b></p> <ul style="list-style-type: none"> <li>• Percentage of incident investigations in which the absence of, or problem with, the monitoring or internal/external assessment of the FRMS was identified.</li> </ul>
<p><b>Possible assessment questions</b></p> <ul style="list-style-type: none"> <li>• Is there a monitoring programme or process in place for the internal and external assessment of the FRMS?</li> <li>• Are assessors trained in audit processes, competent in fatigue risk management and adequately resourced to undertake the necessary assessments?</li> </ul>	
<p><b>Possible supporting leading metrics</b></p> <ul style="list-style-type: none"> <li>• Percentage of internal/external assessment protocols that include fatigue.</li> <li>• Percentage of internal/external assessment findings that include fatigue.</li> </ul>	
<p><b>Possible supporting lagging metrics</b></p> <ul style="list-style-type: none"> <li>• The role of fatigue is included in all incident investigations.</li> </ul>	

## Glossary

**ALARP:** stands for ‘as low as reasonably practicable’—a term often used to describe one of the fundamental principles of risk management, i.e. the reduction of risk to the point beyond which the costs exceed the benefits.

**Alertness:** the state of readiness to respond to any stimulus.

**Alertness strategies:** strategies to enable the individual to improve their readiness to respond to any stimulus despite being fatigued. These include the appropriate use of caffeine, rest or exercise, and social interactions.

**Elevated predicted levels of fatigue:** a level of fatigue predicted using some form of fatigue risk assessment below which fatigue-related adverse events are unlikely to occur.

**Fatigue:** the body’s response to sleep loss or to prolonged physical or mental exertion.

**Fatigue action level:** a level of predicted or assessed fatigue set by an organization above which the organization accepts that action should be taken to reduce the level of experienced fatigue. Action levels are usually dependent on the criticality of the task and its sensitivity to impairment by fatigue.

**Indicator:** typically a qualitative instrument used to monitor performance and provide an indicator of trends.

**Metric:** progress in measurable terms (sometimes but not always, a metric will relate directly to an indicator).

**Occupational driving:** driving for the purpose of company business whether or not the individual is a professional driver.

**Open shifts:** foreseeable or planned vacancies where the vacancy is known at least one week in advance and where overtime will be required to fill the vacancy (non-emergency).

**Shift work:** an organization of work where workers succeed each other at the same workplace while performing similar operations at different times of the day, thus allowing longer hours of operation than feasible for a single worker.

**Sleep debt:** loss of sleep, which can accumulate over a number of days.

**Stakeholders:** potentially include employees, employees’ representatives, managers, health and safety representatives and human resources representatives.

**Window of circadian low:** occurs between approximately midnight and 06:00 in individuals synchronized to day work and nocturnal sleep, during which human alertness and performance reaches a nadir.

## Source documents and references

### Source documents

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