



# Managing Fatigue - A Good Practice Guide

Document no. RS/504 Issue 1

September 2012

© RSSB Copyright 2012 Rail Safety and Standards Board Limited. This publication may be reproduced free of charge for research, private study, or for internal circulation within an organisation. This is subject to it being reproduced and referenced accurately and not being used in a misleading context. The material must be acknowledged as the copyright of Rail Safety and Standards Board Limited and the title of the publication specified accordingly. For any other use of the material please apply to RSSB's Head of Delivery (TOM) for permission. Any additional queries can be directed to [enquirydesk@rssb.co.uk](mailto:enquirydesk@rssb.co.uk).

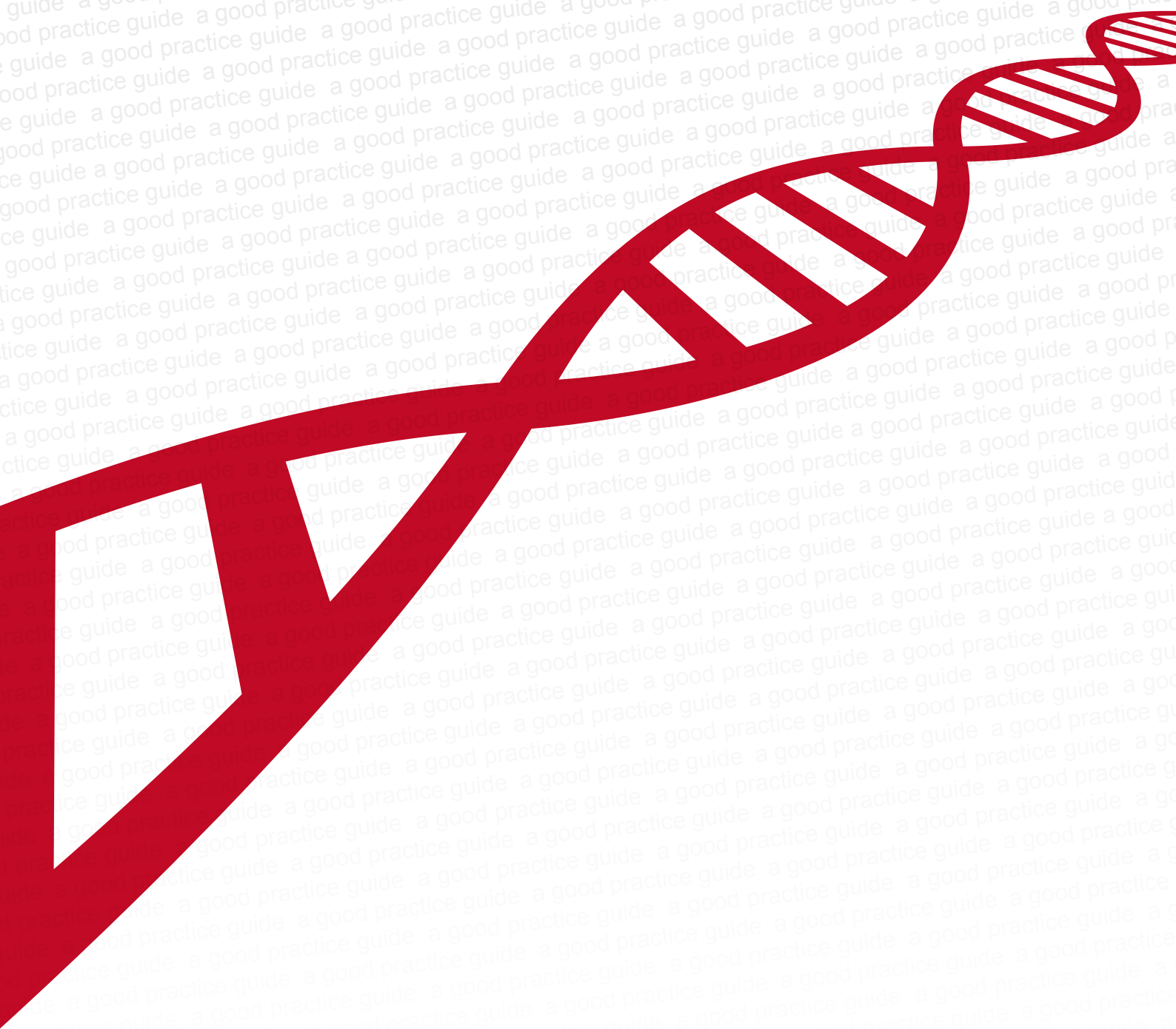
# Contents

<b>1 Introduction .....</b>	<b>5</b>
1.1 Purpose of document .....	6
1.2 Target audience .....	6
1.3 Legislative and regulatory requirements .....	6
<b>2 Background.....</b>	<b>11</b>
2.1 What is fatigue? .....	12
2.2 Causal factors .....	12
2.2.1 Work-related causes .....	12
2.2.2 Non work-related causes .....	12
2.2.3 Consequences of fatigue .....	13
2.3 Fatigue in the rail industry .....	14
<b>3 Fatigue Risk Management - An Overview.....</b>	<b>17</b>
3.1 Overview .....	18
<b>4 Setting up a Fatigue Risk Management System.....</b>	<b>21</b>
4.1 Policy Commitment .....	22
4.2 Roles and Responsibilities .....	23
<b>5 Competence .....</b>	<b>25</b>
5.1 Background .....	26
5.2 All rail safety workers .....	26
5.3 Staff with responsibilities for implementing the FRMS .....	27
<b>6 Consultation .....</b>	<b>29</b>
6.1 Overview .....	30
<b>7 Fatigue Risk Management Process .....</b>	<b>31</b>
7.1 Overview .....	32
7.2 Hazard identification .....	32
7.3 Risk assessment .....	33
7.4 Risk control .....	34
7.4.1 Setting standards and designing working patterns .....	34
7.4.2 Limiting exceedances .....	40
7.4.3 Additional control measures .....	40
7.5 Evaluation .....	45
<b>8 Reviewing Performance .....</b>	<b>47</b>
8.1 Overview .....	48
<b>References .....</b>	<b>49</b>
<b>Appendices.....</b>	<b>53</b>
<b>Appendix 1</b> Hidden Limits on working time .....	54
<b>Appendix 2</b> Key elements of a positive safety culture .....	55
<b>Appendix 3</b> Fatigue assessment tools - important considerations .....	56
<b>Further information on Fatigue and Fatigue Management .....</b>	<b>57</b>
<b>Additional RSSB leaflet titles available on the RSSB website .....</b>	<b>57</b>

# Glossary

<b>BAC</b>	Blood Alcohol Concentration
<b>CIRAS</b>	Confidential Incident Reporting and Analysis System
<b>Circadian rhythms</b>	The name given to the 'internal body clock' that regulates the (roughly) 24 hours cycle of biological processes in humans
<b>HSE</b>	Health and Safety Executive
<b>Fatigue</b>	The reduced mental alertness and performance that results from prolonged physical or mental effort
<b>FRMS</b>	Fatigue Risk Management System - the systematic and co-ordinated processes and procedures a company puts in place to manage and / or mitigate the risks arising from members of its workforce becoming fatigued
<b>FRI</b>	Fatigue and Risk Index – scientifically developed rostering tool that calculates worker fatigue and risk indices based on recorded patterns of working
<b>Night worker</b>	The EU Working Time Regulations 1998 (as amended) define a night worker as someone who, as a normal course, works at least three hours of his or her daily working time at night, or is likely to work at least such proportion of annual working time during night time as specified within a collective agreement or workforce agreement. 'As a normal course' is defined as 'on a regular basis' or at least one third of the working time. Night time is defined as being between 11pm and 6am unless a collective agreement sets a different period of not less than seven hours duration and includes the period between midnight and 5am.
<b>NTSB</b>	United States National Transportation Safety Board
<b>ORR</b>	Office of Rail Regulation
<b>ROGS</b>	Railways and Other Guided Transport Systems (Safety) Regulations 2006 (as amended)
<b>RSSB</b>	Rail Safety and Standards Board Limited
<b>SCW</b>	Safety Critical Worker
<b>SMS</b>	Safety Management System
<b>SPI</b>	Safety Performance Indicator
<b>SPAD</b>	Signal Passed at Danger

# 1. Introduction





# Introduction

## 1.1 Purpose of document

RSSB have published this good practice guide to assist industry stakeholders understand and comply with their duties under the 'Railways and Other Guided Transport Systems (Safety) Regulations 2006' (as amended) (ROGS) [1] - 'Regulation 25 – Fatigue'. This document complements guidance produced by the Office of Rail Regulation (ORR) on 'Managing Rail Staff Fatigue' (2011) [2].

The intention of this guide is to offer infrastructure managers (IMs) and railway undertakings (RUs) a practical illustration of how fatigue risks can be systematically managed to improve the health and safety of the workforce and therefore operations. It sets out the key elements of effective fatigue management and illustrates how these can be incorporated into a company's overarching safety management system. This will assist in reducing the costs associated with accidents and injuries, sickness, absenteeism and turnover due to poor fatigue management and to satisfy a company's duty of care to its employees and the public.

The information in this document is intended as guidance only. It is based on a variety of sources. These include railway-specific documents (eg accident investigations); Health and Safety Executive (HSE) human factors audit reports; aviation, road transport, maritime industry publications and RSSB fatigue research [3,4,5]. The options presented are provided to give a flavour of the variety of approaches available. They are not an exhaustive or validated list; they are simply options for IMs and RUs to consider within the context of different operating environments and existing company fatigue management arrangements.

As future research and information becomes available this good practice guide will be updated accordingly.

## 1.2 Target audience

This guide is primarily aimed at organisations that have a legislative obligation to comply with ROGS – Regulation 25 – Fatigue [1]. This will include those individuals responsible for:

- Defining a company's Safety Management System.
- Attaining safety certificates.
- Specialists who advise on roster design and other background sources of information (eg occupational health; training).

This guide will also be of value to transport companies (eg trams) who should also establish controls, processes and procedures to manage and mitigate the risk of workers becoming fatigued.

## 1.3 Legislative and regulatory requirements

Following the investigation into the Clapham Junction rail disaster [6], Anthony Hidden QC made the following recommendations to address the underlying management failings:

Recommendation 18 – 'BR shall ensure that overtime is monitored so that no individual is working excessive levels of overtime' (paragraphs 8.54 – 8.56).

Recommendation 19 – BR, in conjunction with the Unions, shall introduce the concept of scheduled hours within the Signals and Telecommunications Department in order to make better provision for work which has to be carried out at weekends' (paragraphs 12.25 and 12.26).

As a direct consequence of the Clapham Inquiry, industry adopted what became known as the 'Hidden Limits' on working time which were included in an appendix to Railway Group Standard GH/RT4004 (now withdrawn) (see Appendix 1). The limits were generic (eg not specific to any particular group of safety critical workers) and reflected what was achievable in operational terms at the time, based on expert opinion and agreed good practice. Although not mandatory, they were recommendations to assist IMs and RUs comply with GH/RT4004 and Regulation 4 of The Railways (Safety Critical Work) Regulations, 1994<sup>1</sup>.

The 'Hidden Limits', however, did not address all of the known causes of fatigue (see section 2). There remained, therefore, no guarantee that workers would not continue to experience fatigue and therefore the risks to the operation of the railway were not effectively managed. For example, simply specifying a minimum rest period between shifts will not guarantee that a shift worker is fully recovered. The reason is that the extent of a person's recovery will depend upon many factors. These include, for example, how much sleep a person has been able to obtain; the quality of that sleep; the extent to which the rest period coincides with the normal (circadian) cycle of the biological body clock; and the conscious effort on the part of the individual to obtain sufficient sleep.

<sup>1</sup> The Railways (Safety Critical Work) Regulation, 1994 have now been replaced by The Railways and Other Guided Transport Systems (Safety) Regulations, 2006 (as amended).

In April 2006, 'The Railways and Other Guided Transport Systems (Safety) Regulations 2006' (as amended) (ROGS) came into force [1]. Under 'Regulation 25 – Fatigue', new regulatory requirements to manage fatigue in safety critical workers were introduced. These requirements address recommendations relating to driver management and training included in the Ladbroke Grove Cullen Inquiry [7,8].

Regulation 25 states:

(1) Every controller of safety critical work shall have in place arrangements to ensure, so far as is reasonably practicable, that a safety critical worker under his management, supervision or control does not carry out safety critical work in circumstances where he is so fatigued or where he would be liable to become so fatigued that his health or safety or the health or safety of other persons on a transport system could be significantly affected.

(2) The arrangements in paragraph (1) shall be reviewed by the controller of safety critical work where he has reason to doubt the effectiveness of those arrangements.

As is the case in many high risk industries, the legislation formally shifted the focus away from prescriptive working time limits which specified, for example, minimum rest intervals between shifts and maximum shift lengths, to a more systematic approach to managing fatigue risks. This is in recognition of the fact that, in order to reduce the likelihood of accidents, incidents and errors in which fatigue is a contributing factor, fatigue risk management requires the implementation of effective controls at an individual, job and organisational level.

In July 2006 The Office of Rail Regulation (ORR) produced guidance to support Regulation 25 entitled 'Managing fatigue in safety critical work - Railways and Other Guided Transport Systems (Safety) Regulations 2006' (as amended) [9]. It specified nine high level stages that a controller of safety critical work should address to manage fatigue risks (see Figure 1). If applied in a co-ordinated and systematic fashion, the nine stages would constitute a company's fatigue risk management arrangements. It is, however, important to recognise that the stages do not represent a fixed sequence of static, isolated, steps that must be followed. Rather, each stage represents just one important element in an iterative cycle of risk assessment processes and review procedures that duty holders should have in place to manage and mitigate the risks of a workforce becoming fatigued. Further guidance produced by the ORR to support ROGS is also available via their website [10].

The ORR has recently published updated guidance on fatigue management [2]. The nine stages have been retained as many companies would have put in place arrangements based on the original guidance. It has also been extended to describe legal duties under ROGS, basic fatigue controls, the fatigue risk assessment process, features of a more comprehensive approach to managing fatigue – Fatigue Risk Management Systems (FRMS) - and also describes different potential structures for an FRMS, drawing on the Health and Safety Executive's (HSE) well known POPMAR<sup>2</sup> framework (HSG65) for successful health and safety management [14].

<sup>2</sup> POPMAR is the acronym used to refer to the HSE's five steps to successful health and safety management – Policy, Organising, Planning and implementing, Measuring performance, Reviewing

## Introduction

Stage	Summary
<b>1</b> → Identifying those safety critical workers affected	Identify those people carrying out safety critical work who are liable to be or could become fatigued when carrying out such work.
<b>2</b> → Setting standards and designing working patterns	Identify, set and adhere to appropriate standards and good practice for working hours and working patterns, observing any relevant working time limits that apply.
<b>3</b> → Limiting exceedances	Ensure that any standards and limits that have been identified and set are only exceeded with your prior approval and only on an infrequent basis and in exceptional circumstances.
<b>4</b> → Consulting with safety critical workers	Consult with safety critical workers and their safety representatives on the arrangements needed to manage fatigue and when standards and limits are to be changed.
<b>5</b> → Recording the arrangements	Maintain a record of your arrangements for managing the risks arising from fatigue in safety critical workers.
<b>6</b> → Providing information to safety critical workers	Provide all safety critical workers under your management, supervision or control with clear and relevant information on risks to health and safety owing to fatigue and your arrangements for managing fatigue.
<b>7</b> → Monitoring	Monitor the arrangements for managing fatigue to assess how effectively you are controlling the risks arising from fatigue.
<b>8</b> → Taking action when safety critical workers are fatigued	Ensure, so far as is reasonably practicable, that safety critical workers who report for duty where they are clearly unfit owing to fatigue, or who, through the course of their work shift become clearly unfit owing to fatigue, do not carry out or continue to carry out safety critical work.
<b>9</b> → Reviewing the arrangements	Review your arrangements for managing the risks arising from fatigue when you have reason to doubt the effectiveness of the arrangements.

Figure 1: SUMMARY OF THE NINE ORR STAGES  
(reproduced with kind permission of the Office of Rail Regulation)



Employers also have general responsibilities under health and safety law to assess and reduce, as far as reasonably practicable, the risks from staff fatigue (eg Health and Safety at Work etc Act (1974); Management of Health and Safety at Work Regulations (1999) [11,12]. Under the Health and Safety at Work etc Act (1974), employees also have general duties to take reasonable care for their own health and safety and that of other people who may be affected by their work activities. The implication is that employees should take 'positive steps to understand the risk factors in their work, such as the causes of fatigue.....' [26].

In relation to fatigue management, reference is also often made to The Working Time (Amendment) Regulations 1998 (WTR) which were introduced under the UK's EU "Social Chapter" obligations [13]. The WTR include limits on the number of hours employees can be required to work per week by employers, limit night work hours, and include provision for rest breaks, paid annual leave and health assessments for night workers.

However, the ORR (and the HSE) do not view the WTR as a regulatory way of controlling system risk, or the risk to workers' health and safety from fatigue. Duty holders need to consider and comply with the requirements of WTR, but complying with the WTR is not in itself sufficient to adequately control risks from staff fatigue. The WTR are not risk based, nor are they "relevant statutory provisions" made under the Health and Safety at Work etc Act (1974) [11] and as a consequence contain many exemptions<sup>2</sup> and opt outs<sup>3</sup>. For safety critical workers (as defined under ROGS), the WTR provisions are therefore in addition to, not instead of, protection under ROGS.

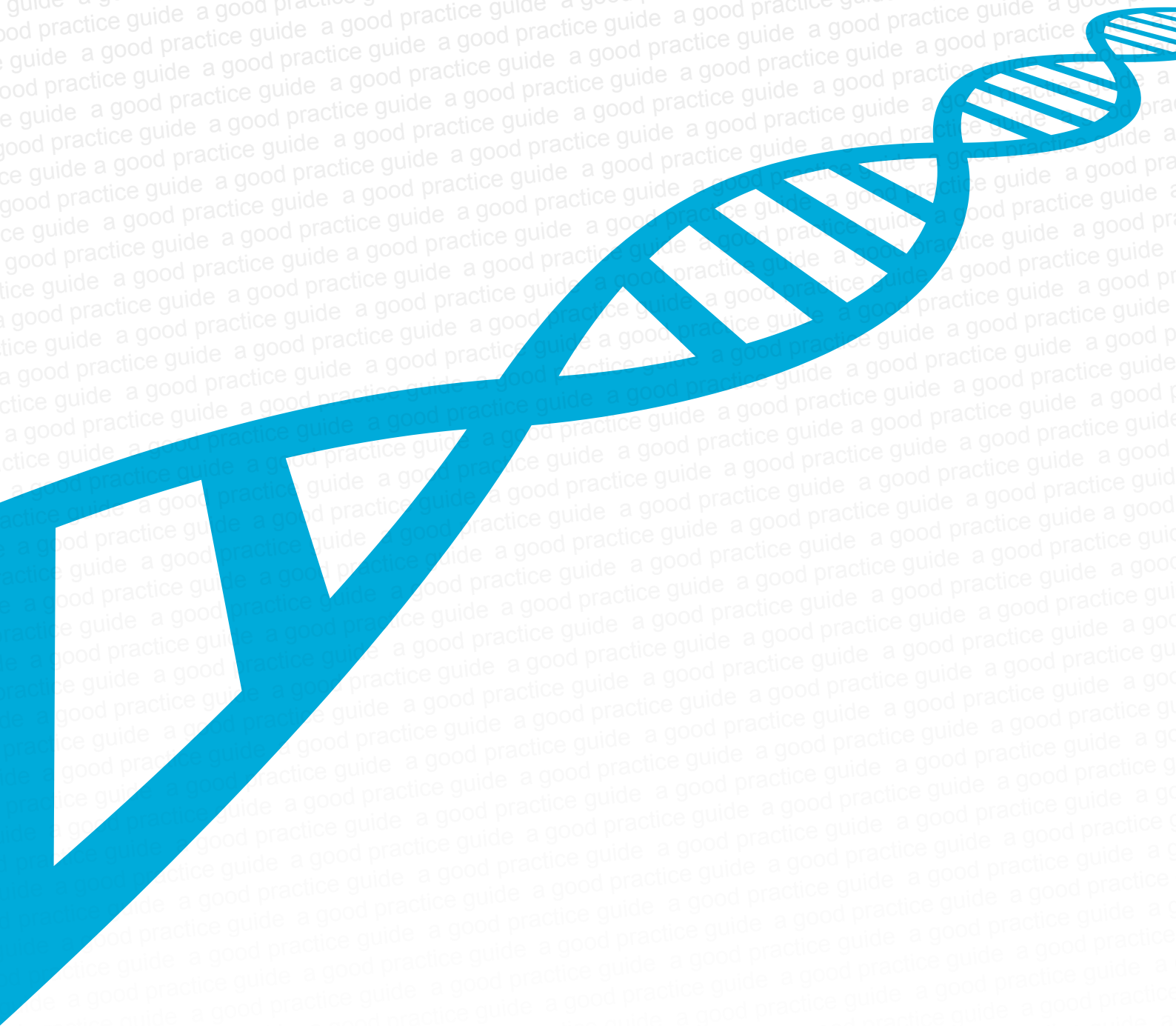
[Further information on the WTR can be obtained by contacting the Working Time Officer (WTO), Office of Rail Regulation].

<sup>3</sup> Subject to workers receiving an equivalent period of compensatory rest, the limits on night working and rest breaks do not apply to the majority of rail workers (this includes drivers, anyone working in possessions, staff on engineering trains, signallers and platform staff) who, under The Working Time (Amendment) Regulations 2003 (regulation 21(f)(i),(ii) or (iii)), can all be reasonably classified as "special cases".

<sup>4</sup> For example, the WTR regulations contain provision for workers to opt out of the limit on weekly working hours.



## 2. Background



## Background

### 2.1 What is fatigue?

There is no single scientific definition of fatigue but it is accepted that fatigue is generally a feeling of extreme tiredness and being unable to perform work effectively. It is a state of impairment that can result from prolonged working, heavy workload, insufficient rest and inadequate sleep and can include mental and/or physical elements.

### 2.2 Causal factors

Fatigue is the result of insufficient sleep and rest between activities. A combination of work and non-work factors can interact to cause deteriorations in human performance and lead to the onset of uncontrollable sleep. To summarise, these include:

- Shift start time.
- Shift duration and time spent in work-related activities.
- Nature of task and working environment.
- Opportunity for, and quality of rest before, during and after work periods.
- Individual factors, such as fitness and health, age, body clock, lifestyle, activities outside work, including second jobs and domestic commitments.

#### Guidance produced for the road transport industry on fatigue management provides the following interesting comparisons:

- After 17 continuous hours awake, including time awake before driving, drivers perform as if they had a Blood Alcohol Concentration (BAC) of 0.05 – this is above the railway accepted limit of 0.03 (30mg per 100ml of blood).
- After 24 hours awake, a driver's performance will be on par with that of a person with a BAC of 0.10 – greater than three times the railway accepted limit.
- Drivers awake for a period equal to or in excess of 17 hours per 24 hour period put themselves and other road users at significant risk.

### 2.2.1 Work-related causes

The main work-related causes of fatigue include:

- Long shifts, particularly those that impinge on the normal hours of sleep (eg nights and early starts).
- Rapid turnarounds (eg insufficient time available between shifts for rest and recovery).
- High numbers of consecutive shifts.
- Inadequate breaks within a shift.
- Variability in the shift pattern (eg a rotating shift pattern that changes about once a week; short notices changes to roster; backward rotating shifts; variable shift start times in a sequence of consecutive shifts).
- Unplanned work (eg on-call duties; overtime; emergencies).
- Commuting time.
- Workload and nature of task.
- Features of the work environment (eg temperature, noise, vibration).

The level of work-related fatigue will be similar across individuals performing the same tasks. It should therefore be assessed and managed at the organisational level.

### 2.2.2 Non work-related causes

The main non-work related causes of fatigue include:

- Domestic and family circumstances that may cause sleep disruption.
- Health (eg sleep disorders).
- Individual differences (eg body clock and preferences for certain shifts; age).
- Strenuous activities, such as second jobs.
- Lifestyle (eg diet; alcohol and drugs).
- Stress (eg physical, mental or emotional response to external events).

Non-work related causes of fatigue are best managed at the individual level as the impact of different factors will vary considerably. Employers should ensure however that employees are aware of the (non work-related) risks and know how and where to go for further information and support (eg Occupational Health department) (see Section 5 on 'Competence').

## 2.2.3 Consequences of fatigue

### Shift workers, particularly those on rotating shifts, have a higher incidence of:

- Sick leave.
- Visits to clinics at the work site.
- Poorer scores on measures of mental health.

One study found that compared to 20% of day workers, 62% of shift workers complained of sleep problems [19].

Human performance can become gradually and insidiously degraded if fatigue is not adequately controlled. This can lead to impaired decision making, alertness and reduced vigilance, together with a general deterioration in motivation and mood. This situation can be exacerbated in high or low workload situations. Signs of fatigue include loss of energy, inability to concentrate and tiredness even after sleep. The outcome is that fatigue can cause or contribute to potentially dangerous errors. This can include, for example, misreading or overlooking a signal, misunderstanding or forgetting communications, incorrect route setting, straying into a place of danger or failing to complete the necessary maintenance checks.

### Case study

An analysis of Coast Guard incidents showed that fatigue contributed to 16% of vessel groundings and 33% of personnel injuries.

- The National Transportation Safety Board (NTSB) found that a major cause of the Exxon Valdez grounding was the failure of the operator to provide a fit and rested crew [33].

On average, individuals require 7-8 hours of nightly sleep. There are also people who require more or less than this average amount. If a person's biological 'sleep need' is reduced by one to two hours, they will experience acute sleep loss and the associated deteriorations in alertness and performance the next day. Excessively long shifts and/or consecutive shifts that curtail the opportunity for sleep, in particular, nights and early morning starts, will accumulate a 'sleep debt' and progressively worsen alertness and performance. If sleep disruption is ongoing, this can lead to chronic sleep deprivation, further deteriorations in work performance and long term physical and mental health problems.

### Case study

An investigation into reported accidents on day, afternoon and night shifts at two paint plants found an indication of a significant increase in accident rates on the night shift, particularly during the last three hours of the shift.

### Health problems

If fatigue is not adequately controlled and sleep disruption is ongoing, shift workers are at an increased rate of:

- Cardiovascular disorders (hypertension, heart disease, high cholesterol).
- Gastro-intestinal disorders (heartburn, peptic ulcers, indigestion).
- Substance abuse (caffeine, nicotine, alcohol, sleeping pills, drugs).
- Sleep problems (insomnia, sleep apnoea, chronic fatigue) [4,5].

Research has found that sleep and health problems among passenger train drivers were common, sometimes severe, with 15% of drivers surveyed reporting symptoms indicative of sleep apnoea [3].

Among freight drivers, research found that insomnia, stress and anxiety correlated with the frequency of night shifts. A lack of control over shifts worked, and the stated working hours, correlated with indigestion, irritability, insomnia, stress and anxiety [4].

People's physical and psychological functioning fluctuates throughout the 24-hour day. These fluctuations are known as circadian rhythms and are genetically determined by the biological 'clock' in the brain. As this 'clock' is sensitive to light and darkness, people are genetically designed to sleep at night and be awake during the day. The reason it is difficult to adapt to shift work is that the body is constantly being drawn back to the day/night default cycle. Mental and physical performance capacity therefore inevitably drops when alertness levels are naturally low in the early morning hours. This has inevitable consequences for how shift workers respond to the nature of different job demands during the course of the day, and particularly on the night shift.



## Background

### Mental alertness

In fully rested people, mental alertness is at its natural low at about 3-5am (or slightly later on the night shift) when the biological need for sleep is greatest. A second drop in alertness occurs mid-afternoon (eg siesta time). The urge to sleep (and propensity to make errors) at these times will be even greater among those who have acquired a 'sleep debt', are working under time pressure, or have a high workload.

A further complicating factor is that people cannot simply sleep 'at will'. The natural urge to sleep will be at its strongest in the early hours of the morning and to wake up around seven hours later. For this reason, the daytime sleep of night shift workers has been consistently found to be one third shorter and of poorer quality than their night time sleep [34]. This is because they tend to spontaneously wake up after only a few hours sleep. Night workers, therefore, have to contend both with less sleep during the day, plus working during the natural low point in performance in the early hours of the morning.

Cross-industry research has also highlighted an association between different work patterns and, for example, an increase in accident rates and personal health problems (see case studies below). These highlight the broad range of fatigue-based issues, both for workers and management, which can contribute to operational safety risk.

### Research has shown:

- A clear and significant increase in self-reported psychological symptoms (such as depression, loss of self-esteem, difficulty in concentrating, etc) in a group of nurses, 15 months after commencing shift work [15].
- A clear decrease in gastrointestinal complaints, and reduced sickness absence in a group of steel workers who were transferred from shift work to day work [16].
- Shift work sleep disorder is now a recognised condition and pharmaceutical companies are researching methods of treatment.

## 2.3 Fatigue in the rail industry

Based on a growing body of operational and scientific evidence, there is now widespread recognition across a range of industries of the risks associated with fatigue. Within the rail industry this has been reinforced by numerous accident inquiries – for example, Clapham Junction (1988) [6], Southall (1997) [39], Brentingby Junction (2006) [36], Badminton (2006) [42], Maltby

North (2006) [43], Grayrigg [2007], East Somerset Junction (2008) [37], Leigh-on-Sea (2008) [41] and Shap (2010) [38]. Fatigue has also been cited as a causal or contributory factor in at least 74 railway accident and incident investigation reports between 2001 and 2009. It is, however, highly likely that fatigue as a contributor to accidents and incidents has, in the past, been underestimated, although this situation is likely to change given improvements in human factors awareness training in recent years. (See Further Information in Fatigue and Fatigue Management).

### Case study

Investigation into the causes of the Clapham Junction rail accident in 1988 identified a number of contributory causes including:

- Degradation of working practices.
- Poor supervision.
- Problems with training.

Uncontrolled levels of overtime working were identified in the 13 weeks preceding the accident: 28% of the workforce worked seven days a week; and another 34% worked 13 days out of 14.

The recommendations included monitoring to reduce excessive overtime working and the introduction of scheduled hours to make better provision for weekend engineering working.

Two major fatigue and shift work research studies have been conducted by RSSB. The first was a direct response to recommendation 1 of the Southall Inquiry (2000) that requested that passenger train (TOC) drivers' hours of work be reviewed [3]. The second was triggered following the derailment of a freight train at Brentingby and specifically targeting the freight driver and track worker communities [4]. In both accidents fatigue was identified as an underlying contributory factor.

Both studies adopted a collaborative approach between management and staff of the participating companies, the unions and external experts in the field of fatigue. Using employee fatigue questionnaires and sleep diaries, together with analysis of fatigue-related accident data, company visits and focus groups, the research identified key factors contributing to an increased risk of fatigue in the target populations. These factors were associated with:

- Shift duration - particularly on night shifts and early starts.
- Time of day (eg when alertness levels are naturally low).

- Unplanned shift extensions and checks on fitness to continue beyond 12 hours.
- Actual versus contracted duty hours (eg overtime levels).
- The first night shift.
- Long consecutive duties.
- Variability in the timing of shifts (eg differences in shift start time between consecutive shifts of the same type).
- Days off and recovery from consecutive shifts.
- On-call duties and spare turns.
- Variability in the shift pattern (eg transitions from one type of shift to another; short notice changes).
- Time off after an overnight or early morning start.
- Lack of control over shifts worked.
- Individual differences (eg shift preferences; ability to cope with nights).
- Sleep and health problems.
- Employee fatigue management guidance and training.
- Features of the working environment (eg cab temperature).
- Remote booking-on.
- Workload factors (eg time spent driving; amount of physical work activity).
- Long drives to and from work.
- Quality and timing of breaks.

The results from the research clearly indicated that there are many aspects associated with the scheduling and design of rail safety critical work that need to be addressed in order to limit the risks associated with high levels of fatigue. The remainder of this document therefore sets out guidance on how to systematically manage fatigue risks and meet the requirements under ROGS.

## Case study

The National Transportation Safety Board (NTSB) determined that fatigue caused the failure of a railroad train engineer and conductor to respond appropriately to wayside signals governing the movement of their train. This led to a fatal collision with another train [17].

As a result of the derailment the 16th car in the train, a tank car loaded with liquefied chlorine, was punctured. The chlorine vaporized and engulfed the area surrounding the accident site. Three people, the conductor and two local residents died from the effects of chlorine gas inhalation.

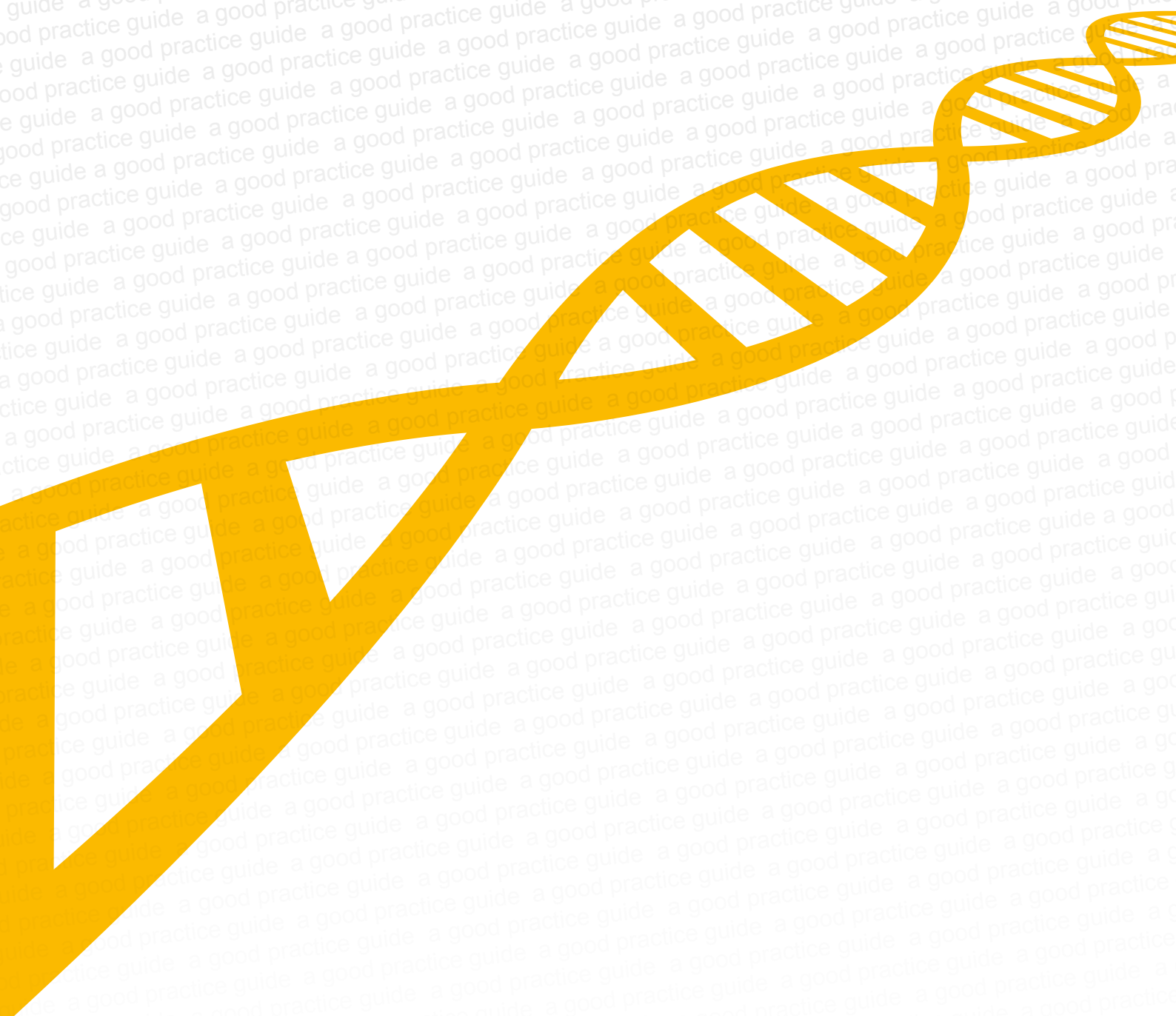
The NTSB investigation determined that sleep debt, disrupted circadian rhythms, limited sleep during the weekend preceding the accident, and long duty hours reduced the capacity of the engineer and conductor to remain awake and alert during the night.

An examination of the engineer's and the conductor's off duty time revealed that neither made effective use of the time available to them to obtain adequate rest. The Board therefore determined the two key contributing factors to the accident were (1) the crewmembers' failure to obtain sufficient restorative rest prior to reporting for duty because of their ineffective use of off-duty time, and (2) the systems for scheduling working hours that created inverted crewmembers' work/rest patterns.'

"Get enough sleep - it sounds so simple and yet we continue to see accidents caused by fatigue" said NTSB Acting Chairman Mark V. Rosenker, "How many more tragedies have to occur before employers and employees get the message that being well rested is critical to job performance?"



# 3. Fatigue Risk Management



# Fatigue Risk Management

## 3.1 Overview

In a 24/7 railway industry, fatigue is an operational concern that needs to be effectively managed just like any other hazard. This is particularly the case in respect of the work carried out by drivers, signallers and maintenance workers which is critical to safe operations. Safety critical work can occur at any time, day or night, in difficult circumstances and against demanding work schedules. It is therefore essential that controllers of safety critical workers understand the multiple causes of fatigue and adopt a more systematic approach to managing the risks.

A Fatigue Risk Management System (FRMS) is the term used to refer to the more formal arrangements for managing fatigue risks. Rather than simply relying on specified hours of work and rest periods, FRMSs take a risk-based approach to ensure workers and the public are protected as far as reasonably practicable. An FRMS is an evidence-based, data-driven and documented process which, through the measurement of actual risks, enables a company to develop tailored controls to offset any potential increase in fatigue levels.

There is no generic, 'one-size-fits-all' FRMS. Rather, a company's FRMS will be dependent upon the nature, size and complexity of its operations and proportionate to the likely fatigue risk. Although the precise content of an FRMS will be specific to an organisation's needs, key components include:

- A company culture that supports an FRMS, including policy commitment and the establishment of a consultation process supported by senior management. This includes the allocation of key roles and responsibilities, effective resourcing and education and training to ensure competency requirements are met.
- A dedicated fatigue risk identification, assessment, control and evaluation process. Information sources that can be drawn upon for this purpose include:
  - The identification of safety critical workers at risk.
  - Staff feedback.
  - A (confidential) reporting system for employees to raise fatigue-related concerns based on the principles of a 'just' culture (see Appendix 2).
  - Investigation of the potential role of fatigue in incidents.
  - The use of predictive models to make an early assessment of fatigue risks associated with base rosters (eg the HSE's Fatigue and Risk Index) [20,21].

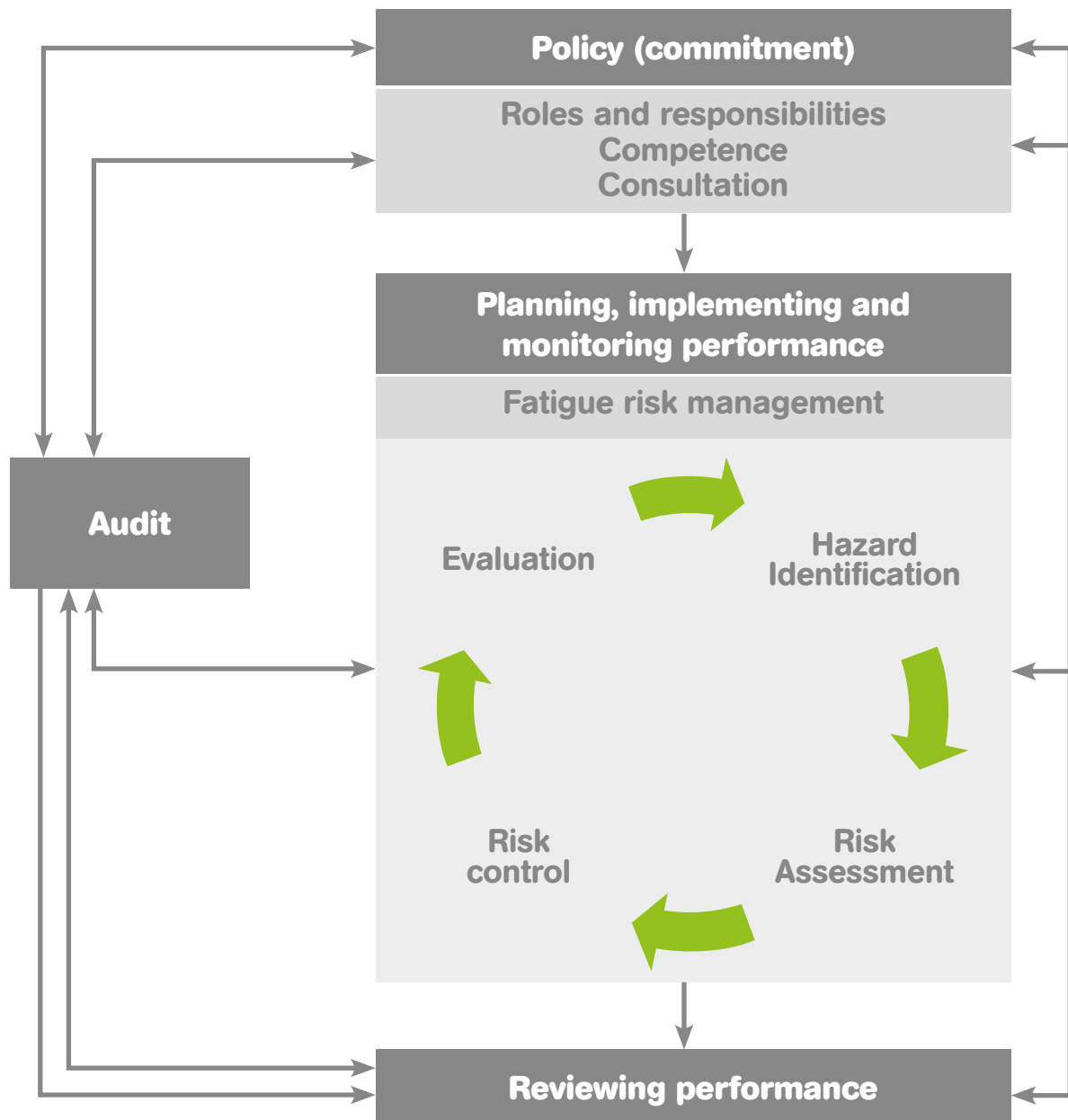
- The design of rosters based on good practice.
- Documented arrangements to enable systematic monitoring, review and audit as part of the continuing improvement cycle.

The FRMS should not be a standalone system. Rather, it should be embedded into a company's overarching safety management arrangements for the identification, assessment, control and monitoring of all risks, including fatigue (see figure 2). This means that, rather than relying on sporadic and isolated controls, fatigue management becomes integrated and is considered regularly as part of day-to-day company business. For example, rather than being an additional, separate process, fatigue should form one element of the risk assessment already being undertaken, within the workplace risk assessment, for different grades of staff. This will avoid duplication of effort and may simply require an extension to existing risk management practices.

### Case study

In the USA, Congress has mandated fatigue risk management in the rail industry [31] and reports from some companies, including Union Pacific, have demonstrated their effectiveness in improving the health and safety of workers [32].





**Figure 2: Fatigue Risk Management within the context of an overarching Safety Management System**  
(Adapted from HSG(65) Successful health and safety management)

For ease of reference, each of the key components of an effective FRMS that form part of the overarching safety management system are discussed separately in the sections that follow.



## 4. Setting up a FRMS



## Setting up a FRMS

### 4.1 Policy Commitment

A fatigue management policy is a statement of an organisation's ongoing commitment and intent to the effective control of fatigue risks. This commitment should be made visible by the actions of those at senior management level.

The policy should be developed by management in consultation with employees and their representatives and be informed by the fatigue risk assessment process.

It should form an integral part of a company's written safety policy and be communicated to all employees.

#### Suggested items for inclusion in a fatigue policy

- A statement of commitment to managing fatigue risks.
- Roles and responsibilities for managing the FRMS across the organisation.
- Work groups covered by the FRMS.
- An understanding of the human performance risks associated with fatigue.
- Summary of organisational fatigue management arrangements (eg policy on overtime, shift exchange, commuting, on-call duties, provision of lodgings and rest facilities etc).
- Definition of the shared responsibilities between employer and employees for managing fatigue.
- Engrain that employees will be consulted and participate in the development of new processes and procedures.
- Fatigue relevant company standards and working time limits.
- Locally negotiated agreements with the trade unions and staff representatives; terms and conditions of employment, etc.
- Assurance to implement corrective actions based on a 'just culture' that encourages honest reporting of errors and safety information.

### 4.2 Roles and Responsibilities

Fundamental to successful fatigue management is recognition of the shared responsibilities between employer and employee. Employees must buy-in to, support and be aware of the rationale behind new work initiatives designed to manage fatigue. They have responsibility for ensuring their behaviour does not create or increase risk. This includes reporting for work fit for duty, taking the opportunities provided to obtain sleep and reporting instances where it was not possible to get sufficient rest. This can be achieved, for example,

by early consultation with employees to identify issues, the establishment of fatigue reporting channels and by proactive fatigue management education and training (see section 5.1). This should include the support available to workers who may be at risk and/or are experiencing difficulties due to fatigue.

It is, however, the legal responsibility of the employer to control fatigue risks. Depending on the size and nature of the organisation, there may be benefit in establishing a Fatigue Management Steering Committee, or appointing a Fatigue Champion(s), to provide overall control of FRMS activities. This requires the allocation of roles and responsibilities for those responsible for different actions and adequate resources to enable effective implementation.

A Fatigue Management Steering Committee, for example, may be a specially convened group, an extension of an existing management committee, roster or safety group at an organisational, divisional, functional or local/workplace level. It should comprise a balanced representation of individuals from across the organisation, including front line staff, union representatives, planners and roster clerks, trainers, and operations and safety specialists.

Visible management commitment is essential for effective fatigue management. Management need to lead by example and provide clear direction on how fatigue risks will be identified, managed and controlled.

The committee's functions could include:

- Allocation of time, resources, roles and responsibilities for different aspects of the fatigue management process (eg policy development; risk assessments, etc).
- Ensuring fatigue controls are coordinated across organisational functions and locations.
- Consulting with rail safety workers and their representatives.
- Specifying company business standards, procedures, training requirements and working practices.
- Determining how and when fatigue risk assessments will be carried out, including use of any 'tools', and what information will be collected.
- Agreeing how overtime, shift exchange, travel time, on-call duties, etc will be controlled.
- Setting company fatigue objectives (eg what is to be achieved, how and why).

- Establishing a non-punitive fatigue-reporting system.
- Promoting the benefits of early reporting of fatigue-related issues.
- Identifying activity and outcome safety performance indicators.
- Agreeing the frequency of monitoring and reviewing activities.
- Communicating the findings and recommendations across the organisation.
- Reviewing incidents where fatigue has been an underlying contributory factor.
- Reviewing any deviations from established FRMS controls.

It is important that those with responsibility for overseeing the FRMS maintain a record of the arrangements in place for managing fatigue risks. The principle here is to establish a management system that records sufficient information in areas where there may be a potential fatigue risk. The aim is not to produce great volumes of additional paperwork, but to focus on recording information in key areas.

Examples of key information that should be recorded include, but are not limited to:

- Planned hours versus actual time worked.
- Shift exchanges, overtime.
- Individuals who are working long hours.
- Individual reports of fatigue.
- Exceedances.
- Data on problematic shifts, diagrams, rosters.
- Fatigue-related ill-health and absenteeism.
- Control strategies.
- Mitigations (eg fatigue counter measures).
- Details from risk assessments.
- Actions taken.

### Good practice example

Amtrak believes that one of the first steps towards creating a successful fatigue management plan is the creation and empowerment of a steering committee. All the major stakeholders should be represented, as well as those with direct knowledge of how fatigue is impacting the company.

The recorded information can then be used as a baseline against which the effectiveness of current arrangements can be monitored and to facilitate a process of continual improvement.





# 5. Competence



## Competence

### 5.1 Background

The phrase 'controllers of safety critical work' is specified in ROGS. This places a duty on an organisation as an entity to ensure that persons under its management, supervision or control are competent, fit for work and not excessively fatigued. This includes, but is not limited to, front line staff, those responsible for setting standards and defining working limits, roster clerks, supervisors and appointed individuals responsible for coordinating FRMS activities.

Companies can manage the competence and fitness of their workers by implementing an effective competence management system (CMS). Like most management systems, a CMS involves a cyclical process of designing, planning, implementing, monitoring and reviewing activities. The aim is to provide continuous improvement in staff competence by identifying and delivering training, development and assessment needs in a logical and integrated manner. The competency requirements of different roles covered by the CMS will depend upon individuals' responsibilities for FRMS activities (see below). A variety of resources are available to assist duty holders develop an effective CMS, including those published by the ORR and RSSB [22,23].

### 5.2 All rail safety workers

Basic knowledge and skills in fatigue management (work and non-work related) should be provided to all rail safety workers. This should include information about the hazards, risks and preventive fatigue measures and is likely to be delivered through periodic education and awareness campaigns rather than as part of a formal CMS. It should also include information on the company's approach to fatigue management. Raising awareness of the risks associated with fatigue encourages employees to take joint ownership for managing fatigue risks and promote buy-in to the FRMS.

Consideration should also be given to the regularity, timing and location of information strategies (eg sensitivity to those working nights and weekends) as this will also play a role in determining the ongoing success of any approach and demonstrate management's visible commitment to fatigue risk management.

Information provided is likely to include some or all of the following:

- Company fatigue policy.
- Recognising the common signs and symptoms of fatigue.
- Understanding the causes of fatigue and associated risks.
- Strategies for fatigue management (eg sleep quality and environment, healthy lifestyle, diet, time and stress management).
- Company standards and working limits, including circumstances in which limits can be exceeded with prior approval.
- The risks of driving when fatigued.
- Employer and employee responsibilities.
- Fatigue reporting channels.
- Sleeping disorders and employee assistance programmes.
- Education material for family members.
- Sleep hygiene/management training.
- Fatigue and shift work guidance booklets and leaflets produced by the HSE and RSSB (see 'Further information for fatigue and fatigue management' section).

#### Good practice

Network Rail has produced an e-learning CD-ROM to introduce learners to:

- What fatigue is and how it develops.
- How fatigue affects behaviour and performance.
- What steps you can take to manage fatigue.

For those responsible for working with rosters the programme aims to improve understanding of:

- The legal and industry requirements to manage working time.
- Network Rail standards and procedures.
- How to limit exceedances.
- The principles of fatigue-friendly rostering.
- How to risk assess roster patterns.

For more information, contact the Network Rail Human Factors team.

IMs and RUs may like to consider expanding the above to include, for example, guidance on how to challenge co-workers who are identified as fatigued. It is vital that employees know what they must do should they experience problems with fatigue (eg due to sleeping disorders). Company policy and employee support channels should therefore be made clear. This may include referral to Occupational Health and/or a General Practitioner. In this respect, issues of confidentiality must also be addressed, together with on-going monitoring of the individual. It is also important to

determine how information will be recorded and fed back into the FRMS for ongoing review and continuous improvement.

Information on fatigue management could be included in worker recruitment, selection and induction practices. For example, potential applicants should be provided with a realistic job preview of the hours of work involved, the effects of shift work and fatigue on them and their family, and the responsibilities of being a safety critical worker (eg preparing for shifts prior to being at work by getting adequate sleep and excluding drug and alcohol intake).

RSSB has produced a free booklet and briefing materials on 'Coping with shift work and fatigue' (see 'Further information in fatigue and fatigue management' section) which was specifically designed for workers. It contains the key applicable research findings following work that RSSB has completed in this area, including topics such as:

- Fatigue countermeasures, such as napping and caffeine.
- Nutrition.
- Sleep management.

### Fatigue management training and awareness

RSSB research reported a general feeling amongst front line staff that more information and training on good fatigue management is needed - 80% of passenger train drivers reported they wanted more effective training [3].

### Good practice

The aviation industry has some good practices in this area, including providing staff with shift-based meal planning cards, for example, what and when to eat prior to commencing a night shift. Additionally, they also use an acronym for their pilots to assess their fitness for duty - I'M SAFE - Illness; Medication; Stress; Alcohol & Drugs; Fatigue; Eating. A similar acronym could be used by companies to help remind staff of their responsibilities when signing on for duty.

American Airlines have a corporate 'Fatigue Hotline' which employees can call for advice on fatigue issues.

Define the formal and informal channels for communication of fatigue issues.

### Good practice

Greyhound Bus Line has a training programme which specifically educates drivers about off-duty behaviour and how it can affect on-duty performance [44].

Capital Metro (a US bus company) runs a one hour safety training session every other month for all employees. Employees are paid overtime to attend these sessions.

## 5.3 Staff with responsibilities for implementing the FRMS

Staff with responsibilities for implementation of the FRMS, for example, Fatigue Champion(s), those responsible for setting standards and designing work patterns, roster clerks, supervisors of safety critical workers, members of a Fatigue Steering Committee, etc should receive more structured training in fatigue management to ensure that they have the required level of competence commensurate with their role. Recommended training topics include, but are not limited to:

- Familiarisation with relevant legislation.
- Effective consultation.
- Guidelines for the recruitment of safety critical staff.
- Assessment and training of staff fatigue management competencies.
- Fatigue risk assessment process.
- Identifying and implementing fatigue risk reduction strategies.
- Roster development and design principles based on good practice (eg identifying safety critical workers affected; recovery time and rest periods between shifts; work/life balance, etc).
- Assessment and review of rosters for their potential to lead to work-related fatigue.
- Fatigue management reporting mechanisms.
- Fatigue countermeasures eg napping policy; driving policy.
- The use of bio mathematical models to assess fatigue risks.
- Workforce planning and the specification of minimum staffing levels.
- Overtime and call-out arrangements.

## Competence

- Resource allocation and contingency planning (eg to cover sickness, vacancies, unplanned maintenance, emergencies and operational disruptions).
- Strategies for managing shift workers returning from extended leave.
- Opportunities and processes for organisational learning.
- Capturing and recording fatigue-related hazards and actions.
- Recognising the early signs of fatigue and taking appropriate action.

### Good practice

Ask the trainees to evaluate the effectiveness of company training in fatigue management as part of the continuous improvement process.

For further information on good practice in training and evaluation, contact the RSSB Human Factors team.



## 6. Consultation



## Consultation

### 6.1 Overview

Consultation with safety critical workers is crucial to the success of an FRMS. Workers should be consulted as part of the ongoing development of new policies and procedures to manage fatigue risks and before the implementation of any changes to current working practices, standards and working time limits.

The involvement of a broad spectrum of workers will provide a rich source of information and inform decision makers. Front line workers have a practical understanding of the potential issues with work processes and the associated hazards. They are also those most at risk of developing health issues as a result of work-related exposure.

#### Good practice

Encourage employees to share their experiences of different work patterns (eg at the end of safety briefs where practicable); discuss which work patterns are the hardest and why; provide examples of alternative work patterns; encourage open discussion and feedback.

Consultation should also include relevant third parties (eg safety representatives, trade unions, interfacing organisations and ORR inspectors) to ensure (local) agreements on working hours and practices are consistent with the company's fatigue policy. This process should ideally be supplemented by feedback received from other channels. For example, accident/incident reporting systems, informal discussions held between staff and their supervisors, confidential and/or anonymous reporting forms or phone lines. This information can be used to enhance a company's existing FRMS by pinpointing, for example, particular roles or tasks that are more fatigue-inducing.

#### Good practice

Consult employees as part of the design and development of the fatigue management system and involve staff in writing procedures and planning and reviewing performance.

The amount and quality of information received from staff will largely depend on the company culture. A company culture refers to the set of values and norms that govern how people understand – and what they expect from – each other within an organisation (see Appendix 2). Some companies will have cultures where asking for feedback from workers will result in a large amount of valuable information. Other companies, however, may find that requests for such information could be met with employee suspicion and large numbers of refusals to participate.

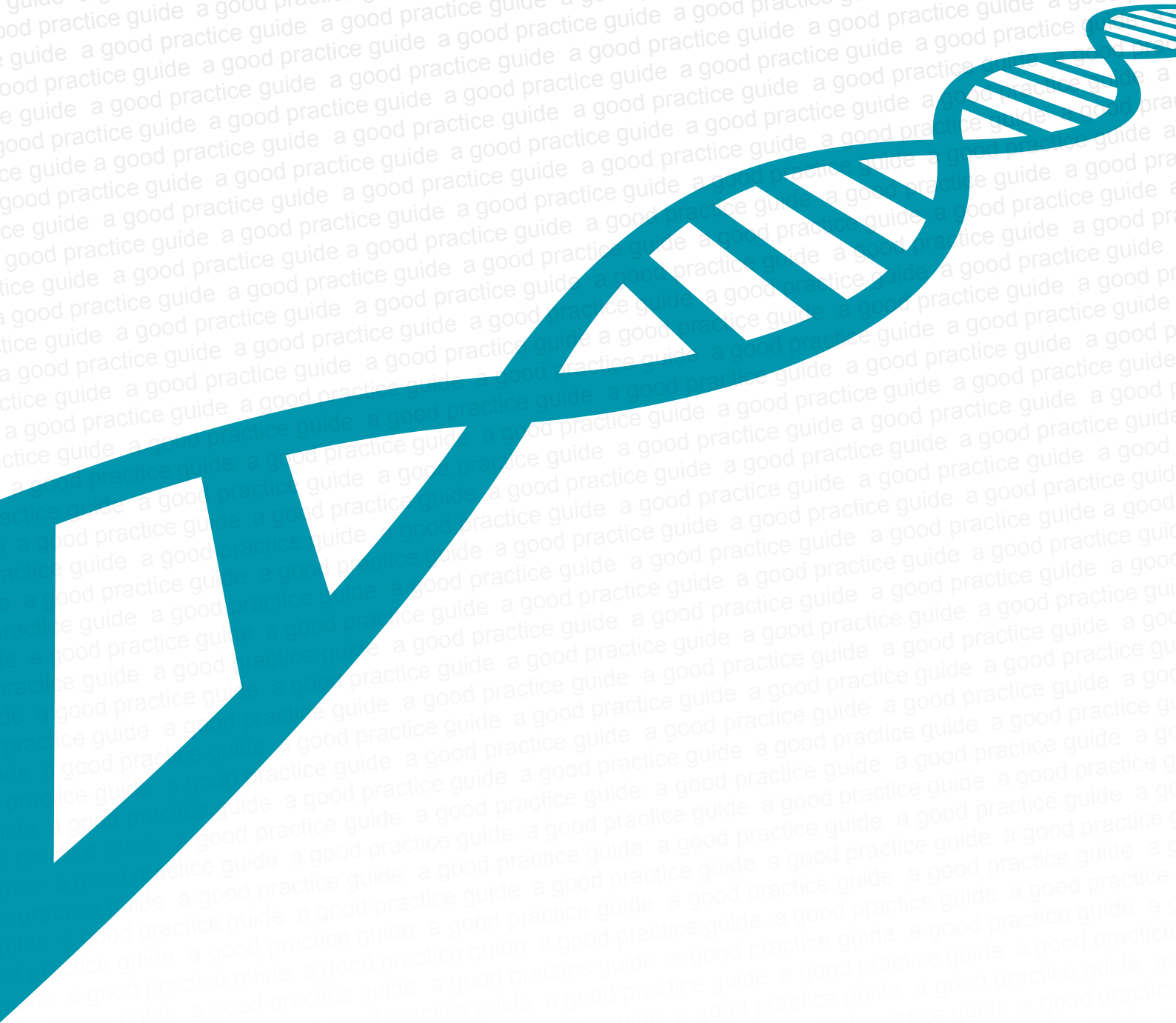
Employees will be more likely to share information if they have seen, or hold the belief that:

- Previously reported information has been responded to appropriately and in a timely manner.
- Matters of a serious nature have been dealt with swiftly.
- Workers are kept informed of matters that are currently being addressed.
- Workers are informed of the reasons why, a particular issue has or has not been addressed.
- Colleagues have not been disciplined, either formally or informally, for making a reasonable suggestion.
- Sufficient time will be given before implementing changes.
- Sufficient people who are affected have been consulted.

#### Good practice

One company, in addition to using the Fatigue Risk Index, asked their workers which were the more tiring rosters and then targeted those rosters for improvement first.

# 7. Fatigue Risk Management Process



# Fatigue Risk Management Process

## 7.1 Overview

At the core of an FRMS is a dedicated fatigue risk management process. It involves a continuous improvement cycle of four key steps:

- (i) Hazard identification – to assess fatigue risks associated with current conditions (see section 7.2).
- (ii) Risk assessment – a dynamic process of evaluating the likelihood and potential consequences of fatigue arising from the identified hazards (see section 7.3).
- (iii) Risk control – the process of eliminating or reducing the risk by putting in place control measures such as shorter shifts, fewer consecutive shifts, fatigue management training and education (see section 7.4).
- (iv) Evaluation – performance monitoring to evaluate the success of control measures put in place and to make further adjustments as necessary (see section 7.5).

As with any system, the effectiveness of the fatigue risk management process is dependent upon the quality of data and information that informs its design. It is therefore necessary to establish good quality systems that can monitor and measure fatigue risks. This includes ensuring fatigue is considered as part of investigations, encouraging the early reporting of fatigue issues, monitoring trends in overtime, shift exchanges, planned versus actual hours, introducing safety performance indicators, use of fatigue risk assessment tools, and a comparison of staff fatigue survey ratings and assessment tool scores before and after any changes.

## 7.2 Hazard identification

The principle here is to provide an informed and coordinated approach to identifying and understanding fatigue risks associated with current conditions. The process would begin by consulting the workforce (including contractors). In addition, a variety of information sources can be used, including:

- Review of workforce demographics (eg age profile; health; medication; social and domestic arrangements).
- Identification of factors that may affect the onset of fatigue (eg job design, nature of the work, workload, and environmental conditions).
- Discussions with workers and their representatives.
- Inspections and task analyses.
- Review of working time exceedances.

- Feedback from staff on rosters and working practices.
- Evaluation of indoor and outdoor work environments.
- Trends in safety performance data.
- Lessons learned and best practice.
- Review of employee surveys/feedback and company analysis of shift work success, etc.
- Audit results.
- Feedback from staff fatigue reports.
- Information on fatigue-related errors from accident and incident reports.
- Staff fatigue training and competency assessments.
- Occupational health reports (eg screening for sleep apnoea [5], staff sickness and turnover rates.)

### Good practice

Studies have shown some success in predicting individuals' ability to working at unusual times and long-term adjustment to shift work has been achieved using measures of flexibility of sleeping habits [24,25].

Non-prescriptive software tools are available to industry to plan and manage work schedules that are based on an understanding of operator fatigue [12]

### Individual differences

RSSB research has found considerable individual differences in preference for working, and ability to cope with, different shifts. Some of these differences correlated with circadian type. For example, those who experience peak alertness and activity early in the day are known as 'morning types' or 'larks'. Those who perform better later in the day, are called 'evening types' or 'owls'.

The severity of sleep problems was found to increase with age. Older individuals found it harder to sleep after the night shift and more difficult to concentrate during the night shift. The night shift was also perceived to impact more on quality of life [3,4].



## 7.3 Risk assessment

The Health and Safety Executive (HSE) has produced specific good practice guidelines on assessing and managing the risks associated with shift work [26]. For example, it is recommended that IMs and RUs carry out a suitable and sufficient assessment of the fatigue risks (and root causes) associated with current conditions. This should take into account the likelihood of a safety critical worker becoming fatigued (eg how long a worker is required to be awake, work intensity, sleep opportunity and quality) and the possible consequences. Risk factors likely to lead to significant fatigue (eg shift patterns that deviate substantially from recommended good practice) and those that can be easily controlled should then be prioritised.

In addition to the information sources highlighted above, the use of fatigue risk modelling tools (eg such as the HSE's Fatigue and Risk Index (FRI)) can assist in identifying specific factors that could lead to fatigue [20,21]. They can be used to assist in the planning of work rosters, be applied to key safety critical roles, both during normal operations and following incidents, to highlight those at risk from fatigue and to evaluate/review existing practices (eg work type within different shifts) before and after implementing changes to work patterns. Such tools must, however, be used with caution and only in conjunction with other sources of fatigue-related information as part of a holistic FRMS approach to fatigue management. See Appendix 3 for a summary of uses and limitations of fatigue risk modelling tools.

The gathering and evaluation of this information should be recorded (see section 4.2). This intelligence can then be used to determine the actions an organisation needs to take to address any potential weaknesses through the implementation of additional control measures. This may include, for example, shorter shifts, the provision of rest facilities, compensatory time off following extended working hours, reduced variability in shift start times, extended reporting system, fatigue management training and employee education (see section 7.4). This also provides a baseline against which future risk assessments can be made as part of the continuous improvement cycle.

### Good practice

Ask safety critical staff for feedback on the extent to which the working patterns implemented are effective in controlling fatigue.

Factors that should be considered when assessing fatigue risks associated with different groups of safety critical workers include, but are not limited to:

#### *Roster design and work planning:*

- Is there enough time between shifts to allow for adequate sleep, taking into consideration circadian rhythm effects (eg time of day), and where sleep is taken?
- Shift duration (eg is any one shift longer than 12 hours (including overtime/call-outs), how long are night and early shifts, and shifts starting before 05:00 hours?).
- Number of consecutive shifts (eg are too many consecutive night and early shifts being worked?).
- Quality, timing and duration of rest breaks within a shift (eg do breaks enable workers to recuperate, refresh and nourish themselves?).
- Shift pattern (eg are shifts forward or backward rotating? Is shift rotation fast or slow?).
- Are split shifts required?
- Standby and on-call duties, overtime working, emergencies and unplanned work (eg how much notice are staff given of changes to the roster? Are good rostering principles taken into account when making roster changes? Are staff asked if they are fit-to-continue if duties are extended?).
- Actual versus contracted weekly hours (eg how many hours per week are being worked, including overtime?).
- Commuting (eg are long drives to and from work reducing the time available for restorative sleep? Is transport/lodgings provided for workers with long commutes?).
- Supervision (eg does a worker have good support from their supervisor/manager? Do workers have face-to-face contact with a supervisor/manager? Do they receive recognition of good work?).
- Training (eg is training/refresher training/continuing professional development factored in to the number of working hours?).
- Shift swapping (eg do staff have control over shifts worked? How is shift swapping controlled?).
- Resources (eg are there sufficient numbers of staff to cover normal/emergency/degraded operational safety critical requirements?).

#### *Individual and non-work factors:*

- Individual differences (eg have the demographics/shift preferences of the workforce been taken into account when designing rosters – such as younger/older workers, contractors, owls/larks?).

## Fatigue Risk Management Process

- Welfare (eg is there any evidence of health problems, such as sleeping disorders, psychological issues, drug/alcohol use?).
- Other personal factors (eg is there any evidence of domestic/social problems, such as relating to family illness, poor sleep environment, second job, etc?).
- Employee fatigue management guidance and training (eg have staff been trained in good fatigue management and are they kept up-to-date with company FRMS policies and procedures?).
- Education and awareness campaigns (see section 6 and further information in Fatigue and Fatigue Management Section).
- Changes to CMS arrangements (see section 5).

### **Working environment:**

- Fatigue reporting channels (eg do staff use/are they aware of how to report fatigue related issues?).
- Type of work activity (eg Is the work physically demanding? Is the work repetitive or monotonous? Does the work require high levels of sustained concentration and vigilance? Is the work conducted under time pressure? Does the worker have any control over the work pace? Are complex or strenuous tasks scheduled at the end of a shift, particularly on the night shift?).
- Work-related road driving (eg does the work require long periods of driving between sites? How is this managed?).
- Physical environment (eg is the worker exposed to sustained extreme conditions, such as high/low temperature, noise, vibration?).
- Team working/lone working (eg does the work involve working alone or in a work group?).
- Familiarity with work environment (eg how familiar is the worker with the working environment?).

## 7.4 Risk control

Based on a comprehensive understanding of current conditions, the need for new, and adequacy of existing, controls to reduce or eliminate fatigue risks can be determined. Consideration must be given to timeframes, roles and responsibilities, employee consultation, communication and training. New controls may include, but are not limited to:

- Setting new standards and re-designing working patterns, based on good practice (see section 7.4.1).
- Limiting working time exceedances (see section 7.4.2).
- Introducing new fatigue countermeasures and procedures for dealing with staff who are fatigued (see section 7.4.3).

### 7.4.1 Setting standards and designing working patterns

The approach to setting standards and designing work patterns may differ between IMs and RUs according to the size and complexity of the organisation. As stated previously, duty holders will need to assess the probability of fatigue risk specific to its operations. In situations of medium to high risk, it is essential that the adequacy of existing control measures in place, or planned, to mitigate the effects of fatigue are assessed. Cross-industry examples of different approaches to fatigue management are included at the end of this guide [27,28,29].

In keeping with the FRMS approach and move away from prescriptive hours, this section presents aspirational recommendations for the design of work schedules based on good rostering practice and informed knowledge of current working practices across the rail industry [3,4]. It is not proposed to specify fixed limits relating to duty hours and roster design, but, in recognition of the multiple causes of fatigue, to focus on a systematic approach to fatigue management rather than hours of work. Where specific numbers are mentioned, these should be regarded as indicative of good practice. Duty holders should therefore consider their practical application in the context of their specific operational environments.

#### **Good rostering principles**

The extent to which fatigue accumulates is a function of shift length, rest intervals between shifts, and recovery following a block of consecutive shifts. Other factors include the nature of the work, working environment and quantity and quality of rest breaks. Fatigue experts therefore agree that the following rostering principles, marked by '►', should be considered when designing work schedules for safety critical workers:

- **Minimise the build up of fatigue during a shift and by restricting the number of consecutive night and/or early morning shifts**

#### **Shift duration**

Duration of shift is a key factor influencing fatigue, with tiredness steadily increasing with increasing shift duration. The relative risk of an accident or incident has also shown to increase with increasing shift length over



eight hours [4]. The interaction with shift start time and time of day that the shift is being undertaken also has a strong influence on levels of fatigue, particularly on nights and early morning shifts.

### Good practice

There is a strong case for limiting the duration of a shift to 12 hours (and if 12 hours, then no overtime), with further restrictions on duties that impinge significantly on normal hours of sleep, for example, 10 hours for nights or early morning starts. RSSB research [3] recommends limiting very early starts (eg those starting before 0500hrs) to eight hours. If a member of staff works longer than their rostered hours (ie due to overrunning engineering work), checks on their fitness to continue working should always be undertaken.

As well as shift duration and timing, it is also important to consider the content of a shift, including the frequency and adequacy of rest breaks (see below), as the effects of fatigue can be more evident on, for example, tasks that are repetitive, monotonous or those that demand continuous concentration.

### Consecutive shifts

It is essential to minimise the build up of fatigue by restricting the number of long shift sequences, in particular consecutive nights and very early starts. For example, it has been estimated that an individual may lose two hours sleep for each night shift worked [14]. Research has also shown an increase in SPAD risk after six consecutive shifts [4]. This risk is further compounded over consecutive early or night shifts. Whilst people may prefer to work more consecutive shifts in order to take a block of days off at the end, this needs to be balanced against the risks associated with the effects of cumulative fatigue.

### Good practice

It is advisable to set limit of say six consecutive duties, with a lower shift duration limit (eg 10 hours) on duties that impinge significantly on normal hours of sleep (eg consecutive nights, and early shifts). RSSB research [3] recommends setting a limit of five consecutive duties for early shifts. Where night shifts exceed eight hours, it is recommended consecutive shifts be limited to a maximum of three before a rest day.

### Duty hours

In the rail industry working hours are currently determined on a weekly basis. This allows a high number of hours to be worked each week, long shifts and short recovery times. It is therefore crucial to allow sufficient recovery time between shifts.

### Good practice

Consider adopting a duty hour limit based on a seven-day rolling period which is limited to 55 hours before a rest day is scheduled [4]. This is comparable with restrictions in other industries (eg aircrew and heavy goods vehicle drivers).

#### ► Afford workers sufficient opportunity to rest and recover before, during and between a block of consecutive shifts

The first night shift in a sequence of nights has also been reported to be the most fatiguing and nights and early morning shifts identified as the times when mistakes were more likely [4]. This is due to the difficulties workers can have adapting their sleep patterns due to the effects of the internal body clock which corresponds to the normal cycle of night and day (see section 2.2.3).

It is important therefore to allow sufficient time for recovery, both before the start of a sequence of shifts, within a shift, and between consecutive shifts, particularly on nights and earlies, so that individuals can 'recharge their batteries' and maintain work performance on return to work.

### Good practice

Research has suggested that even individuals who work constant night shifts never fully adapt [46]. Although staff may adjust to working nights during the week, there will be (circadian) disruption at the weekend when presumably they adopt a more social day pattern when not at work.

Where night work has to be done, shifts should rotate clockwise (eg day to evening to night), and include plenty of rest days between shifts and the avoidance of early morning starts.

# Fatigue Risk Management Process

## Rest between shifts

### Good practice

Include a minimum rest period of 12 hours between consecutive shifts and extend this to 14 hours [3] between consecutive nights. This would, however, in most cases be addressed by limiting the night shift to 10 hours as outlined above.

The current industry standard is for a minimum rest period of 12 hours between booking off from a turn of duty to booking on for the next turn. However, RSSB research [4] found evidence of rest periods between shifts of less than 12 hours. Shortened rest periods was also an important factor contributing to fatigue, sleep and health issues. Evidence has also been found of the smallest recovery between two nights or early shifts, with overall fatigue levels at the end of a shift found to be a five on a seven-point scale of sleepiness [4]. In safety critical industries that is indicative of the need to introduce fatigue mitigation measures.

### Good practice

Build regular free weekends into the shift schedule.

Shift workers should be given a minimum number of work-free hours in a 14-day period to aid recovery. This should include provision for two full nights' sleep.

Rest day working should be kept to a minimum to ensure planned recovery time is used effectively.

It is also important to consider the travelling time of the workforce as this can reduce the opportunity for rest between shifts. Long travel times to and from work should be monitored and shift workers should be given guidance on the risks of long periods spent driving.

### Good practice

Where travel time is anticipated to exceed one and a half hours, alternative arrangements should be considered where practical, in the form of provision of transport or lodgings [4]. This is particularly important when long shifts are anticipated and after the night shift.

## Recovery following a sequence of shifts

It is important to ensure staff are given sufficient time to recover following a sequence of consecutive duties. The length of shifts and daily rest intervals will need to be taken into account. Where a sequence of consecutive night shifts are worked, a single rest day may not provide adequate recovery and it may be necessary to schedule more time off. For example, following a night shift that ends at 0600 hours, there will be a requirement for more than a single day off to ensure complete recovery.

### Good practice

Given the difficulties in adapting to circadian rhythm effects (eg adjusting the timing of sleep to meet the demands of different shift types), it is recommended that the first shift following a period of extended leave should not be rostered as a night or early morning shift.

Following a late shift, provision should be made for a full night's sleep (eg 30 hours minimum) before moving to another shift, especially an early shift. It is also recommended that provision is made for two rest days (eg 54 hours minimum) when changing from a night to an early shift.

## Breaks

### Good practice

Following a review of SPAD incidents, research findings recommend a maximum period of work of four hours before a break of 15 minutes which is completely free of all work-related activities [3]. The HSE recommended good practice limit is three hours.

The duration of continuous duty without a break contributes to fatigue. Breaks are an effective way of controlling the build up of fatigue and restricting the period of continuous duty. RSSB research found evidence of an increase in SPAD risk after five hours or more, together with an interaction with early starts and night shifts [4]. This highlights the importance of rest breaks in reducing the risk of incidents. Inadequate breaks (eg in terms of their timing and quality) were also found by the research to be linked to issues such as health, dissatisfaction with the shift pattern and levels of fatigue.

## Good practice

Provide similar facilities at night as those available during daytime (eg refreshments and rest rooms) and ensure shift workers are given adequate time off for access to training and development (eg build into roster patterns).

Provide sufficient resources to cover breaks, emergencies, unplanned events.

Provide adequate facilities for workers to refresh, rest and nourish themselves during breaks.

To maximise the beneficial effects of breaks it is important to consider their timing within a shift. Scheduling breaks at the start or end of a shift reduces any beneficial effects. Ideally breaks should be scheduled towards the middle of a shift or at a suitable time with regard to task activities. It is important they allow the opportunity to relax, away from work interruptions, and provide access to adequate rest facilities, including food and drink.

The facility to take a short nap during a break can also be effective in controlling the build up of fatigue, particularly for safety critical workers on the night shift (see section 7.4.3 for more detail).

### ► Rostering practices – plan shift rotations and minimise variability in shift start times

## Good practice

Reduce the day-to-day variation in the timing and duration of shifts and include greater contingency in the roster to deal with unplanned events, such as overrunning engineering work. Provide staff involved in planning and managing with rosters training in factors that impair sleep and alertness.

Although some variability in the start times of shifts is inevitable when running an efficient railway, it makes it difficult for staff to predict when they are working and be able to plan adequate rest and domestic arrangements. For example, the shift start time of a driver on a 'spare turn' can vary by up to four hours. Irregular, non rostered hours of work and on-call duties also make it difficult for workers to plan sufficient sleep.

Organisational arrangements should be put in place to ensure that staff are given sufficient opportunity for sleep to manage all foreseeable scenarios. This includes overrunning maintenance work, long standing vacancies, sickness absence, organisational changes and training delays.

A lack of roster stability, frequent short notice changes to shift start time, and the lack of control over working hours and shifts worked has been found to contribute to fatigue, stress, problems with sleep and job dissatisfaction [6]. This is often overcome by workers by swapping shifts. However, this may contribute to the potential risk by increasing the variability in the shift pattern, and therefore needs to be managed.

## Good practice

Allow some individual choice and consider individual preferences for certain shifts when designing work patterns.

If occasional shift swapping is permitted, it may be possible for workers to undertake shifts they find less fatiguing and that fit better with their domestic situation. Careful monitoring of actual shift patterns and number of hours worked would be needed to avoid exceeding set limits and to prevent the revised shift patterns being more fatiguing than the original rosters. Checks would also need to be made to ensure workers do not lose job-specific knowledge by selecting only certain shifts.

Amongst freight staff, research has found that variability in the timing of shifts was the most important factor contributing to fatigue and sleep problems, with 40% of drivers surveyed reporting sleep problems [4]. Switching from regular weekday to weekend working and back to weekday rosters, or switching from a late or night shift to an early start, has also been found to be particularly fatiguing.

## Case study

RSSB research into fatigue among the train driver population [3] found that drivers were more satisfied with the shift system when they had a higher level of control over the specific shifts they worked.

It is therefore essential to plan shift start times and on-call duties and to put in place contingency arrangements in the event of unforeseen circumstances which may extend a shift beyond the recommended limits. Where this is not possible, additional control measures should be put in place, for example, planning additional breaks during a shift, reducing the length of a shift, asking the worker if they are fit to continue beyond 12 hours, a longer rest period before resuming work. Consecutive shifts with large variation in shift start time should be avoided due to the increased levels of fatigue-related risk.

## Fatigue Risk Management Process

Evidence suggests that rapid changes from one type of shift to another and back again often did not include sufficient time for recovery [4]. A rapid switch from a late finish or night shift to an early shift is particularly fatiguing. This is known as a backward rotating shift pattern in which a shift starts earlier than the previous one. It is therefore recommended that the principle of forward rotation is used when designing schedules, eg shifts to start later than the previous one.

### Good practice

Consider the nature of different jobs, eg workload and potential for mental and physical fatigue, when designing work schedules.

Allow workers time for social/domestic commitments between shifts/cycles.

Remain vigilant of non-work/individual factors.

Provide access to (confidential) occupational health/employee assistance/sleep disorder clinic.

Table 1 below provides a summary of the key good practice recommendations arising from RSSB research [3,4] which investigated fatigue and shift work issues amongst passenger and freight train drivers and track workers.

<b>Fatigue management - A summary of RSSB research and good practice recommendations</b>
<p><b>Duration of shift</b></p> <p>Hours to be worked (eg length of shift) per turn of duty to vary with type of shift</p> <ul style="list-style-type: none"> <li>• Day shift – 12 hours.</li> <li>• Night &amp; early shifts – 10 hours.</li> <li>• Shifts starting before 05:00hrs – eight hours (from TOC study).</li> </ul>
<p><b>Duty hours</b></p> <p>A target of 55 hours per seven day period as a maximum for any rolling week.</p>
<p><b>Rest between shifts</b></p> <p>12 hour minimum rest period between booking off from a turn of duty to booking on for the next turn. This should be extended to 14 hours between consecutive night shifts.</p>
<p><b>Consecutive shifts</b></p> <p>Number of consecutive shifts before a rest day:</p> <ul style="list-style-type: none"> <li>• Day (including mixed patterns) – six.</li> <li>• Night – three (where nights exceed eight hours).</li> <li>• Early – five.</li> </ul> <p>Rest days:</p> <ul style="list-style-type: none"> <li>• Two days before an early start after a night shift. (minimum 54 hours rest when changing from nights to early shifts).</li> <li>• A single rest day following a sequence of night shifts may not provide adequate recovery – may be necessary to schedule more time off.</li> <li>• One day before an early shift after a late shift.</li> <li>• Option of representing rest days in hours to ensure an adequate recovery period.</li> </ul>
<p><b>Additional recommendations</b></p> <ul style="list-style-type: none"> <li>• A maximum period of work of four hours before a break of 15 minutes which is completely free of all work-related activities. The HSE recommended good practice limit is three hours.</li> <li>• Avoid scheduling breaks at the start or end of a shift and improve the quality of breaks (eg facilities).</li> <li>• Minimise variability of shift start times and last minute changes to the roster.</li> <li>• Limit overtime so that the total time working does not exceed 12 hours.</li> <li>• Minimise rest day working.</li> <li>• Company informed shift swapping should accommodate, where practicable, individual differences in shift preferences.</li> <li>• Use of the HSE Fatigue and Risk Index [20,21] to aid roster design and modifications.</li> <li>• Consider implementing a napping policy for freight drivers.</li> <li>• If commuting before the start of a shift exceeds one and a half hours make arrangements to provide transport or lodgings for staff.</li> <li>• Consider nature of work content (eg mental/physical demands) and design tasks to maximise alertness (particularly at the end of long shifts).</li> <li>• Ensure checks on fitness to continue are undertaken.</li> <li>• Put in place contingency arrangements to cover unplanned events, emergencies, absentees.</li> <li>• Build regular free weekends into the shift schedule where possible.</li> <li>• Facilitate communication between workers and supervisors (eg reporting of problems, particularly at shift handover).</li> <li>• Use the principle of forward rotation (eg next shift starts later than the last). For example, for three-shift systems, better patterns rotate rapidly in a forward direction – MMAANNRR – where M=morning shift, A=afternoon shift, N=night shift, R=rest day.</li> <li>• Research suggests a more rapidly or slowly rotating shift pattern is easier to adjust to than one that changes about once a week.</li> <li>• Remain aware of non-work/individual factors and provide access to (confidential) occupational health/ employee assistance schemes.</li> </ul>

**Table 1 Summary of key RSSB research and good practice recommendations**



## Fatigue Risk Management Process

### 7.4.2 Limiting exceedances

It is important to ensure that any standards and limits that have been identified and set are only exceeded with prior approval and only on an infrequent basis in exceptional circumstances. This is to avoid employees working excessive hours (eg overtime; on-call duties) that could lead to someone being tired or slower to recover from long working hours. Safety briefings, planned or delayed training, long standing job vacancies, a block of maintenance work extending over a few days and organisational changes should not be a reason for exceeding working limits. They are all foreseeable circumstances that should be taken into consideration when planning or altering rosters.

Therefore, once company standards and working limits have been set, it is necessary to provide clear criteria for those infrequent and exceptional circumstances when these limits may be exceeded with prior approval. The controls required to ensure all risks are mitigated will also need to be defined.

Factors for consideration include, but are not limited to:

- The outer limits which workers cannot exceed (eg what is an acceptable level of overtime, number of call-outs, number of times an additional shift may be permitted in a roster period?).
- Clear criteria for when limits may be exceeded on an infrequent one-off basis (eg failed trains, extreme weather) and the controls in place.
- A documented process for whom has responsibility for authorising exceedances, and under what circumstances.
- Capacity of rail safety worker to continue working safely.
- Circumstances when safety critical workers can decline to continue working beyond agreed limits.
- Clear means of reporting exceedances, summarising the risks considered and corresponding fatigue controls and mitigation measures put in place.
- Limiting the availability of workers following additional hours of work.
- How the company will examine the differences between master and actual rosters to allow for continual refinement of the master roster.
- Utilising a fatigue risk modelling tool.
- Consultation – employee buy-in; how have employers consulted with their employees?

Those with responsibility for overseeing the FRMS should be notified of exceedances as part of the continuous review process.

#### Good practice

- 1) One company monitors their exceedances as a key safety performance indicator, with trends being addressed accordingly. Other companies may prefer to track, for example, exceedances to their organisational-specific operating limits or notable deviations from master rosters.
- 2) Provide additional justification and control measures for when operating at a higher level of risk under certain circumstances.
- 3) Do not roster staff to the limits as it leaves no time available for contingencies.
- 4) Where staff are required to exceed working limits, where practicable, provide relief as soon as possible in order to minimize the amount of exceedance.
- 5) Once company policy and standards on work patterns have been set, and any related within-company agreements are in place, these should be reflected in individuals' terms and conditions of employment.

### 7.4.3 Additional control measures

Further control measures that IMs and RUs may like to consider include:

#### *Sleep contracts*

This is a new area and further investigation is required into the efficacy of sleep contracts for the railway industry. A brief summary is provided below, however, to introduce the concept.

A sleep contract refers to a joint framework for setting working limits and managing fatigue that is negotiated between an employer and employee and that both parties sign up to. For example, it would include clarification on:

- What is too tired to work?
- What actions a company would take if a worker was found to be, or reported themselves to be, fatigued on a number of occasions over a pre-defined time period (eg one, three or 12 months).



- What actions would a company take to address different underlying causes of fatigue, eg inadequate sleep or company rostering practices?
- What constitutes a valid reason for being fatigued?

A publication by the Energy Institute [30] discusses the topic of sleep contracts and presents some useful methods and ideas for consideration to address fatigue.

### ***Sleepiness at work and signing-on for duty***

This area presents a genuine challenge for IMs and RUs in their approach to fatigue management. IMs and RUs may like to consider the following options for monitoring fatigue.

The first option is to conduct a fatigue risk assessment, whereby safety critical workers are asked to indicate the amount and quality of sleep they have had prior to signing on for duty (see Table 2 on page 42).

An alternative approach is to consider the use of some of the following questions:

- Do you feel fatigued, exhausted, tired or not up to par?
- Do you feel that in some way your sleep was not refreshing or restful?
- Have you had periods during the day when you have trouble paying attention, remembering things or staying awake?
- Have you experienced any of the following today:
  - Trouble keeping your head up?
  - Wandering, disconnected thoughts?
  - Eyes closed for a moment or went out of focus?
  - Eyelids drooped?
  - Couldn't stop yawning?
  - Couldn't remember driving the last few miles?
  - Missed a brake or acceleration notch?
  - Braked too late/too much?

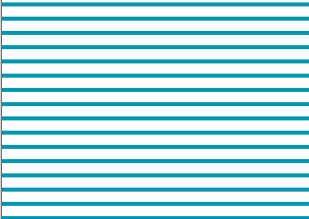
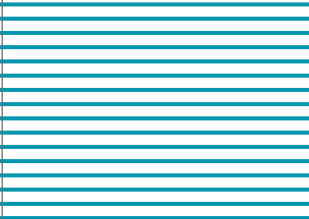
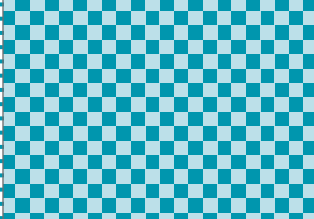
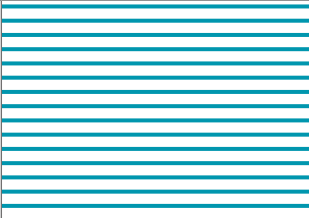
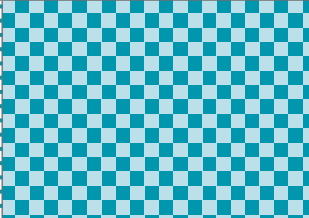

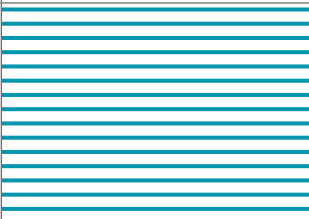
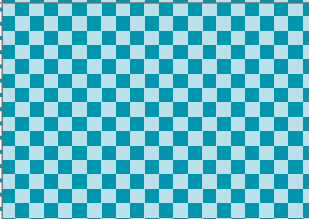

The options presented above for asking safety critical workers to indicate the amount and quality of sleep they have had prior to signing-on can be used in a variety of ways by IMs and RUs. However, they all have the limitation in that they are transparent and consequently workers will quickly learn their intent. How workers then react will most likely depend on the way the company responds to a fatigued individual. If IMs and RUs choose to punish workers who admit to being fatigued or are deemed to be fatigued via any of the options presented

in this guide, it is unlikely that an accurate assessment of fatigue levels among workers will be achieved.

Alternatively, these strategies could be used as reminders at worker signing-on points, as prompt questions for roster staff when allocating overtime, or at other times that an organisation deems appropriate.

Ultimately the success of the above options will depend upon a company's culture and the extent of employee involvement in and awareness of the purpose of systems to manage fatigue. The aim should be to encourage employee participation in the FRMS and to promote a culture of mutual responsibility, openness and trust. This will encourage workers to openly report genuine issues with fatigue.

## Fatigue Risk Management Process

		Amount of Sleep		
		Little to No sleep	Some sleep	Normal amount of sleep
Quality of sleep	Poor			
	Average			
	Good			

**Table 2 Example sign-on sleep risk assessment to be used by roster staff with safety critical workers**  
(Note: this is a subjective scale where 'poor' (quality of sleep) is typically taken to mean broken/disturbed sleep, to 'good' referring to unbroken/undisturbed sleep with no waking up).

### Key:



The worker is fit for work.



The worker is fit for safety critical work with additional risk mitigation strategies (eg, extra breaks) (see stage 8).



The worker is not fit for safety critical work.

\*Further questions required, eg is it a one-off? – if the answer is “yes” then consider fit to work; if the answer is “no” then consider additional risk mitigation strategies.

### ***Taking action when safety critical workers are fatigued***

The advice presented below focuses on ensuring, so far as is reasonably practicable, that safety critical workers who report for duty where they are clearly unfit owing to fatigue, or who, through the course of their work shift become clearly unfit owing to fatigue, do not carry out or continue to carry out safety critical work.

The practicality of the options will obviously vary depending on the circumstances involved, such as what has caused the fatigue and where the worker is located. It is important to highlight that it is not acceptable to simply ask if a worker feels fit to continue as there is now clear scientific evidence to support the link between fatigue and an increase in accident rates.

The options include:

- Putting on a replacement worker.
- Putting a worker on alternative non safety critical duties.
- Modifying the scheduling of breaks to allow a worker to have a nap.
- Providing food and liquid refreshments.

The options presented above are reactive in nature, and consequently quite limiting for IMs and RUs. Alternatively, considering the following points during work planning and scheduling and/or during the supervision of work can help mitigate the effects and/or the build up of fatigue:

- Varying the work being undertaken, to minimise the effects of completing repetitive tasks.
- Where the working conditions are uncomfortable, ensure opportunities are provided for the individual to take breaks away from that environment.
- Ensure arrangements for additional monitoring or additional support from a colleague or supervisor is in place.
- Ensure regular breaks of at least 15 minutes duration, which are completely free from all work-related activities.
- Consider those shifts/workers which are already high risk or bordering on high risk, before a shift commences. This will allow contingency plans to be put in place in the event of an unplanned event affecting the duration of shift in question.

### ***Napping***

The concept of napping is not a new one in the area of fatigue management. The principles are fairly straight forward, in that a person supplements their primary sleep period with additional shorter sleep periods, which are referred to as naps. It is important to emphasise, however, that the concept of napping is not appropriate to all groups of safety critical workers, eg those required to provide a continuous monitoring function whilst on shift.

It may be useful to put this in context for shift workers at this point (eg proactive anticipatory naps taken before a night shift, or reactive compensatory naps taken after a period of sleep loss such as following the night shift).

Napping can be roughly divided into two categories. Those that can combat the accrual of a 'sleep debt' (the difference between the amount of sleep a person needs and what they actually get) and last for around one and a half to two hours in length. Alternatively, naps can help to mitigate or delay the onset of fatigue and are considerably shorter in length, around 10 – 40 minutes in length.

The logic behind these figures relates to the changes in the body during the sleep state. Sleep can be divided into a series of stages which differ in their level of 'depth' and restorative effects. A complete sleep cycle lasts for approximately 90-120 minutes, and consequently, the longer napping option allows a person to receive the restorative benefits of all sleep stages and then awaken at a lighter sleep stage. Consequently, they will experience less sleep inertia or 'grogginess' when they rise. Additionally, napping for shorter periods of time is also designed to ensure that a person avoids sleep inertia. However, if you are sleep deprived you can quickly enter what is referred to as slow wave sleep (SWS) and experience sleep inertia. By limiting the nap period you are trying to limit the chances of entering deep sleep and hence reduce the impact of sleep inertia.

It may be useful to point out that there is a balance to be struck between the benefits in terms of alertness and the duration and nature of sleep inertia. A nap of say one hour will be beneficial over a longer period than a short nap of 20 minutes. However, the impact of sleep inertia is likely to be greater and longer in a nap of one hour than for the 20 minute nap. So it depends on whether you need to mitigate fatigue over the short or long term.

The information presented so far is based on the premise that a person does not start the shift with any accrued fatigue. However, this is often not the case on the railways, even during day work. A person may have an accrued sleep debt, been awake a considerable period of time before commencing work or, about to

## Fatigue Risk Management Process

work during a period when the body is used to being asleep. All of these scenarios could result in a person immediately falling into one of the deeper sleep stages and waking with the associated grogginess. The resulting effect for employers and workers is to allow sufficient recovery time so that employees can recover their alertness sufficiently to either undertake their safety critical duties at work or get themselves safely to work after napping in preparation for their upcoming shift.

To optimise any napping period it is also important to plan for a person to fall asleep (some airlines allow 10 minutes for this), awaken from sleep and be fit for safety critical work (eg 20-30 minutes). See Table 3 below for an example napping schedule. Other good practice points of napping are:

- Naps taken before a shift commences (proactive napping) are generally better at enhancing worker performance when compared to naps taken once a person is already fatigued (reactive napping). Consequently workers could be encouraged to plan in a nap to help them prepare for the night shift or to aid recovery following an early shift, for example.

- Naps are best taken in the afternoon (eg the siesta period, 14:00 to 16:00hrs) when the body naturally slows down. Alternatively, naps can be at their least effective if taken during the peak in the circadian rhythm (in terms of performance and alertness) which is generally considered to occur at around 18:00hrs. It will therefore be more difficult to initiate and maintain sleep during this period.
- Workers will vary in their response to napping opportunities and ease of napping. One option is for a company to provide relaxation training for its workers so that they can optimise the benefits of napping by reducing the time it takes to fall asleep.
- As people age, sleep quality taken during the night time can decrease, resulting in increased sleepiness during the day. Consequently, napping for older workers could have particular importance.

Time Period	Napping Components	Sub-Activities
10 minutes	Sleep preparatory behaviour	<ul style="list-style-type: none"><li>• Worker has a cup of coffee.*</li><li>• Worker starts relaxing away from bright lights, social interaction etc.</li><li>• Worker prepares napping environment to their liking eg lighting, temperature, angle of chair recline, setting alarm.</li></ul>
20 minutes	Napping	
15 minutes As indicated above it may be better to suggest at least 20 minutes	Sleep Recovery Period	Worker leaves the napping environment and uses alerting strategies such as social interaction, eating a light meal, moving into bright lights, etc.

\* Caffeine takes approximately 30 minutes to affect a person's alertness; therefore by taking it prior to napping, it can help mitigate the effects of sleep inertia during the sleep recovery period. It is important that employees are educated to use stimulants, such as caffeine from coffee, only when needed at work, as the body gets used to their use and consequently their effects are reduced.

**Table 3 Example napping schedule**

Consideration also needs to be given to the napping environment, eg those facets that impact on sleep quality. This may include the immediate environment where the person naps (eg quiet, darkened room that is at a suitable temperature, possibly with eyeshades and earplugs) and what the location is (eg bed or reclining chair). Finally, providing an alarm is a good strategy for limiting the nap duration as this will reduce the likely impact of sleep inertia which results when a person enters the deeper stages of sleep.

A final point to consider on the area of napping is that of individual differences within the workforce. Each worker will vary in the benefit received, time taken to recover and level of comfort with napping. IMs and RUs will need to consult with staff to agree on the most appropriate implementation of napping, that will jointly meet the needs of the business and its staff.

Further information on napping and other sleep topics can be found on the National Sleep Foundation website ([www.sleepfoundation.org](http://www.sleepfoundation.org)).

## 7.5 Evaluation

It is important to evaluate any arrangements made for managing fatigue to assess how effectively the risks have been reduced. IMs and RUs should therefore consider developing policies and procedures to ensure that regular monitoring of their chosen operating limits and management arrangements are formally integrated into their FRMS or overarching SMS. This will also reinforce management's commitment to the objectives set out in the fatigue policy and encourage continuous improvement in the development of a positive health and safety culture (see Appendix 2).

As part of the monitoring process, it is important that risk assessments are repeated at regular intervals to evaluate the effect of existing and any new arrangements/changes made to working patterns. This will enable attention and resources to focus on key areas where additional improvements may be required (eg to address an increase in fatigue-related reports from safety critical staff). It is also important to evaluate the success of arrangements in place to manage fatigue risks.

Information to monitor the performance of the FRMS can be generated through the use of safety performance indicators (SPIs) [35]. There are two key types of SPI:

- Activity indicators – these are measures of whether a risk control system is in place. They enable weaknesses in the implementation of the FRMS (to address fatigue risks at the organisational, job, and individual levels) to be identified and direct actions to strengthen and improve processes and procedures before an accident or incident occurs.
- Outcome indicators – these are measures of events after they have occurred, such as fatigue-related sickness absence, ill-health, accidents and incidents. They provide an indication of the effectiveness of the risk controls in place.

A variety of company sources will be available that can be used for such purposes and a sample of these is highlighted below:

### ***Accidents, near misses and safety critical events***

One measure of success is to examine records to see if there has been a reduction in accidents, near misses and safety critical events.

Post-incident and accident investigations provide a rich source of data on the performance of an FRMS. In order for this to be effective, however, accident reporting guidelines need to include relevant questions or processes to determine the contribution, if any, of fatigue. Listed below are questions IMs and RUs could consider asking to determine if fatigue was a contributory factor:

- At what time of day did the incident take place?
- Was the operator's normal circadian rhythm disrupted (eg did the incident occur during a period of low or high alertness)?
- Time on duty.
- Time on tasks.
- How many hours had it been since the operator awoke?
- Does the 72 hour sleep history suggest a sleep deficit?
- Does the person(s) involved display any common fatigue characteristics, eg impaired memory, slower reaction times, poor decision-making, reduced vigilance, slurred speech, moodiness, etc?
- Was the person involved working for more than four and a half hours without a break?

Organisations may also want to consider the following points in an investigation context:

- Focus on actual hours worked (including any overtime) and examine the previous shifts since the individual had a reasonable time period off work (eg three or more days off).
- Sleep history over the past week.
- Examine precursor events, eg the levels and distribution of overtime, shift swapping and number and duration of vacancies within safety critical roles

## Fatigue Risk Management Process

relevant to the people involved.

- Examine what role the organisation's, and respective depot/work team's approach to fatigue management played in the incident (eg rostering practices, local culture relating to admitting feeling fatigue).
- Job factors, such as workload, variety, etc.
- Environmental factors such as weather, temperature, noise, etc.
- Work history over the previous 14 days. This should include variable start times, breaks, number of consecutive shifts, night work, etc.
- Individual factors, such as length of time in post, training, competency levels, family commitments (eg caring for an elderly parent or a new baby), commuting and personal health.

- Review of records to determine if there has been an increase/change in performance and/or productivity.
- Review of records to determine if there has been a reduction in absenteeism and staff turnover.

A final option that could be considered is to identify operational markers of fatigue. For example, On Train Data Recorder (OTDR) downloads, where specific attention is paid to delayed acceleration or braking curves, instances of over-braking, etc. Obviously, this would not provide conclusive evidence that a person is fatigued; however it would be another form of data for IMs and RUs to integrate into their FRMS.

### Good practice example

One company has extended their current incident investigation process to capture more information on possible precursor events, prior to a major incident (eg station overruns, fail to call) occurring. By doing so, they can monitor and respond to trends between these precursor events and consequently reduce the likelihood and possible severity of a major incident in the future.

### Good practice

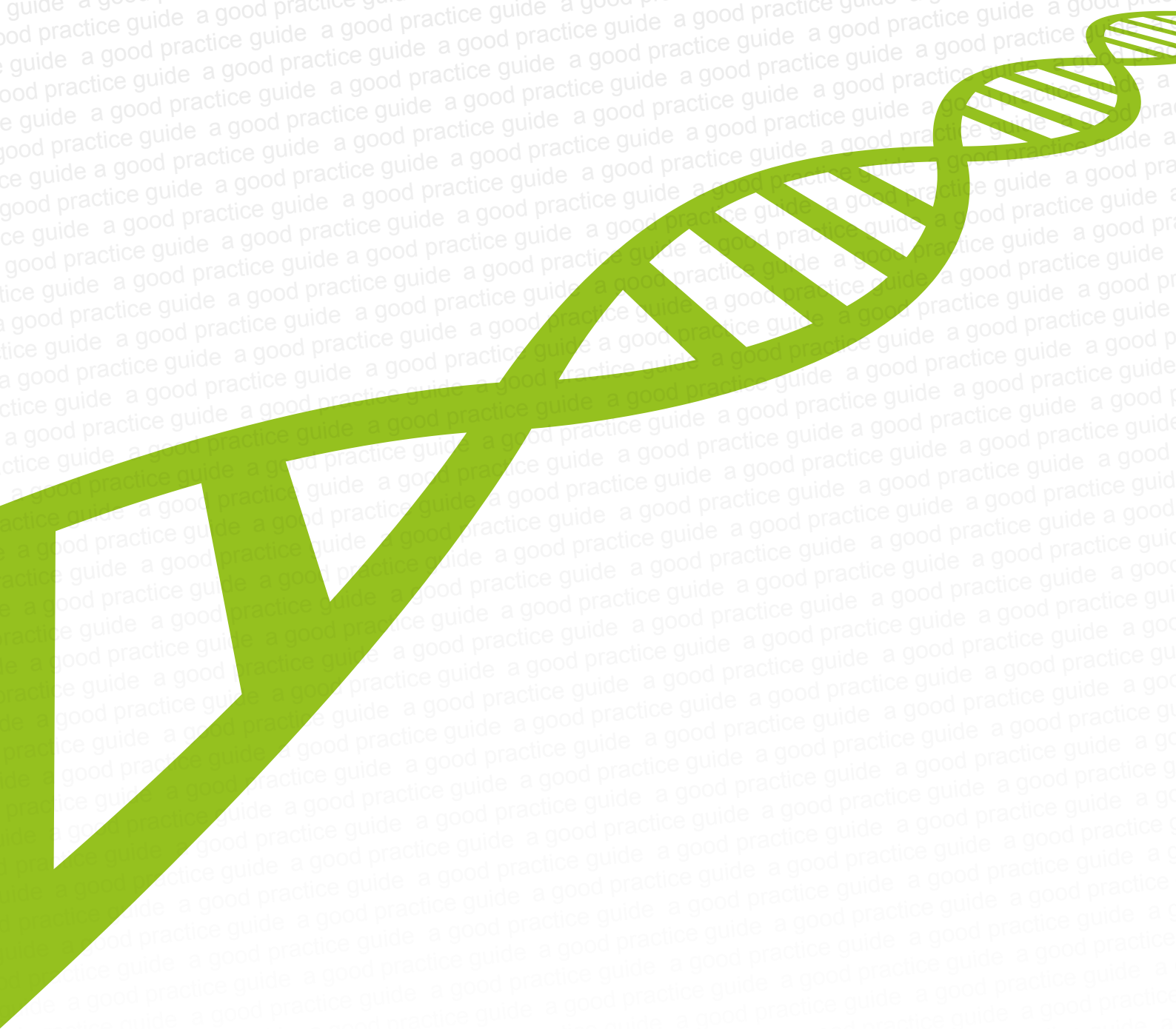
Define who is responsible for frequent monitoring and what procedures are followed.

Further options available to IMs and RUs to monitor fatigue include, but are not limited to, the following:

- Introduction of a non-punitive fatigue reporting system.
- The use of fatigue risk modelling tools to identify if the arrangements made for managing fatigue have reduced the risks.
- Comparing actual work patterns against good practice.
- Monitoring shift exchanges, overtime, on-call duties, commuting times and working time exceedances.
- Interviews and focus groups with staff to collect feedback on particular shifts.
- Comparison of fatigue questionnaire rating scores before and after the introduction of fatigue risk controls.



# 8. Reviewing Performance



## Reviewing Performance

### 8.1 Overview

The FRMS should be a self correcting system which incorporates review 'triggers'. Various occurrences could trigger IMs and RUs reviewing their FRMS. Obvious events include: fatigued-related incidents/accidents; reports from safety critical staff; internal/external audit findings; changes to the work patterns and tasks, when the maximum limits are consistently exceeded, changes in recommended good practice for managing fatigue. This may also be supplemented, for example, with information relating to regular shift swapping for particular turns.

Reviews of a company's FRMS should, where practicable, be conducted by competent persons outside the scope of the review (eg internal audit/external specialists).

Gathering feedback directly from workers (and occupational health and safety representatives) can be a valuable source of information for a company to identify fatigue-inducing conditions or work practices. IMs and RUs will need to consider their own needs in relation to gathering information in this area, such as establishing a new system, modifying an existing reporting arrangement to cover the area of fatigue, or utilising information gained from existing reporting mechanisms within the industry (eg CIRAS).

Another option for IMs and RUs is to measure the effects of fatigue and shift work within different groups of safety critical workers in the workforce. RSSB's research in this area was built around a questionnaire and diary shift work survey. Similar measuring tools can be used by IMs and RUs to assess fatigue levels over a period of time, eg 12 months. They could also be used to measure the effectiveness of specific fatigue countermeasures or an enhanced FRMS if administered both before, and after, a change has been implemented. RSSB can provide further guidance in this area as needed.

#### Good practice

Review the arrangements when:

- An incident or accident has occurred where fatigue has been a causal or contributory factor.
- Work patterns change, or
- When the maximum limits are increased.

#### Good practice

Define the purpose and frequency of reviews, who is involved and the process for making system corrections and changes. Integrate FRMS reviews into the overarching SMS.

Other sources of information available for review purposes include, but are not limited to:

- Effectiveness of consultation process and key roles and responsibilities assigned.
- Key safety performance indicators (eg percentage of staff deemed competent in fatigue management).
- Changes in fatigue assessment tool scores.
- Number of recorded fatigue-related errors.
- Deviations of actual hours worked from planned hours and review against company policy and benchmark levels.
- Evidence of increased sleep.
- Self reports.
- Management/safety representatives' inspections and safety tours.
- Evaluation of fatigue management training and education.

It is essential that rail operators act upon recommendations from reviews to ensure the arrangements in place are effective in managing fatigue. Any changes or remedial actions taken should be communicated to staff to ensure their continued buy-in and support for the FRMS.

# References



## References

1	Railways and Other Guided Transport Systems (Safety) Regulations 2006 (as amended) (ROGS). ( <a href="http://www.opsi.gov.uk/si/si2006/uksi/20060599_en.pdf">www.opsi.gov.uk/si/si2006/uksi/20060599_en.pdf</a> )
2	Managing Rail Staff Fatigue. Office of Rail Regulation.
3	T059 Human factors study of fatigue and shift work. Guidelines for the management and reduction of fatigue in train drivers. RSSB Research report.
4	T699 Shift patterns of freight & infrastructure workers: Implications for fatigue & safety. RSSB Research report.
5	T299 Obstructive Sleep Apnoea Syndrome in Train Drivers. RSSB Research report.
6	Investigation into the Clapham Junction Railway Accident. Department for Transport. ( <a href="http://www.railwaysarchive.co.uk/docSummary.php?docID=36">www.railwaysarchive.co.uk/docSummary.php?docID=36</a> ).
7	The Ladbroke Grove Rail Inquiry Part 1 Report – ISBN 07176 20565. HSE Books.
8	The Ladbroke Grove Rail Inquiry Part 2 Report – ISBN 07176 21073. HSE Books.
9	Managing fatigue in safety critical work – Railways and Other Guided Transport Systems (Safety) Regulations. (as amended) July 2006. Office of Rail Regulation. ( <a href="http://www.rail-reg.gov.uk/upload/pdf/293.pdf">www.rail-reg.gov.uk/upload/pdf/293.pdf</a> )
10	The Railways and Other Guided Transport Systems (Safety) Regulations 2006 (as amended) – A guide to ROGS. May 2011. Office of Rail Regulation. <a href="http://www.rail-reg.gov.uk/upload/pdf/rogs-guidance-may11.pdf">http://www.rail-reg.gov.uk/upload/pdf/rogs-guidance-may11.pdf</a> .
11	Health and Safety at Work etc Act (1974). <a href="http://www.hse.gov.uk/legislation/hswa.htm">http://www.hse.gov.uk/legislation/hswa.htm</a>
12	The Management of Health and Safety at Work Regulations (1999). <a href="http://www.legislation.gov.uk/uksi/1999/3242/contents/made">http://www.legislation.gov.uk/uksi/1999/3242/contents/made</a>
13	The Working Time (Amendment) Regulations 1998. The National Archives. <a href="http://www.legislation.gov.uk/uksi/1998/1833/regulation/6/made">http://www.legislation.gov.uk/uksi/1998/1833/regulation/6/made</a>
14	Successful health and safety management. HSG65. HSE. 1997.
15	Endo, T. and Kogi, K. (1975). Monotony effects of the work of motormen during highspeed train operation. Journal of Human Ergology, 4, 129-140.
16	Bohle, P. and Tilley, A. J. (1989). The impact of night work on psychological well-being. Ergonomics, 32, 1089-1099.
17	Collision of Two Union Pacific Railroad Trains. Bertram, California. November 2007. Railroad accident brief. National Transportation Safety Board. <a href="http://www.nts.gov/investigations/fulltext/RAB0804.html">http://www.nts.gov/investigations/fulltext/RAB0804.html</a>
18	HSE (1999). 'Validation and development of a method for assessing the risks arising from mental fatigue'. Contract Research Report 254/1999. ISBN 0 7176 1728 9.
19	Occupational Safety and Health Service New Zealand (1998). ISBN 0-477-03604-X
20	Fatigue and risk index calculator – Version 2.2. Health and Safety Executive. ( <a href="http://www.hse.gov.uk/RESEARCH/rrpdf/rr446g.pdf">www.hse.gov.uk/RESEARCH/rrpdf/rr446g.pdf</a> )
21	The development of a fatigue/risk index for shift workers. Health and Safety Executive. ( <a href="http://www.hse.gov.uk/research/rrhtm/rr446.htm">www.hse.gov.uk/research/rrhtm/rr446.htm</a> )
22	Developing and maintaining staff competence. Office of Rail Regulation (2007). <a href="http://www.rail-reg.gov.uk/upload/pdf/sf-dev-staff.pdf">http://www.rail-reg.gov.uk/upload/pdf/sf-dev-staff.pdf</a>

23	Good Practice Guide on Competence Review and Assessment. RS/701. Issue 2. August 2008. RSSB. <a href="http://www.rgsonline.co.uk/Railway_Group_Standards/Traffic%20Operation%20and%20Management/RSSB%20Good%20Practice%20Guides/RS701%20Iss%202.pdf">http://www.rgsonline.co.uk/Railway_Group_Standards/Traffic%20Operation%20and%20Management/RSSB%20Good%20Practice%20Guides/RS701%20Iss%202.pdf</a>
24	Folkard, S., Monk, T. H. and Lobban, M.C. (1979). Towards a predictive test of adjustment to shiftwork. <i>Ergonomics</i> , 22: 79-81.
25	Costa, G., Lievore, F., Casaletti, G., Gaffuri, E. and Folkard, S. (1989). Circadian characteristics influencing interindividual differences in tolerance and adjustment to shiftwork. <i>Ergonomics</i> . 32(4): 373-385.
26	Managing shift work – Health and safety guidance. Health and Safety Executive. HSG256.
27	Fatigue Risk Management System Assessment Checklist. Australian Government Civil Aviation Safety Authority. ( <a href="http://bureau.panopticsearch.com/search/search.cgi?query=fatigue+checklist&amp;collection=casa&amp;form=advanced&amp;scope=-rrp.casa.gov.au">http://bureau.panopticsearch.com/search/search.cgi?query=fatigue+checklist&amp;collection=casa&amp;form=advanced&amp;scope=-rrp.casa.gov.au</a> )
28	Fatigue Management Program Pilot Evaluation. Queensland Transport, Australia. ( <a href="http://www.transport.qld.gov.au/">http://www.transport.qld.gov.au/</a> )
29	Development of a Fatigue Management Program for Canadian Marine Pilots. Transport Canada. ( <a href="http://www.tc.gc.ca">www.tc.gc.ca</a> )
30	Viability of using sleep contracts as a control measure in fatigue management. Energy Institute publication. February 2006. ( <a href="http://www.energyinst.org.uk/index.cfm">http://www.energyinst.org.uk/index.cfm</a> )
31	Gertler, J. B., & Raslear, T. G. (2009). The fatigue status of the US Railroad Industry: A preliminary analysis. International Conference on Fatigue Management in Transportation Operations, 12.
32	Holland, D. W. & Sherry, P. (2009). Review of a Fatigue Risk Management System and the monitoring of related health concerns. International Conference on Fatigue Management in Transportation Operations, 93.
33	Lutzhof et al (2007). Fatigue at sea: A field study in Swedish shipping. VTI Publications. <a href="http://www.mastermariners.ca/newfoundland/uploads/09cfasreport.pdf">http://www.mastermariners.ca/newfoundland/uploads/09cfasreport.pdf</a>
34	National Rail Safety Guidelines. Management of Fatigue in Rail Safety Workers. National Transport Commission, Australia. June 2008.
35	Measuring Safety Performance. How to develop and manage safety performance indicators for Britain's railways. RSSB Good Practice Guide. <a href="http://www.rssb.co.uk/SiteCollectionDocuments/pdf/reports/Research/T852_guide_final.pdf">http://www.rssb.co.uk/SiteCollectionDocuments/pdf/reports/Research/T852_guide_final.pdf</a>
36	Derailment of a freight train at Brentingby Junction, near Melton Mowbray, 9 February 2006. Rail Accident Report. Rail Accident Investigation Branch. <a href="http://www.raib.gov.uk/cms_resources.cfm?file=/070123_R012007_Brentingby.pdf">http://www.raib.gov.uk/cms_resources.cfm?file=/070123_R012007_Brentingby.pdf</a>
37	Derailment of two locomotives at East Somerset Junction. 10 November 2008. Rail Accident Report. Rail Accident Investigation Branch. <a href="http://www.raib.gov.uk/publications/investigation_reports/reports_2009/report282009.cfm">http://www.raib.gov.uk/publications/investigation_reports/reports_2009/report282009.cfm</a>
38	Uncontrolled freight train run-back between Shap and Tebay, Cumbria. 17 August 2010. Rail Accident Report. Rail Accident Investigation Branch. <a href="http://www.raib.gov.uk/publications/investigation_reports/reports_2011/report152011.cfm">http://www.raib.gov.uk/publications/investigation_reports/reports_2011/report152011.cfm</a>
39	The Southall Rail Accident Inquiry Report. Health and Safety Commission. <a href="http://www.railwaysarchive.co.uk/documents/HSE_Southall1997.pdf">http://www.railwaysarchive.co.uk/documents/HSE_Southall1997.pdf</a>

## References

40	Freight train collision at Leigh-on-Sea. 26 April 2008. Rail Accident Report. Rail Accident Investigation Branch. <a href="http://www.raib.gov.uk/publications/investigation_reports/reports_2009/report242009.cfm">http://www.raib.gov.uk/publications/investigation_reports/reports_2009/report242009.cfm</a>
41	Derailment at Grayrigg. 23 February 2007. Rail Accident Report. Rail Accident Investigation Branch. <a href="http://www.raib.gov.uk/publications/investigation_reports/reports_2008/report202008.cfm">http://www.raib.gov.uk/publications/investigation_reports/reports_2008/report202008.cfm</a>
42	Collision at Badminton. 31 October 2006. Rail Accident Report. Rail Accident Investigation Branch. <a href="http://www.raib.gov.uk/publications/investigation_reports/reports_2007/report302007.cfm">http://www.raib.gov.uk/publications/investigation_reports/reports_2007/report302007.cfm</a>
43	Derailment of a freight train at Maltby North. 28 June 2006. Rail Accident Report. Rail Accident Investigation Branch. <a href="http://www.raib.gov.uk/latest_news/news_archive/news_archives_2007/070716_pn_maltby.cfm">http://www.raib.gov.uk/latest_news/news_archive/news_archives_2007/070716_pn_maltby.cfm</a>
44	Greyhound and Fatigue Management. <a href="http://onlinepubs.trb.org/onlinepubs/.../2011/FatigueInTransit/.../A1%20Smith.pdf">onlinepubs.trb.org/onlinepubs/.../2011/FatigueInTransit/.../A1%20Smith.pdf</a>
45	The Working Time (Amendment) Regulations 2003. The National Archives. <a href="http://www.legislation.gov.uk/uksi/2003/1684/contents/made">http://www.legislation.gov.uk/uksi/2003/1684/contents/made</a>
46	Folkard, S. (2008). Do permanent night workers show circadian adjustment? A review based on the endogenous melatonin rhythm. Chronolbiol Int. Volume 25(2), 215-224.



# Appendices



## Appendices

### Appendix 1 Hidden limits on working time

'Hidden Limits' on working time	
1.	No more than 12 hours to be worked per turn of duty.
2.	No more than 72 hours to be worked per calendar week (Sunday to Saturday).
3.	A minimum rest period of 12 hours between booking off from a turn of duty to booking on for the next turn. This may be reduced to eight hours at the weekly shift changeover, in the case of staff working a shift pattern which rotates or alternates on a weekly basis.
4.	No more than 13 turns of duty to be worked in any 14 day period.
5.	For Signalling and Telecommunications Testing Staff, a maximum of 23 turns duty in any two consecutive 14 days periods.

## Appendix 2 Key elements of a positive safety culture

- *Effective and appropriate management systems:*

Organisational systems, procedures, training and workplace environment that support safe working behaviours and foster positive attitudes (eg do excessively complex procedures and controls unwittingly induce unsafe behaviours)?

- *Demonstrable (senior and line) management commitment to health and safety:*

Visible (senior and line) management commitment, leadership and involvement in improving health and safety performance is vital. The interest in, and priority placed on, safety by management needs to be 'felt' by the organisation (eg management modelling of safe behaviours, good quality and effective communications, safety tours).

- *Participation, involvement and workforce attitudes to health and safety:*

Taking personal responsibility for safety means that staff at all levels accept they have a role in making sure their behaviour and decisions do not endanger others. Individuals (peers and managers) should feel comfortable to intervene and challenge unsafe behaviour, but this should be done from a coaching, not blame perspective.

- *Organisational learning and continuous improvement:*

Incidents and failures are seen by organisations with good safety cultures as valuable opportunities to improve operations and learn lessons to avoid more serious events. This includes: (i) in-depth root cause analysis and learning from accidents, incidents & near misses; (ii) soliciting and responding to ideas from employees, and (iii) providing timely feedback and sharing of information across the organisation.

- *A Just Culture:*

In a just culture, the company line is more clearly drawn between acceptable (non-culpable) and unacceptable (culpable) behaviour (eg clear statement in company safety policy) so that appropriate action can be taken to prevent a recurrence. Based on an understanding of human factors, unintentional unsafe acts (eg honest errors, routine and situational violations) are seen as opportunities for organisational learning. Conversely, deliberate, intentional unsafe acts (eg reckless non-compliance, criminal behaviour, substance abuse and sabotage) are dealt with accordingly, with the required level of sanction.

- *A reporting culture:*

An effective reporting culture recognises that the 'system' needs to be proactively monitored to accommodate human error to ensure continual improvement. This should include the use of good quality lead indicators to provide feedback on key organisational behaviours (eg number of suggestions for safety improvements; perceptions of management commitment to safety; safety policy published; number of safety tours carried out; percentage of improvement solutions closed out). Employees need to be encouraged and willing, even rewarded, for coming forward and reporting essential safety-related information (eg errors they have made; behaviours they have observed) without fear of sanction. This crucially depends on how an organisation handles blame and punishment and the building of an atmosphere of trust.

## Appendices

### Appendix 3 Fatigue assessment tools – Important considerations

The table below provides a summary of the potential benefits and limitations of fatigue risk assessment tools. It is important therefore that duty holders are aware of the specific assumptions and limitations made by different tools when using them as part of the fatigue risk assessment process.

Benefits	Limitations
They can assist in the identification of likely fatigue risk associated with current work schedules.	They are based on a set of mathematical predictions to estimate the probability of fatigue and relative risk of an incident.
They can assess the likely impact of fatigue associated with proposed changes to the working pattern.	They do not take account of the multiple causal factors of fatigue, eg individual differences, circadian type, commuting, job role, workload, work and non-work environment.
They can identify particular shifts or shift sequences within a work pattern associated with a higher risk of fatigue to enable risk reduction strategies to be implemented accordingly.	They make assumptions that individuals will get sleep of sufficient quality and quantity between shifts.
They can identify particular features associated with different shifts, shift sequences or work patterns and to estimate the benefits of compensatory measures such as providing additional breaks or shortening shifts.	The outputs should be treated with caution and used alongside other sources of fatigue information, such as staff reports and feedback, as part of the broader FRMS.
They can be used to explore whether fatigue was a contributory factor as part of incident investigations.	Recommended thresholds are not a definitive measure of a good fatigue control. They are indicative values based on the theoretical knowledge and assumptions made by the model's developers.
Some tools can be incorporated into an organisation's resource planning and monitoring systems.	They are not a substitution for a well thought out and comprehensive FRMS, but just one element of a company's overarching approach to effective fatigue management.

## Further Information on Fatigue and Fatigue Management

**British Nutrition Foundation** [www.nutrition.org.uk](http://www.nutrition.org.uk)

**Federal Railroad Administration** [www.fra.dot.gov](http://www.fra.dot.gov)

**Food Standards Agency** [www.food.gov.uk](http://www.food.gov.uk)

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

**Medical fitness standards** [www.rgsonline.co.uk](http://www.rgsonline.co.uk)

(GO/RT3451, GO/RC3561, GO/GN3655)

**National Sleep Foundation** [www.sleepfoundation.org](http://www.sleepfoundation.org)

**Office of Rail Regulation** [www.rail-reg.gov.uk](http://www.rail-reg.gov.uk)

**Opsweb** [www.Opsweb.co.uk](http://www.Opsweb.co.uk)

**RSSB** [www.rssb.co.uk](http://www.rssb.co.uk)

**RSSB** Professional Driving DVD [enquirydesk@rssb.co.uk](mailto:enquirydesk@rssb.co.uk)

**RSSB** Human Factors CD ROM [enquirydesk@rssb.co.uk](mailto:enquirydesk@rssb.co.uk)

**RSSB** Human Factors Awareness Training Materials [enquirydesk@rssb.co.uk](mailto:enquirydesk@rssb.co.uk)

**The Sleep Apnoea Trust** [www.sleep-apnoea-trust.org](http://www.sleep-apnoea-trust.org)

## Additional RSSB leaflet titles available on the RSSB website

**RSSB** 'Feeling Tired?' Leaflet

**RSSB** 'Coping with Shift work & Fatigue – a good practice guide for drivers' Handbook

**RSSB** Understanding Human Factors – a guide for the railway industry







