

Understanding Fatigue Risk Management

Fatigue Risk Management in the UK Rail Industry



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To understand fatigue in an organisation, data from multiple different sources are needed to complete the 'jigsaw' that is the picture of fatigue.

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Introduction

What is the aim of this white paper?

This paper is designed to provide an overview of fatigue risk management guidance and what that means in practical terms for operators in the UK Heavy and Light Rail Industry. It follows from the introductory paper in this series – 'Understanding Fatigue Risk Management: What are fatigue risk management approaches, and why do we need them?'

What Regulations and Guidance materials are relevant to UK Rail?

The regulatory requirement to manage the fatigue of the workforce in the UK Rail sector is long-standing. It is outlined under Regulation 25 of the Railways and Other Guided Transport Systems (Safety) Regulations 2006 (ROGS), and guidance has been published for fatigue risk management by the Office of Rail and Road (ORR) in their document Managing Rail Staff Fatigue¹ (2012). For any operator with safety critical workers and/or shiftwork or significant overtime, the ORR requires that the operator implements a Fatigue Risk Management System (FRMS, described below). Where there is no safety critical work, and work is undertaken without the need for shiftwork or significant overtime, fatigue can be managed through basic controls and the

safety management system. The ORR documentation is supported by publications from both the Rail Safety and Standards Board (RSSB)² and the Light Rail Safety and Standards Board (LRSSB)³.

Practical advice for implementing FRMS in the rail industry

Informed use of bio-mathematical fatigue models

Bio-mathematical fatigue models are software tools that predict average fatigue levels associated with a working pattern. After entering the working pattern information (including start and finish times, commute and break duration, for example), they calculate the likely average fatigue based on predicted sleep and circadian factors. Such models can be useful in providing an overall prediction of fatigue levels and 'hotspots' where high levels of fatigue need to be addressed. They can form one part of your overall FRMS approach, and should be used appropriately with clear understanding of what results and thresholds mean.

In a report published in 2022, the Rail Accident Investigation Branch (RAIB) made an observation relating to the Fatigue Risk Management approach of Train Operating Company (TOC)⁴. The report noted that, whilst fatigue did not play a causal role in the

¹ Managing Rail Staff Fatigue January 2012. Office of Rail Regulation.

² Accessible here: <https://www.rssb.co.uk/what-we-do/key-industry-topics/fatigue-and-alertness> (accessed 06/07/2023)

³ Accessible here: <https://resources.lrssb.org/resource/lrg-6---fatigue-management-guidance> (accessed 06/07/2023)

⁴ https://assets.publishing.service.gov.uk/media/62f1228e8fa8f5032b58cee0/R072022_220811_Kirkby.pdf

accident, a review of the operator's FRMS approach found it did not follow current industry guidance and good practice. This was a result of the use of the HSE Fatigue and Risk Index (HSE:FRI) in isolation, and not comparing working patterns against the ORR 'fatigue factors'⁵.

The HSE:FRI is a bio-mathematical fatigue model that is widely used across the rail sector, and was historically available as a free download from the HSE website. The HSE withdrew the index in June 2021 for a couple of key reasons:

1. The index was developed in a no-longer supported version of Microsoft Excel
2. The HSE was concerned about how the tool was being used, in particular the thresholds that are utilised.

Whilst fatigue models are useful and can play a role in the management of fatigue in any large organisation, they are a tool that must be used appropriately. This includes ensuring that fatigue models:

- Provide one source of data amongst others (e.g. fatigue reports from workers), not the only measure
- Are always used in an informed manner, and any thresholds used for analysis purposes are well understood, and appropriate to the operation and task

In guidance for the industry published in 2012, the ORR explained that that bio-mathematical fatigue models are only **one** element in fatigue risk assessments, and good practice and actual staff experiences should be considered alongside the model⁶ and that '*Such tools are not a substitute for a comprehensive FRMS, rather they are just one useful component*'. Similarly, the RSSB has stated that fatigue models are '*very useful if they are used correctly. But if they are misunderstood or misused, that can have*

a big impact on workers' fatigue, their safety, health, livelihoods and families'⁷.

As the first paper in this series outlined⁸, to understand fatigue in an organisation, data from multiple different sources are needed to complete the 'jigsaw' that is the picture of fatigue. Given the limitations of fatigue models, in that they may not accurately reflect workload, mitigations, the effects of breaks, or consider the variability between different people – they cannot be used as the primary and only source of fatigue data.

Fatigue model thresholds

Identifying appropriate thresholds is another essential factor when using fatigue models. The commonly used thresholds in UK rail for the HSE:FRI are values of 30-35 for work during the day, and 40-45 for work during the night. But what do these values mean? FRI scores reflect a predicted average percentage likelihood of a worker experiencing a severe level of sleepiness (reflected by a Karolinska Sleepiness Scale, KSS, score of 8 or 9) at some point during the shift. At this level of sleepiness, microsleeps are highly likely, along with the potential for significant performance decrements. The thresholds used in the industry seem to have emerged from a study completed by the ORR and the Health and Safety Laboratory (HSL) in 2008⁹ - although this study did not identify acceptable or safe thresholds, rather it found that these scores were achievable for most working patterns in use at the time. Operators must decide for themselves, using data from multiple sources, the level of fatigue they deem acceptable for different types of shift.

Reporting unfit to work due to fatigue

Another RAIB report, published in 2023¹⁰ highlighted deficiencies in a key protection against elevated fatigue risk. The key deficiency was an ineffective system for

⁵ RAIB report 07/2022 Kirkby, pp 29 para. 104.

⁶ Managing Rail Staff Fatigue (2012), Appendix A

⁷ <https://www.rssb.co.uk/what-we-do/key-industry-topics/fatigue-and-alertness/fatigue-risk-management-systems/using-biomathematical-models-to-assess-rosters-for-fatigue>

⁸ Accessible from: <https://www.bainessimmons.com/knowledge/papers-and-presentations/>

⁹ Health and Safety Laboratory report RSU/08/03 Evaluation of the UK Rail Sector Initial Fatigue and Risk Index Thresholds: Identifying Good Practice

¹⁰ https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1167991/R132022_221109_Enfield_Town.pdf

safety critical workers identifying that they are experiencing a high level of fatigue, and declaring themselves unfit for duty. For this line of defence to be effective, there are many elements of an FRMS that need to be in place:

- Workers are competent to recognise when they are no longer fit to operate safely, and know what to do next
- Company culture means that declaring yourself unfit due to fatigue is welcomed as a positive safety action. Or are there fears of negative consequences?
- Other policies do not conflict with removing yourself due to fatigue, such as absence management, or communications regarding avoidance of delays
- The organisation trending instances of fatigue to identify common themes and reducing them where possible

So how should we manage fatigue?

Appropriate use of fatigue models can play a role in an FRMS, but they must be supported by other sources of data, and other areas of risk management. Whilst the ORR has not published prescriptive limitations on hours of work as a legal requirement, they have produced **best practice** in the form of the **Fatigue Factors**¹¹. This is a list of elements of a roster or working pattern that are likely to be associated with an elevated level of fatigue within the working pattern. They do not have to be avoided, but working patterns should be compared against the list, and the factors minimised so far as is reasonably practicable – although some cannot be completely removed without significant impact on the operation. Examples of the Fatigue Factors include:

- The time of day factors (e.g. night shift covering the period between 00:00 and 05:00 (FF1)),
- Intervals between duties factors (e.g. less than 12h rest in any 24h period for day shifts(FF13)), and

- Cumulative fatigue factors (e.g. more than 4 consecutive 12h day shifts (FF10)).

The best practice guidance material from the ORR also recommends a POPMAR approach to implementing the FRMS:

- **Policy**
- **Organising** (i.e. developing your organisation, identifying roles and functions)
- **Planning and Implementing** (Where are you now? How do you get to where you want to be? Training all appropriate members of the workforce, comparing working patterns to the fatigue factors)
- **Measuring Performance** (measuring fatigue in actual operations, fatigue reporting, use of fatigue models, fatigue surveys and incident investigation)
- **Auditing and Reviewing Performance** (Key Performance Indicators, internal and external audits for compliance and effectiveness, feeding back to FRMS improvements)

This approach places the use of a fatigue model into the overall context of the FRMS – it forms one part of measuring performance, there are many more elements that must be implemented. The scale and nature of these will depend on the outcomes of the risk assessments undertaken as part of your POPMAR steps.

How effectively are you managing fatigue?

The ORR guidance material also provides a checklist¹² that can be used to identify elements of an FRMS as present or absent in your organisation. This checklist can be used for internal audits, and tracking continuous improvement in your FRMS, particularly if it is combined with a measure of maturity of the different elements, for example the levels of maturity in the RM3 model¹³.

¹¹ <https://www.orr.gov.uk/media/10935>

¹² Managing Rail Staff Fatigue (2012) Appendix F. An FRMS Checklist

¹³ <https://www.orr.gov.uk/guidance-compliance/rail/health-safety/strategy/rm3>

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ORR Fatigue Factors (available from <https://www.orr.gov.uk/media/10935>)

ORR RM3 model (available from <https://www.orr.gov.uk/guidance-compliance/rail/health-safety/strategy/rm3>)

Authors

Sarah Booth

SENIOR MANAGER, BAINES SIMMONS

Sarah Booth is our Senior Manager of Fatigue Risk Management. A specialist in human performance in the aviation and aerospace environments, Sarah has worked with operators to develop and implement Fatigue Risk Management Systems (FRMS) across multiple regulatory environments, and provides scientific support to Regulators assessing FRM submissions and scientific safety cases.

Sarah specialises in the integration of key data streams into the FRMS. A highly experienced user of bio-mathematical fatigue models, Sarah develops key metrics for the analysis of roster-related-fatigue levels and roster-related fatigue contributors. Sarah also works closely with operators to implement effective, data-rich fatigue reporting systems, and to identify barriers to reporting.

In the last two years, Sarah has undertaken scientific safety cases, fatigue management diagnostics and implemented Fatigue Risk Management in some of the world's largest airlines, as well as in the rail and maritime industries and for search and rescue helicopter operations.

Sarah obtained an honours degree in Physiological Sciences from the University of Oxford, focusing on cardiovascular physiology and immunology, a Master's degree in Space Physiology and Health at King's College London, and a Master's Degree in Sleep Medicine at the University of Oxford.

Dr Cristina Ruscitto

SENIOR RESEARCHER, BAINES SIMMONS

Dr Cristina Ruscitto is a Senior Researcher in the Fatigue Risk Management Team. She specialises in the psycho-behavioural predictors of jet lag and fatigue in the aviation sector. Her role involves a wide range of tasks, including the development of fatigue surveys and survey analysis, development of fatigue investigation process, review and recommendations of procedures, scientific study of roster patterns and the use of bio-mathematical models to conduct roster analysis.

Cristina joined the team in April 2018, having previously completed her PhD in Health Psychology exploring the psycho-behavioural predictors of jet lag amongst long-haul cabin crew at the University of Surrey, UK. Her research examined the relationship between subjective (symptom perception) and objective (shift in melatonin acrophase) jet lag in order to provide a comprehensive account of jet lag in long-haul cabin crew. The nature of subjective jet lag was further explored in terms of how long-haul crew make sense of jet lag and how this affects their adaptation to jet lag. Finally, based on recent evidence about the circadian resetting properties of food timing, Cristina also evaluated the impact of mealtimes for reducing jet lag in long-haul crew.

Cristina's interest in the field of jet lag and fatigue in aviation is not only academic but also personal having worked as long-haul cabin crew for 24 years. Cristina also works as a Visiting Researcher and Academic Tutor in Psychology for the University of Surrey. She is a Chartered member of the British Psychological Society and an Associate Fellow of the Higher Education Academy.

Reviewer

Dr Alexandra Holmes

Alexandra Holmes PhD is a fatigue risk management (FRM) specialist at Baines Simmons, an aviation safety risk management consultancy. For over 20 years, Alex has worked with operators to undertake large-scale scientific safety studies of pilot fatigue and performance, including pilots operating ultra long-range trips between the Middle East and the USA, to island hopping seaplane pilots.

Alex is currently on the EASA Scientific Committee reviewing research into the effectiveness of flight time limitations. She was on the Flight Safety Foundation (FSF), Fatigue Countermeasure Group that authored Guidance for Operators for controlled rest, and a member of the ICAO Helicopter Fatigue Management Task Force that developed the revised SARP and guidance material on fatigue management for helicopter operations.

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We are specialists in aviation regulations, compliance and safety management and partner with the world's leading civil and defence aviation organisations to improve safety performance.

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