

Understanding Fatigue Risk Management

Increasing maturity of airline Fatigue Risk Management, and undertaking safety cases

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Introduction

For many airlines (Commercial Air Transport, CAT, operators) around the world, the requirement to specifically manage fatigue as a hazard has been in place for multiple years. For example, EASA first published ORO.FTL¹ through rule-making in 2014, whilst the FAA's FAR-117² became effective in January 2014. The updated rule-sets contained familiar areas – prescriptive flight and duty time limitations – but also the explicit requirement to use data- and evidence-based approaches to manage the risk associated with fatigue. Under these requirements, operators must be able to demonstrate that their duties and roster patterns do not result in an excessive level of fatigue, even if they are operating well within the published flight and duty limitations.

What the regulations mean is that **all** airlines must use fatigue risk management approaches in order to demonstrate compliance. For most operators, this means using the safety management system processes to identify contributors to fatigue, fatigue 'hotspots' in the operation, and the steps needed to mitigate against this elevated fatigue.

Given the time since the regulations were implemented, this requirement will be familiar to all operators, who did significant work prior to the rules coming into force. However, how should an operator increase the maturity of these systems, to ensure that they are effectively managing fatigue within the operation? Fatigue risk management processes should be able to adapt to change in the operation, whether that is post-Covid routes, changes in the numbers of flight and cabin crew as a result of the pandemic, periods of high training load, introduction of new fleets, peak summer travel etc. Operators must also be able to demonstrate continuous improvement, always seeking to identify new risks, mitigations, and increase overall maturity.

Increasing maturity of fatigue risk management approaches

Please note, this section relates to all operators who must manage fatigue through their SMS – it is not discussing an 'approved FRMS/FRM' which currently only apply to relatively small numbers of operators. However, for those operators who have implemented 'approved FRMS/FRM', the strategies below may also be useful.

¹ Regulation (EU) No 83/2014, Annex III (Part-ORO) Subpart FTL: Flight and duty time limitations and rest requirements
² 14 CFR Part 117 Flight and Duty limitations and rest requirements: Flightcrew members

1) Identify your current state

Before beginning any improvement programme, it is important to understand where you currently are. This requires an assessment of the current effectiveness of your system, and an understanding of fatigue levels. Tools are available to support with this assessment, such as the EASA FTL/FRM Inspector's Checklist³ – part 1 provides a list of questions that can be used to assess compliance with the Operator Responsibilities that all airlines flying to ORO. FTL must follow, whilst part 2 is used to assess compliance with the prescriptive flight and duty limitations.

The EASA FTL/FRM Inspector's checklist contains specific checks to carry out for each area of the regulation. For example, checks which relate to ORO.FTL.110 b) (*ensure that flight duty periods are planned in a way that enables crew members to remain sufficiently free from fatigue so that they can operate to a satisfactory level of safety under all circumstances*) are:

- 'Check if the operator's documented rostering policy and procedures are tailored to the type and scope of operation and fatigue risk exposure
- Check if the applicable legal requirements and operator's rostering policy and procedures are reflected in the operator's roster planning tool/software
- Check if planned FDPs allow for buffers to the maximum permitted FDPs
- Check if the operator provides for specific mitigation measures in its rostering policy to address fatiguing duties such as: FDPs with extensions; FDPs with WOCL encroachment; training flights, consecutive duties etc., as applicable
- Check if the operator measures the effectiveness of those mitigation measures
- Check if the operator uses performance metrics to monitor and measure flight duty periods in terms of their duration, workload, WOCL encroachment and consecutiveness.'

Different data sources, such as fatigue reporting, bio-mathematical models, fatigue surveys and focus groups with crew can be used to help identify fatigue levels in the operation. This will show where your mitigations and fatigue risk management approaches are working, where there is room for improvement, and where new mitigations are needed. Other sources of data from the broader SMS include the results of investigations, whether they are following incidents, Air/Cabin Safety Reports (ASRs/CSRs), or Flight Data Monitoring (FDM) events.

2. Identify priorities for improvement

The Fatigue Safety Action Group (FSAG) or equivalent should then use the findings of the assessment of the current state to identify priorities for improvement. Areas of high risk or any non-compliance are obviously urgent areas to address. Most improvements are likely to require time to implement – for example ensuring frequent and effective communication across the organisation relating to fatigue risk management, or supporting the Safety Culture of the operation to improve fatigue reporting rates. Such improvements require a strategy developed by the FSAG, approved by Senior Leadership, and consistent effort from across the organisation to ensure that it is effective.

3. Identify if new sources of data are available which can inform fatigue risk management

Effectively managing fatigue can only occur with sufficient information. Since the fatigue risk management processes were first developed, new potential sources of information may have become available. For example:

- Updates to the rostering system may provide greater insights through ability to extract reports
- Journey logs or apps to collect anonymous information on Electronic Flight Bags may provide the ability to collect data on sleepiness across flight duty periods (e.g. Top Of Descent Surveys etc.)

³ FTL/FRM Inspector's checklist – supporting material for NAA Inspectors. Edition 2. 15.12.2022. Freely available from <https://www.easa.europa.eu/en/downloads/106865/en>

- Updates to software may make submitting a fatigue report quicker and more simple, for example through automatically completing fields relating to name, rank, role and roster history
- Fatigue models have had significant improvements in recent years, the newest version may provide new reports or tools to identify more fatiguing factors

Safety cases and 'approved FRMS'

For operators who identify that they have an elevated fatigue risk, wish to assure themselves that fatigue is being effectively managed in a complex operation, or have identified business benefit from an application to work outside a specific part of the flight and duty limitations, they can implement an FRMS approach.⁴

As outlined by ICAO, an FRMS is '*a data-driven means of continuously monitoring and managing fatigue-related safety risks, based on scientific principles and knowledge as well as operational experience that aims to ensure relevant personnel are performing at adequate levels of alertness*' (ICAO 2011). It requires more detailed data collection and mitigation than for operators who are managing fatigue through their safety management system. An FRMS only needs to be 'approved' by the regulator if it is in support of an application to work outside the published FTLs as part of a safety case.

Under the ICAO SARPs, regulators may offer their operators an 'FRMS approach' – whereby specified operations may be conducted outside published flight and duty time limitations, so long as they are supported by:

1. An FRMS approved by the regulator
2. A safety case, demonstrating **at least** an equivalent level of safety to operating within published limitations

Implementing an FRMS

A fatigue risk management system (FRMS)⁵ is a significant undertaking, requiring more resource, data and mitigation than managing fatigue through the SMS. ICAO provides a suite of guidance material for the aviation industry, including the Fatigue Management Guide for Airline Operators (2015)⁶, and the Manual for the Oversight of Fatigue Management Approaches (Doc 9966) (2020)⁷. For an operator looking to implement an FRMS, or to assess their current FRMS, the 'example FRMS evaluation form' provided in appendix K of ICAO document 9966 provides a clear assessment of FRMS elements. The checklist uses an assessment of maturity of elements, not simply a present/absent marking criteria, and therefore can be used to track continuous improvement.

Undertaking a safety case

Like other elements of risk management, the evidence presented in the safety case must be proportional to the size and nature of the derogation or difference that you are requesting from the regulator. This impacts the amount and level of data that you collect, and mitigations required to demonstrate the equivalent level of safety to the current operation.

For most safety cases, a 'trial' is required where you collect data from the operation you are applying for. This may require a temporary derogation by the regulator to enable the activity, if it is outside current limitations. The trial period should have additional risk monitoring and management, and prior to the trial you will need to satisfy your regulator that it can be conducted without excessive fatigue risk. This may be achieved through modelling example roster patterns including the operation you are applying for, as well as providing examples of mitigations and risk management that will be implemented.

⁴ Please note, an FRMS approach to working outside published flight and duty regulations may not be made available by all NAAs – refer to your regulations for clarity.

⁵ Under the EASA system, FRMS is called FRM, and the requirements are outlined in ORO.FTL.120

⁶ Fatigue Management Guide for Airline Operators. 2nd Edition 2015. IATA, ICAO and IFALPA.

⁷ Manual for the Oversight of Fatigue Management Approaches (Doc 9966), Second Edition, Version 2 (revised) 2020. ICAO.

What data do we need to collect?

It depends on what you are applying for. Just like other areas of hazard identification within your FRMS, the safety case should consider predictive, proactive and reactive sources of data, and test what would be operated in reality, not a 'perfect' or 'best-case' scenario.

Where it is likely that the derogation will impact on the sleep of crew members, it is important to collect sleep data. This may be through sleep diaries, but a more accurate approach is to use scientifically validated sleep monitoring devices such as Actigraphs. There are pros and cons for each approach – obviously the increased accuracy and objective nature of sleep monitoring devices are desirable, but it can be prohibitively costly or administratively challenging where data is needed from a large, distributed population, or if you are studying unpredictable events.

Sleep data should be complemented with measures of alertness and performance during the waking period – both when working and off-work (if appropriate to your safety case). Workload (both high and low) should also be considered, along with the experiences of staff working both your current and the proposed pattern during the trial.

To increase the validity of the data collected, it should – so far as possible – be from both objective and subjective sources. Objective data is external to an individual, and cannot be swayed by opinion or feelings. Examples of objective data are using sleep monitoring devices, fatigue models, and tests such as reaction time tasks. Subjective data is provided directly by the participant, and outlines how they feel (for example their sleepiness levels). Both are necessary to understand both fatigue and its impacts on the workforce.

As part of the safety case you should also examine data from your current operation and, where possible, the experiences of other operators who have similar operations to that which you are proposing. The safety case also needs to consider the controls that will be in place to identify elevated fatigue

across the operation, and the mitigations that will be implemented. This is why it is essential to have a mature and functioning FRMS in place to support your safety case.

How do we present our safety case?

A safety case is a **structured argument** that presents the evidence both for and against the operation you are applying for. The argument provides the evidence on both sides, and offers a conclusion based on the balance of this evidence. As part of the argument, the safety case document will include the specific hazards identified, the risk assessments undertaken, and the mitigations that have been implemented to control fatigue. The onus is on the operator to demonstrate that fatigue is controlled to a level considered As Low as Reasonably Practicable (ALARP), and at least as low as that provided by operating within the regulation.

When developing your safety case, it is essential to work closely with your regulator. This ensures that you can present the level of detail they are looking for, and allows the regulator to have confidence in the approach that you are taking.

Summary

All airlines are required to demonstrate that they are managing the risk of fatigue through their SMS. With significant change to many operators as a result of the Covid-19 pandemic, changes in routes and in staffing levels, it is essential to regularly review fatigue risk management to ensure that it is still effective. Tools are available to support operators in assessing the effectiveness of their fatigue risk management arrangements, as well as their compliance with the regulatory requirements.

For the small number of operators wishing to apply to have limited areas of their operation outside the published flight and duty regulations, a mature and functioning FRMS is required. An application to the regulator includes a safety case, which is a structured argument presenting the evidence collected through appropriate data collection and operational experience.

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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