An introduction to the new EU fatigue management framework
Overview

What is fatigue?

The science of sleep and circadian rhythms

What are fatigue hazards in aviation?

The new approach to fatigue management
What is fatigue?
“My mind clicks on and off...I try letting one eyelid close at a time while I prop the other open with my will. But the effort’s too much. Sleep is winning. My whole body argues dully that nothing, nothing life can attain, is quite so desirable as sleep.”

– Charles Lindbergh, describing the fatigue that struck him nine hours into his 33-hour solo Atlantic crossing.
Microsleeps
Microsleeps detected using PSG

Number of microsleeps before landing during A340 certification flights TLS-SFO-TLS and TLS-SIN-TLS

- Time before landing
  - 90-60 min
  - 60-30 min
  - 30-0 min

- Number of microsleeps
- 18
- 16
- 14
- 12
- 10
- 8
- 6
- 4
- 2
- 0

- Outward
- Return
Fatigue degrades performance

- Perception of risk lowered
- Increased risk tolerance
- Situational awareness reduced
- Tunnel vision
- Tasks forgotten or ignored
- Increased errors
- ...
Effects of sleep loss on brain functions

- **Parietal lobe**: integrates information from the senses. Calculations, manipulation of objects.

- **Thalamus**: Alertness.

- **Prefrontal cortices**: Problem solving.

- **Occipital lobe**: Visual processing.

Parts of the brain responsible for understanding the world and the data around us start to slow down – priority given to the thalamus.
Fatigue reduces the safety margin.
What is fatigue in aviation?
Self-assessments of fatigue are not accurate

*Van Dongen, Maislin, Mullington, and Dinges (2003)*
From intuition to science

Scientific concept

Subjective experience

Everybody has the feeling to be an expert

Linked to physiological mechanisms

Perception influences behaviour

Perception of fatigue linked to psychological, social, cultural factors

Fatigue

Perception of fatigue linked to psychological, social, cultural factors
Alertness is regulated by three processes

1. Sleep/wake
   Alertness increases with sleep and decreases with hours awake

2. Circadian rhythms
   Alertness varies in a 24-hour rhythm

3. Sleep inertia
   Temporary grogginess experienced upon waking from sleep

Circadian rhythms

Generated by the **body clock**, located in the hypothalamus

Prepare us for **activity** during day and **sleep** at night

Timing influenced by external cues, particularly **light**.
The body clock

- Highest testosterone secretion 10:00
- Bowel movement likely 08:30
- Melatonin secretion stops 07:30
- Sharpest rise in blood pressure 06:45
- Lowest body temperature 04:30
- Deepest sleep 02:00
- Midnight 00:00
- Noon 12:00
- Best coordination 14:30
- Fastest reaction time 15:30
- Greatest cardiovascular efficiency and muscle strength 17:00
- 18:30 Highest blood pressure
- 19:00 Highest body temperature
- 21:00 Melatonin secretion starts
- 22:30 Bowel movements suppressed

*Taken from Wikimedia Commons*
Sleep propensity

Schematic representation of time periods favouring sleep onset
(from Stampi, 1989)
Alertness components

The components of the three-process Model of alertness, adapted from Åkerstedt et al, 2008
What is cumulative sleep loss?

Fatigue factors

- Circadian
- Cumulative sleep debt
- Amount of recent sleep
- Time awake
- Time on task
Sleep inertia

Temporary feeling of grogginess and reduced performance that occurs immediately after waking

Most severe in the first 5 min after waking

Effects can last longer than 30 min

Impaired short-term memory, reaction time, decision making ability

Worst when woken from deep sleep, particularly if this coincides with the WOCL
Fatigue: a hazard in aviation

Time of Day

Fatigue

Time awake

“Sleepiness”

Task related factors

“Sleep”

Rest

Reduced Performance Capability

Accident
Causes and consequences of fatigue

Fatigue Causes & Consequences

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<tr>
<th>Job Factors</th>
<th>Individual Factors</th>
<th>Fatigue</th>
<th>Human Performance</th>
<th>Health</th>
<th>Operational Performance</th>
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<td>Roster</td>
<td>Individual Factors</td>
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<td>Timing</td>
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<td>Opportunity for naps</td>
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<td>Environment</td>
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Individual Factors:
- Traits
  - e.g. health
  - medications
  - chronotype
- Lifestyle
  - e.g. sleep environment
  - recreation
  - second job
  - domestic situation

Fatigue

Human Performance
- Mood
- Communication
- Memory
- Vigilance
- Problem solving
- Risk taking
- Reaction time

Well-being
- Cardiovascular
- Gastrointestinal

Health

Incidents
- Insurance
- Absenteeism
- Productivity
- Costs
- Morale
- Retention
- Reputation
Effective fatigue control needs more than just ‘numbers’.
<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
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<tr>
<td>Clear boundaries</td>
<td>Limits not based on science and do not adequately consider the circadian rhythms in sleep and alertness</td>
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<tr>
<td>Offer a simple level of protection to employees</td>
<td>Only address one cause of fatigue (hours of work) and not fatigue caused by the nature of work, lifestyle factors, health difficulties, commuting or the environment</td>
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<td>Maximum limits perceived as safe and often used as “targets”.</td>
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<td>We assume that if “it’s legal, it’s safe”</td>
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<td>“One size fits all” and static: don’t reflect differences between operators or changes over</td>
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<td>Responsibility remains with the regulatory authority/State</td>
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Scientific principles in FTL

...regulations shall be based upon scientific principles and knowledge,...

...rules based on scientific knowledge and best practices...

...taking into account the latest scientific and technical evidence...
The new EU fatigue management framework

When?
Reg. 83/2014 Art. 2 – 18 February 2016

To whom?
CAT operations by aeroplane except Air Taxi, Single Pilot & EMS

Opt out
In-flight rest until 17 February 2017
Cover Regulation

Derogations / deviations to address particular national considerations
Interaction with working time requirements (social legislation)

Recitals
FTL without prejudice to more protective social legislation
Flexibility provisions Arts. 14 & 22.2

Regulation 216/2008 art 14 / art 22
- 1 immediate reaction to a safety problem
- 4 exemptions for operational needs of limited duration, not repetitive
- 6 derogation achieving equivalent level of safety by other means
- Individual flight time specification schemes

Continuous review of effectiveness
Impact of new rules on aircrew alertness
Implementation

ARO.OPS.230
Determination of disruptive schedules

ARO.OPS.235
Approval of individual flight time specification schemes
Fatigue management & SMS

SMS
- ORO.GEN.200 Management system
- AMC/GM

Fatigue management
- FTL
- FRM
- FTL combined with FRM
The rostering systems need to address rest

- ORO.FTL.110 OPERATOR RESPONSIBILITIES (d, g & h)

- ORO.FTL.235 Rest
  - (a & b) Minimum rest
  - (c) Reduced rest
  - (d) Recurrent extended recovery rest
  - (e) Rest to compensate for disruption

- CS FTL.1.235(c) Reduced rest
- CS FTL.1.235(a) Disruptive schedules
- CS FTL.1.235(b) Time zone differences

- AMC1
  - ORO.FTL.110(b)(2) SCHEDULING
  - ORO.FTL.235(b)(2) MINIMUM REST AWAY FROM HOME BASE

- GM1
  - ORO.FTL.235(a)(2) MINIMUM REST AT HOME BASE WITH ACCOMMODATION
  - CS FTL.1.235(b)(3) TIME ELAPSED SINCE REPORTING
The operator should nominate a home base.

**ORO.FTL.115 CREW MEMBER RESPONSIBILITIES**

**ORO.FTL.200 HOME BASE**

**ORO.FTL.235(e)(3) REST**

**CS FTL.1.200(a)**
Home base

**CS FTL.1.200(b)**
Home base

**GM1 CS FTL.1.200 TRAVELLING TIME**
Flight time specification scheme

Crew member responsibilities

Operator responsibilities

F(R)M

January 14

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KEY POINTS

IR, CS, AMC and GM are a system, they complement each other

Don’t look at rules or numbers in isolation

Fatigue management is a shared responsibility

Your safety is our mission.
What is new?

SMS
- ORO.GEN.200 Management system
- AMC/GM

Fatigue management
- FTL
- FRM
- FTL combined with FRM
What is fatigue risk management?
Fatigue Risk Management

A data-driven, business risk management approach to fatigue

Processes for measuring, mitigating and managing fatigue risk

More effective than FTL alone

Based on scientific principles and knowledge, data collection and analysis, and so enables to maintain an equivalent level of safety whilst allowing greater operational flexibility.
## FRM is an integral part of SMS

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<th>SMS</th>
<th>FRM</th>
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<td>Safety policy &amp; objectives</td>
<td>FRM policy &amp; documentation</td>
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<tr>
<td>Safety risk management</td>
<td><strong>Fatigue risk management process</strong></td>
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<td>• Identification of hazards</td>
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<td>• Risk assessment</td>
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<td>• Implementation</td>
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<td>Safety assurance</td>
<td><strong>Fatigue safety assurance</strong></td>
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<td>• Monitor effectiveness of FRM</td>
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<td>• Management of change</td>
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<td>• Continuous improvement of FRM</td>
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<td>Safety promotion</td>
<td><strong>FRM promotion process</strong></td>
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<td>• Training programmes</td>
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<td>• FRM communication plan</td>
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FRM Structure

FRM Policy

Effective Reporting System / Just Culture

Fatigue Risk Management (FRM) Processes
- Data Collection & Hazard Identification
- Risk Assessment
- Risk Mitigation

FRM Safety Assurance Processes
- Performance Monitoring & Continuous Improvement
- Managing changes that may impact on the FRM
- FRM Audit and Review

Safety Performance Indicators (SPI)

Communication: Safety Promotion & Feedback

Fatigue Management Training
Example sources of data on fatigue

- Roster metrics e.g. stability, standby usage, number of sectors
- Statistics: absenteeism, sickness, turn-over, commute
- Fatigue reports and incident investigations
- Ergonomic assessment of work and sleep environment
- Fatigue model analysis of rosters
- Crew surveys and focus groups
- Scientific studies e.g. sleep diaries, actigraphy
Phased Implementation

Phase 1
Planning
- Gap analysis
- Policy & documentation

Phase 2
Implement reactive
- Identification of hazards
- Risk assessment
- Select mitigations

Phase 3
Implement predictive & proactive
- Identification of hazards
- Risk assessment
- Select mitigations

Phase 4
Implement safety assurance
- Monitor performance
- Management of change
- Continuous improvement

Develop and implement **documentation**

Develop and implement **communications**

Develop and implement **training**
Approval & Oversight (2)

- Aesthetics versus Substance

Balanced communication
Clear reporting process
Appropriate reporting forms
Manual relevant to the operator
Assurance finding
Access to all

Eye candy
Flashy power points
Overly detailed reporting forms
“Familiar” Manual
“Perfect” paperwork
Waffle
Approval & Oversight (3)

• How to tell the difference?

- Ask to see how the process works in operation
- Uniform message from CEO to junior crewing officer
- Question to test understanding
- Feedback system in place
- Assurance = findings tracked and closed
- Continuous improvement

It’s the people that make the difference
Performance Indicators*

- Roster metrics
- ASR
- FDM
- LOSA
- MOR
- Fatigue reporting

*These are not performance indicators for the FRM. PIs need to be varied and take a total system approach.
Performance Indicators

Must be relevant and useful

Approval & Oversight (5)

- Surveys & Research
- Fatigue reporting
- Use of CD
- MOR
- LOSA
- Roster metrics
- FDM
- ASR
Approval & Oversight (6)

- State not ready
- Operator has compliance issues
- Lack of senior management commitment
- Lack of resources
- Reverse engineering
- Unclear policy
- Lack of feedback
- Just Culture not implemented
- Unbalanced use of science
- Rushed implementation
- Don’t pass the ‘show me’ test

No (not yet)
State needs to be ready

Operator demonstrates compliance with FTL through fatigue management
Relevant PIs, reporting system etc.

Demonstrable commitment to FRM
Rather than complying with prescriptive limits, FRM relies on actually measuring and managing the fatigue-related risks.

Increased risk knowledge enables enhanced management of safety.

Benefits include reduced safety events, informed strategic decisions, increased operational flexibility, reduced insurance premiums, more effective regulatory oversight and improved relations with the unions.