Staff fatigue: the approach in rail

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Human Factors,
Office of Rail and Road

What's fatigue, & why is it important?

- *"Perceived weariness that can result from prolonged working, heavy workload, insufficient rest and inadequate sleep*"

- Fatigue's effects:
  - Less alert
  - Slower reactions
  - Drowsiness
  - More errors
  - Less patient
  - "Lose the picture…"

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What factors affect fatigue?

- Work related factors e.g.
  - Planned work hours
    - Length, timing in 24h cycle, variability, predictability?
  - Actual work hours
    - overtime, extra shifts?
  - Nature of tasks
    - How mentally demanding, repetitive, mundane, strenuous?
  - Work environment
    - Warm/cool? Bright/dim? People around? Active/sitting?
  - Culture?
    - Pressure (real or perceived) to carry on?

- Non-work related factors e.g.
  - Amount of sleep obtained
    - Opportunities for sleep between shifts, & how used
  - Sleeping environment
    - Light, noise, comfort etc
  - Health e.g.
    - Sleep disorders
    - Other health conditions & medications

Some controls for fatigue

- Work & travel hours?
  - Make work patterns “fatigue-friendly” : keep “fatigue factors” to a minimum (see later)
    - e.g. long night shifts
- Fatigue education & awareness?
  - Staff
  - Managers
  - Whoever plans work patterns
- Fitness-for-duty controls?
  - At recruitment:
    - medical, sleep disorder screening
  - For every shift:
    - Enough sleep before work? How long awake by end of shift?
- Fatigue reporting process?
- Fatigue surveys & other feedback

Fatigue Risk Management System?

- Fatigue has MANY causes, so…
- Need MANY controls to prevent / minimise it
- A “Fatigue Risk Management System”
- Use HSE’s “POPMAR” risk management cycle →

ORR guidance…
…a fatigue risk management system

- ORR checklist helps company:
  - Assess its fatigue controls
  - build the skeleton of a system

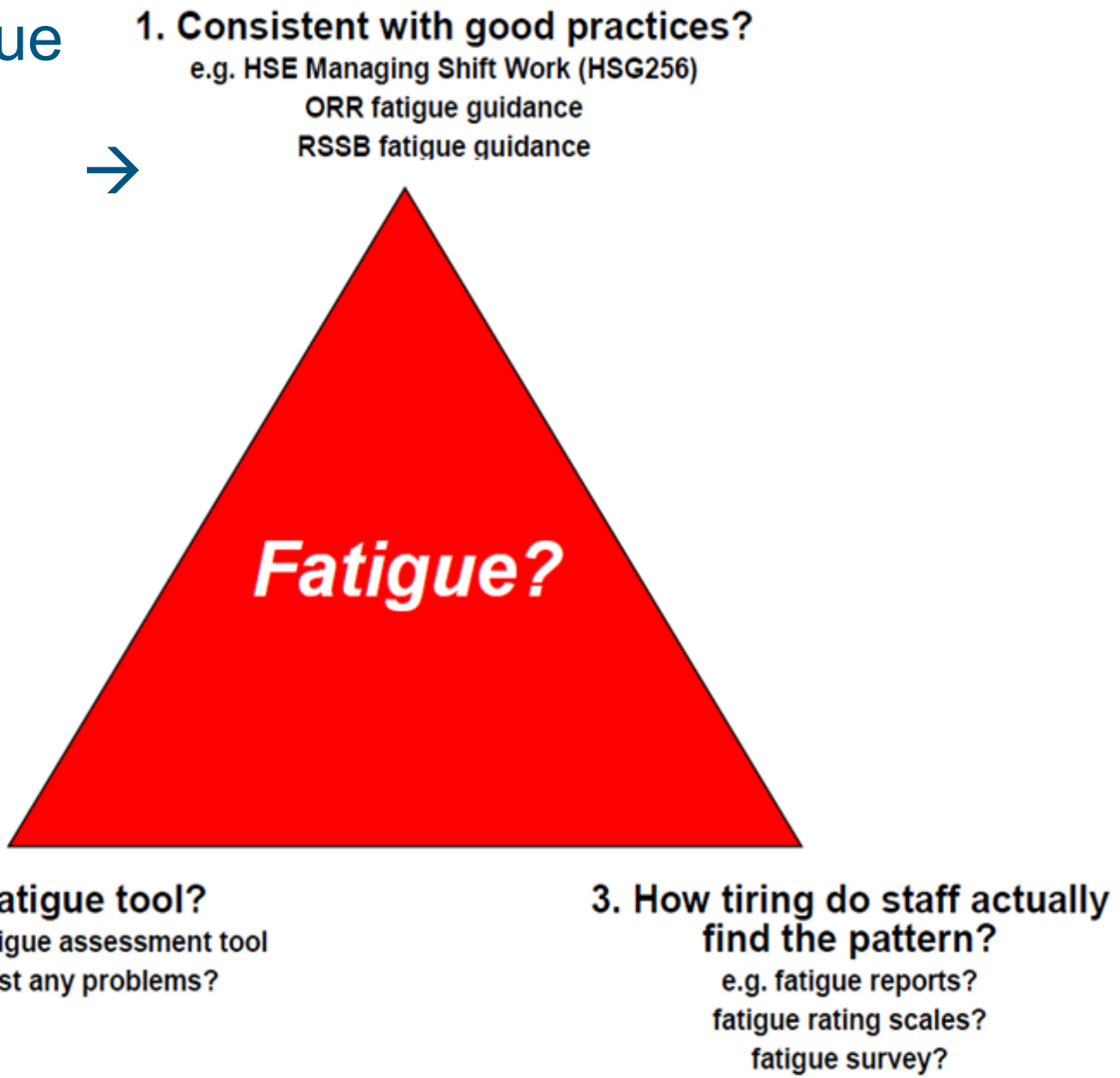
12.1 Some features of a Fatigue Risk Management System (FRMS) are summarised in the t
which may be useful as a checklist when organisations are considering the adequacy of their
management arrangements. The FRMS should be proportionate to the size and complexity o
operation and the likely risks from fatigue – it is recognised that not all items in the checklist w
appropriate for all organisations.

No.	Para in this guidance	Issue	Company FRMS / SMS ref?	Comments?
		General		
1	5.7	Is the FRMS integrated with wider Safety Management Systems?		
2	5.8	Does the FRMS identify & draw together the preventive & protective measures which help control fatigue? Does a document provide "signposting" to these various fatigue controls?		
3	5.9	Is the FRMS proportionate		

Some areas rail companies struggle with…

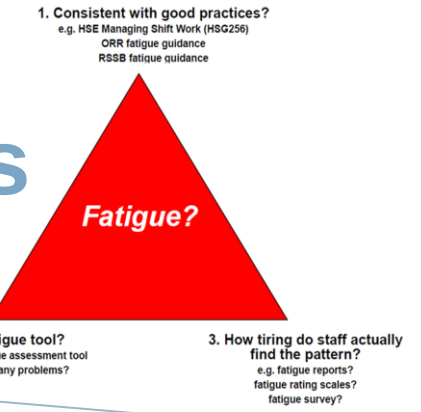
Assessing working patterns

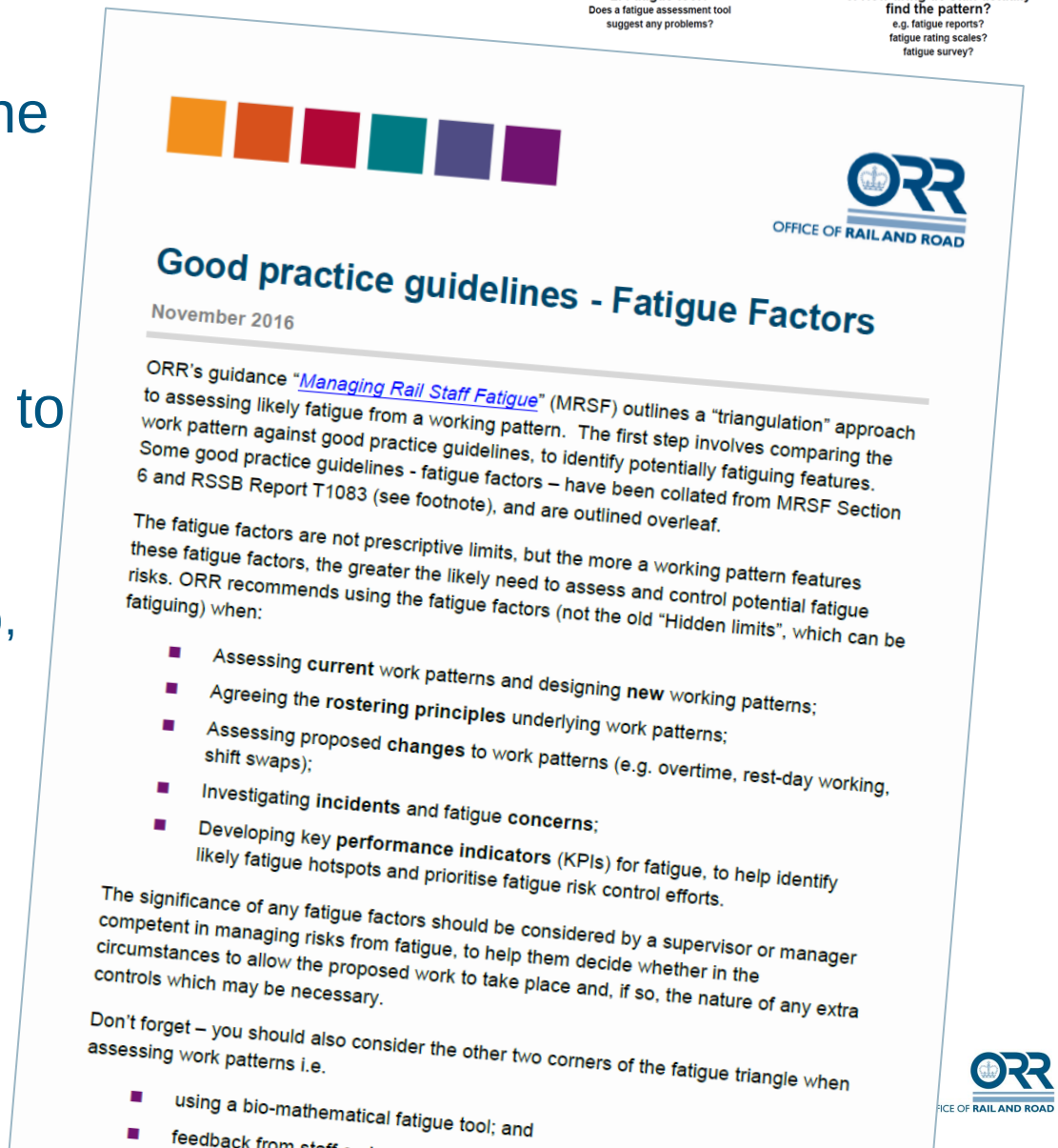
- "Triangulate" fatigue
- Use all 3 corners →



1st corner : work pattern guidelines

- Build fatigue-friendly working patterns
- "Fatigue Factors" increase the likelihood of fatigue →
- So…where reasonably practicable, avoid them
- If not reasonably practicable to avoid a fatigue factor:
  - Justify why (e.g. clearly, some work HAS to be done at night), then
  - Minimise the factor, and
  - Control the associated risks





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Good practice guidelines - Fatigue Factors

November 2016

ORR's guidance "*Managing Rail Staff Fatigue*" (MRSF) outlines a "triangulation" approach to assessing likely fatigue from a working pattern. The first step involves comparing the work pattern against good practice guidelines, to identify potentially fatiguing features. Some good practice guidelines - fatigue factors – have been collated from MRSF Section 6 and RSSB Report T1083 (see footnote), and are outlined overleaf.

The fatigue factors are not prescriptive limits, but the more a working pattern features these fatigue factors, the greater the likely need to assess and control potential fatigue risks. ORR recommends using the fatigue factors (not the old "Hidden limits", which can be fatiguing) when:

- Assessing **current** work patterns and designing **new** working patterns;
- Agreeing the **rostering principles** underlying work patterns;
- Assessing proposed **changes** to work patterns (e.g. overtime, rest-day working, shift swaps);
- Investigating **incidents** and fatigue **concerns**;
- Developing key **performance indicators** (KPIs) for fatigue, to help identify likely fatigue hotspots and prioritise fatigue risk control efforts.

The significance of any fatigue factors should be considered by a supervisor or manager competent in managing risks from fatigue, to help them decide whether in the circumstances to allow the proposed work to take place and, if so, the nature of any extra controls which may be necessary.

Don't forget – you should also consider the other two corners of the fatigue triangle when assessing work patterns i.e.

- using a bio-mathematical fatigue tool; and
- feedback from staff

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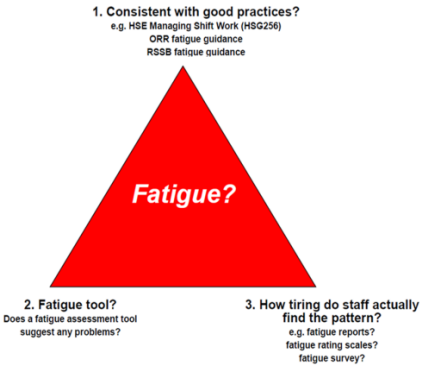
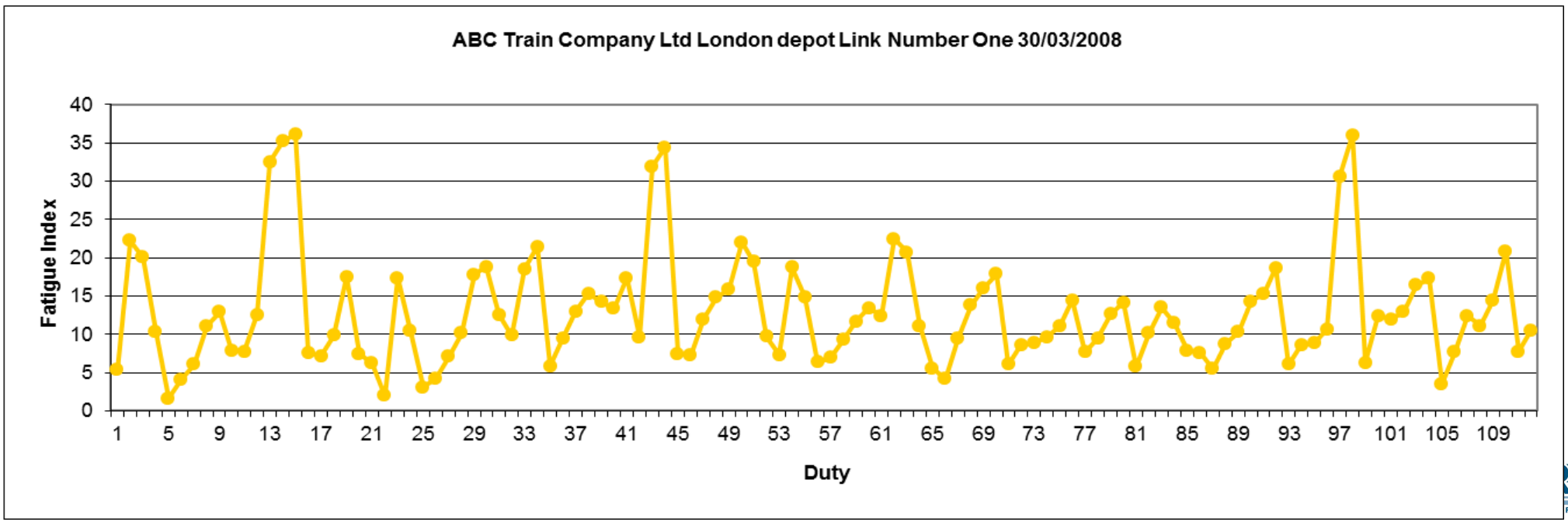
Uses of “Fatigue Factors”?

- “Fatigue Factors” in:
  - rostering principles?
  - assessing work patterns?
  - Assessing changes to planned work e.g.
    - Overtime?
    - rest-day working?
  - investigating incidents & staff concerns?
  - fatigue KPIs
    - to help identify fatigue hotspots & priorities?
- Train roster staff in them
- Incorporate in scheduling software, to help predict likely problems

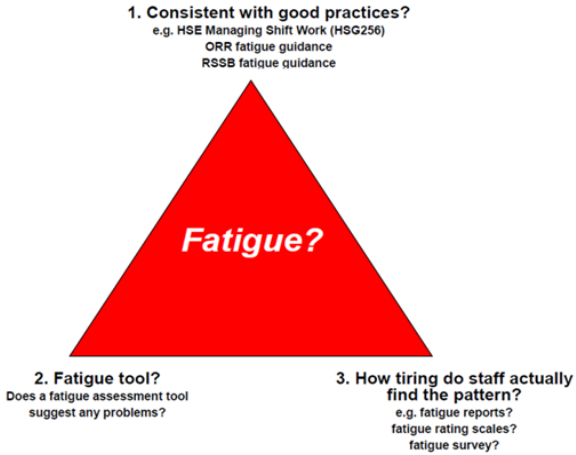
2nd corner – fatigue tool



- Computer program, tries to mimic what makes people fatigued e.g. working hours, time of day/night etc
- e.g. HSE Fatigue & Risk Index
- To SUPPLEMENT other two corners - an aid, not “gospel” !
- Scores aren’t “limits to work up to”: understand what they mean!
- Use charts to help ID likely peaks, trends, hotspots…



3rd corner: feedback from staff



- **Talking** with staff!
- Fatigue **survey**?
  - *"Which turns do you find most tiring? Why? How could we improve it?"*
- Fatigue **rating scale** →
  - Takes 10s: e.g. before, ½ way thru & end of shift
  - To help ID more tiring shifts
  - To assess effect of changes to shift (before v after)?
  - Is it the shift or the person?
  - Aim: improve shifts to get rid of all sixes? Then reduce fives?

What was your level of fatigue at the START of the duty period? *(circle one number)*	Mental fatigue rating** 1 2 3 4 5 6 7
What was your level of fatigue at the VERY END of the duty period? *(circle one number)*	Mental fatigue rating** 1 2 3 4 5 6 7

**** MENTAL FATIGUE RATING**

1= fully alert, wide awake;
2= very lively, responsive, but not at peak;
3= okay, somewhat fresh;
4= a little tired, less than fresh;
5= moderately tired, let down;
6= extremely tired, very difficult to concentrate;
7= completely exhausted, unable to function effectively.

Remember…all three corners!

1. Consistent with good practices?

e.g. HSE Managing Shift Work (HSG256)
ORR fatigue guidance
RSSB fatigue guidance

2. Fatigue tool?

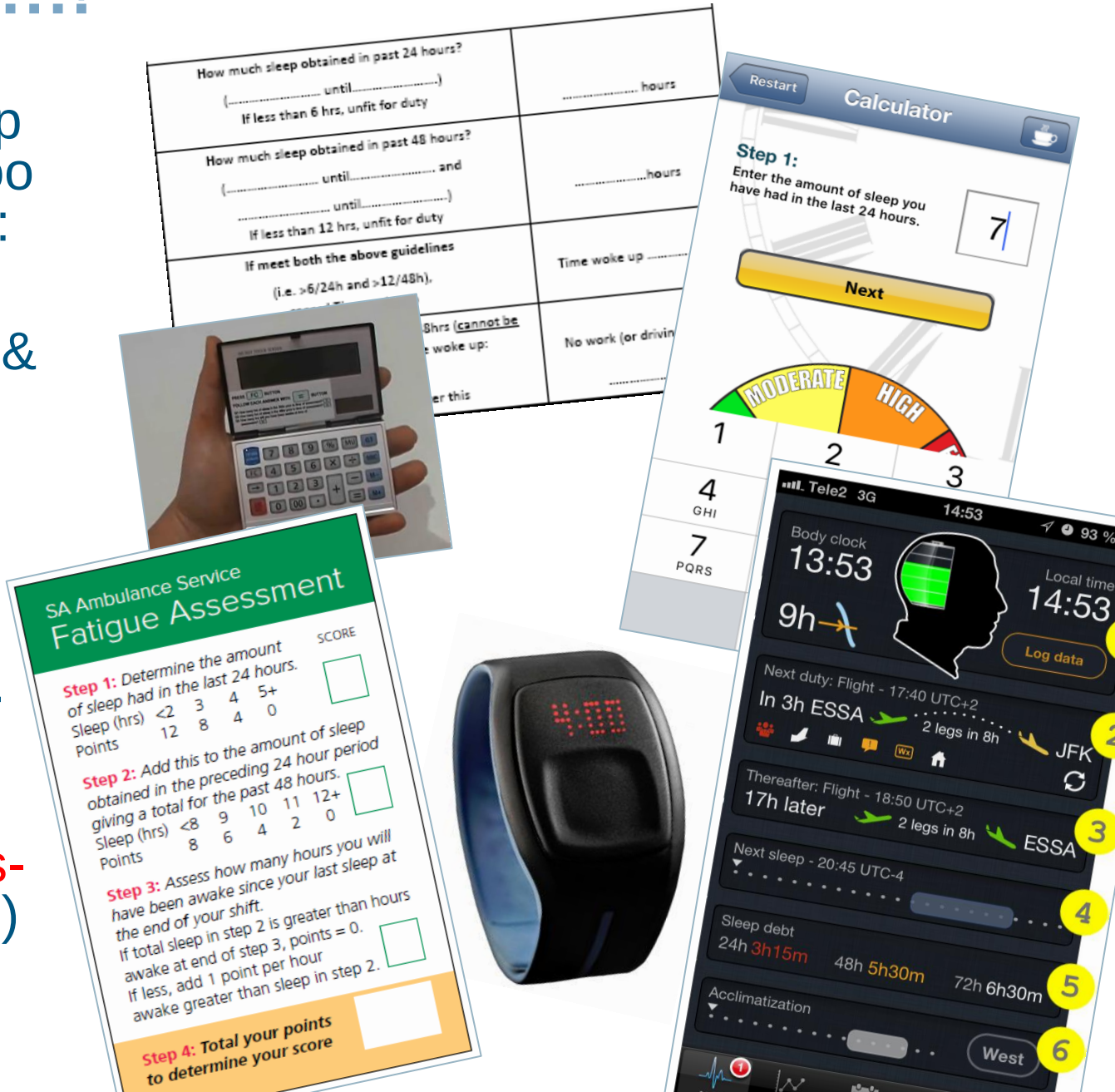
Does a fatigue assessment tool suggest any problems?

3. How tiring do staff actually find the pattern?

e.g. fatigue reports?
fatigue rating scales?
fatigue survey?

Fitness for duty: recent sleep is key, but often neglected…!

- Not enough recent sleep and/or staying awake too long means fatigue, but:
- Many tools like Fatigue & Risk Index assume you get sleep…!
- Q: Fitness for duty thru' whole shift? Travelling home? Hard to judge…
- RSSB Project T1082 → Decision-aids for fitness-for-duty (booking on etc)



Rough "rules of thumb" on recent sleep…

- "*Have I had enough sleep?*"
  - You may feel OK when you book-on, but it's hard to tell how tired you're likely to become through the whole of your shift. Here are some rough guidelines. Everyone's different, and many things affect fatigue - you may be too tired even within these guidelines. If in doubt, put safety first, tell your supervisor and don't put yourself or others at risk.
- Your performance is likely to be impaired:
  - If you've had less than 6 hours' sleep in the previous 24 hours
  - If you've had less than 12 hours' sleep in the previous 48 hours
  - When you've been awake longer than your total sleep in the previous 48 hours (up to a maximum of 16 hours, whichever is the lower)

Sleep disorders

- Still get incidents due to sleep disorders e.g. sleep apnoea
- Get Occupational Health advice on medical assessments, including
  - sleep disorder screening
  - Require staff to declare any sleep disorder
- Remember : sleep disorders can often be successfully treated

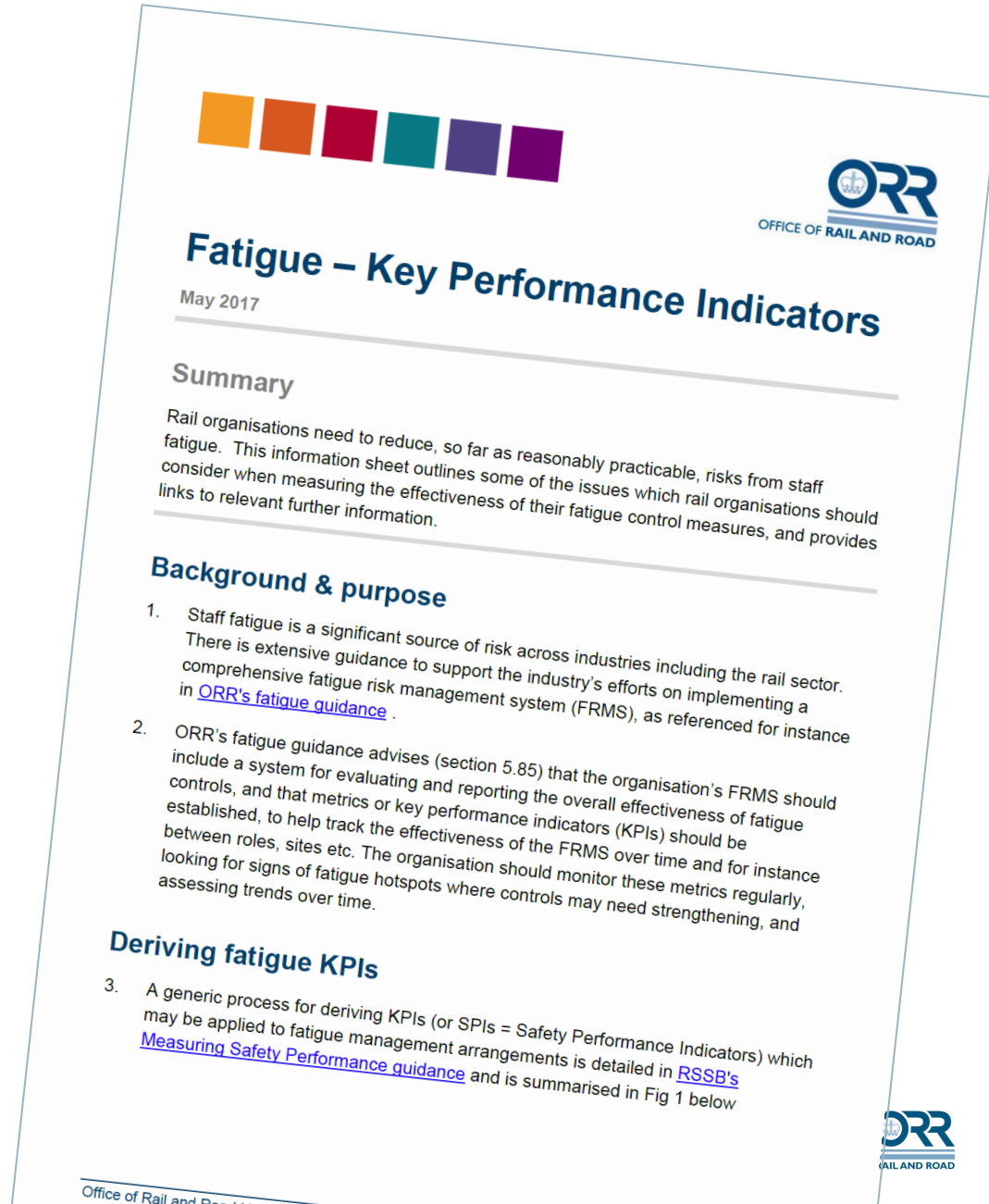
What to measure – devise suitable fatigue KPIs?

Outcome indicators e.g.

- % of shifts (planned/actual) containing xyz fatigue factors
- % of shifts covered by overtime

Activity indicators e.g.

- % rosters assessed using “fatigue factors” & fatigue tool
- % shifts where fitness-for-duty checks completed (e.g. recent sleep & time awake)
- % of rostering staff assessed as competent in fatigue



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Fatigue – Key Performance Indicators

May 2017

Summary

Rail organisations need to reduce, so far as reasonably practicable, risks from staff fatigue. This information sheet outlines some of the issues which rail organisations should consider when measuring the effectiveness of their fatigue control measures, and provides links to relevant further information.

Background & purpose

1. Staff fatigue is a significant source of risk across industries including the rail sector. There is extensive guidance to support the industry’s efforts on implementing a comprehensive fatigue risk management system (FRMS), as referenced for instance in ORR’s fatigue guidance .
2. ORR’s fatigue guidance advises (section 5.85) that the organisation’s FRMS should include a system for evaluating and reporting the overall effectiveness of fatigue controls, and that metrics or key performance indicators (KPIs) should be established, to help track the effectiveness of the FRMS over time and for instance between roles, sites etc. The organisation should monitor these metrics regularly, looking for signs of fatigue hotspots where controls may need strengthening, and assessing trends over time.

Deriving fatigue KPIs

3. A generic process for deriving KPIs (or SPIs = Safety Performance Indicators) which may be applied to fatigue management arrangements is detailed in RSSB’s Measuring Safety Performance guidance and is summarised in Fig 1 below

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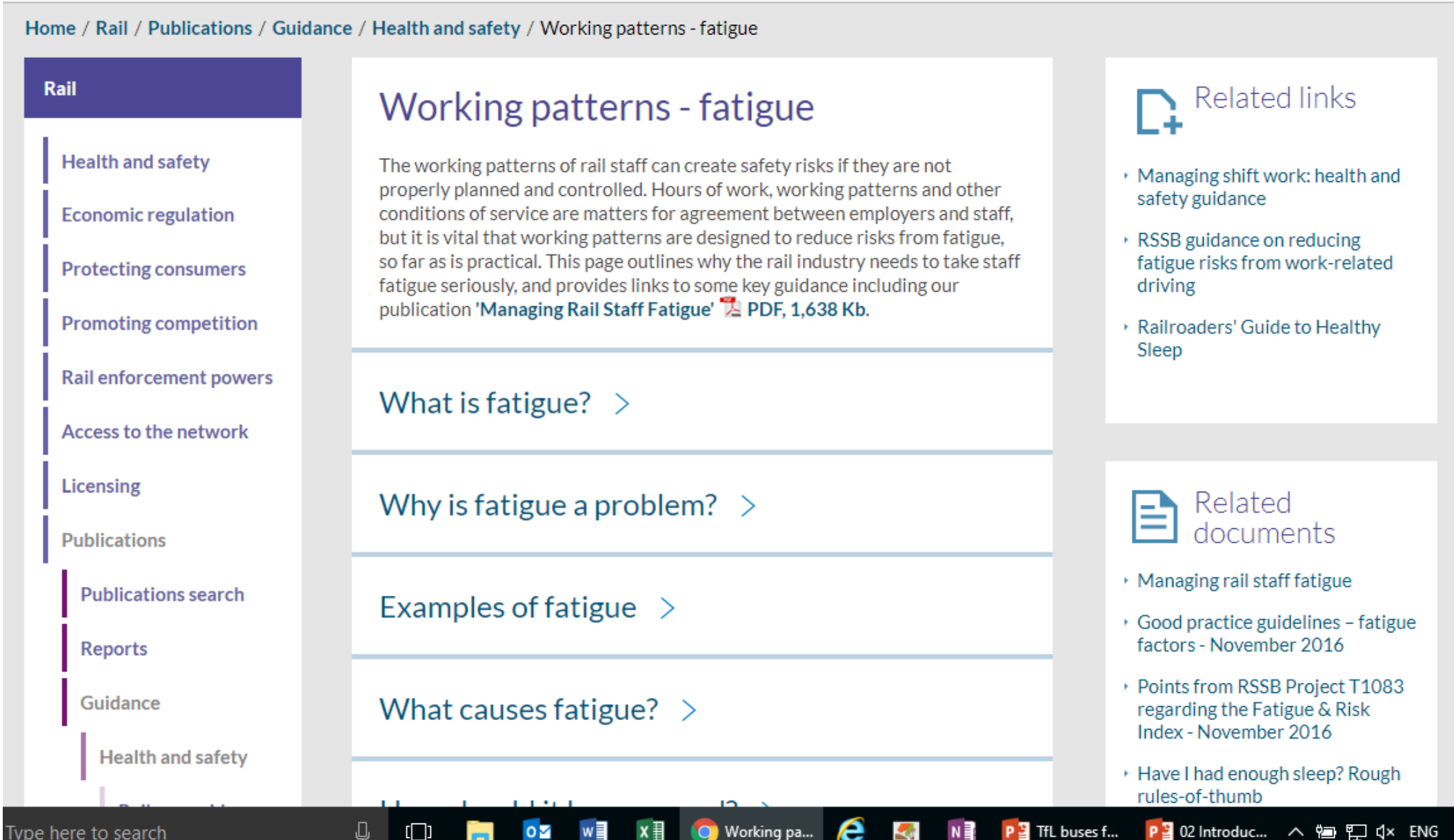
Links with company "culture"

- Management, staff / union interests may conflict
- Pay arrangements may encourage long hours:
  → may suppress fatigue reporting?
- Staff may like fewer, longer shifts for long blocks off work…but how safe?
- Pressure (real or perceived…) to keep service running may suppress fatigue reporting
- Personal responsibility to use sleep opportunities, but:
- Staff won't raise fatigue concerns if think they'll be "punished"
  - *"How will I be treated if I say I'm too tired?"*
- Openness, trust, honesty: a "just" culture
- Collaboration
  - a joint management & staff group to progress fatigue?

No magic wand for fatigue!

- Comprehensive fatigue risk management system
- Staff involvement
- Open, honest, trusting culture

More info? ORR website “Working Patterns”



Thank you - questions?

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Advanced Fatigue Management
Fatigue Risk Management Science Limited

Perceptions and Lessons Learned in Managing Fatigue in Aviation Operations

Douglas Mellor
Founder and Director FRMSc Limited

14th November 2017

douglas.mellor@frmsc.com

FRMSc

Content

1. The Aviation Business Environment
2. The Need for Fatigue Management
3. The Approach - how it is managed in aviation
4. Who Benefits
5. Summary

1. THE AVIATION BUSINESS ENVIRONMENT

The Aviation Business Environment

- Highly competitive environment
  - Low Cost Carrier model challenging
- Highly regulated safety culture
  - Two pilots minimum
  - Pilots have heavy responsibility for safety
  - ICAO – world source of safety policy
- Wafer thin margins (mostly)
  - Main cost is aircraft… … .
  - … then fuel costs, aircrew and support staff and then… … not a lot left for other stuff.
  - All paid in US Dollars.
- Highly unionised workforce
  - Agreements often work against fatigue management… .

2. THE NEED FOR MANAGEMENT

Is there a Problem?

Our experience suggests:

- Airline industry is a lot safer than other modes of transport
  - 2 pilots check each other's decisions
- Early starts and late finishes are problematic as are long, consecutive duties and overnight flights.
- Air Crew tend not to report fatigue until asked
  - Fear of being criticised for declaring fatigue
- Fatigue issues can be hidden
  - Employees of all industries prefer to work additional duties to get a longer time off work
  - Culture and payment systems can mask fatigue issues

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Why worry?

Fatigue related accidents and incidents

- 1993 Kalitta International DC-8-61F at Guantanamo Bay
- 1994 Air Algerie737-200F at Coventry, UK
- 1997 Korean Air 747-300 at Guam
- 1999 American Airlines MD-82 at Little Rock, USA
- 2001 Cross AirBAe146 at Zurich, Switzerland
- 2002 Agco Corp Challenger 604 at Birmingham, UK
- 2004 MK Airlines 747-200F at Halifax
- 2004 Corporate Airlines BAeJetstream31 at Kirksville, USA
- 2004 Med Air Learjet35A at San Bernadino, California

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Why worry?

Fatigue related accidents and incidents

- 2005 Loganair B-N Islander at Machrihanish, UK
- 2006 Comair CRJ100 at Lexington KY
- 2007 Cathay Pacific 747F ground collision at Stockholm Arlanda
- 2007 Pinnacle Airlines Bombardier CRJ-200 ran off runway at Traverse City, Michigan
- 2008 Go Bombardier CRJ-200 flew past destination airport, Hawaii
- 2009 Colgan Dash 8-Q400 at Buffalo, NY
- 2010 Air India Express, Boeing 737-800, Mangalore, India

Why worry?

Fatigue related accidents and incidents

- 2012 CRJ7, Lorient France, a Brit Air Bombardier CRJ 700 landed long on a wet runway at Lorient and overran the runway. Poor decision making as a result of fatigue
- 2013 London Heathrow, the fan cowl doors on both engines of an Airbus A319 detached as it took off from London Heathrow.
- 2013 Asiana Air – pilot misjudgement on speed and height on landing. Crashed into sea wall. Passengers ejected on impact.
- 2015 BAe HS 125-700/ Hawker 700A from Dayton to Akron failed to complete a non-precision approach. All on board were killed

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CEO Requires Information:

1. Are we compliant?
2. What could go wrong? Why won't that happen?
   a) today?
   b) tomorrow?
3. Is the Safety Management System working as it should?
4. What resources do you need? Why? Where is the business case?
5. Are we improving? Show me the data.

3. THE MANAGEMENT APPROACH IN AVIATION

It started with Flight Time Limitations… ..

5 Petersham Mews,
Gloucester Road,
London, SW7

4 June 1973

THE RIGHT HONOURABLE LORD BOYD-CARPENTER
CHAIRMAN OF THE CIVIL AVIATION AUTHORITY

Dear Chairman,

I am pleased to submit to you the Report of the Committee on Flight Time Limitations, of which I was appointed Chairman when you set up the Committee on 16 November 1972.

To keep the Report as short as possible we have avoided the repetition of the arguments. A proper appreciation of the Report therefore depends on studying the Report as a whole.

The Report is unanimous.

Yours sincerely,

Douglas Bader.

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Limits for total flight time (or duty time)

Time interval	AUS	CRO	FRA	GB	GER	JAP	RUS	SCA	SWI	USA
1 week	30	-	-	(50)	-	-	(41)	-	-	30
2 weeks	-	-	-	-	-	-	-	-	60	-
1 month	100	-	75-95*	100	(210)	80	70-80*	-	100	100
2 months	-	-	180	-	-	-	-	-	-	-
3 months	-	-	265	-	-	220	-	-	280	300-350*
6 months	-	-	510	-	-	-	-	-	-	-
1 year	900	1000-(1600)	935	900	1000	840	700-800*	-	1000	1400

* Depending on the aircraft type and flight range

From Missoni *et al* 2009

This shows the hours that were allowed by each regulatory body. There is quite a difference for essentially the same job

Factors used in scheduling in 10 ICAO member states

Each Regulator looks at a portfolio of different measures to regulate essentially the same industry.

		AUS	CRO	FRA	GB	GER	JAP	RUS	SCA	SWI	USA	Total states
Operations	Aircraft type	+	-	+	-	-	+	+	-	-	-	4
	Crew no. #	+	-	-	+	-	-	+	-	-	+	4
	No. of flight segments	-	+	-	+	+	+	-	+	+	-	6
	Flt range	+	+	+	-	-	+	+	-	-	+	6
Scheduling	Flt time	-	-	+	+	-	+	-	-	+	+	5
	Duty time	+	+	-	+	+	+	+	+	+	-	8
	Time of day*	-	-	-	+	-	-	-	-	+	-	2
	Time zones	-	-	-	-	+	-	-	+	+	-	3
	Night flying	+	+	+	+	+	-	-	+	+	-	7
Crew	Augmentation	+	-	-	+	+	+	+	+	+	+	8
	Previous rest	-	+	-	-	-	-	+	-	-	+	3
	Night sleep	+	-	+	-	-	-	-	+	-	-	3
Total no. of factors		**7**	**5**	**5**	**7**	**5**	**6**	**6**	**6**	**7**	**5**	

excluding augmentation not mentioned (-); * excluding night hours

From Missoni *et al* 2009

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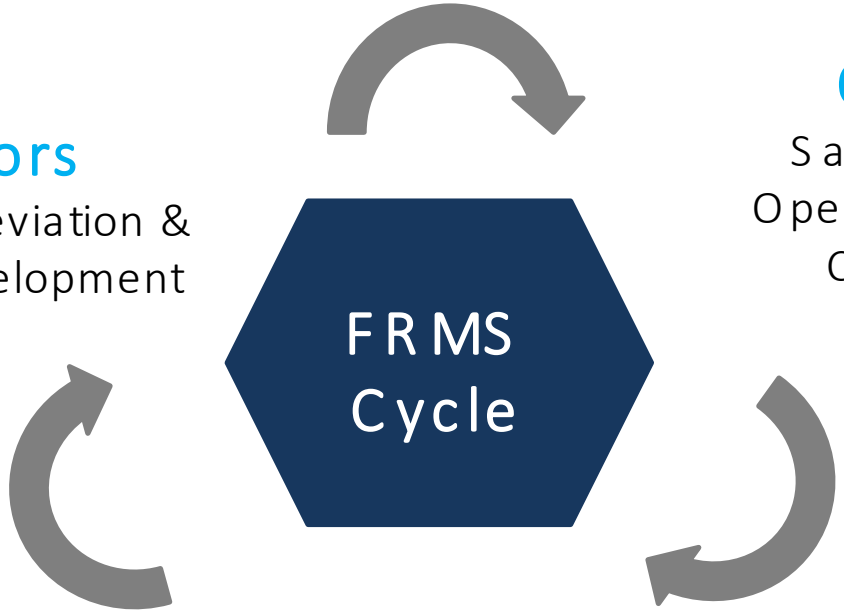
FRMS – A continuous improvement cycle

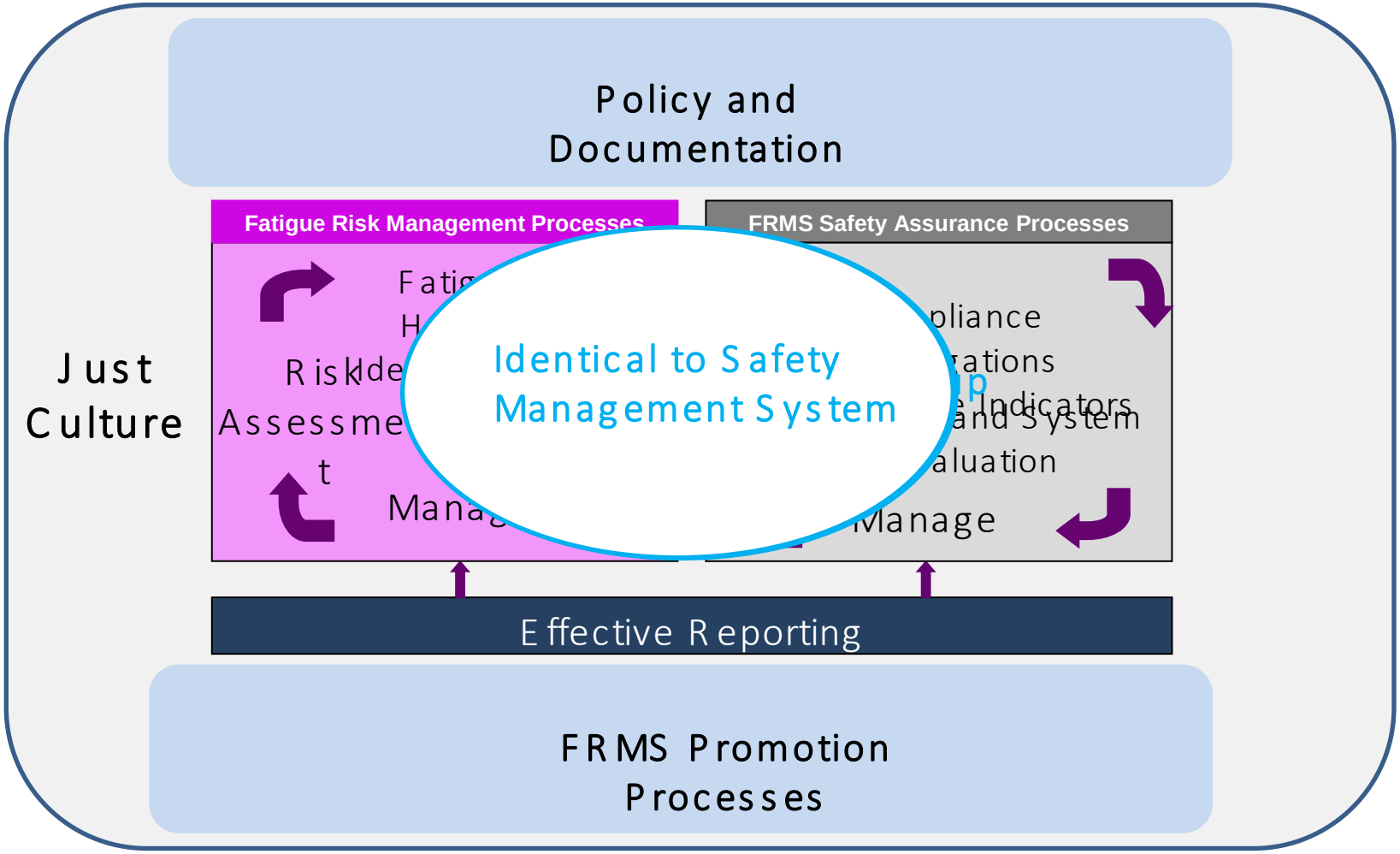


Regulators
Compliance, Alleviation & Regulation Development

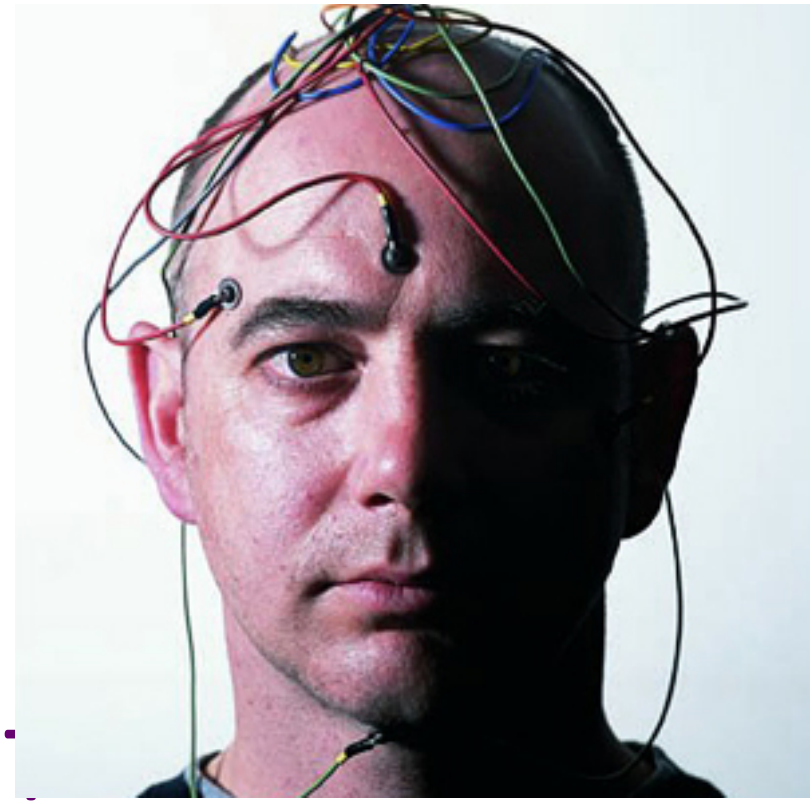
Operators
Safe performance
Operational Flexibility
Cost reduction

Research
Fatigue science & operational risk assessments

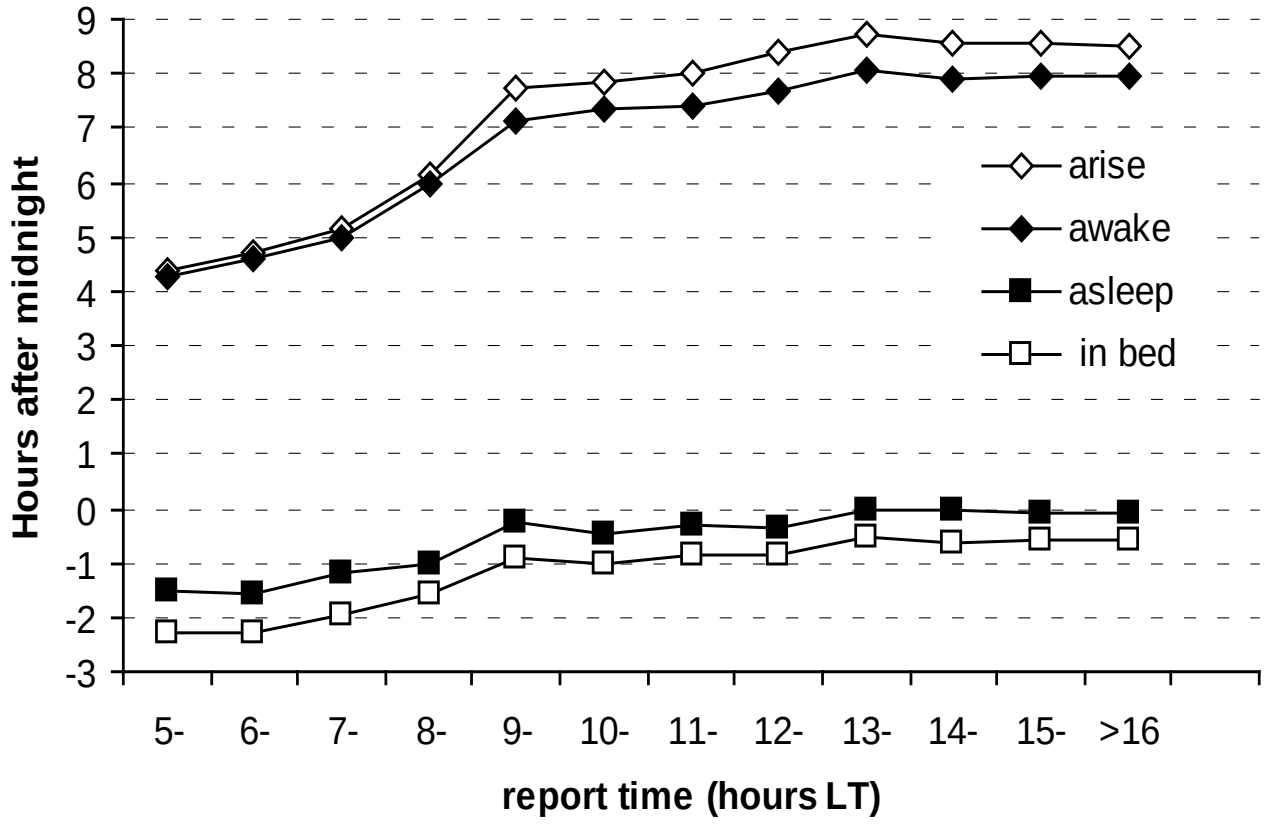
An outline of FRMS



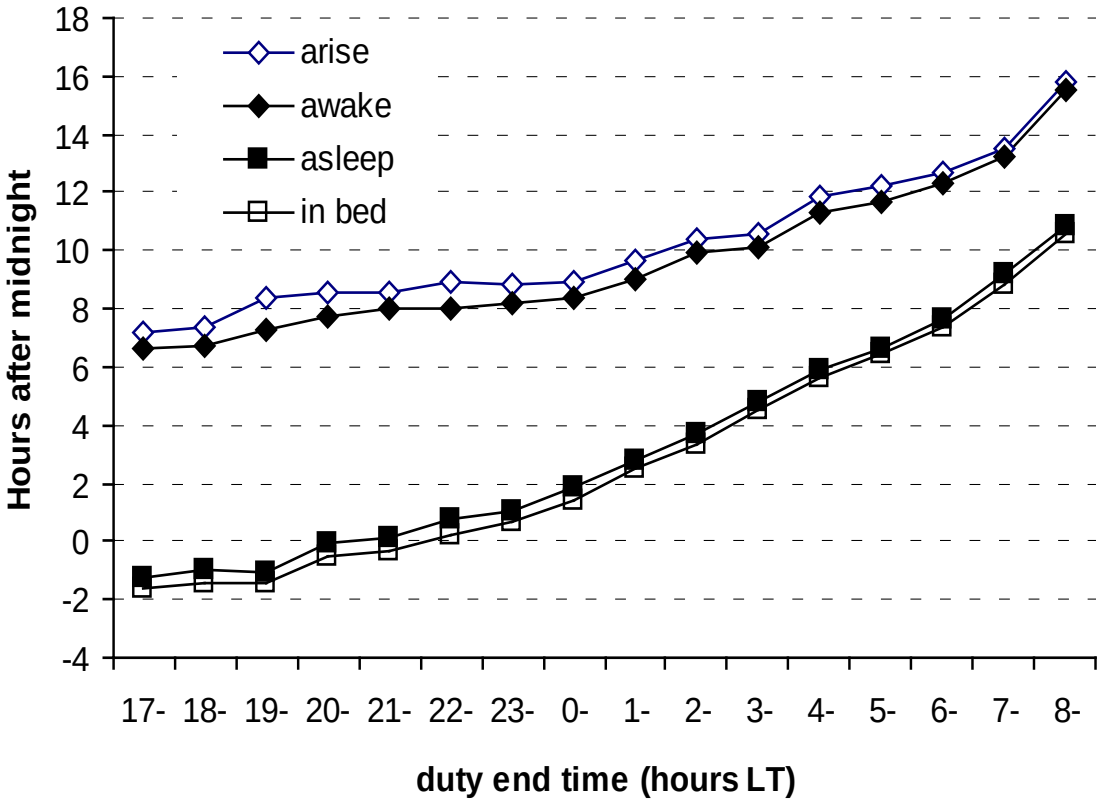
4B. MEASUREME
IS MANAGEMENT



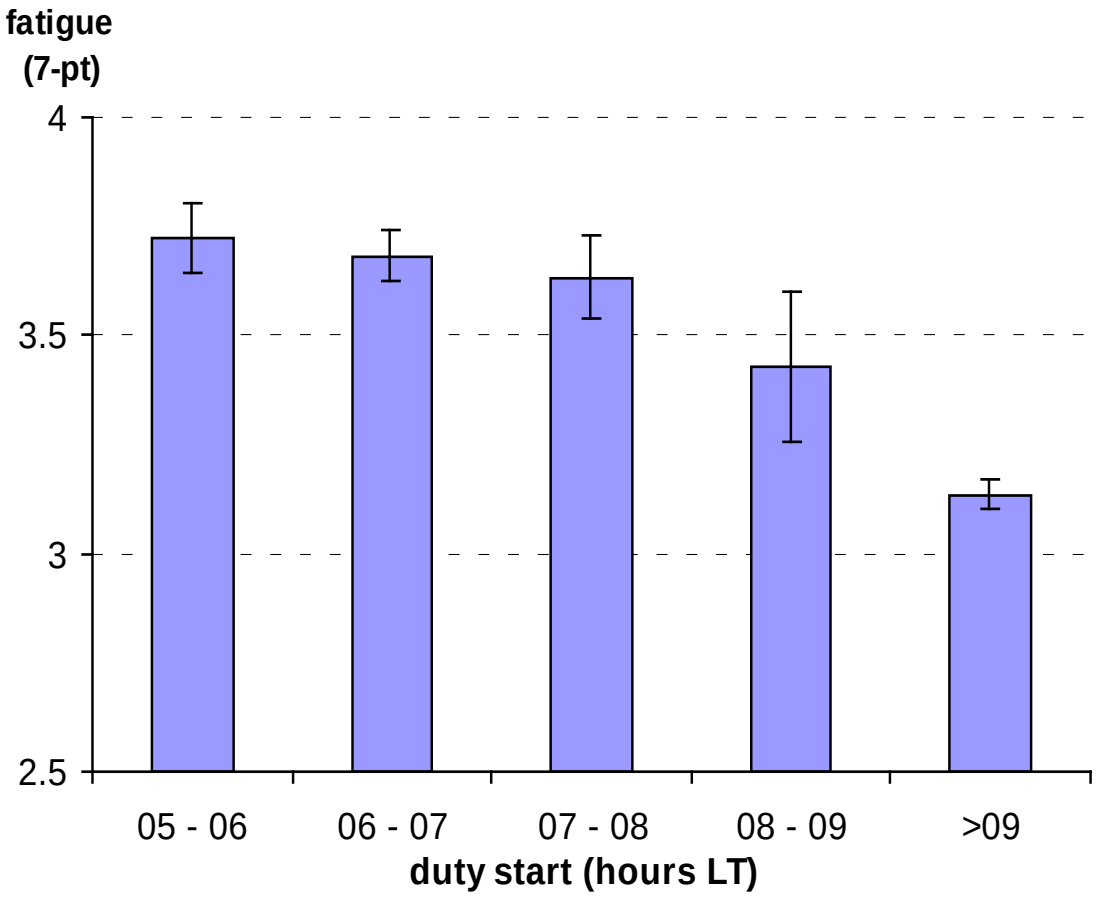
Sleep before early starts



Sleep after late finishes

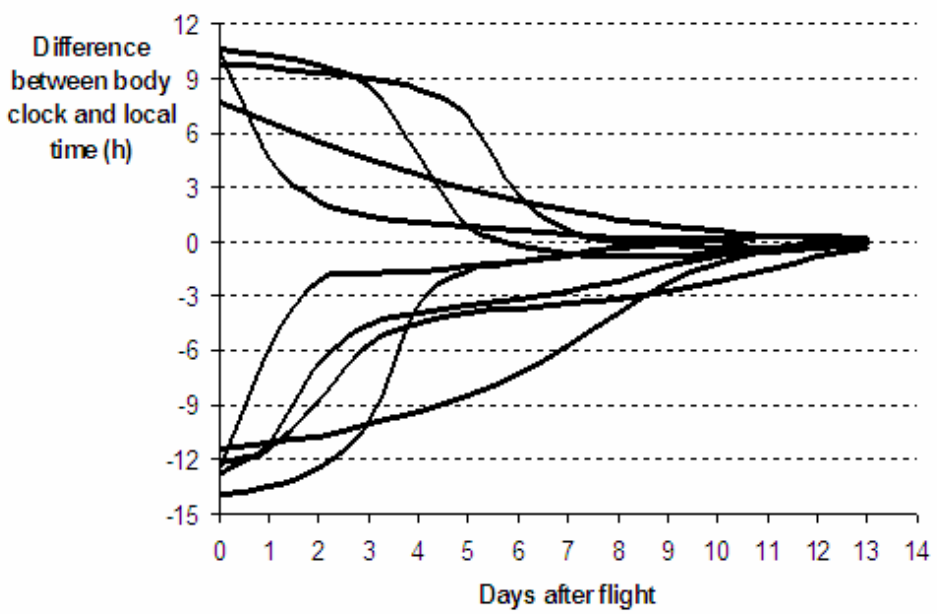


The effect of early starts



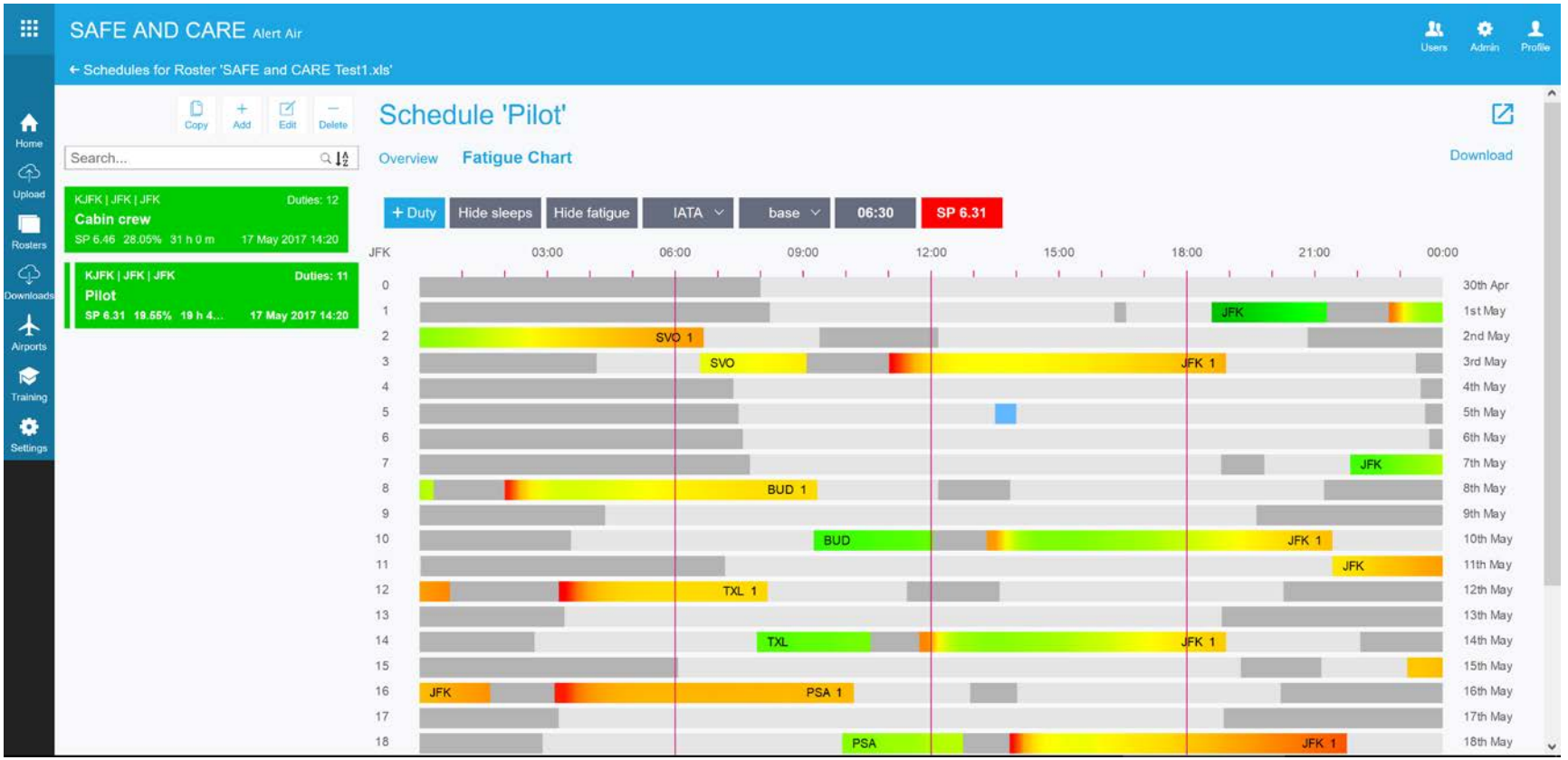
Recovery after a 10-hour eastward transition

- Pattern of adaptation varies considerably
  - some individuals took more than a week to adapt
- Even the direction of adaptation varied
- The amplitude of the rhythms was much reduced



Bio-mathematical Models

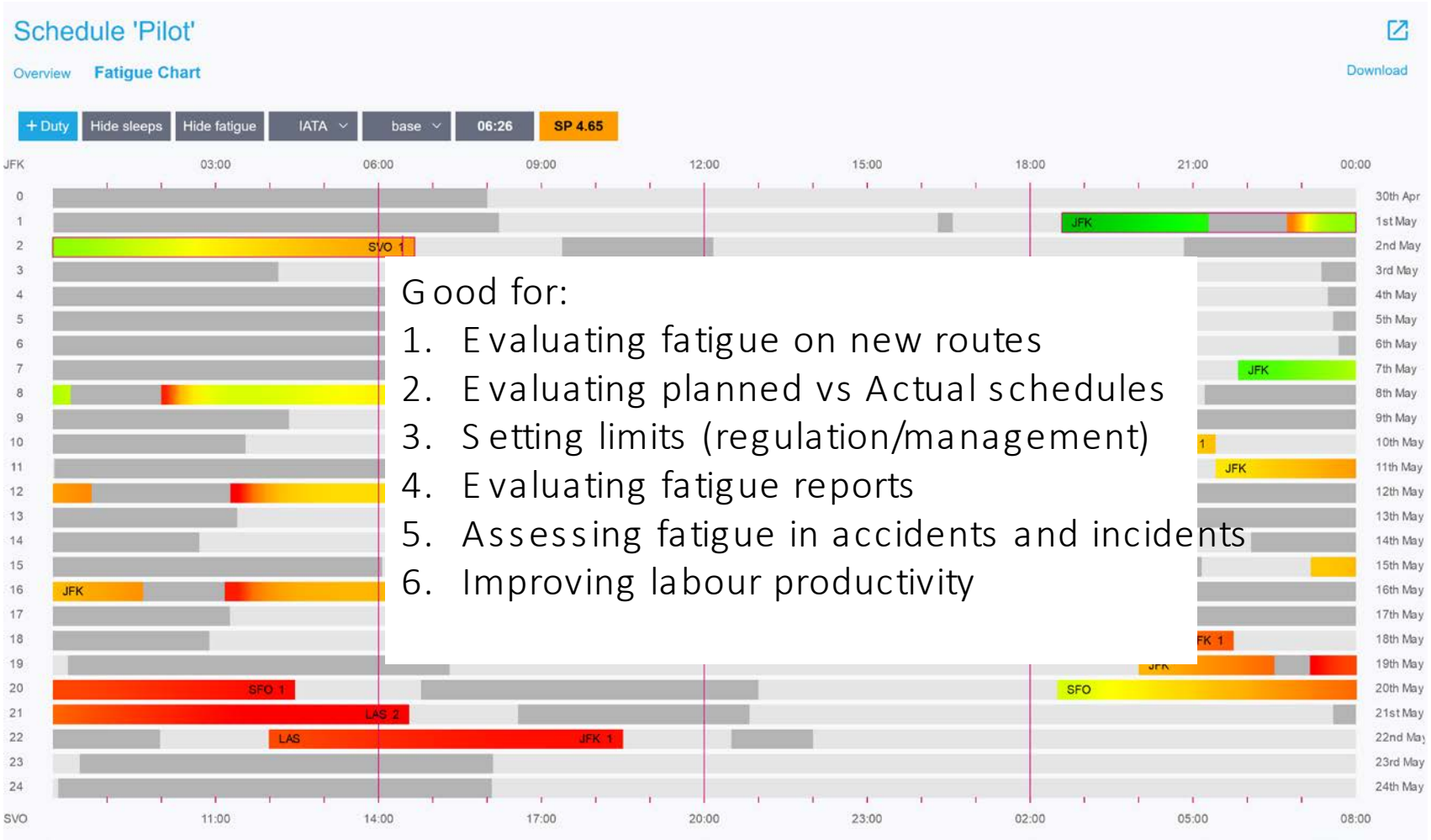
The SAFE model for pilots



Useful for identifying and assessing hazards

1. How many
2. How big
3. Where they are

Bio-mathematical Models



Good for:

1. Evaluating fatigue on new routes
2. Evaluating planned vs Actual schedules
3. Setting limits (regulation/management)
4. Evaluating fatigue reports
5. Assessing fatigue in accidents and incidents
6. Improving labour productivity

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The Fatigue Risk Index

Available from HSE website

Risk Index Calculator

Read the manual before using! Go to http://www.hse.gov.uk/RESEARCH/rrpdf/rr446g.pdf

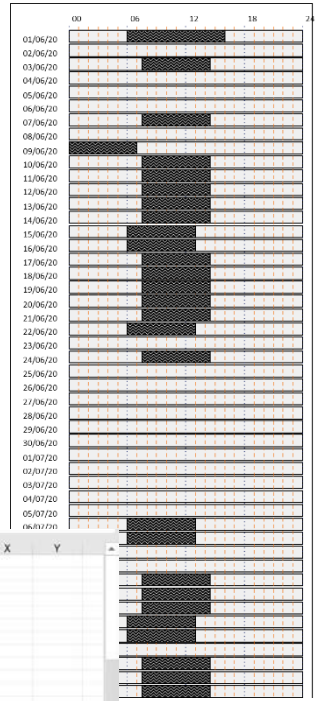
Company Test
Location NN accident
Shift ID anon
Date June 2013 to 21 Jan 2014
Mode Risk | Defaults | Reset Index | Calculate Index

Assessor JAM
☑ **Display schedule**
☑ **Display charts**

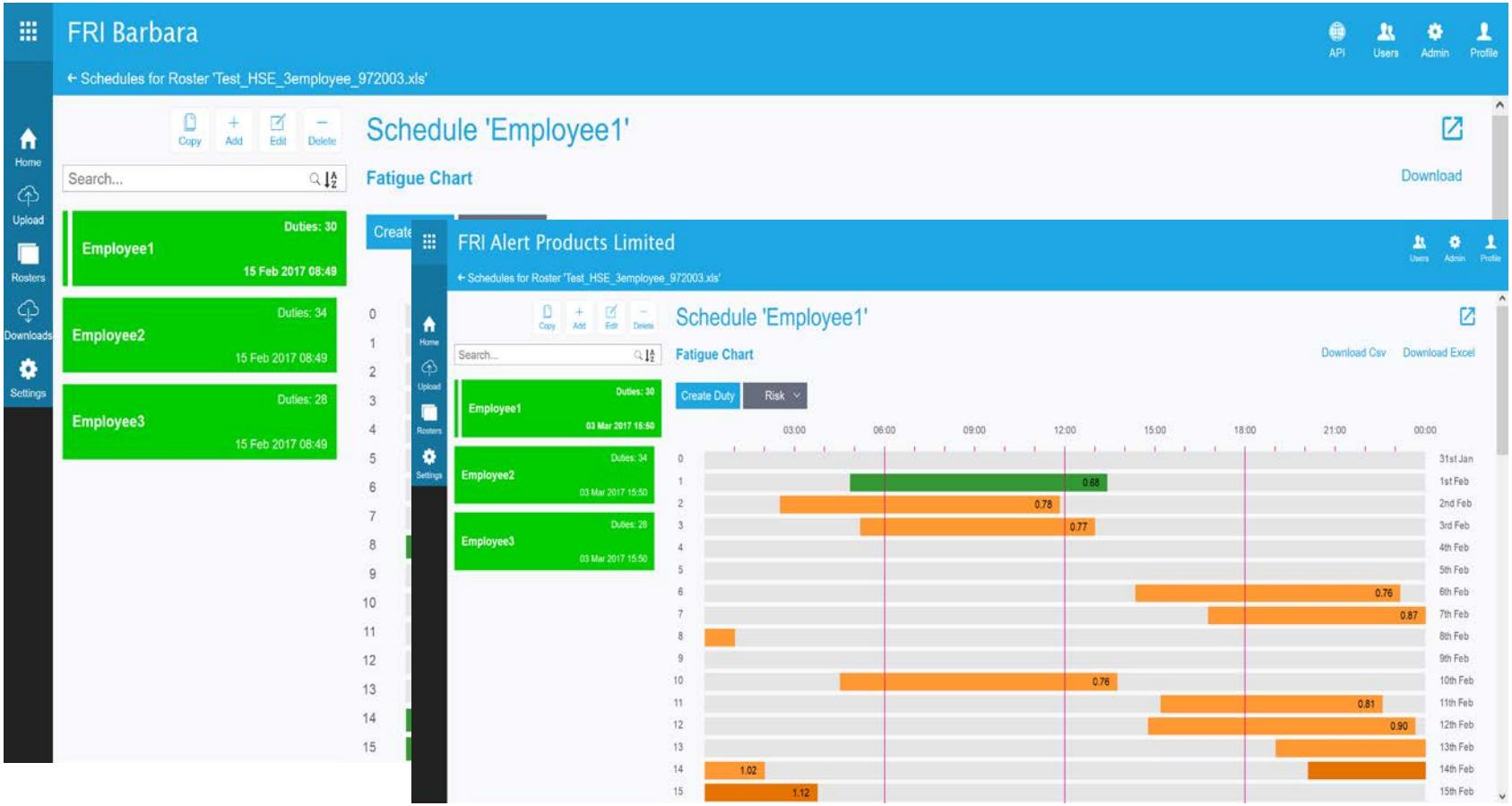
Version 2.3

About

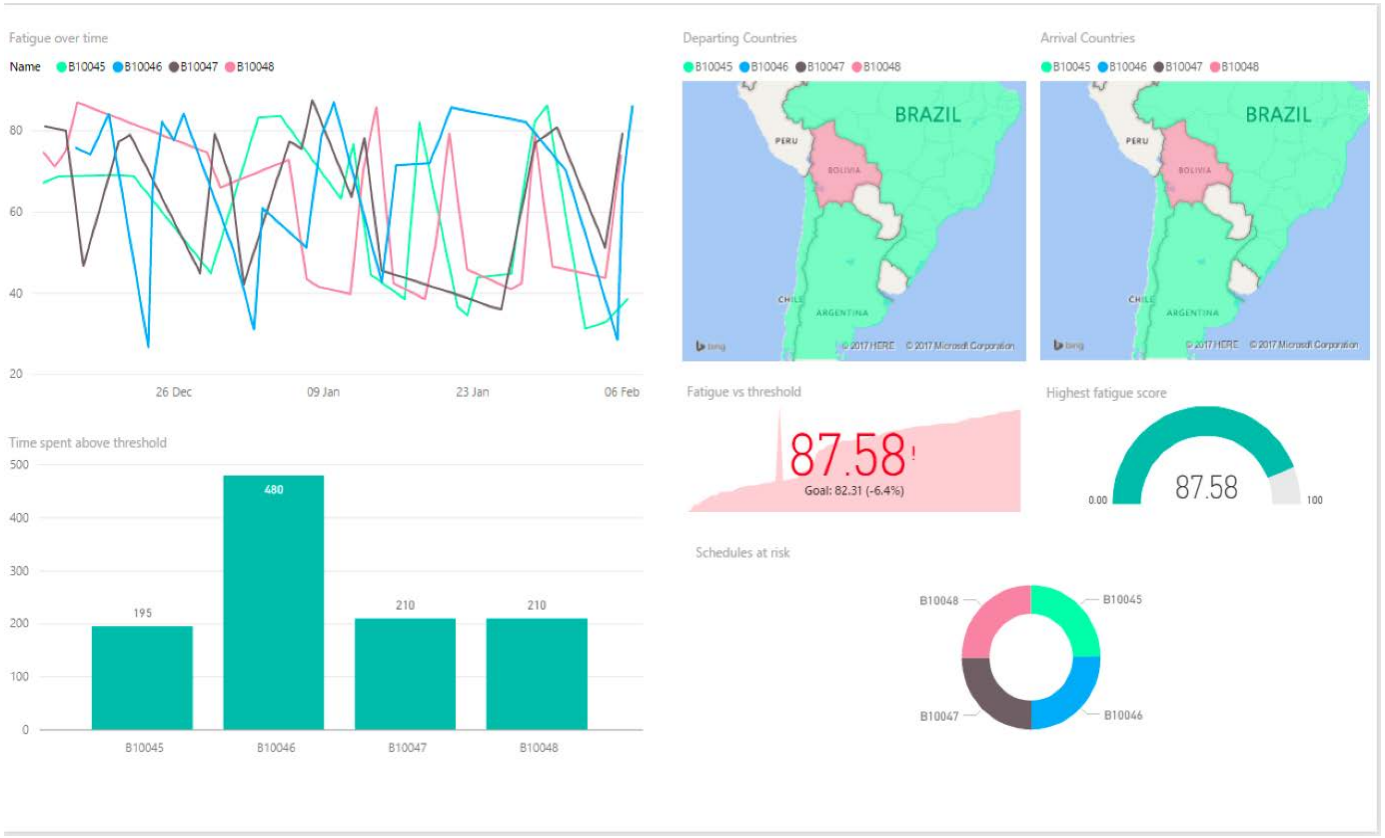
Day	On Duty	Off Duty	Job type / breaks	Commuting Time	Duty Length	Rest Length	Average duty per day	Cumulative component	Duty timing component	Job type / Breaks component	Risk Index
01/06/2013	06:00	16:00	Default	Default	10h	Fully Rested	10h	0.89	0.81	1.05	**0.75**
03/06/2013	07:30	14:30	Default	Default	7h	1d 15h 30m	5h 40m	0.89	0.71	1.05	**0.66**
07/06/2013	07:30	14:30	Default	Default	7h	3d 17h	3h 26m	0.89	0.71	1.05	**0.66**
09/06/2013	00:01	07:01	Default	Default	7h	1d 9h 31m	3h 27m	0.89	0.83	1.05	**0.77**
10/06/2013	07:30	14:30	Default	Default	7h	1d 29m	3h 48m	0.96	0.71	1.05	**0.72**
11/06/2013	07:30	14:30	Default	Default	7h	17h	4h 5m	1.01	0.71	1.05	**0.75**
12/06/2013	07:30	14:30	Default	Default	7h	17h	4h 20m	1.06	0.71	1.05	**0.79**
13/06/2013	07:30	14:30	Default	Default	7h	17h	4h 32m	1.11	0.71	1.05	**0.83**
14/06/2013	07:30	14:30	Default	Default	7h	17h	4h 43m	1.15	0.71	1.05	**0.86**
15/06/2013											
16/06/2013											
17/06/2013											
18/06/2013											
19/06/2013											
20/06/2013											
21/06/2013											
22/06/2013											
24/06/2013											



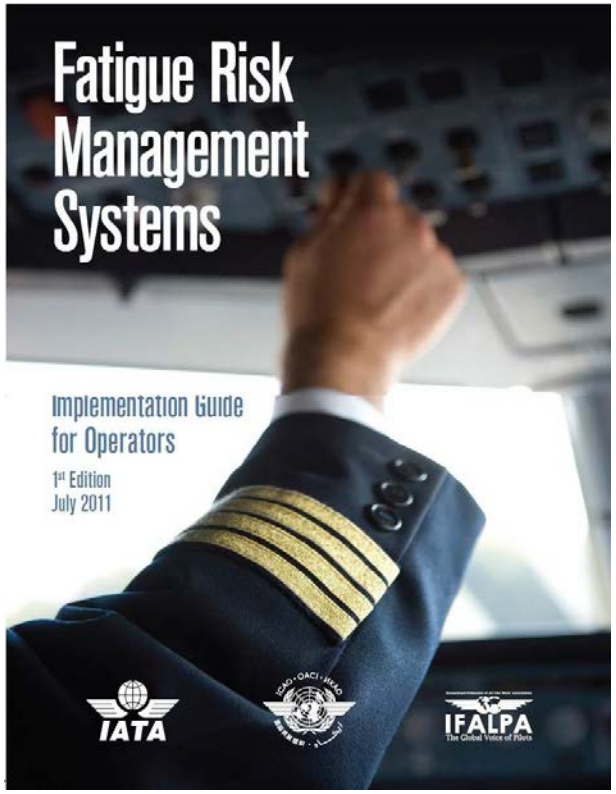
The (New) Fatigue Risk Index



Business Information



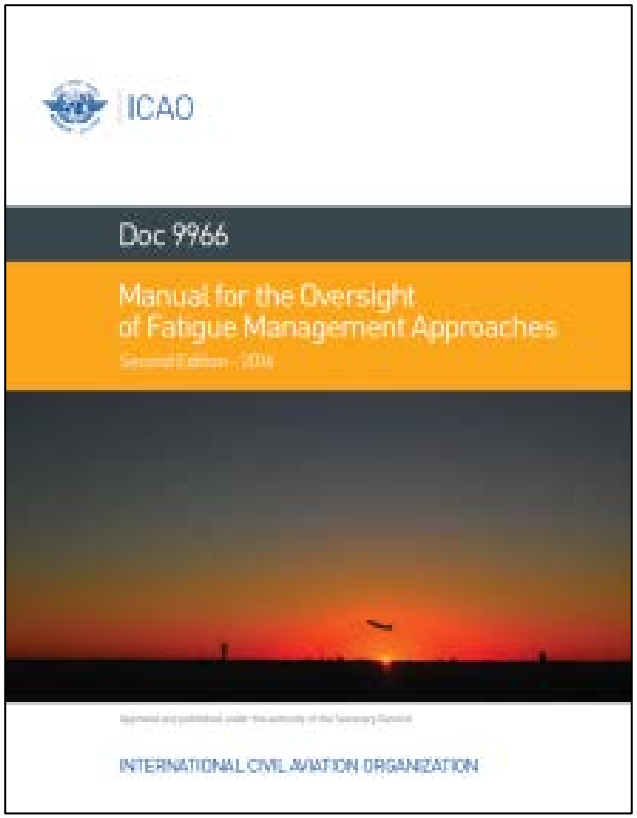
4C. PROCESSES



Advice from ICAO

The "What to Do"

- First produced in 2011
- Updated 2016
- Operators manual
- Regulators manual
- Contains
  - Fatigue science
  - Management requirements
    - Including Policy, FSAG, management of risk, documentation, data collection
  - QA processes
  - Training requirements
  - Promotion processes



Use Safety Management System

FRMSc

How to do it

4C. EXTERNAL HELP

Networking and learning opportunity

The “How to do it”

The FRMS Forum started in 2008

- Not for profit organisation
- Run by the aviation industry for any industry
- Membership provides access to documents, advice and meetings

www.frmsforum.org

FRMSc
Advanced Fatigue Management

Oslo Conference Agenda

28 and 29 November 2017

Day 1 – 28th November 2017 at Quality Expo Hotel, Oslo, Norway

09:00 Welcome. Douglas Mellor (FRMSc)

09:05 The fatigue management approach at Norwegian Airlines Stein Lien, (Norwegian Airlines)

09:30 Managing Fatigue in Norway. Trond-Eirik Strand Norway CAA

09:50 Day to day management of fatigue and how it fits into SMS. Frederic Martini (Air France)

10:15 COFFEE

11:00 The effect of FRMS on manning levels. Torkil Hungnes (Norwegian Airlines)
Followed by a panel session Moderator: Jim Mangie (Delta Airlines)

12:30 LUNCH

14:00 Managing fatigue – using SMS with a prescriptive approach. A path to FRMS. Don Wykoff (Delta Airlines)

14:30 Predictive Fatigue Risk in unscheduled business jet operations. Claudia Cabaco (NetJets)

15:00 The Regulations for Air Traffic Control. UK NATS

15:30 TEA

16:00 Considering in-flight rest in 2 pilot operations. Brad Favors (South West Airlines)
Followed by a panel session. Moderator: Jim Mangie (Delta Airlines)

17:00 FINISH

19:30 Networking Dinner. A networking dinner has been arranged at the hotel. Those who wish to attend should make their booking and payment on the website.

AGENDA FOR THE 2017 CONFERENCE IN OSLO

27th November 2017

18:30 Cocktail party – sponsored by The FRMS Forum.

A cocktail reception for all delegates registered for the Forum's conference, will be held at Brasserie-X in the hotel. It will start at 18:30. Delegates are invited to explore Oslo's excellent restaurants for their dinner afterwards. Please register your place for the conference on the website

Day 2 – 29th November 2017

09:00 Welcome back. Douglas Mellor (FRMSc)

09:05 Implementation of FRMS and the EASA ITSFF. Kathryn Jones (UK CAA)

09:05 Insight into regulation within South Africa. Roger Langman (CAA South Africa)

10:30 COFFEE

11:00 Supporting EASA in rule making for Air Taxis and Emergency Medical Services. Joel Hencks (EBAA)

11:30 FINISH & LUNCH

FRMSc
Advanced Fatigue Management

5. BENEFITS OF AN FRMS APPROACH

Benefits from implementing an FRMS

Collecting data, creating leading indicators

- **Benefits to Air Crew**
  - Feel better, perform better, fly safer
  - "The company's recognition of our fatigue indicates we're a team!"
- **Benefits to safety manager**
  - Higher safety perimeter,
    - another risk managed
  - Regulatory compliance.
- **Benefits for CEO**
  - A high performance workforce
  - Lower risk of On the Job Injuries
  - Increase flexibility and productivity
  - Lower operational risk = lower insurance costs.

6. SOME LESSONS LEARNED

Some lessons learned

The Operator: Getting started

- Get the buy in from all three stakeholders right at the beginning
  - Union, operator, regulator
  - All three have a role in managing fatigue
  - Get Operator CEO buy-in at start.
- Communicate constantly
- Put responsibility at right level in organisation
- FSAG has important to drive fatigue management through the organisation
- Many high scores have roots in lifestyle or health of employees
- Use fatigue management within the regulations. Use FRMS when working outside regulations.
- Train well on fatigue and countermeasures.

Some lessons learned

Management

- Get top level management support
- Put responsibility at right level in organisation
- Measure and use data to support decision making
- Modelling can inexpensively identify and describe the fatigue hazard
- Encourage fatigue reporting
- Use existing safety management processes- don't duplicate
- Promote the Just Culture to harvest fatigue reports and promote responsibility
  - Analyse and feed back on all reports
- Provide napping facilities
- Managing fatigue makes good business sense
- pilot vs cabin crew vs maintenance engineers
- The company will try to keep status quo.
- Focus not only on Safety but also on better business

FRMSc

Questions?

Thanks for listening

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