

FATIGUE AND FATIGUE MANAGEMENT



Overview

In this session we will cover:

- What is fatigue? Definition and types of fatigue
- Hazards/Risks/the effects associated with fatigue.
- Reasons for sleep deficit; Shift work, Circadian rhythms/personal circadian rhythms, time awake, quantity and quality of sleep, mental exertion, lifestyle etc.
- Tips and tools for fatigue and sleep management, Scheduling, getting enough sleep (both quantity and quality), balancing life and work etc
- Theoretical tools of fatigue mitigation/How to mitigate the risks of fatigue (as we need to work shift and night etc)
- Solutions/Resources (guides, tools, and manuals)



What is fatigue?
What causes fatigue?

Theoretical definition of fatigue

- ICAO defines fatigue as “a **physiological state** of **reduced mental or physical performance** capability resulting from sleep loss or extended wakefulness, circadian phase, or workload (*mental and/or physical activity*) that can impair alertness and ability to perform safety-related duties”.



Types of fatigue

There are two types of mental fatigue:

- **Acute** fatigue refers to a temporary state of reduced vigilance and attention resulting from prolonged wakefulness or extended mental exertion.
- **Chronic** fatigue pertains to a persistent and prolonged state of weariness that extends beyond the usual recovery period.

What causes fatigue?

Cumulative sleep debt.

- Sleep debt refers to the impact of receiving less than a full night's sleep for multiple days.

Time of day

- Fatigue is, in part, a function of circadian rhythms. Human waking and sleep cycles follow a 24-hour cyclical wave pattern known as the internal body clock. Fatigue is most likely and, when present, most severe, during a four-hour period between the hours of 2:00 AM and 6:00 AM, the so-called Window of Circadian Low (WOCL) when the body is programmed to sleep and during which performance is degraded.

Amount of recent sleep.

- If a person has had significantly less than 8 hours of sleep in the past 24 hours, he or she is more likely to be fatigued.

Time awake.

- A person who has been continuously awake more than 17 hours since his or her last major sleep period is more likely to be fatigued.

Time on task.

- The longer a person has continuously been doing a job without a break, the more likely he or she is to be fatigued.



What causes fatigue?

Shift scheduling.

- Including regular hours of work and shift cycles, specific shift patterns (fixed or rotating (Alteration of the circadian time-keeping system and physiology of sleep homeostasis often results in fatigue)), irregular shifts, e.g. rotating shift-and night-work schedules (disrupt the circadian system), speed of shift rotation, starting time of shift/work, rest periods/breaks, number of off-days, the regularity of shift schedules, reserve duty.

Night shifts.

- Permanent nightshifts have an elevated risk of metabolic syndrome-type medical conditions, circadian system de-synchronisation, and associated sleep disruption and fatigue.

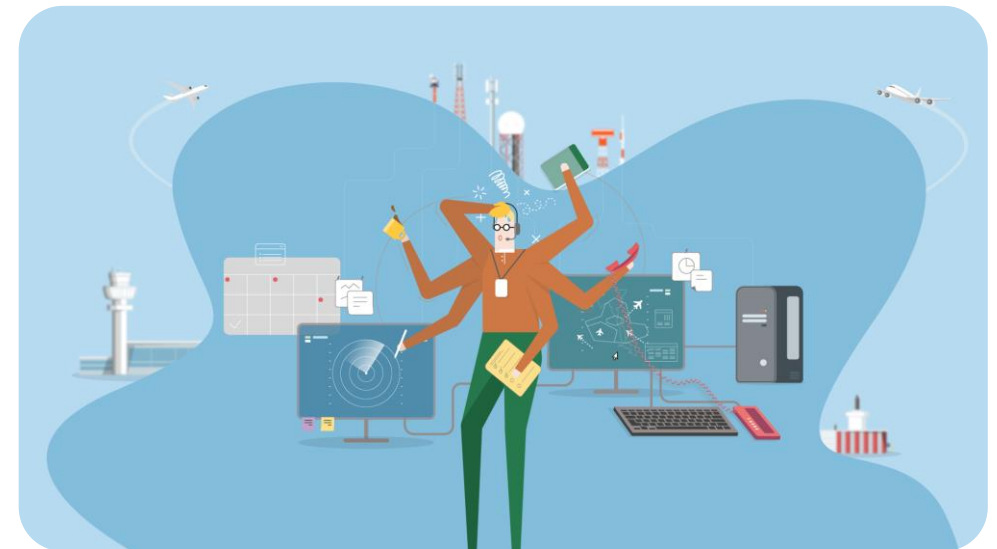
Overtime

- Overtime can reduce the available recovery time (timing of the shifts and the temporal placement of the overtime). Current shortage of ATC staff can increase the need for overtime to maintain service levels.



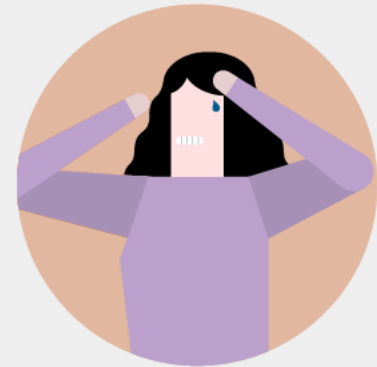
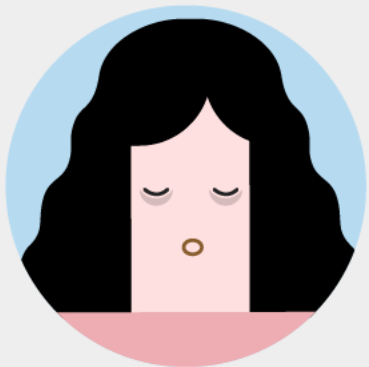
Studies say.....

“WORKLOAD CAN CONTRIBUTE TO AN INDIVIDUAL’S LEVEL OF FATIGUE. LOW WORKLOAD MAY UNMASK PHYSIOLOGICAL SLEEPINESS WHILE HIGH WORKLOAD MAY EXCEED THE CAPACITY OF A FATIGUED INDIVIDUAL.”



Factors affecting fatigue

- Circadian rhythms & sleep patterns
- Shift work & scheduling the shift
- Bedtime routines and napping
- Light, noise, music, books, TV & internet
- Caffeine, alcohol & nicotine
- Food, diet & medications
- Exercise & break time stretches
- Relaxation
- Emotions & balancing life
- Ride home after shift





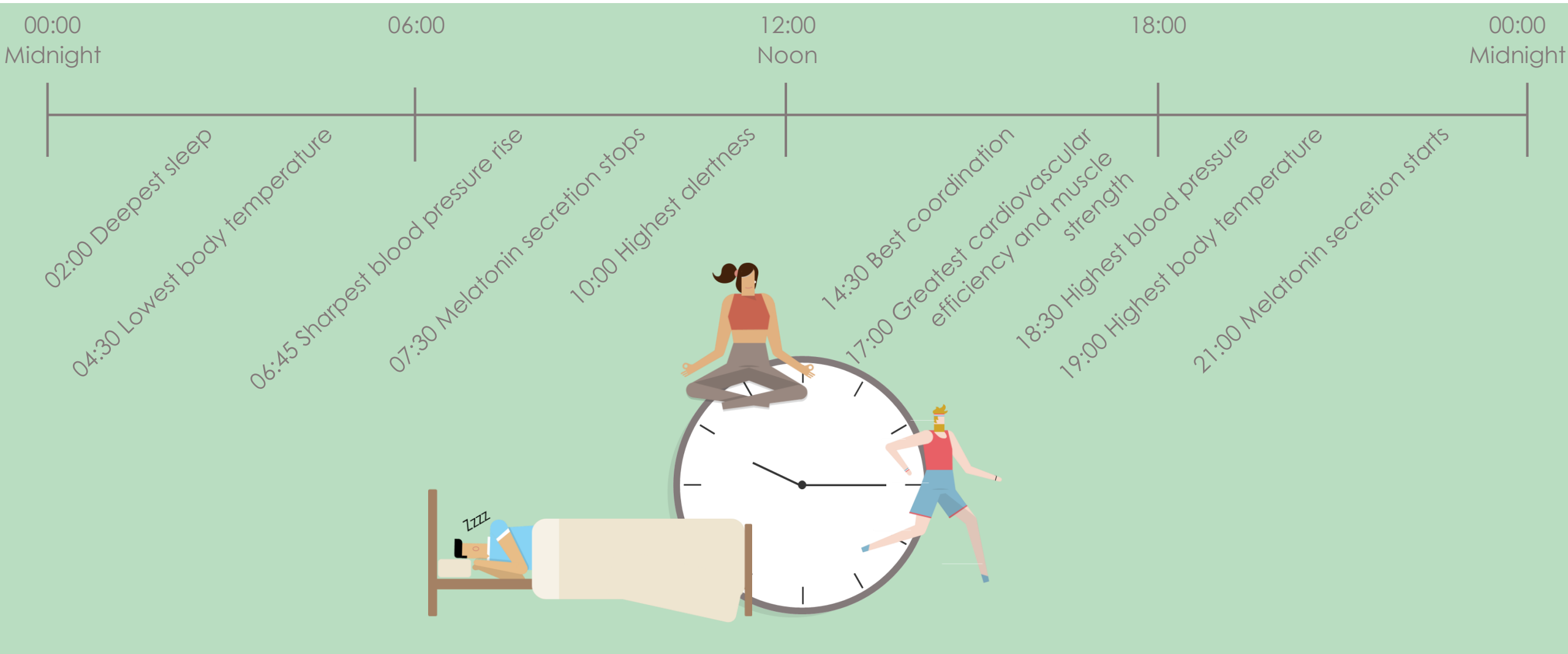
Sleep

Sleep patterns

- Biological clock
- Sleep reservoir

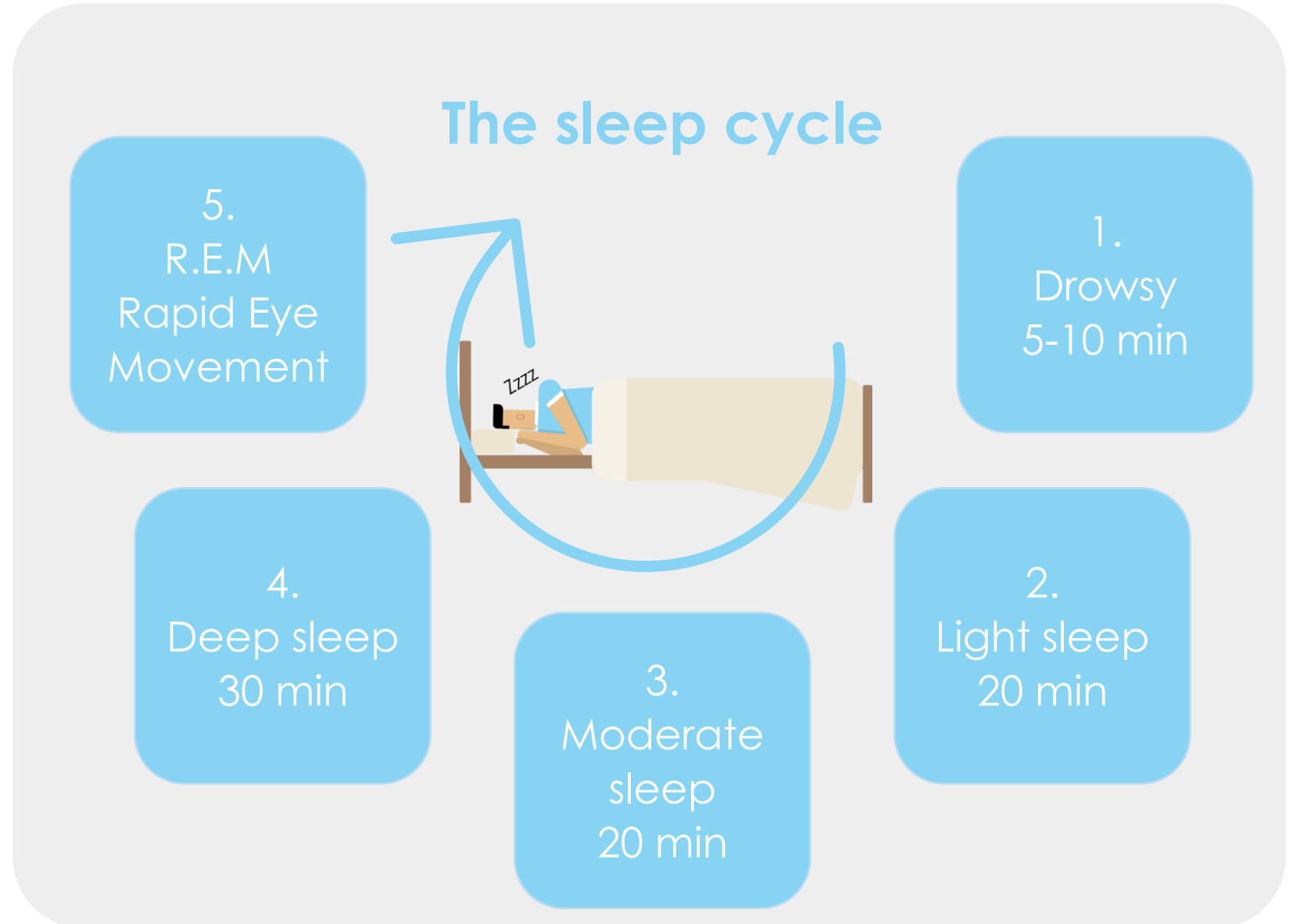


The Circadian cycle



Rest vs Sleep

The 5 stages of sleep:



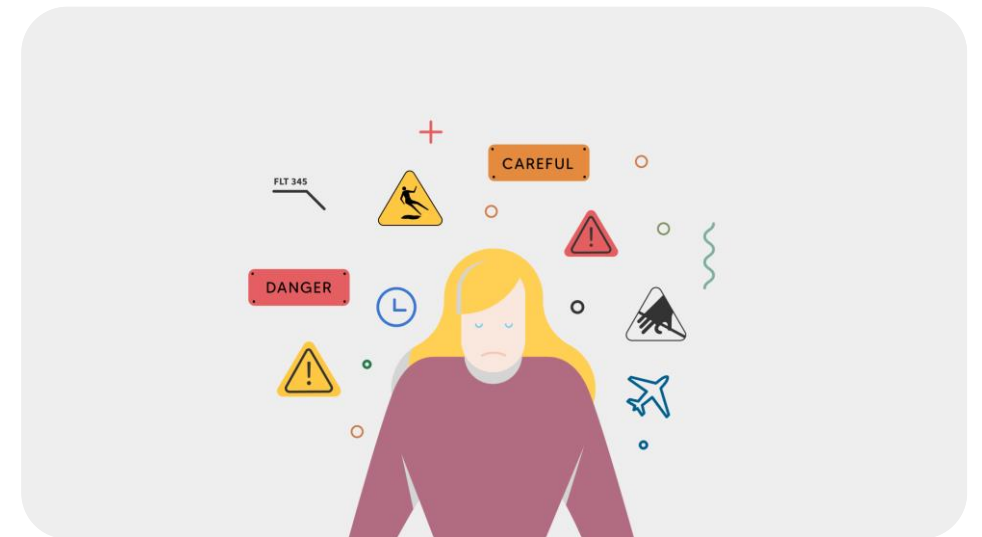
Studies show.....

“PERIODS OF WAKE NEED TO BE LIMITED. GETTING ENOUGH SLEEP (BOTH QUANTITY AND QUALITY) ON A REGULAR BASIS IS ESSENTIAL FOR RESTORING THE BRAIN AND BODY”

“REDUCING THE AMOUNT OR THE QUALITY OF SLEEP, EVEN FOR A SINGLE NIGHT, DECREASES THE ABILITY TO FUNCTION AND INCREASES SLEEPINESS THE NEXT DAY.”

What are the effects of fatigue?

- Increased reaction time
- Reduced attention (lapses)
- Sacrificing routine tasks
- Diminished memory
- Withdrawn mood
- Micro sleeps
- Reduced/ineffective communication
- Reduced motivation
- Health/weakened immune system





Defences

Fatigue management

- Fatigue management refers to the methods by which aviation service providers and operational personnel address the safety implications of fatigue. – ICAO



Fatigue Management Approaches

- a **prescriptive approach** that requires the service provider to comply with duty time limits defined by the State, while managing fatigue hazards using the SMS processes that are in place for managing safety hazards in general; and
- a **performance-based approach** that requires the service provider to implement a Fatigue Risk Management System (FRMS) that is approved by the State.

When complying with prescribed limits, the Service Provider is obligated to manage their risks, including those related to fatigue, using their SMS.

An FRMS allows a Service Provider to go beyond prescribed limits. With an FRMS, the Service Provider must do more to manage fatigue than would reasonably be expected using an SMS.

Fatigue Management Approaches

FRMS

Service providers meet additional requirements to have flexibility outside prescriptive limitation regulations.

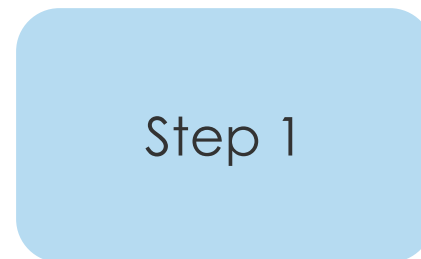
SMS

Service providers manage fatigue risks using SMS processes within prescribed limits.

Basic

Service providers follow hard limits set by the regulator.

Prescriptive



Scientific facts to take into account

- In this context it is paramount to understand that **sleep is the only effective fatigue countermeasure**. Whilst muscles can recover with rest, **the brain can only recover with sleep**.
- A system to effectively manage fatigue, be it prescriptive or performance based, must be based on **scientific principles**. The scientific principles used for the revision of this rule are in a nutshell:

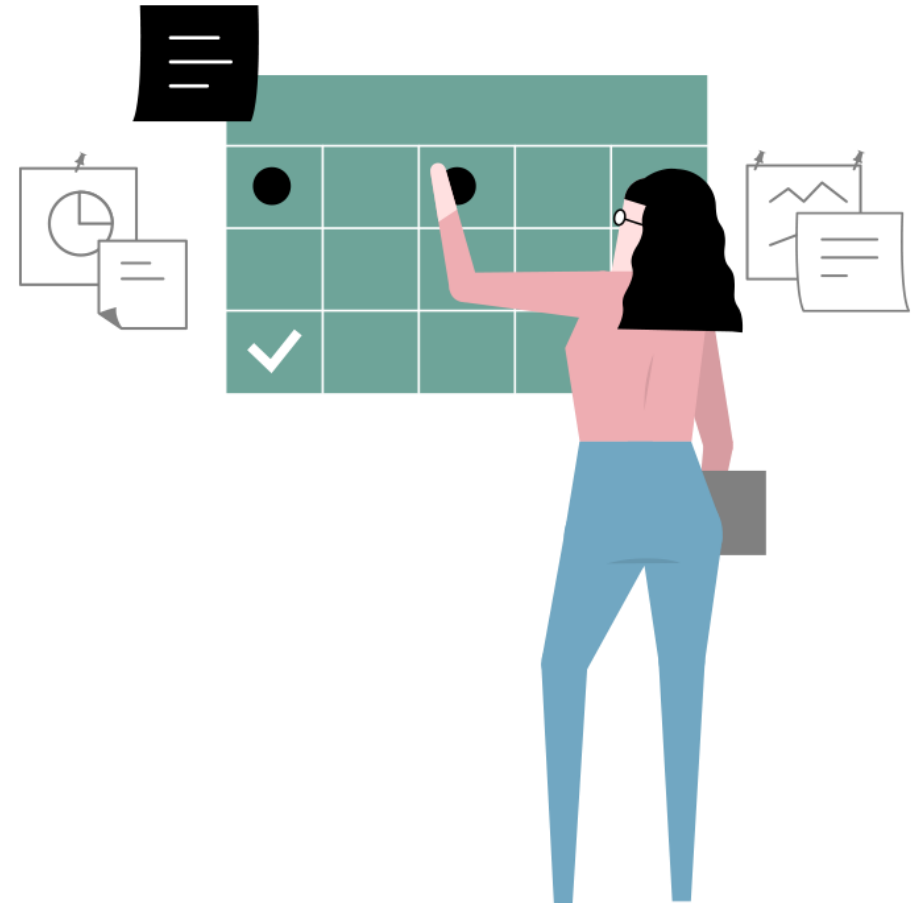
An average adult person needs between 6 and 8 hours of sleep per day to sustain optimal performance.	There are two biological 'windows' for sleep in a day, one during the night, covering the Window of Circadian Low (WOCL) and the other one in the afternoon.
The effects of sleep loss on performance degradation are cumulative and dose dependent.	Sleep at sub-optimal times in the circadian rhythm is likely to be shorter and of lower quality.
The quality of sleep depends on the structure and continuity of sleep. The quality of sleep depends, amongst other factors, of the time of the day.	The pressure to sleep increases with the duration of sustained wakefulness and depends on the circadian body clock.
	The combination of sustained wakefulness (or sleep deprivation) and a phase of the circadian body clock favourable for sleep result in sleepiness followed by micro-sleeps and lastly uncontrolled sleep.

Examples of areas to define

- Maximum consecutive working days
- Maximum hours per duty
- Maximum hours of providing service without breaks
- Maximum duty periods encoraching on night time
- Minimum rest period after a duty period encoaching on night time
- Minimum number of rest periods within a roster cycle

Rostering

- Scheduling is a sensitive topic and there is no “perfect roster” that fits all the physiological, social and organisational constraints.



Rostering

Permanent schedule, slow rotation schedule or rapid rotation schedule.

Clockwise rotation

- *(also called forward rotation), the work week starts with a day shift, rotating later in the week to an afternoon shift, and finally changing to a night shift.*

Counter-clockwise

- *(backward rotation), the work week starts with an afternoon shift, then advances to an early day shift, to finally end with a night shift.*

	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Morning	X	X					
Afternoon			X	X			
Night					X		

- circadian rhythms adjust better when moving ahead than back.
- gives longer rest between shifts (16 -24 hours)

Cumulative sleep debt in the backward rotation is considerably higher and is concentrated in the three last shifts.

- opposition to the natural biological clock
- only gives short rest periods between shifts (8 hours), often scheduled in daytime.

Measuring fatigue and sleepiness

Examples:

- Samn-Perelli seven-point fatigue scale (SPS)
- The Karolinska Sleepiness Scale (KSS)
- Sleep diaries
- Actiwatches



Classification of risk, fatigue

Table 5-2. Safety Risk Assessment Matrix (adapted from ICAO SMM, 3rd Edition)

Likelihood		Fatigue Severity				
		Catastrophic A	Hazardous B	Major C	Minor D	Negligible E
Frequent	5	5A	5B	5C	5D	5E
Occasional	4	4A	4B	4C	4D	4E
Remote	3	3A	3B	3C	3D	3E
Improbable	2	2A	2B	2C	2D	2E
Extremely Improbable	1	1A	1B	1C	1D	1E

Accident
Large safety reduction
Significant safety reduction

Table 5-3. Example of Fatigue Severity Classification: Perceived levels of fatigue.

Samn-Perelli Score	Meaning	Value
7	Completely exhausted, unable to function effectively	A
6	Moderately tired, very difficult to concentrate	B
5	Moderately tired, let down	C
4	A little tired	D
3	Okay, somewhat fresh	E
2	Very lively, responsive, not at peak	E
1	Fully alert, wide awake	E

This type of methodology may be used:

- to identify the causes of fatigue associated with a single duty / type of shift;
- to give a single duty or type of shift a specific and comparable “fatigue value”;
- to identify effective mitigations for a single duty / type of shift (part of the risk mitigation process);
- to be able to compare the same trip or tasks undertaken at different times;
- as starting point for a safety case

Fatigue incident report

- Investigating fatigue in depth
- Questionnaire to find the reason for a fatigue assessment high on the scale



Results, example

Acceptability	Action
Accept	<ul style="list-style-type: none">No mitigation required
Check and mitigate	<ul style="list-style-type: none">Identify mitigations to reduce relevant fatigue factorsIdentify mitigations to reduce the remaining fatigue factors to the minimum
Not Acceptable	<ul style="list-style-type: none">Identify mitigations to reduce the remaining fatigue factors to an acceptable minimum. If not possible this duty is not permissible.

- Recommend pre shift nap
- Limit amount of the shift type allocated
- Restrict non-acceptable shift rostering
- Ensure error management/error tolerability
- Make specific checklists
- Avoid training students during certain shift types

ANSPs responsibilities

- **Duty rosters** should be prepared and published sufficiently in advance to provide FISOs the opportunity to plan **adequate rest**. Consideration should be given to the cumulative effects of undertaking long duty hours interspersed with minimum non-work periods, and of avoiding rosters that result in the serious disruption of an established pattern of working and sleeping. Rosters should cover a period of at least (*) days.
- **Minimum non-work periods need to provide adequate rest** such that the FISO can achieve a suitable sleep period, as well as allowing for consideration of other physiological requirements and any associated travelling or commuting time.
- In order to avoid any detriment to an FISO's performance, **opportunities to consume a meal** must be arranged when the duty period exceeds (*) hours.
- The Service Provider should **not require an FISO to undertake any safety related task if** it is known or suspected that the FISO is **fatigued** to the extent that safety may be adversely affected.
- To provide **evidence of compliance** with prescriptive limits, records will be kept for (*) months of the duties performed and non-duty periods achieved so as to facilitate inspection by the service's authorized personnel and audit by the State of the Service Provider.

Duty limitation parameters

Regulation should include regulation for:

- **Duty period** (*rules for daily rest, max work hours per day, weekly rest maximum nr of operational days in sequence*)
- **Operational duty** (*rules for max nr of operational hours without a break, rules for length of breaks, rules for length of operational shifts*)
- **Night duty** (*definition of night duty, max nr of hours of night duty in sequence, max nr of night shifts in a row, max nr of night duties per period e.g., month*)
- **On call duty** (*rules for how many on call duties per period e.g., week, maximum nr of hours per on call duty shift*)

FISOs responsibility

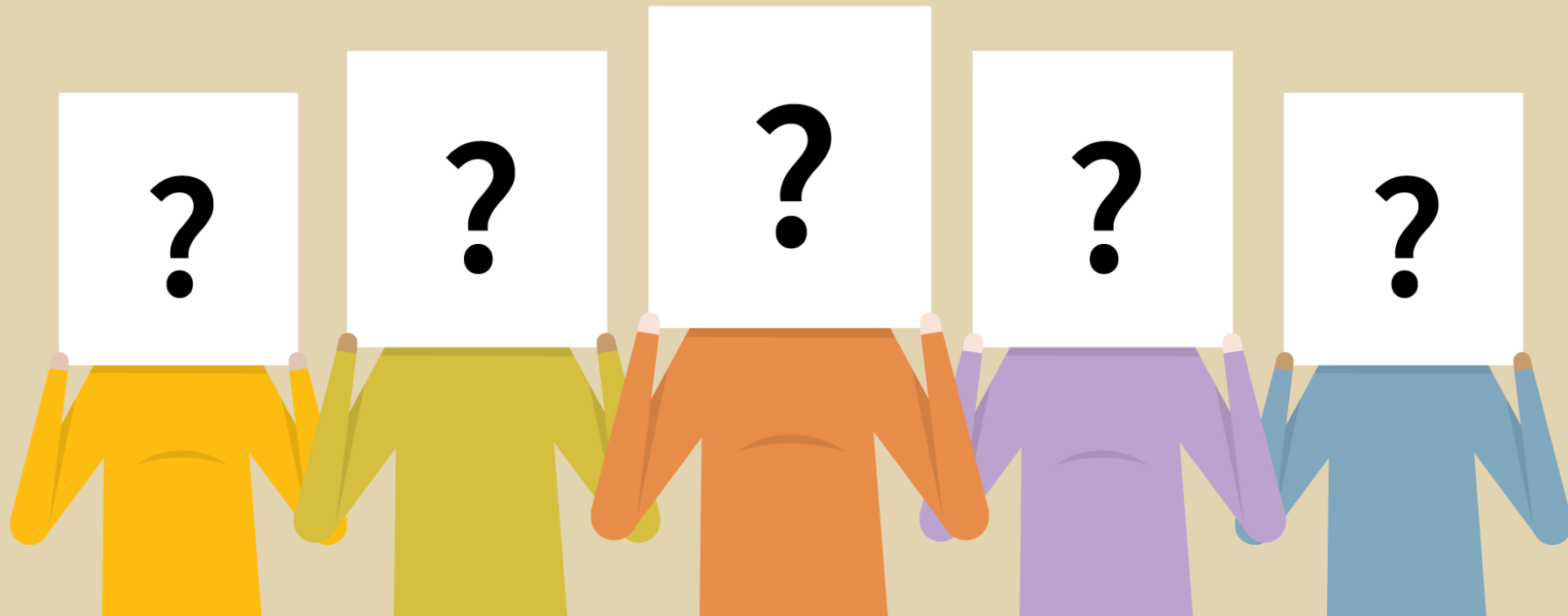


- An FISO should **not perform any safety relevant tasks when** he or she knows that he or she is **fatigued** or feels unfit to the extent that safety may be adversely affected.
- FISOs should **make best use of the facilities and opportunities** that are provided **for rest and** for the consumption of **meals**. They should plan and use rest periods to **ensure that they are fully rested**.

Fatigue training

- Fatigue awareness
- Personal responsibilities
- Tips and tricks
- Rostering recommendations
- Awareness of fatigue risks
- Awareness of responsibility for fitness for duty





Questions?

References

- [ICAO, Manual for the Oversight of Fatigue Management Approaches \(Doc 9966\)](#)
- [ICAO, Fatigue Management Guide for Air Traffic Service Providers](#)
- [IFATCA, A short guide to human fatigue and associated risk based management Systems for air traffic control](#)
- [IFATCA, Fatigue Risk Management Systems](#)
- [EUROCONTROL, Fatigue and Sleep Management](#)