



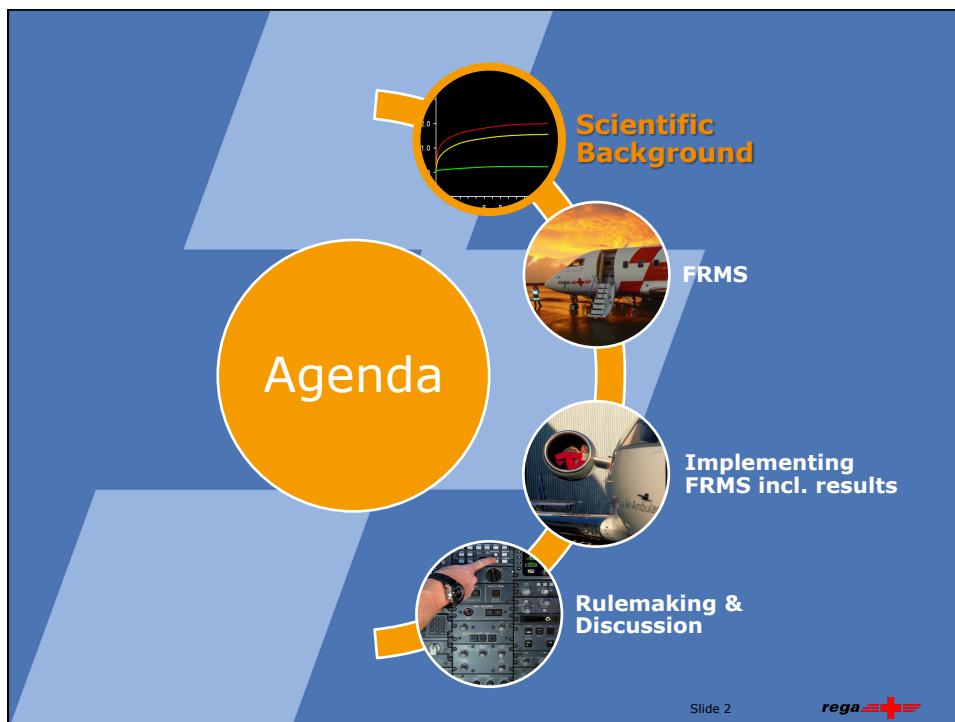
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Fatigue Risk Management

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Head of Corporate Development


SASCON '15 | 8 September 2015

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Agenda


- Scientific Background
- FRMS
- Implementing FRMS incl. results
- Rulemaking & Discussion

Slide 2 

Fatigue – A measurable factor?

The diagram is titled "Fatigue – A measurable factor?". It is divided into two main sections: "Subjective Measurement" and "Objective Measurement".

- Subjective Measurement** (orange box):
 - Karolinska Sleepiness Scale (KSS)
 - Visual Analogue Scale of Fatigue Severity (VAS-F)
 - Samn Perelli Scale (SPS)
- Objective Measurement** (dark blue box):
 - Polysomnography with EEG
 - Electro-oculography
 - **Actigraphy**

Slide 3 

Fatigue – An overestimated factor?


Fatigue-related risks

The diagram is titled "Fatigue – An overestimated factor?". Below the title is a large blue box containing the text "Fatigue-related risks".

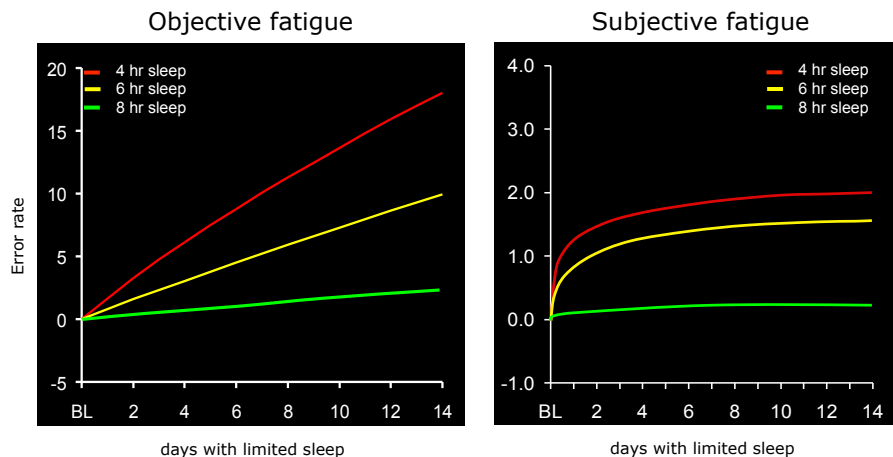
Below this box are several smaller boxes representing factors:

- Sleep debt** (green box)
- Long wakefulness** (green box)
- Sleep quantity** (brown box)
- Sleep quality** (brown box)
- Sleep disruptions** (brown box)

At the bottom of the diagram is a large orange arrow pointing to the right, labeled "Awareness".

Slide 4 

Error rates



Van Dongen, Maislin, Mullington, and Dinges (2003)

Slide 5



Performance

2008 National Sleep Foundation

- 28% of the 1,000 respondents: sleepiness interferes with their daytime activities at least a few days each month.

NASA Study

- Pilots on trans-Pacific flights were instructed to nap for 40 minutes.
- 26 minutes (avg.) led to 34% improved performance and 54% improved alertness

Slide 6



NASA Aviation Safety Reporting System (ASRS)

- 21% of the incidents reported to ASRS are fatigue-related
- 261,000 incident reports with about 52,000 of these reporting a fatigue-related occurrence
- The FAA has identified fatigue research as an important aviation safety issue in its National Plan for Aviation Human Factors

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Cumulative Fatigue: Guantanamo Bay Accident

CPT (8h per day requ.) FO (8h per day requ.)

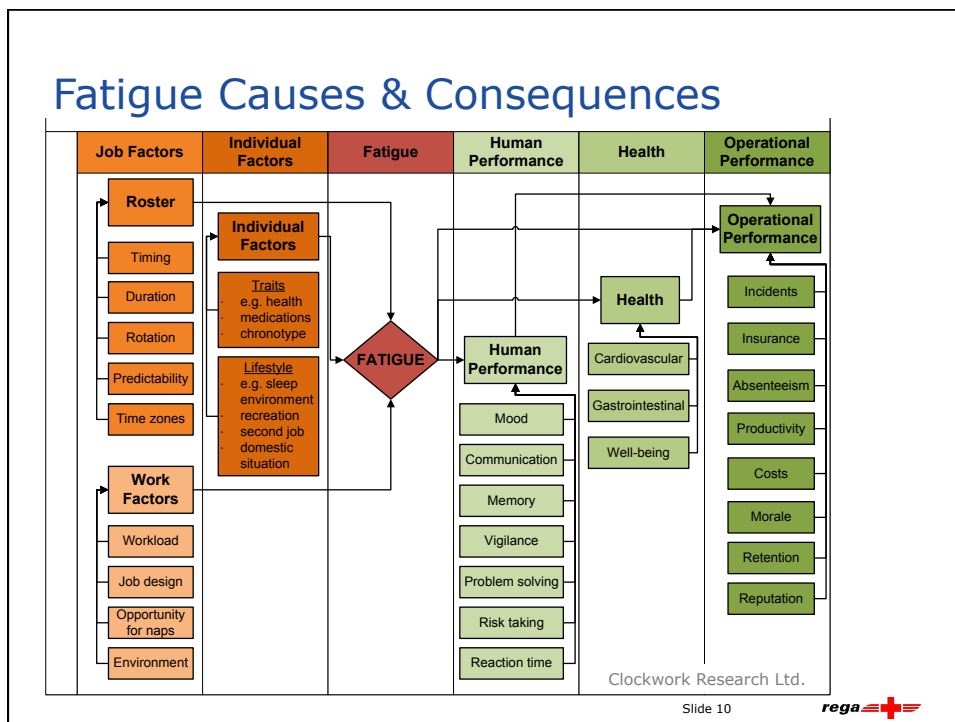
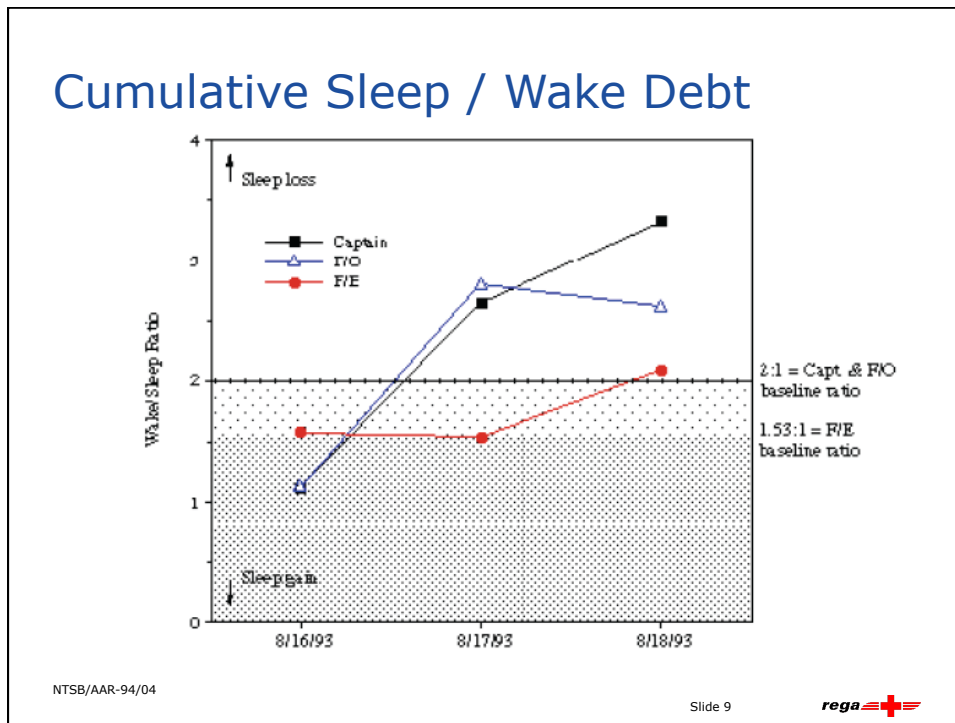
- | | |
|-------------------------|-------------------------|
| ▪ 50h awake / 15h sleep | ▪ 30h awake / 12h sleep |
| ▪ slept 8h | ▪ slept 8h |
| <hr/> | |
| ▪ 9h awake | ▪ 9h awake |
| ▪ 2h nap prior to FDP | ▪ 2h nap prior to FDP |
| <hr/> | |
| ▪ 17h awake | ▪ 19h awake |
| ▪ 5h sleep in DFW | ▪ 8h sleep in DFW |
| ▪ 23.5h awake | ▪ 19h awake |

41h awake / 5h sleep 38h awake/10h sleep

NTSB/AAR-94/04

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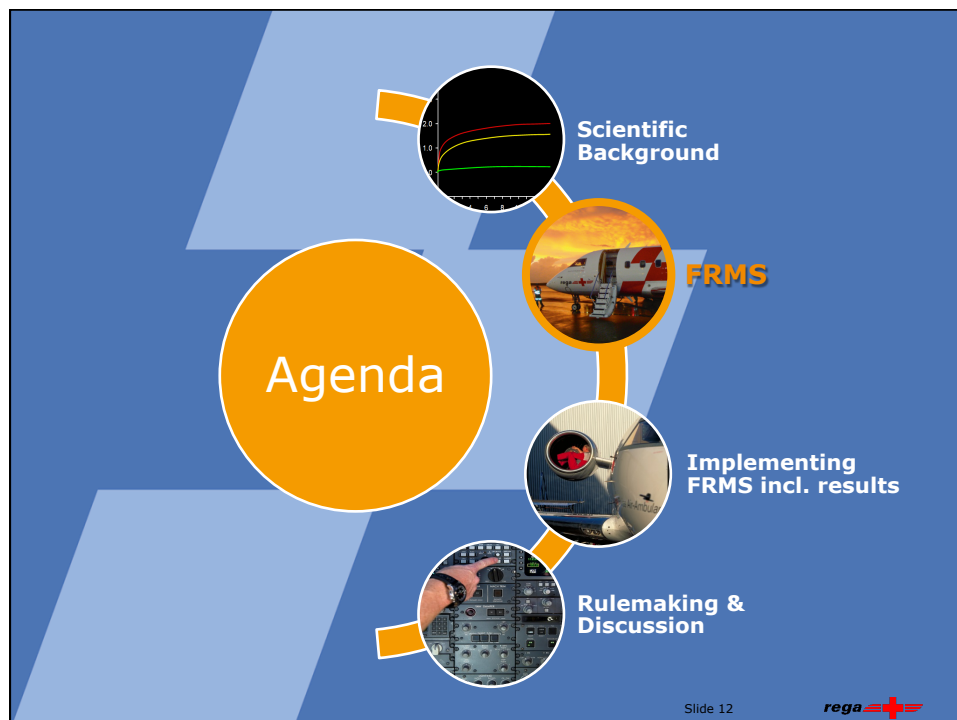




Medical-operational Conclusions

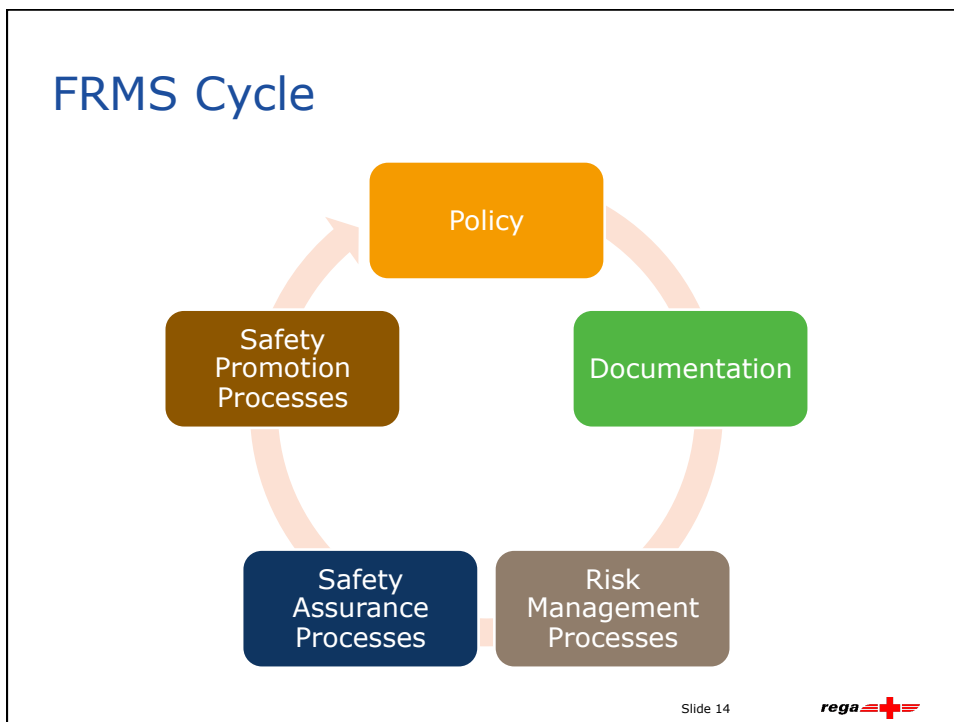
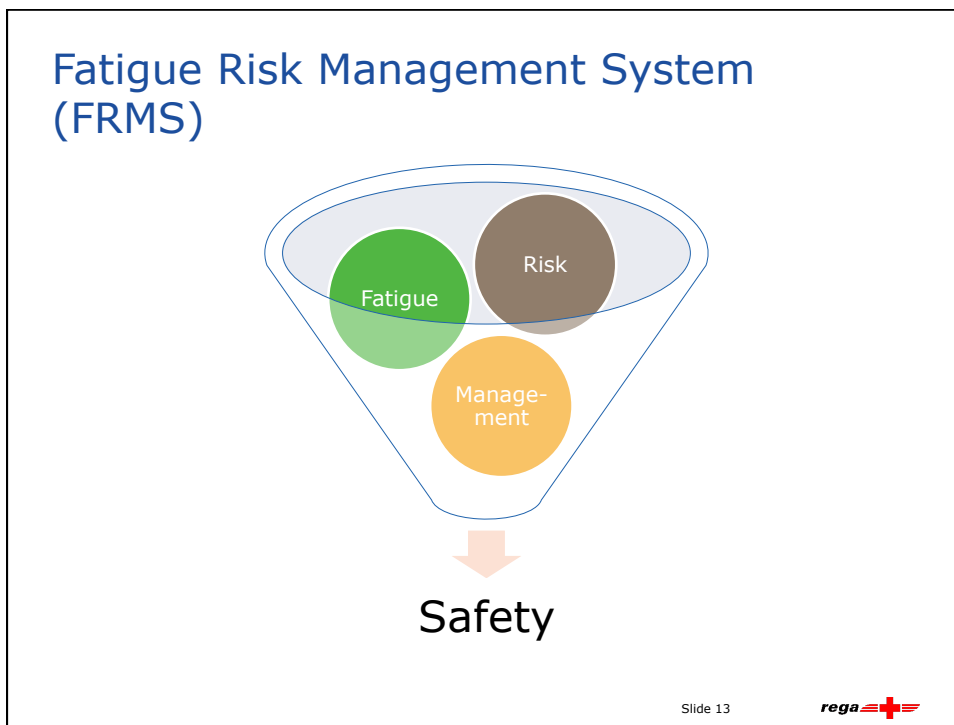
- Sleep is a vital human physiological function
- Sleepiness affects waking performance, vigilance, and mood
- Sleep loss accumulates into a sleep debt
- Discrepancy of physiological vs. subjective sleepiness

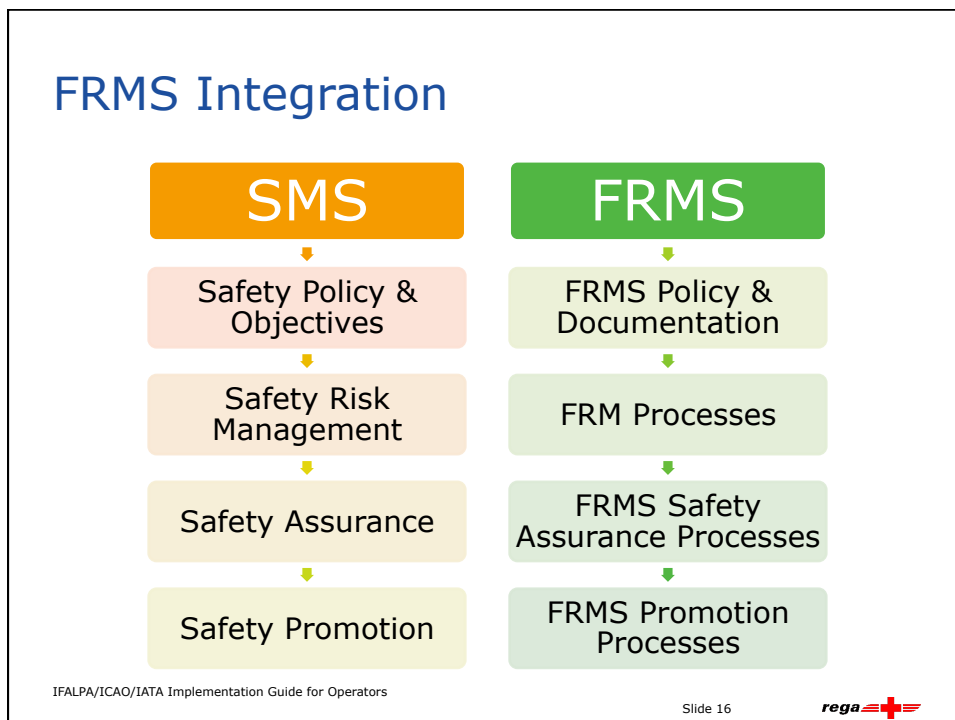
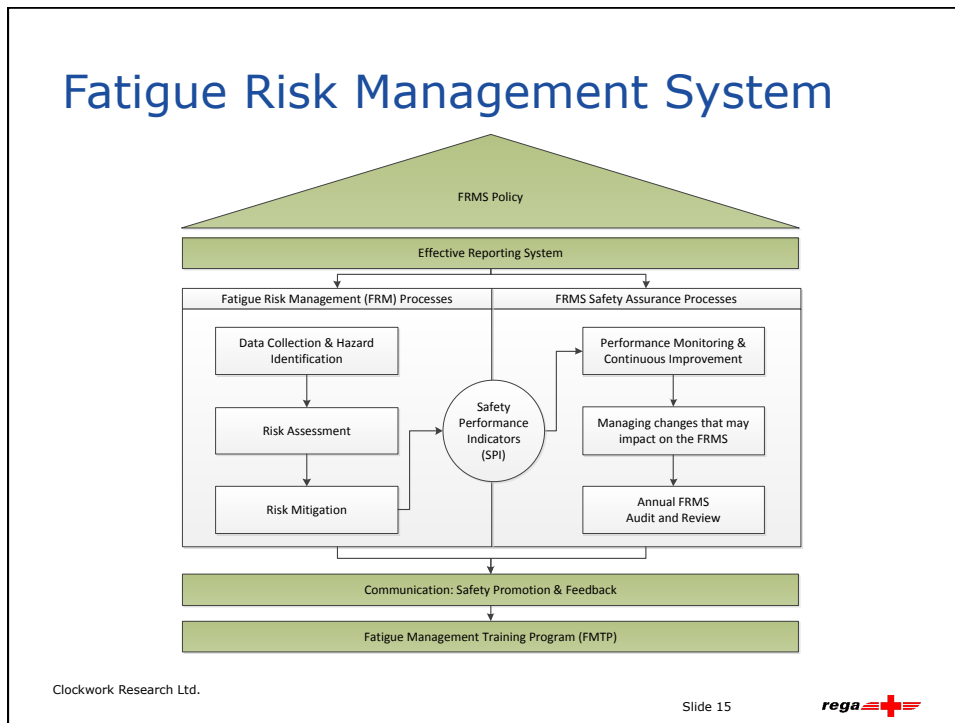
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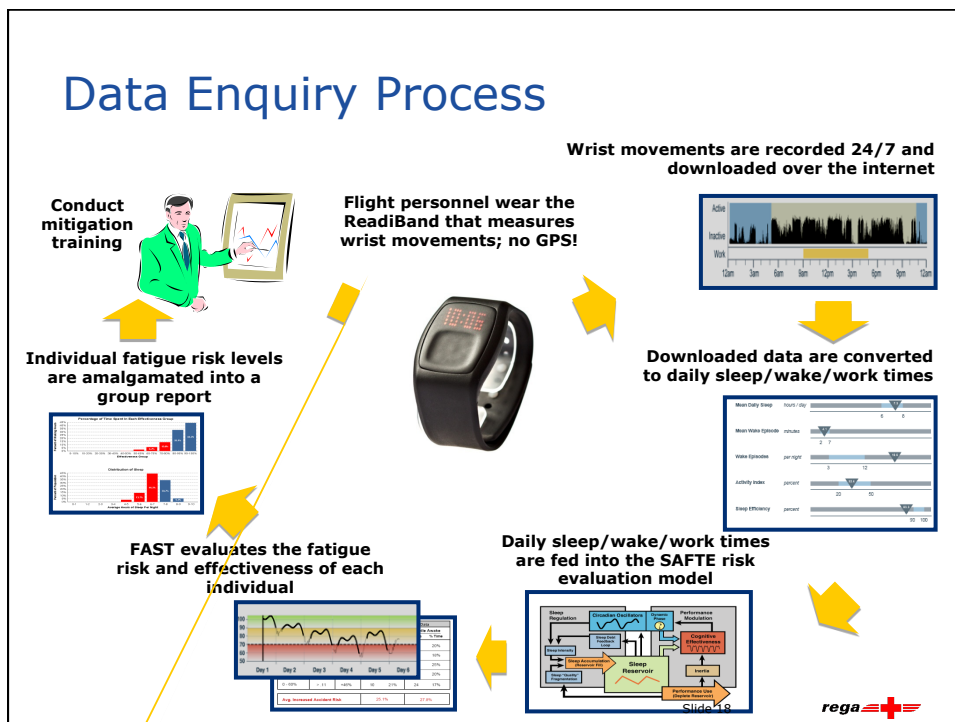
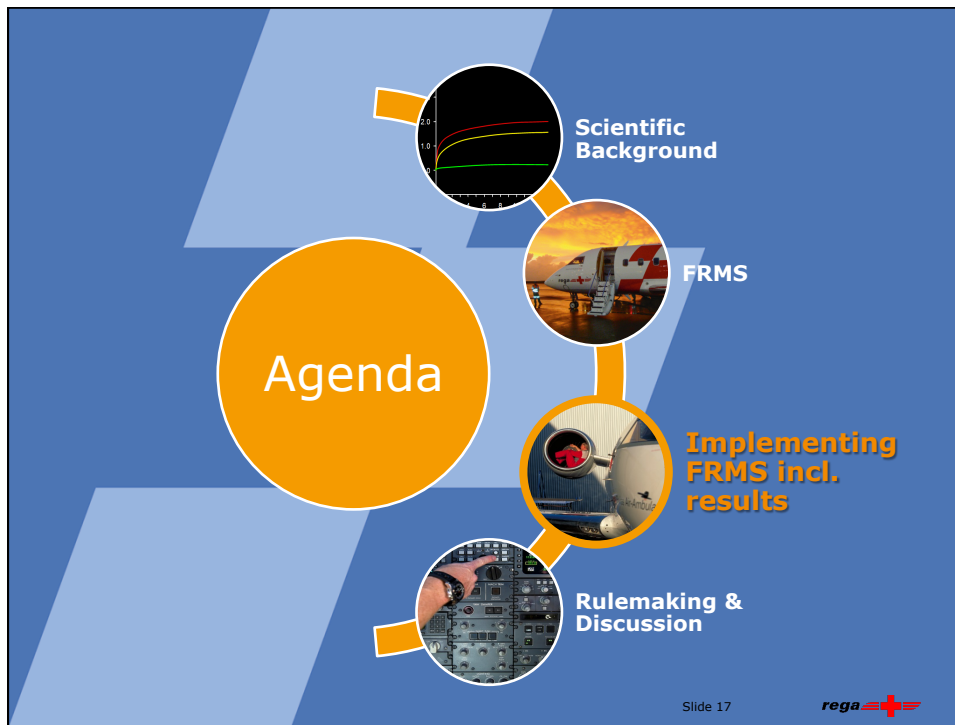


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Rega Data Components for Studies

Actigraph

- Objective fatigue

Sleep Log

- Subjective fatigue acc. Samn-Parelli-Scale before and after sleep phases

PVT

- Performance
 - absolute
 - relative

PVT: Thorne, Johnson, Redmond, Sing, Belenky, & Shapiro, 2005

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Actigraphy vs. Polysomnography

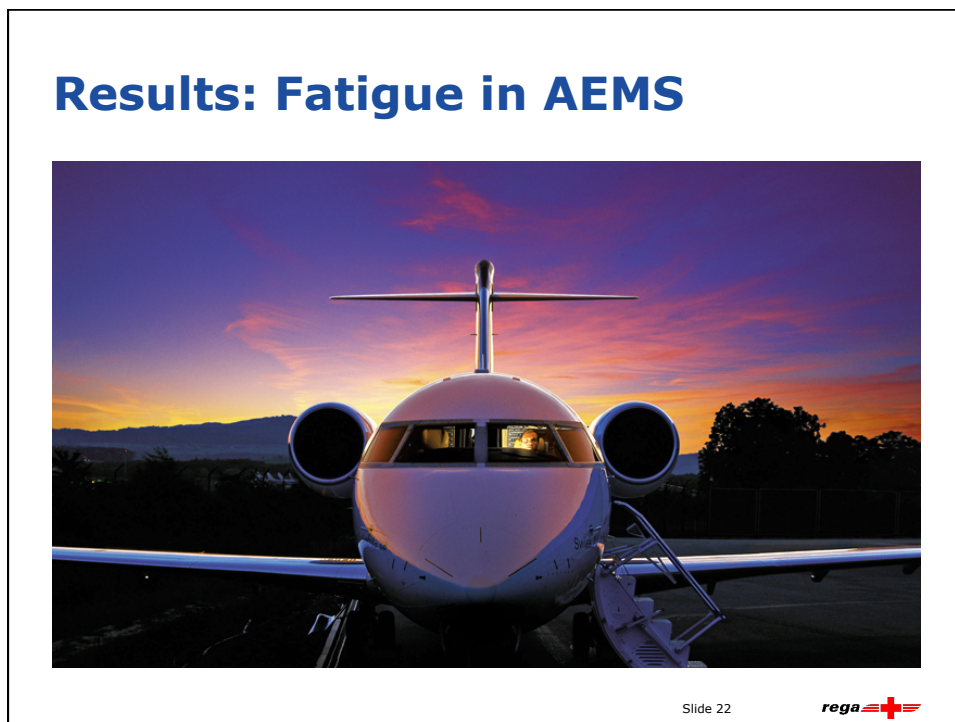
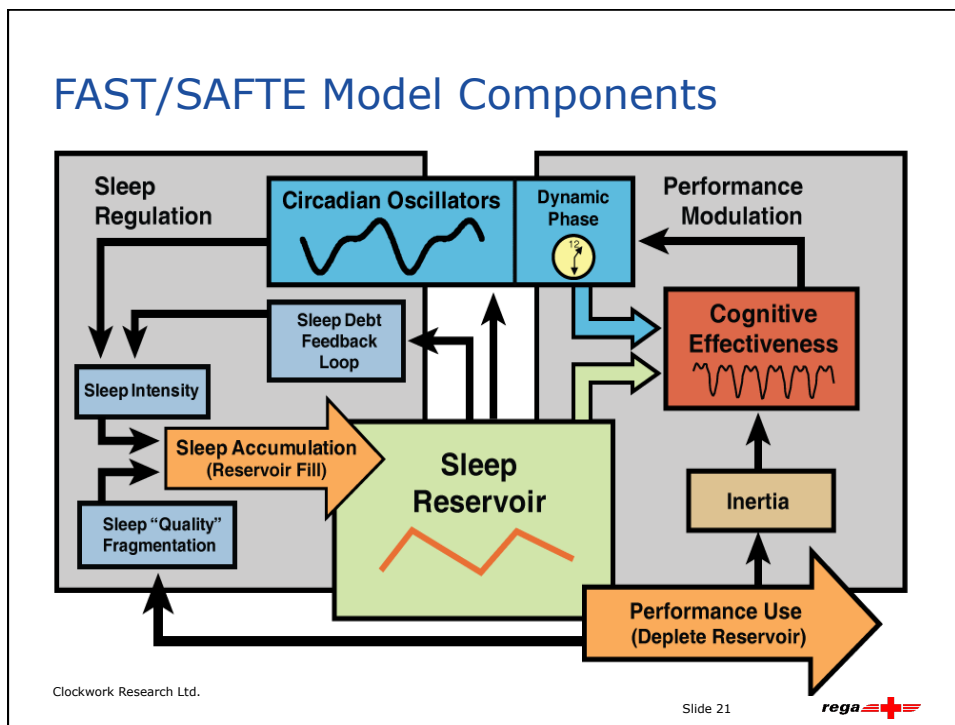
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EEG

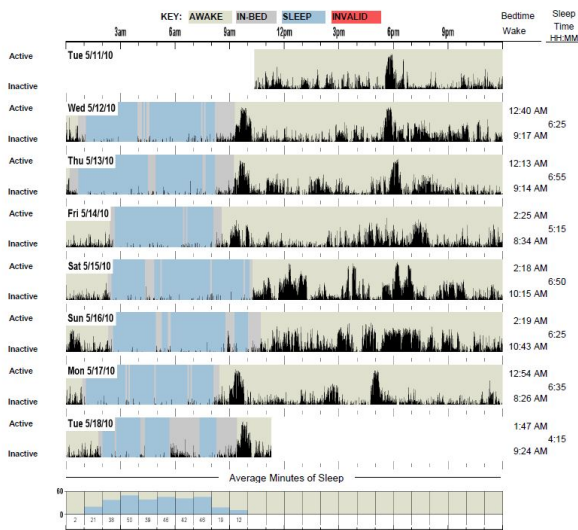
92%

ReadIBand

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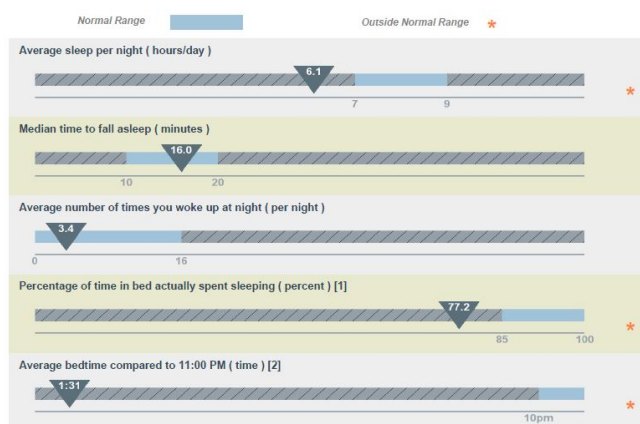
Sleep / Wakefulness Analysis



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Relative Analysis



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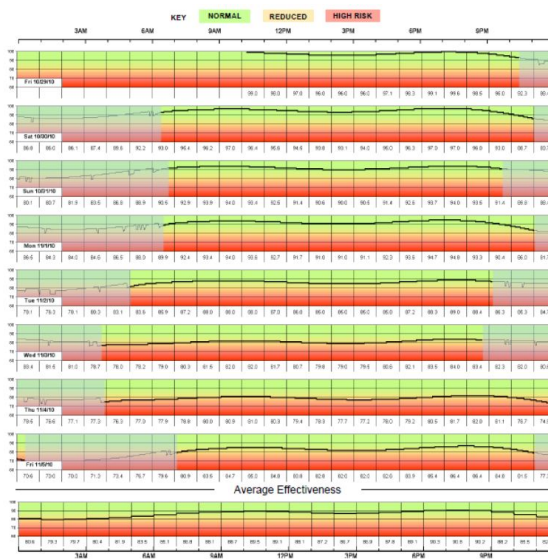
Performance Classification

	Mental Effectiveness Range	Percentage of Time
Normal	90 - 100%	70%
Reduced	80 - 90%	16%
	70 - 80%	10%
High Risk	60 - 70%	4%
	0 - 60%	0%

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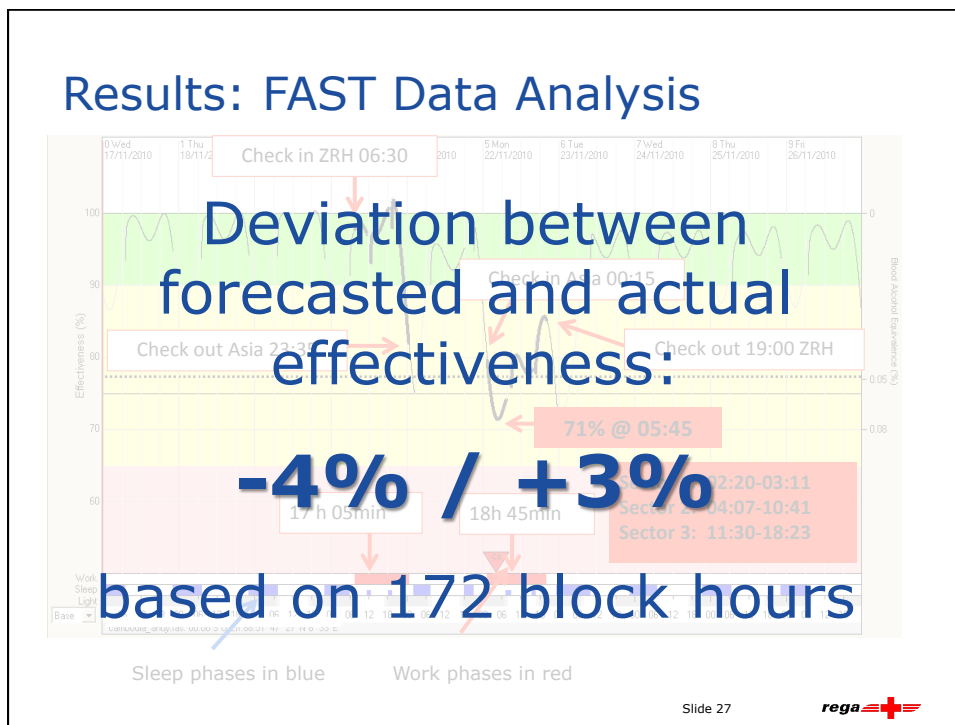


Personal Mental Effectiveness



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Results: Operational risk factors

- Duty hours and cumulative duty
- Basic maximum flight duty period
- Night, early and late duties
- Duty extensions (also due to in-flight rest)
- Positioning and travelling
- Extension by on-ground break
- Pilot-in-command discretion
- Airport standby
- Standby other than airport
- Basic rest (incl. basic rest-reduced rest)
- Time zone crossing

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Operational mitigation strategies ①

- Predicting the expected level of fatigue during the mission phases by means of FAST and, where necessary, scheduling additional crew members
- Activating the crew as early as possible
- Pre-positioning with night stop ideally in the same time zone
- Planning missions in accordance with circadian principles, in particular avoiding starts and landings during the window of circadian low (WOCL)

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Operational mitigation strategies ②

- Food
- Planned in-flight rest (bunk/cabin) in accordance with the crew members' circadian rhythms and potentially fatiguing mission phases
- Changed in-flight rest structure
- Caffeine
- Increased use of SOPs
- Took fatigue into consideration during briefings
- Notified flight crew member (FCM) of fatigue
- Increased use of automation

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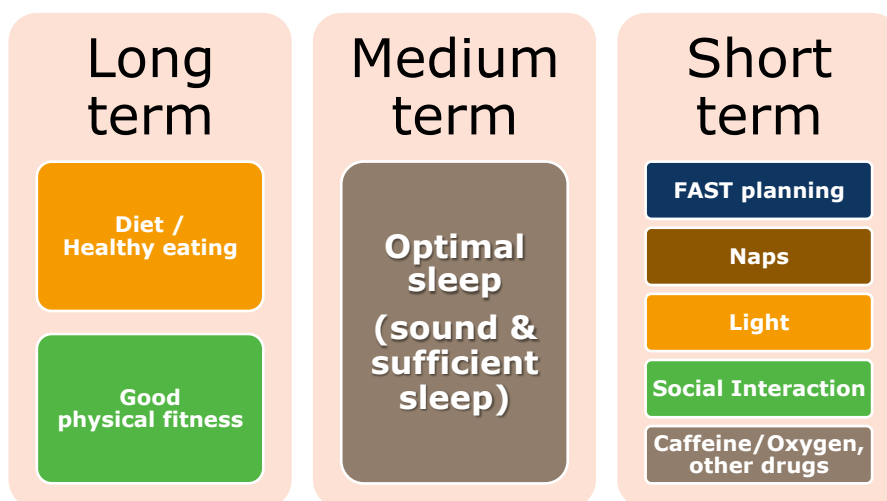
Operational mitigation strategies ③

- Enhanced use of crew resource management (CRM)
- Targeted advance sleeping at the Rega Centre before early-start duties
- Naps in the afternoon before starting a night duty
- Naps during ground patient transfers at airports
- Use of cockpit iPad
- Use of ear plugs and sleep masks
- Use of own sleeping bags and pillows

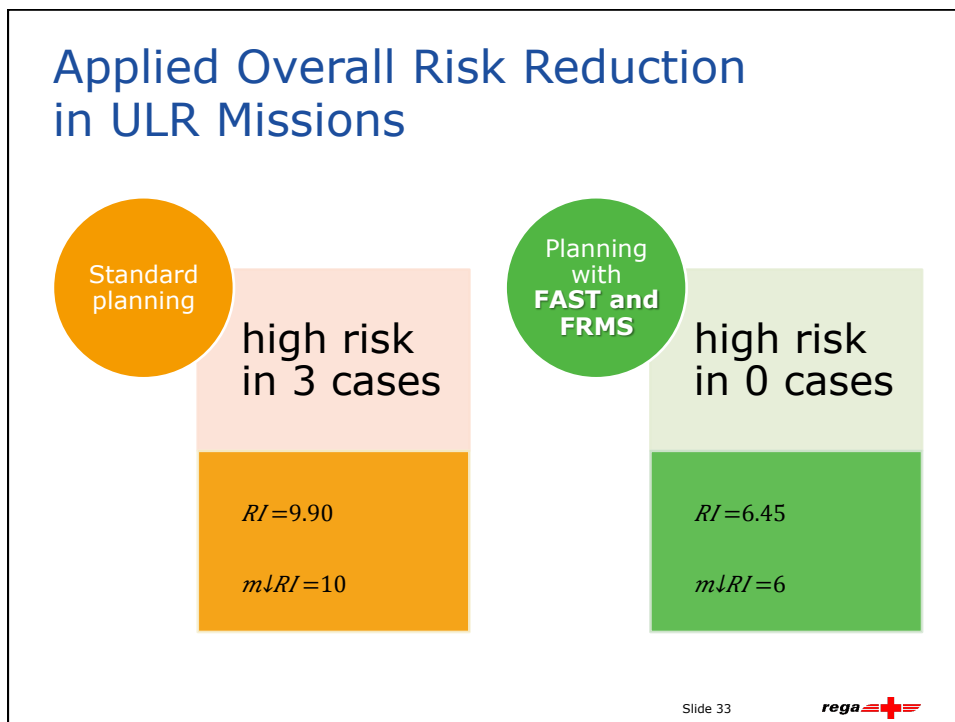
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Fatigue mitigation strategies



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Results: Fatigue factors in HEMS

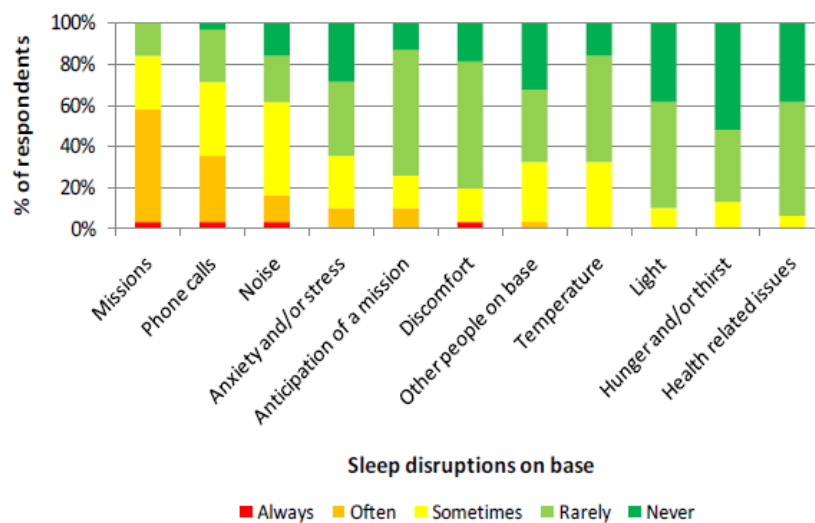
- Night missions
 - +1 point on the KSS per mission
 - +2 points on the KSS per mission using NVG
 - Length of the mission
- Sleep quantity
- Sleep quality
- Sleep disruptions

- No significant differences between the fatigue experienced by pilots and by HCM/TCM

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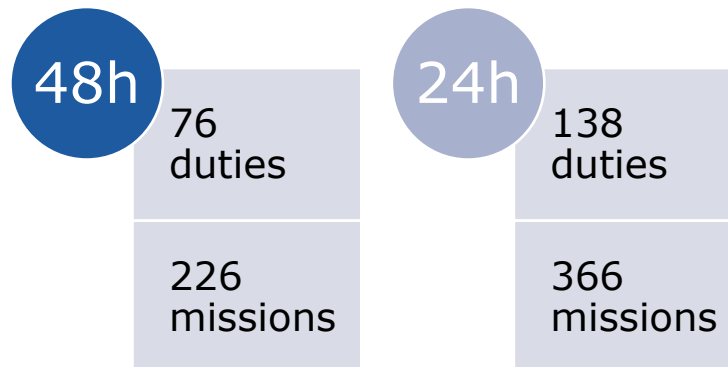
Results: Sleep disruptions on bases



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Results: Comparison study



No advantages relating to operational safety could be identified in connection with the 24-hour model, thus reconfirming the results of the preceding HEMS main study.

Clockwork Research Ltd., 2013

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Swiss Air-Ambulance HEMS OM

- Each crew member must have at least **one period of 48 consecutive hours** of rest time during a period of **10 days**.
- Each crew member is entitled to at least **eight days free of duty** and on-call duty within **every calendar month**, and **96 days within a calendar year**. In the event of holiday, part-time employment and military service, this entitlement is reduced on a pro rata basis.

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Swiss Air-Ambulance HEMS OM

- The requirement for taking over a night-time on-call duty after 22:00 LT is that during a duty day, **breaks totalling at least three hours** must have been taken between 08:00 LT and 22:00 LT, at least **once two hours of them consecutively**. If it is not possible to guarantee that these breaks have been observed, a **rest period without on-call duty lasting 6 hours must be observed**.

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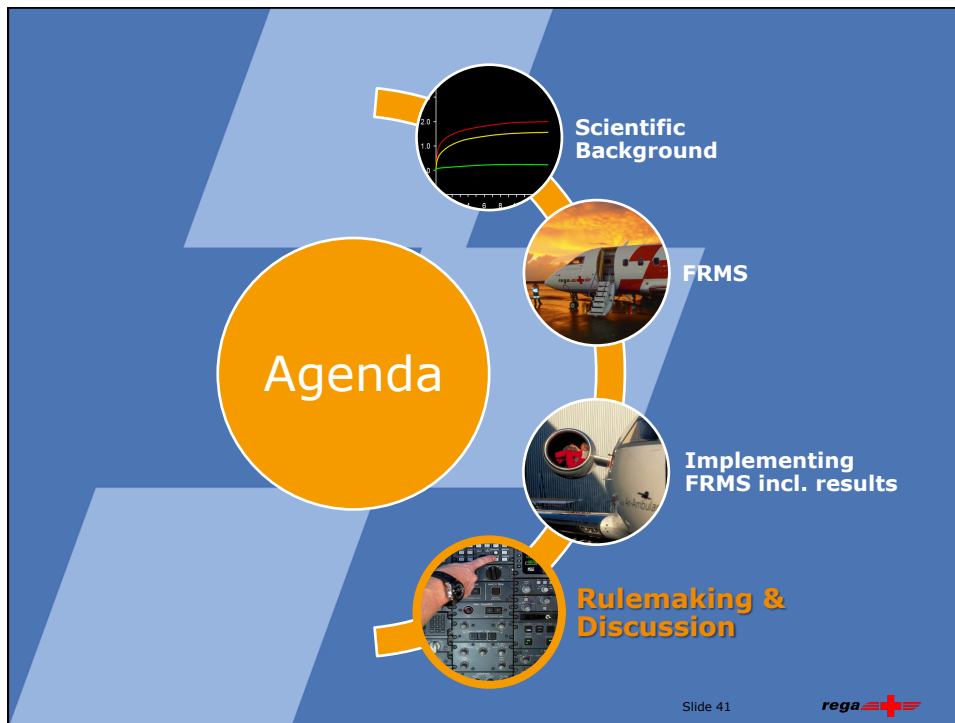


Swiss Air-Ambulance HEMS OM

- If within one duty day, between **22:00 LT and 06:00 LT more than one mission** is carried out, or a **mission lasts more than 3 hours**, the pilot and the HEMS crew member should subsequently, however at the latest by 08:00 LT, **observe a rest time without on-call duty lasting 6 hours**.

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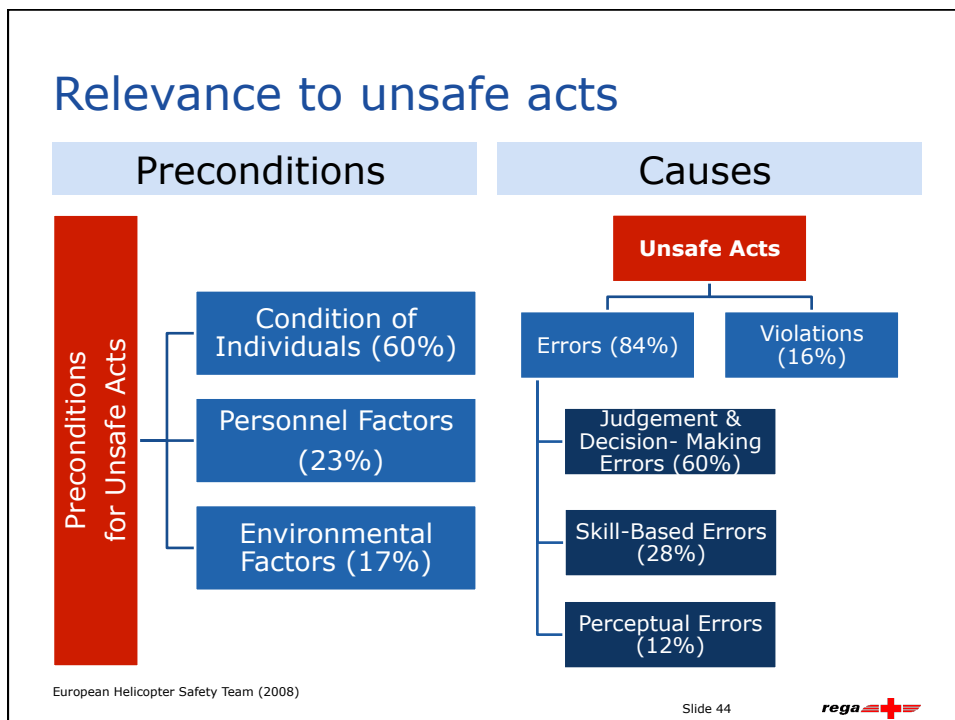
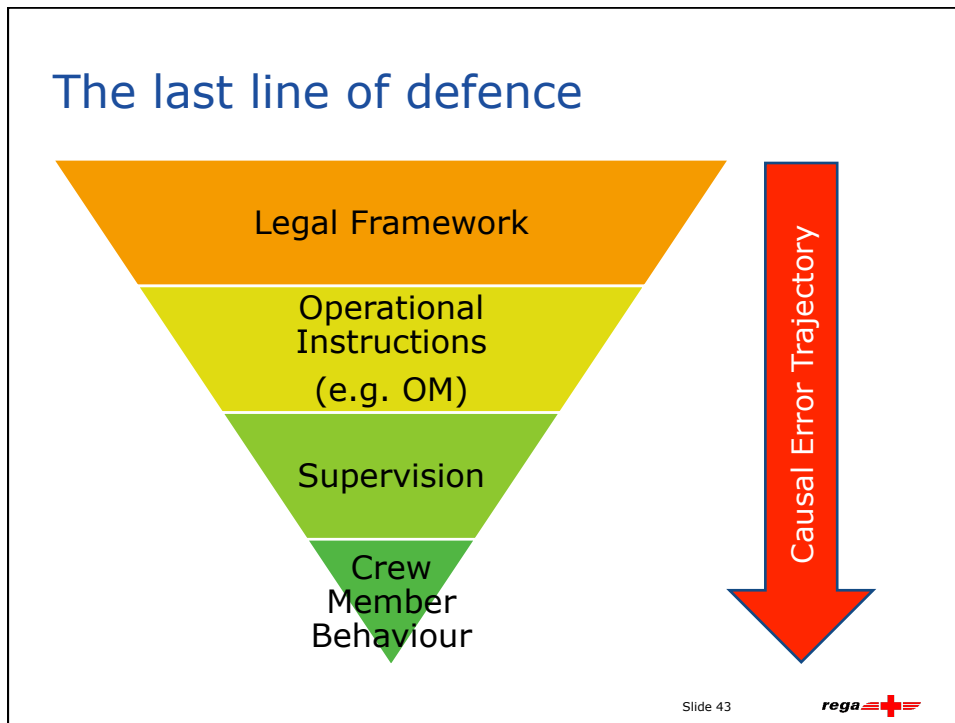


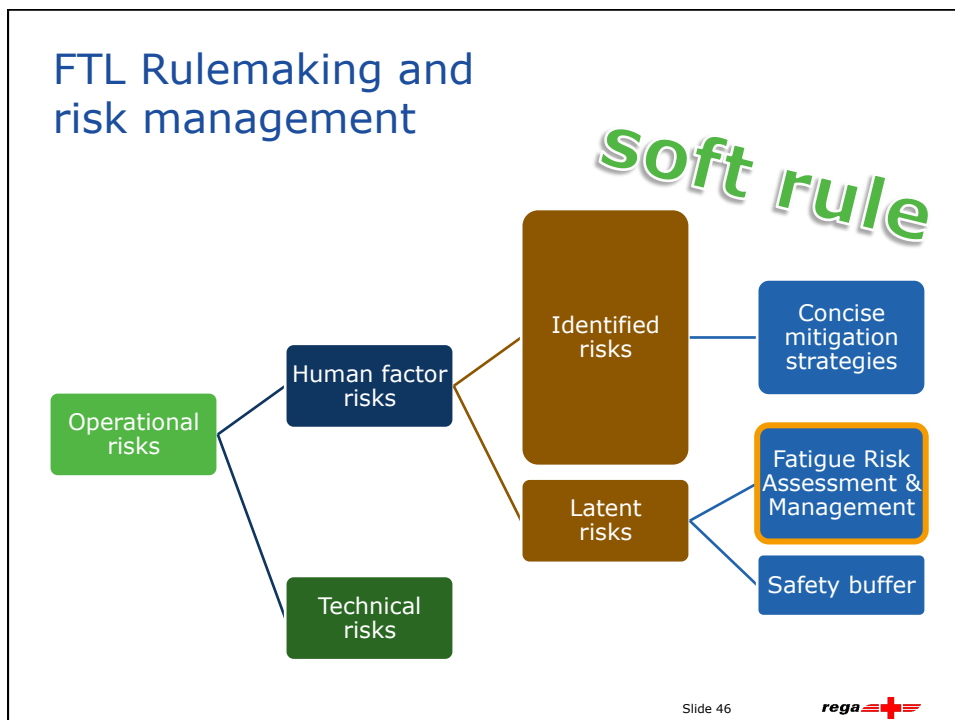
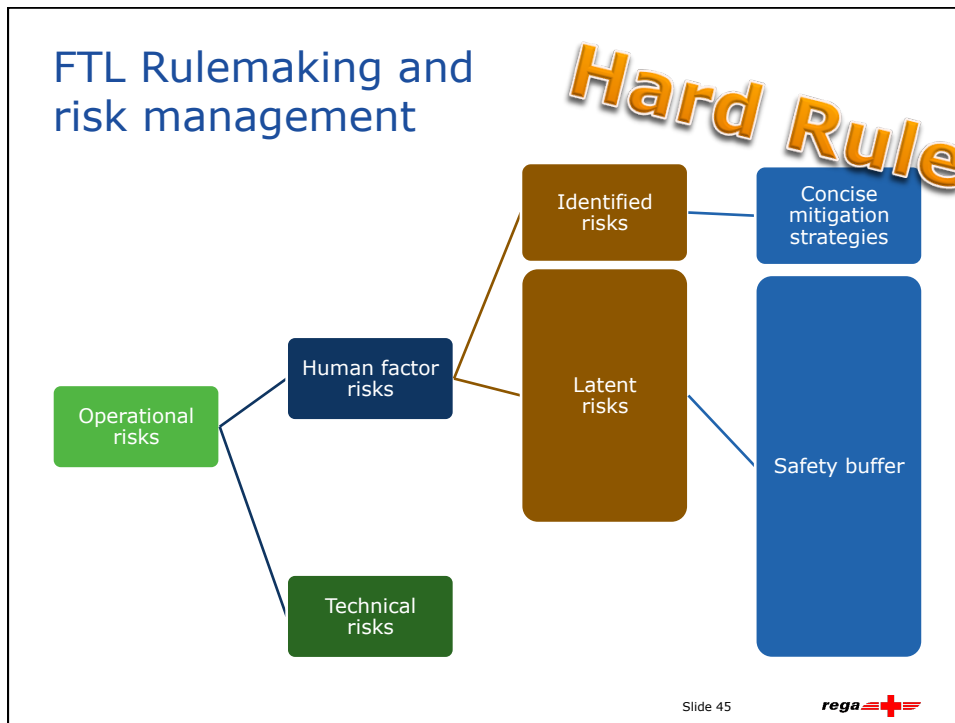
From Operators & Regulators



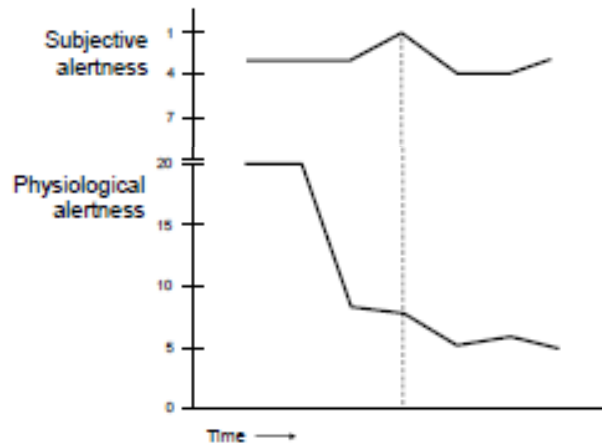
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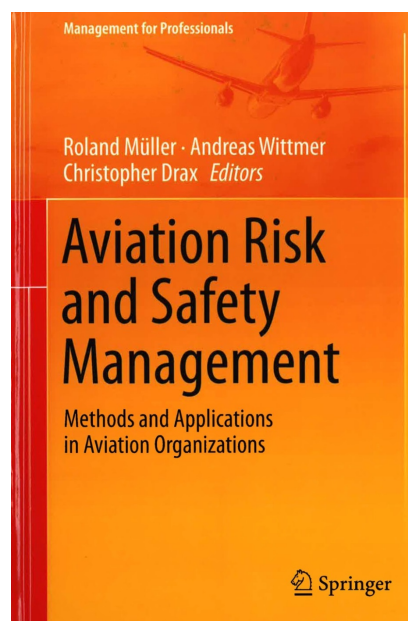


NASA: Alertness reports often inaccurate



Sasaki, Kurosaki, Mori, Endo: ASEM (1986)

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