疲勞管理相關資訊分享

行政院飛航安全委員會

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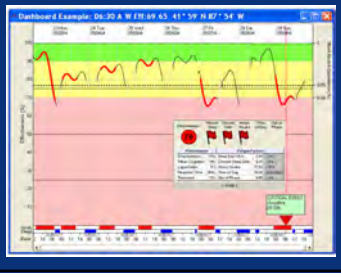
簡報大綱

- 引言
- 疲勞風險管理系統之發展
- ICAO疲勞管理之標準、建議措施及手冊
- TACARE疲勞相關報告評析
- 結語

引言

2011年飛安資訊研討會
– 疲勞相關案例及風險管理

- 駕駛員疲勞飛行案例
  - 夜間直昇機緊急救護任務
  - 時差及累積型睡眠不足之疲勞案例
- 國內航空公司之疲勞管理機制
- 加拿大之疲勞風險管理系統
- 疲勞評估模式與軟體



2011年研討會後
– 疲勞相關資訊分享

- 2011年飛安自願報告系統簡訊第22、23及24期
  - 夜間直昇機緊急救護任務疲勞相關議題
  - 長程跨時區飛行任務疲勞案例探討
  - 我國籍航空公司疲勞管理方法概況探討
  - 疲勞風險管理系統國際上之發展概況
- 接受航空公司飛安刊物之邀稿
  - 疲勞管理的現在與未來

疲勞風險管理系統之發展

疲勞風險管理系統之發展

- ICAO於2008年宣示規劃將FRMS納入第六號附約，2009年8月成立工作小組，草擬FRMS之技術文件。
- 2011年6月15日ICAO正式將**FRMS相關之標準及建議措施納入第六號附約**，並於2011年12月15日起生效。
- ICAO另於2011年發布Doc 9966- Fatigue Risk Management Systems Manual for Regulators。
- ICAO亦與國際航空協會（IATA）及國際飛行員協會（IFALPA）共同於2011年7月11日發表供航空公司參考使用之FRMS建置指引- Fatigue Risk Management Systems Implementation Guide for Operators。

http://www2.icao.int/en/FatigueManagement/Pages/FatigueManagementTools.aspx

- Annex 6 Part 1
  - 4.10 Fatigue management
  - Appendix 8 FRMS Requirements
- Guidance Material
  - Operators
  - Regulators

ICAO疲勞管理之標準、建議措施及手冊

ICAO對疲勞之定義

- *A physiological state of reduced mental or physical performance capability resulting from sleep loss or extended wakefulness, circadian phase, or workload that can impair a crew member's alertness and ability to safety operate an aircraft of perform safety-related duty.*
- **疲勞狀態**：身體或認知之行為表現能力下降
- **疲勞原因**：睡眠不足、持續清醒時間過長、生理時鐘、及工作負荷。
- **疲勞對任務執行的影響**：削弱組員的警覺能力及安全執行任務之能力。

ICAO對疲勞風險管理系統之定義

- *A data-driven means of continuously monitoring and managing fatigue-related safety risks, based upon scientific principles and knowledge as well as operational experience that aims to ensure relevant personnel are performing at adequate levels of alertness.*
- 一套藉由資料蒐集與分析以持續監視及管理疲勞相關風險的管理方法。
- 系統運作須依據科學的理論、知識及營運經驗。
- 系統建置目的係為確保線上作業人員能在足夠的清醒程度下執行工作。

觀念的改變

Are you legal?

→ Are you too tired to fly?

組員感到疲勞主動提出

→ 組員/航空公司/監理單位共同承擔疲勞管理責任

Annex 6, Part 1, 4.10 Fatigue Management 4.10.1 (Standard)

- 會員國須建立相關規定以管理疲勞
- 相關規定須依據科學的原則及知識
- 確保飛航及客艙組員於任務時能保持足夠的警覺
- 為此，會員國須：
  - ① 訂定 flight time/flight duty period/duty period/rest time等限制（mandatory）
  - ② 訂定FRMS相關規定，授權航空器使用人可藉由FRMS管理組員疲勞（optional）

是否要訂定FRMS相關規定

① Is the State's safety oversight system mature enough?

- ICAO USOAP: State's capability for providing safety oversight by assessing whether the critical elements of a safety oversight system have been implemented effectively
- Lack of Effective Implementation(LEI) measurement : Low score

② Have adequate resource?

- FRMS: a performance-based regulatory approach
- Maturity of existing flight & duty time limit
- Man power/competency/ training/ guidelines/tool/ specialist support

Annex 6, Part 1, 4.10 Fatigue Management 4.10.2 (Standard)

- 會員國須要求航空器使用人遵循依據4.10.1所訂定之相關規定，以管理疲勞相關風險
- 航空器使用人有下列三種選擇：
  - ① 所有任務皆遵循工時規定中有關flight time/flight duty period/duty period/rest time之要求
  - ② 所有任務皆使用FRMS管理組員疲勞
  - ③ 部分任務使用FRMS；其餘仍遵循工時相關規定

Annex 6, Part 1, 4.10 Fatigue Management 4.10.4 (Standard)

- 航空器使用人以FRMS取代工時相關規定前，其FRMS須經監理機關審核。
- 監理機關核准之FRMS相較於工時相關規定應能提供等同或更佳之安全水準。

Annex 6, Part 1, 4.10 Fatigue Management 4.10.5 （Standard）

- 會員國須建立一程序，以確保航空器使用人之FRMS相較於工時相關規定能夠提供等同或更佳之安全水準，此程序之一部分須包括：

① 要求航空器使用人訂定flight time/flight duty period/duty period最大值及rest time最小值，且須基於科學原則及知識，受safety assurance processes之檢視，以及經監理機關核准

② 一旦分析顯示該等數值太高或太低，監理機關有權強制要求航空器使用人調整

③ 惟有航空器使用人基於其運作FRMS所累積之經驗及疲勞相關數據資料，證明其增加任何最大值及減少任何最小值具合理性時，監理機關始能核准

Annex 6, Part 1, 4.10 Fatigue Management 4.10.6 （Standard）

- 當航空器使用人係藉由FRMS管理疲勞相關風險時，航空器使用人至少應：

① 應用科學之原則及知識於FRMS中

② 持續識別疲勞相關危害（hazard）及評估其風險

③ 確保疲勞相關危害之改善作為能有效地減少其風險，且盡速推動

④ 持續監視及定期評估相關改善作為之成效

⑤ 持續改善FRMS之整體績效

Annex 6, Part 1
Appendix 8 FRMS Requirements

SMS Framework	FRMS
1. Safety policy and objectives	1. FRMS policy and documentation
2. Safety risk management	2. FRM processes • Identification of hazards • Risk assessment • Risk mitigation
3. Safety assurance	3. FRMS safety assurance processes • FRMS performance monitoring • Management of operational and organizational change • Continuous FRMS improvement
4. Safety promotion	4. FRMS promotion processes • Training programs • FRMS communication plan

① FRMS policy and documentation

② **Fatigue risk management processes**
- predictive
- proactive
- reactive

③ **FRMS safety assurance processes**

④ FRMS Promotion Process

Hazard Identification

① Predictive processes：examining crew scheduling affect sleep & fatigue
- previous experience
- evidence-based scheduling practices
- bio-mathematical models

② Proactive processes：monitoring fatigue level within operation（crew participate）
- self-reporting of fatigue risks（subjective）
- crew fatigue surveys （subjective）
- analysis of planned versus actual time worked
- monitoring crew’s sleep
- relevant crew performance data （objective）

Hazard Identification

③ Reactive processes：contribution of crew fatigue to safety reports & event

- fatigue reports
- confidential reports
- audit reports
- incidents
- flight data analysis events

組員疲勞評量方法

① Crewmembers' recall of fatigue

1) Fatigue Reporting Forms
2) Retrospective Survey

② Monitoring crewmember fatigue during flight operations

③ Evaluating contribution of fatigue to safety events

Fatigue Reporting Forms

① When happened?

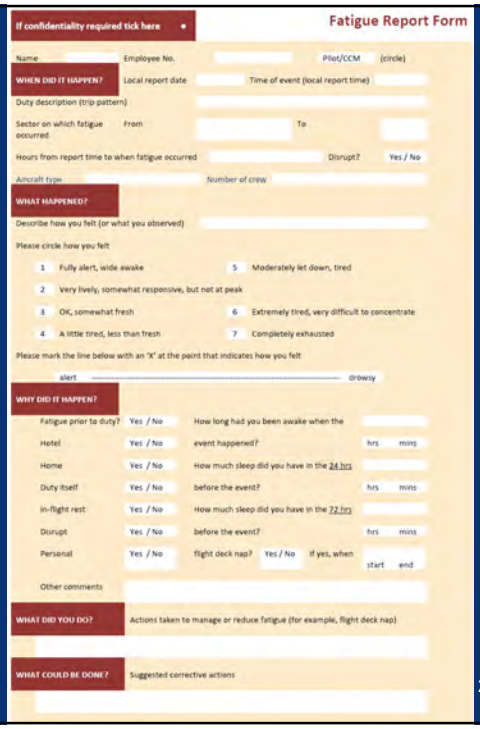
② What happened?

③ Why happened?

④ What did you do?

⑤ What could be done?

- 特定的任務類型或航線之報告數量持續出現或顯著增加時，即表示可能需要更深入的調查。



Fatigue Report Form

If confidentiality required tick here

Name | Employee No. | Pilot/CCM (circle)

WHEN DID IT HAPPEN? | Local report date | Time of event (local report time)

Duty description (trip pattern)

Sector on which fatigue occurred | From | To

Hours from report time to when fatigue occurred | Disrupt? Yes / No

Aircraft type | Number of crew

WHAT HAPPENED?

Describe how you felt (or what you observed)

Please circle how you felt

1 Fully alert, wide awake
2 Very lively, somewhat responsive, but not at peak
3 OK, somewhat fresh
4 A little tired, less than fresh
5 Moderately let down, tired
6 Extremely tired, very difficult to concentrate
7 Completely exhausted

Please mark the line below with an 'X' at the point that indicates how you felt

alert ——— drowsy

WHY DID IT HAPPEN?

Fatigue prior to duty? Yes / No | How long had you been awake when the event happened? hrs mins

Hotel Yes / No

Home Yes / No | How much sleep did you have in the 24 hrs

Duty itself Yes / No | before the event? hrs mins

In-flight rest Yes / No | How much sleep did you have in the 72 hrs

Disrupt Yes / No | before the event? hrs mins

Personal Yes / No | flight deck nap? Yes / No | If yes, when start end

Other comments

WHAT DID YOU DO? | Actions taken to manage or reduce fatigue (for example, flight deck nap)

WHAT COULD BE DONE? | Suggested corrective actions

Retrospective Survey

- 相對較低成本之方式取得大量的資料
- 主觀之衡量方法，問卷信度會受到受訪者是否能正確地回想及組織公正文化的影響
- 不同時期或群體之比較仍有其價值

How likely are you to doze off or fall asleep in the following situations, in contrast to feeling just tired? This refers to your usual way of life in recent times. PLEASE TICK ONE BOX ON EACH LINE

	would never doze	slight chance	moderate chance	high chance
Sitting and reading	0 ☐	1 ☐	2 ☐	3 ☐
watching TV	0 ☐	1 ☐	2 ☐	3 ☐
Sitting inactive in a public place (eg. theatre, meeting)	0 ☐	1 ☐	2 ☐	3 ☐
As a passenger in a car for an hour without a break	0 ☐	1 ☐	2 ☐	3 ☐
Lying down in the afternoon when circumstances permit.	0 ☐	1 ☐	2 ☐	3 ☐
Sitting and talking to someone	0 ☐	1 ☐	2 ☐	3 ☐
Sitting quietly after a lunch without alcohol	0 ☐	1 ☐	2 ☐	3 ☐
In a car, while stopped for a few minutes in traffic	0 ☐	1 ☐	2 ☐	3 ☐

Figure B1: The Epworth Sleepiness Scale

組員疲勞評量方法（續）

① Crewmembers' recall of fatigue

② Monitoring crewmember fatigue during flight operations:

- body clock/sleep/fatigue/performance

1) Subjective Fatigue & Sleepiness Ratings
2) Objective Performance Measurement
3) Monitoring Sleep
4) Monitoring the Circadian Body Clock Cycle

③ Evaluating contribution of fatigue to safety events

Subjective Fatigue & Sleepiness Ratings

- 不同的任務階段，自我評估疲勞狀況
- 疲勞程度愈嚴重鑑別能力愈不佳
- 信度會受到組織公正文化的影響
- 大量且快速取得資料
- 不同時期或群體之比較仍有其價值
- 作為是否深入調查之參考

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

Figure B5: The Samn-Perelli Crew Status Check

Objective Performance Measurement

- Supplement the subjective data collected in fatigue reports & survey responses

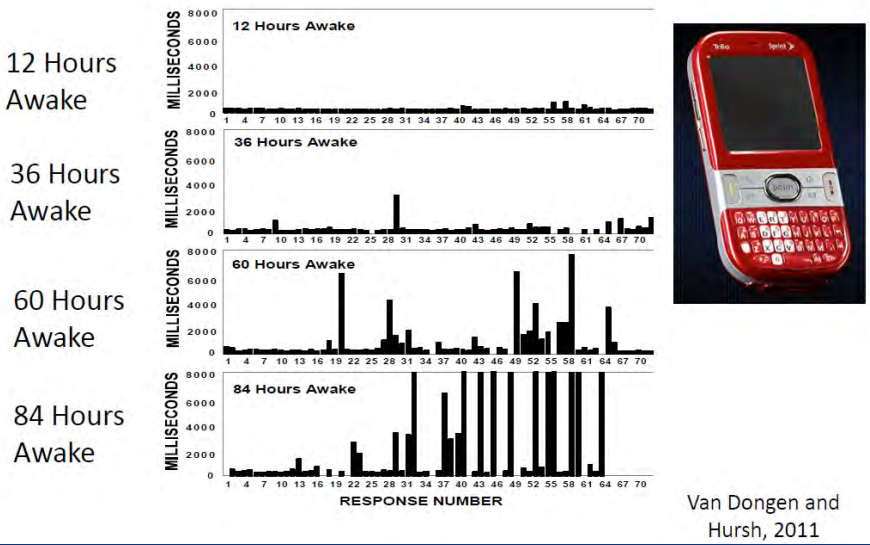
① Flight data analysis

② Trained flight deck observers rating the performance of crew on the flight deck

③ Simple tests developed in the lab: PVT Test

- 測量受測者之察覺能力及反應速度
- 無加強飛航組員時航空公司執行上會有所顧忌
- 無法完全代表複雜認知處理過程之績效表現

Measuring Performance with the PVT …



Van Dongen and Hursh, 2011

Monitoring Sleep

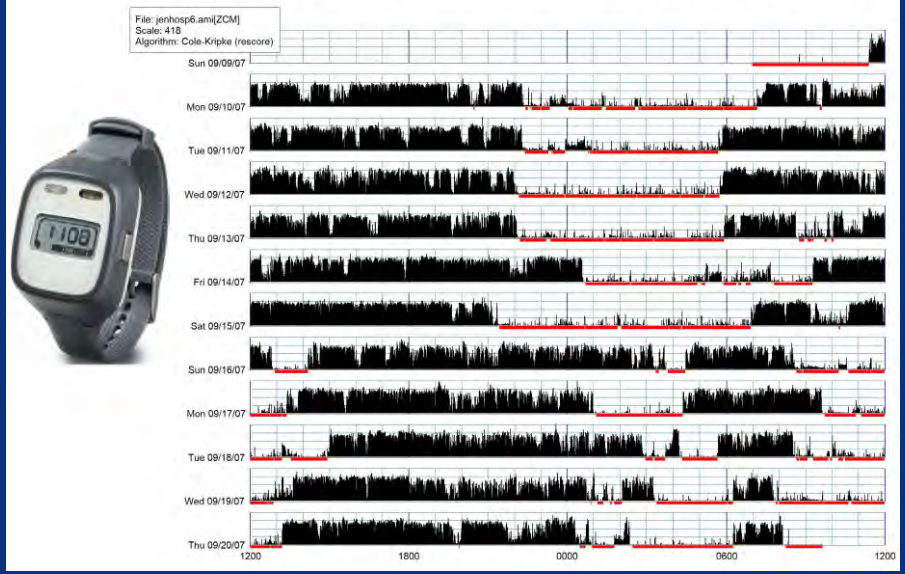
- Sleep is a key factor to fatigue

① Sleep diary-睡眠紀錄
- 群體睡眠量平均值具信度
- 公正文化影響組員正確填答意願

② Actigraphy-加速計
- 群體睡眠量平均值具信度
- 攜帶及使用方便

③ Polysomnography-多重睡眠電圖:腦波/眼動/肌電波
- 可衡量睡眠量、睡眠結構、睡眠品質、清醒時之警覺力
- 已有攜帶式，然需技術人員陪同、儀器安裝及檢測耗時
- 新航於首次ULR（SIN-LAX）時曾使用

Measuring Sleep with the Actigraph



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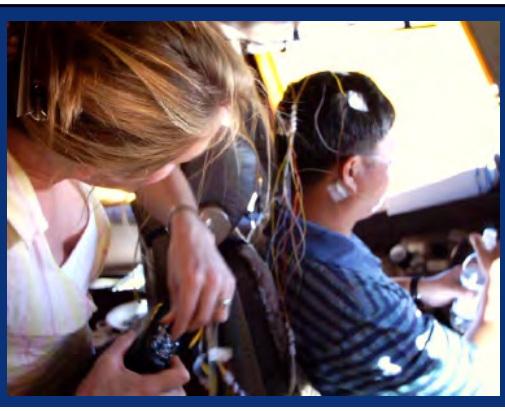
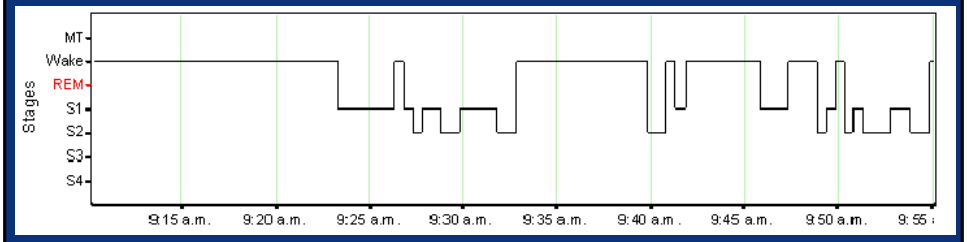




1st in-flight rest period on the SIN-LAX flight

組員疲勞評量方法（續）

① Crewmembers' recall of fatigue

② Monitoring crewmember fatigue during flight operations

③ Evaluating contribution of fatigue to safety events

- Checklist 1：疲勞形成條件評估
- Checklist 2：行為表現評估

Checklist 1: Establishing the fatigued state

QUESTIONS	BEST CASE RESPONSES	INVESTIGATOR'S NOTES
QUANTITY OF SLEEP *(Establish whether or not there was a sleep debt)*		
How long was last consolidated sleep period?	7.5 to 8.5 hours	
Start time?	Normal circadian rhythm, late evening	
Awake Time?	Normal circadian rhythm, early morning	
Was your sleep interrupted (for how long)?	No	
Any naps since your last consolidated sleep?	yes	
Duration of naps?	Had opportunity for restorative (1.5-2 hrs) or strategic (20 min) nap prior to start of late shift	
Describe your sleep patterns in the last 72 hours. (Apply sleep credit system)	2 credits for each hour of sleep; loss of one credit for each hour awake - should be a positive value	
QUALITY OF SLEEP *(Establish whether or not sleep was restorative)*		
How did the sleep period relate to the individual normal sleep cycle i.e., start/finish time?	Normal circadian rhythm, late evening/early morning	
Sleep disruptions?	No awakenings	
Sleep environment?	Proper environmental conditions (quiet, comfortable temperature, fresh air, own bed, dark room)	
Sleep pathologies (disorders)	None	
WORK HISTORY *(Establish whether hours worked and type of duty or activities involved had an impact on sleep quantity and quality)*		
Hours on duty and/or on call prior to the occurrence?	Situation dependent - hours on duty and/or on call and type of duty that ensure appropriate level of alertness for the task	
Work history in preceding week?	Number of hours on duty and/or on call and type of duty that do not lead to a cumulative fatigue	

Checklist 2: Establishing the link between fatigue and the unsafe act(s)/decision(s)

PERFORMANCE INDICATORS	INVESTIGATOR'S NOTES
Attention	
Overlooked sequential task element	
Incorrectly ordered sequential task element	
Preoccupied with single tasks or elements	
Exhibited lack of awareness of poor performance	
Reverted to old habits	
Focused on a minor problem despite risk of major one	
Did not appreciate gravity of situation	
Did not anticipate danger	
Displayed decreased vigilance	
Did not observe warning signs	
Memory	
Forgot a task or elements of a task	
Forgot the sequence of task or task elements	

組員疲勞評量方法 – 小結

- ICAO選擇上述疲勞評量方法之標準
  - ① 經過科學驗證
  - ② 經適當之規劃，組員仍可安全執行任務
  - ③ 航空界已在使用，有利於經驗交流與比較
- 航空公司如何選擇
  - ① 組員、管理階層及監理機關可接受
  - ② 預期可能之疲勞危害程度

TACARE疲勞相關報告評析

長程飛行任務駕駛員疲勞經驗報告

- 駕駛員執行為期七日之美國線任務，返回台灣後，公司有給予法定之休息時間，惟接著連續三日都是早班的短航線任務。由於先前的美國線任務身體狀況尚未恢復，執行至第三天早班任務時，已感到非常的疲勞。
- 加強飛航組員：飛航組員飛航二地之時間差如於六小時以上，且在不同時區超過四十八小時停留者，於任務完畢返回基地後至少於四十八小時內，航空器使用人不得再派遣任何飛航任務。

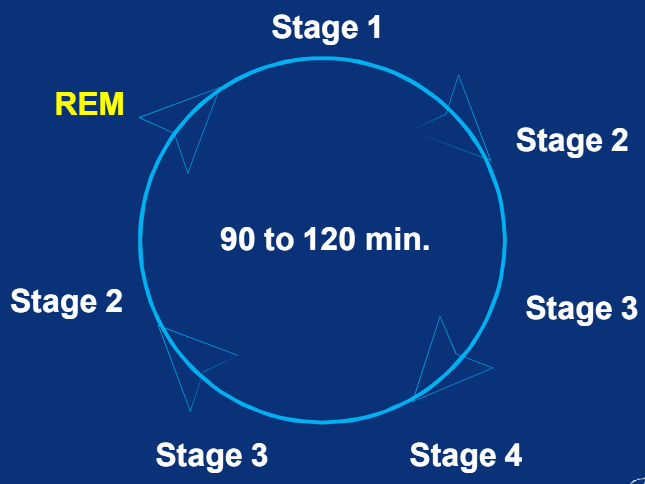
報告評析

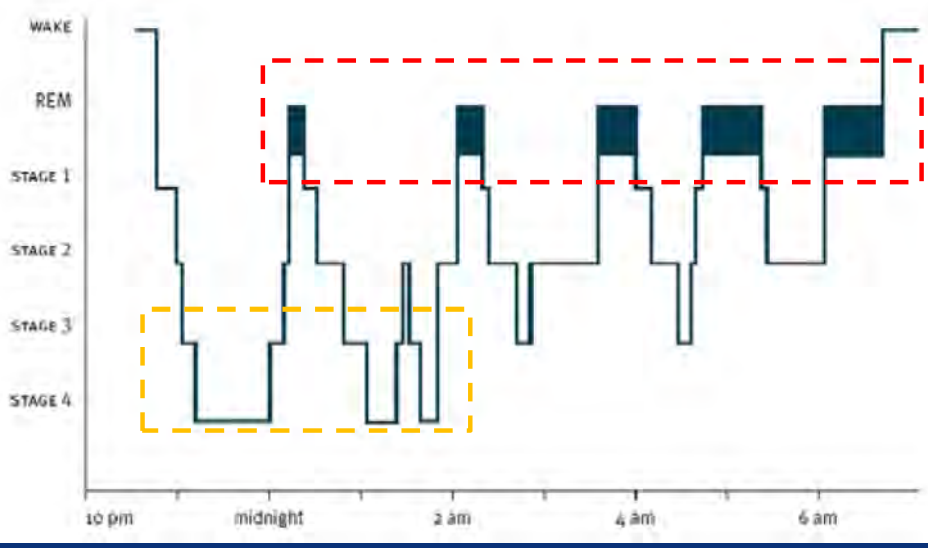
- 較長休息時間之目的
  - ① 時差調整
  - ② 彌補任務所造成之睡眠債（Sleep Debt）
- 至少48小時之可能原因

Sleep = REM + Non-REM

Non-REM = 淺眠（Stage 1&2）+熟睡（Stage 3&4）

Stage 3 + Stage 4 = Slow-wave sleep



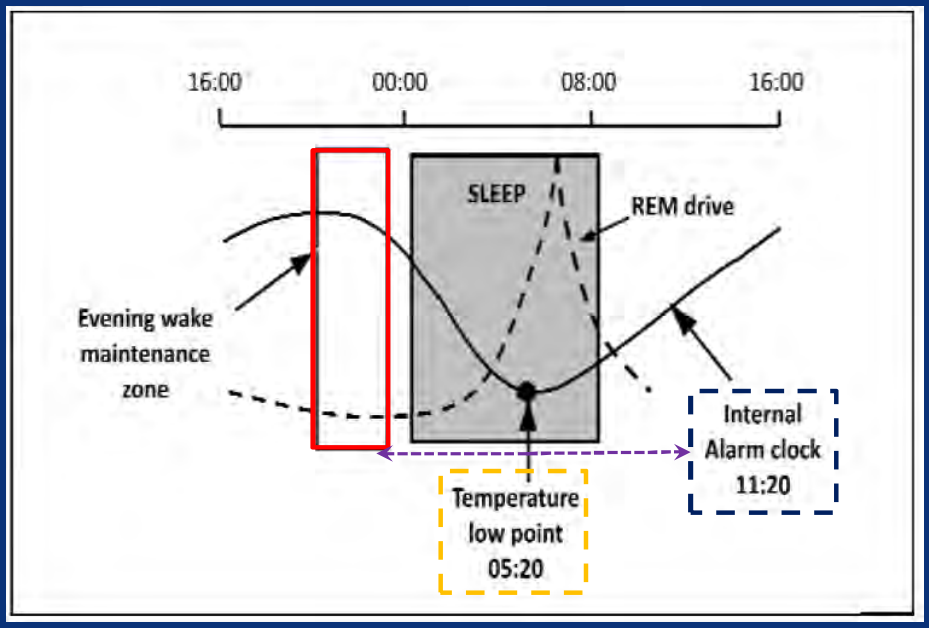


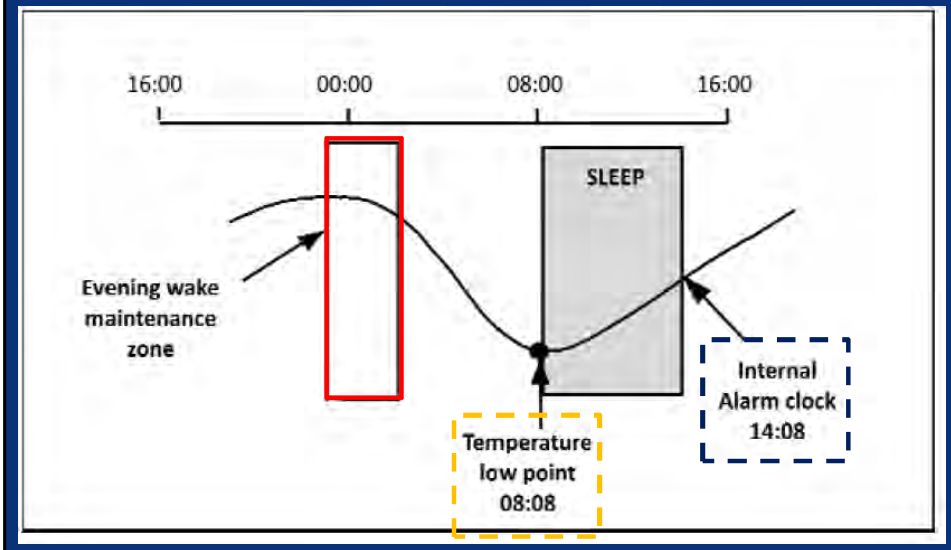
Mitigation Strategies for Sleep Debt

- Minimum of two consecutive night
  - ① First recovery night: more slow-wave sleep than usual, not enough time to REM sleep
  - ② Second night: more REM sleep than usual
  - ③ Third night: non-REM/REM cycle back to normal
- 48 hrs begin at 0200 vs 40 hrs begin at 2000
- Additional nights be needed if a crew circadian body clock not already adapted to local time zone

夜班維修人員疲勞相關報告

- 停機線維修人員因每月飛機調度，常值大夜班，致長期睡眠不正常。並出現上班時想打瞌睡、性情改變，易怒暴燥等疲勞徵狀。
- 維修人員疲勞相對被重視的程度較低。
- 生理時鐘雖會調整，然調整時間冗長，且無法完全與夜間工作/日間睡眠之作息型態匹配。





Mitigation Strategies for Night Duty

- Rotating clockwise & slow
- Napping before the duty period
- Napping during the duty period: napping should be limited to 40-45 mins；additional 10-15 mins to dissipate sleep inertia
- Night shift shorter
- Getting off duty earlier increases the time available for sleep in the morning, before the circadian body clock make it difficult for crew to stay asleep

結語

結語

1. 不論航空公司未來是否會使用FRMS管理組員疲勞，ICAO FRMS相關手冊中依據科學原則及知識所訂定之疲勞因應措施仍具參考價值。
   - What is happening in the brain during sleep
   - The issue of sleep quality
   - Consequences of not getting enough sleep
   - The circadian body clock and sleep
   - Sensitivity of the circadian body clock to light
   - Shift work
   - Jet lag
2. ICAO FRMS手冊附錄中，提供組員疲勞評量方法及組員駕駛艙休息程序等相關資訊，可做為航空公司疲勞管理之參考。

結語（續）

3. 本次研討會後，本會仍繼續藉由「飛安自願報告系統簡訊」分享有關疲勞管理之相關資訊。

- http://www.tacare.org.tw/

報告完畢