Flight Operations Support & Line Assistance

coping with

long-range flying

Issue I - November 1995

Customer Services

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coping with long-range flying

recommendations for crew rest and alertness a flight operations view

in co-operation with the Direction Générale de l'Aviation Civile & the University René Descartes in Paris

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TABLE OF CONTENTS

This recommendation guide was put together after a series of extensive field studies supported by the DIRECTION GENERALE DE L'AVIATION CIVILE spanning some 156 long-range flights during military transport and commercial airline service.

Data collection on physiological behaviour and crew functions and activities were the result of a joint effort by the UNIVERSITY RENE DESCARTES in Paris and AIRBUS's Training and Flight Operations Support Division.

Volunteer crews of COTAM, SABENA, NORTHWEST, UTA, AEROMARITIME, AIR France and LUFTHANSA provided invaluable cooperation for this years-long effort that led to a solid set of practical recommendations.

Operations engineers from Airbus (P. Alizon, A. Balk, Ph. Burcier, M. Brandt, M.H. Combes, C. Monteil, J.J. Speyer) assisted medical researchers from the Laboratoire d'Anthropologie Appliquée (Prof. A. Coblentz) and the Laboratoire de Physiologie des Adaptations (Dr J.P. Fouillot of Cochin Faculty) and provided operational experience without which this work would not have been achieved. For the A340 certification the German DLR also participated with the team of the Institute of Flug Medecine led by Dr H. Wegmann. Dunlap & Associates (R.D. Blomberg, J. Hamilton, B. Bassin) provided invaluable support to this program with contribution for workload measurement and flight crew observation software.

Initiated and developed at Sabena (A310), Northwest (A320), UTA (DC-10, B747-200, B747-400) and Aeromaritime (B767) the following recommendations were tested and validated at Air France (B767-300, A340). They were successively compiled, structured and written by the following authors:

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Would you please send your comments critics and remarks to the following contact point at AIRBUS. They will be taken into account in the following issues to be edited.

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Aeronautical

ACARS	:	Aircraft Communications Addressing and Reporting System
AFS	:	Automatic Flight System
APP	:	Approach
ATC	:	Air Traffic Control
ATIS	:	Air Terminal Information Service
ATS	:	Autothrust System
A/T	:	Autothrottle
BRG	:	Bearing
CM	:	Crew Member
CM1	:	Aircraft Captain or left-seated pilot
CM2	:	Aircraft First Officer or right-seated pilot
C/L	:	Checklist
CDU	:	Control & Display Unit (cathode ray tube)
CRM	:	Crew Resource Management
ECAM	:	Electronic Centralized Aircraft Monitor
EICAS	:	Engine Indicating Caution & Advisory System
EFIS	:	Electronic Flight Instrument System
ELS	:	Electronic Library System
ETOPS	:	Extended Twin Operations
ETP	:	Equitime Point
FAC	:	Flight Augmentation Computer
FFCC	:	Forward Facing Crew Cockpit
FBW	:	Fly-By-Wire
FCOM	:	Flight Crew Operating Manual
FCU	:	Flight Control Unit
FD	:	Flight Director
FMS	:	Flight Management System
FMGS	:	Flight Management and Guidance System
FWC	:	Flight Warning Computer
GA	:	Go Around
G/S	:	Glideslope
HF	:	High Frequency
IMC	:	Instrument Meteorological Conditions
ILS	:	Instrument Landing System
LOC	:	Localizer
MCDU	:	Multipurpose Control & Display Unit
MCP	:	Mode Control Panel
NAV	:	Navigation
ND	:	Navigation Display

PF	:	Pilot Flying
PFD	:	Primary Flight Display
PNF	:	Pilot Not Flying
PROF	:	Profile
SD	:	System Display
SOP's	:	Standard Operating Procedures
SSR	:	Secondary Surveillance Radar
VHF	:	Very High Frequency
VMC	:	Visual Meteorological Conditions
VNAV	:	Vertical Navigation
VOR	:	VHF Omni Range
WD	:	Warning Display

General

ADL	:	Aircrew Data Logging System
AWM	:	Airbus Workload Measure
DGAC	:	Direction Générale de l'Aviation Civile
DUNLAP	:	Dunlap & Associates, Inc, Norwalk, Connecticut, USA
OCV	:	Organisme de Contrôle en Vol
PC	:	Personal Computer
FAA	:	Federal Aviation Administration
NASA	:	National Aeronautics & Space Administration

Medical

α	:	Alpha
β	:	Beta
δ	:	Delta
θ	:	Theta
ECG	:	Electro-cardiography
EEG	:	Electro-encephalography
EOG	:	Electro-oculography
GERPA	:	Groupe d'Etude et de Recherche en Physiologie Ambulatoire
LAA	:	Laboratoire d'Anthropologie Appliquée, Université René Descartes – Paris V
LPA	:	Laboratoire de Physiologie des Adaptations, Faculté de Médecine Cochin – Port Royal Université René Descartes – Paris V
RR	:	Time interval between two ventricular heart contractions

I - BOOKLET PRESENTATION

Initial flights starting at Sabena on A310 in 1990

Initial flights on A340 at Airbus Flight Test in 1992

Far Eastern flights on B747-400 at UTA in 1990

North American flights on B767-300 at Air France in 1993

This document provides a practical set of recommendations for the use of long-range crewmembers:

- alertness decrement,
- sleep,
- napping,
- life hygiene.

During long-haul rotations, partial or complete compliance with these recommendations should allow pilots to:

- better manage their levels of alertness in flight,
- limit sleep loss related to night flights,
- facilitate, if applicable, adaptation to local layover times, depending on time zone differences.

The choice of recommendations will of course have to be adapted to the circumstances. Partial reliance on these recommendations is therefore also acceptable.

To help the reader we should refer to two synonyms regularly used:

- **alertness** for level of arousal or wakefulness
- **jet-lag effects** for circadian desynchronosis.

This guidebook consists of three parts:

- A brief summary of research conducted by LAA-GERPA of the René Descartes University (Paris V) in cooperation with AIRBUS on alertness and sleep with long-haul flight crews,
- Practical cards concerning:
  - pre-flight rest and flights,
  - layover rest for westward eastward and north-south flights.
- Short summaries concerning alertness levels, alertness decrement, sleep, jet-lag effects, etc.

Summaries are provided to help with adapting or customizing recommendations, keeping all personal or cultural sleeping habits and social rhythms in mind. They can be used as a basis for adapting recommendations to cope with extreme cases, as for example, very early departures and/or very short layovers (cargo flights).

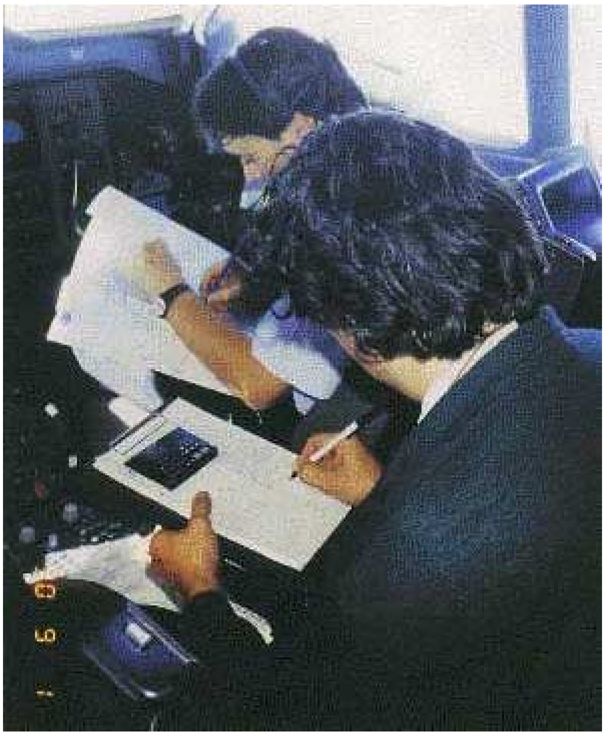
The preventive aspect of these practical suggestions must be emphasized. Their validity is not only based on most recent scientific knowledge but, above all, they reflect experimental validations conducted with long-haul technical crews.

Better sleep management through knowledge of one's own biological rhythms is a genuine personal undertaking. Once committed to, it should rapidly improve general well-being in one's professional activities and extra-professional life.

This approach should therefore provide a real contribution to improve health for air crew and air transport safety.

North American Flights on DC-10-30 at UTA in 1990

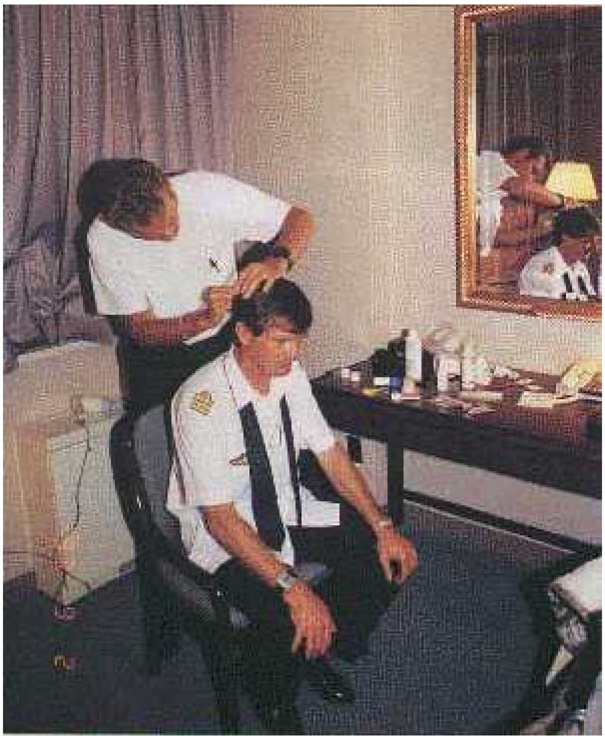
Delivery Flights to Northwest on A320 in 1991



Taking handwritten flight logs at Sabena in 1990

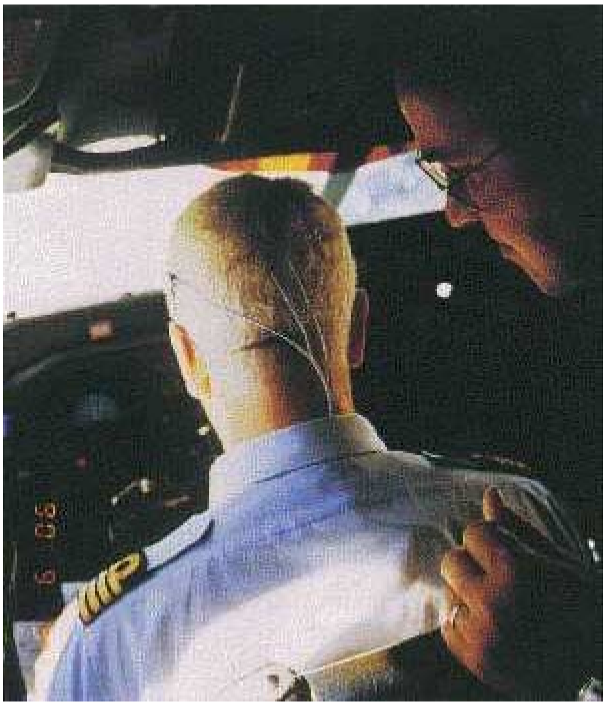
Aircrew Data Logging with laptop computer at Air France in 1993

II – DEVELOPING AND VALIDATING RECOMMENDATIONS: MAIN RESULTS



Preparing Air France pilots for ambulatory monitoring before departure

Volunteer Air France pilots with their equipment preparing for flight



Checking EEG encephalographic recording before take-off at Sabena

Checking EKG heart rate recording during cruise at Air France

The recommendations concerning the alertness and sleep of long-haul aircraft crews were developed following research conducted by LAA-GERPA. This endeavor, grant-aided by DGAC, was performed in three stages:

1 - Objective measurements of alertness decrement occurrences and sleep loss for pilots engaged in long- and very long-haul flights.

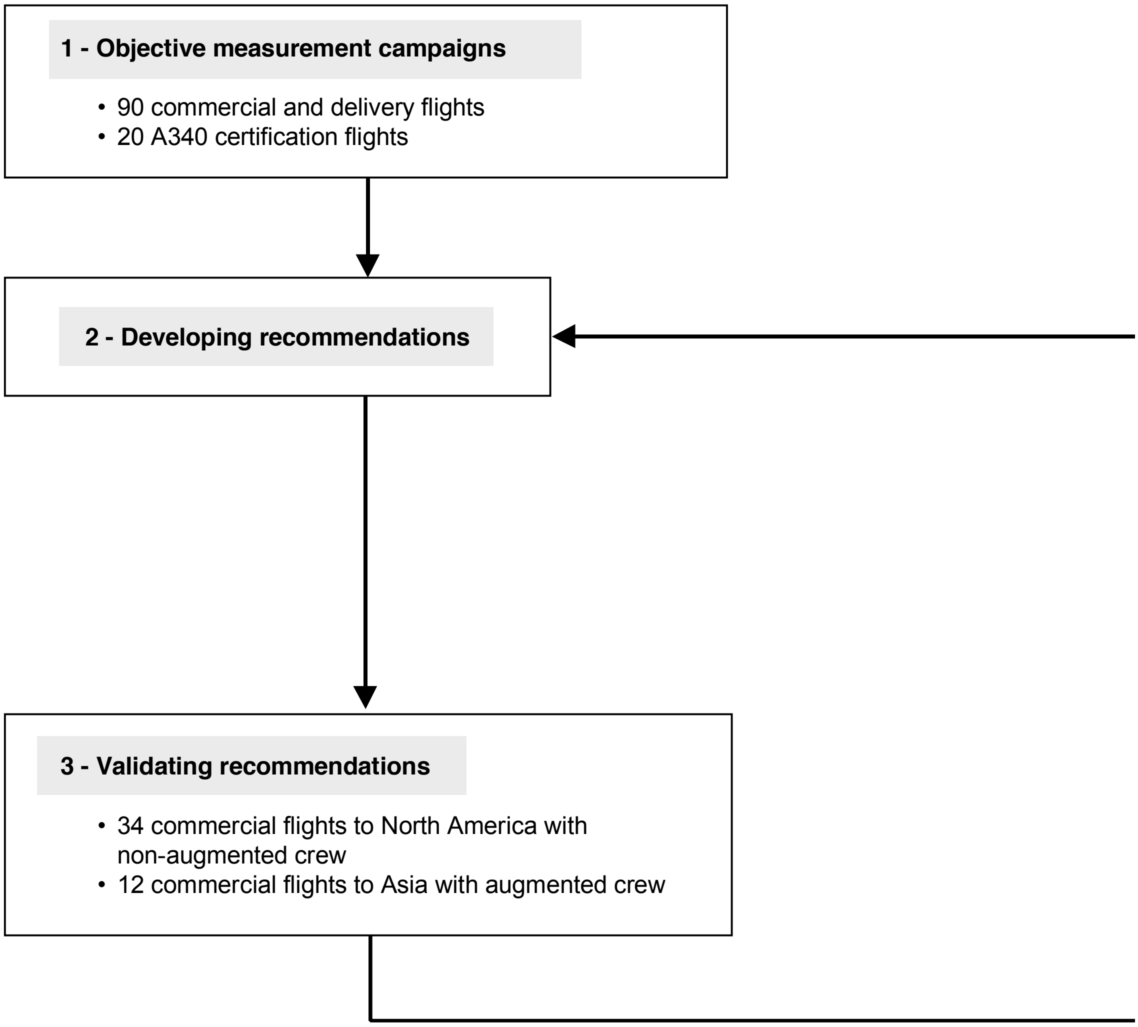
2 - Developing recommendations.

3 - Validating recommendations.

The part related to observation of flight management activities and workload measurement was performed in cooperation with AIRBUS operations engineers who participated activity to all flights.

Voluntary crews from several airlines, SABENA, NORTHWEST, UTA, Aeromaritime, LUFTHANSA, AIR FRANCE participated in this project. A total of 156 flights was made to various destinations on different types of aircraft: Boeing 747-200 and 747-400, Boeing 767, Mac Donnell Douglas DC-10, Airbus A310, Airbus A320 (delivery flights), and Airbus A340.

Our recommendations are also based on recent data from scientific literature in the aeronautical field and on the work conducted at LAA. This relates to alertness, sleep and rest-activity scheduling for personnel involved in supervisory activities and engaged in shiftwork and irregular working hours.


1 - Objective measurement campaigns
• 90 commercial and delivery flights
• 20 A340 certification flights
2 - Developing recommendations
3 - Validating recommendations
• 34 commercial flights to North America with non-augmented crew
• 12 commercial flights to Asia with augmented crew

Literature

- Main work:
  - resynchronization of biological rhythms after transmeridian flights (Klein and Wegmann, 1974)
  - sleep and jet lag (Nicholson et al. 1986; Sasaki et al., 1986)
  - cockpit napping effects (Graeber et al., 1990)

(refer to syntheses)

LAA work

- Impact of monotony breaks on alertness and operators' performance (Cabon, 1992):
  - laboratory work
  - validation with military air surveillance operators
  - findings with control room operators in nuclear powerplants.

- Use of bright light to prevent disorders related to changes in sleep-wake schedules (Bougrine, 1994):
  - laboratory work
  - validation with operators working on offshore barges
  - prevention of jet-lag in top-level sportsmen who travel.

(refer to syntheses)

Recommendations booklet

- Recommendation cards
  - Pre-flight rest
  - In-flight rest and activities management
  - Layover sleep management
- Syntheses: alertness levels, circadian rhythms, sleep, napping, etc.

1 - OBJECTIVE MEASUREMENT CAMPAIGNS

1.1 - Alertness levels and decrements in long-haul technical crews

PERIODS CHARACTERIZED BY ALERTNESS DECREMENTS OCCUR FREQUENTLY:
UP TO 15 % OF ACTIVE DUTY TIME SPENT IN COCKPIT

These periods are predominantly observed:

- during transatlantic (Europe-North America) and north-south flights with non-augmented crews, somewhat less frequently on transcontinental flights (Europe-Asia),
- during quiet cruise phases, when the crew is not engaged in any specific activity (monitoring),
- immediately after meals or snacks,
- during periods favouring sleep (11pm – 1am and 1pm – 3pm).

They often occur:

- simultaneously for both pilots, even for basic non-augmented crews,
- during critical phases (e.g. descent) or when the crew is performing tasks related to flight management (i.e. radar control, etc.).

These are reduced under certain circumstances:

- verbal communications,
- motor activities associated with mental tasks, for example, navigation management (i.e. FMS).

Observing the crew's activity reveals a spontaneous tendency to synchronize periods of activity and rest which can explain the occurrence of simultaneous alertness decrements. In addition, the mutual knowledge that the pilots may have of the aircraft and the sector may contribute towards reducing the alertness levels.

1.2 - Layover sleep duration and quality

SLEEPING DURATION AND QUALITY ARE REDUCED BY JET-LAG AND NIGHT FLIGHTS

The following are observed:

- extensive sleep loss related to night flights,
- layover sleep, timing, duration and quality are not significantly affected on transatlantic rotations when the outbound flights are made during daytime,
- rebound effects on layover sleep for rotations comprising night-time outbound flights eastwards-westwards. A rebound effect is characterized by an increase in the duration and a reduction in the quality of sleep leading to very frequent awakenings.

1.3 - Duration and quality of in-flight sleep with augmented crews

THE DURATION AND QUALITY OF IN-FLIGHT SLEEP DEPEND ON THE PREVIOUS PERIOD SLEEP AND ON THE REST TIME SCHEDULING IN FLIGHT

The following was observed:

- absence of crew coordination in the days preceding the flight and, therefore, insufficient preparation for the rotation not taking into account in-flight rest schedules.

This results in:

- short sleeps of poor quality for rests taken during the early part of the night flight,
- longer duration and better quality of sleep during the latter parts of the flight.

2 - DEVELOPING RECOMMENDATIONS

AIMS:
TO REDUCE ALERTNESS DECREMENT EPISODES IN FLIGHT, MAINLY THOSE OCCURRING SIMULTANEOUSLY FOR BOTH PILOTS THROUGH:

- **GOOD SLEEP MANAGEMENT,**
- **ORGANIZATION OF ACTIVITIES REDUCING MONOTONY IN THE COCKPIT,**
- **OPTIMAL FLIGHT REST ORGANIZATION.**

The recommendations:

- <u>Sleep and nap management before the rotation</u> as a function of in-flight rest times, when this can be planned in advance.
- Management of in-flight activities and rest:
  - desynchronization of activity and rest periods for the two pilots: alternating <u>passive and active vigilance phases</u> every 20 to 40 minutes with formal handover between pilots; this recommendation should contribute to enhance crew cooperation,
  - alternating meals,
  - mainly for night flights: making use of passive vigilance phases <u>to take a nap of 20 to 40 minutes</u>,
  - for flights with augmented crew, modulation of rest time according to its timeframe: in particular, increasing rest duration when taken during first part of flight.

- Layover rest:
  - adjustment to local time or not, depending on layover duration,
  - sleep and nap management,
  - exposure to daylight, moderate physical exercise,
  - food hygiene (drinking of coffee, tea, etc.)

These recommendations have been devised to be adaptable to all long-haul flights. Their strict application pertains mainly to extreme situations, in particular for cargo flights, with very early departures (6am) and including very short layovers (less than 24 hours).

3 - VALIDATING RECOMMENDATIONS

Validation was carried out in two stages:

- validation on 34 transatlantic long-haul flights, flight times varying between 8 and 11 hours,
- validation on 12 very long-haul flights to Asia, with augmented crew, including flights of 12 to 16 hours.

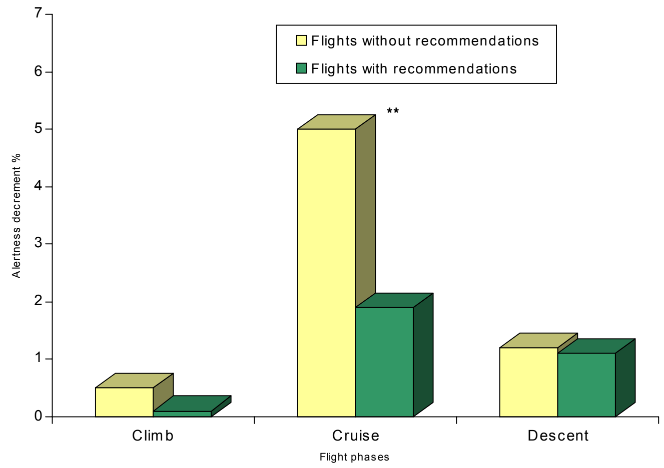
Recommendations proved their efficiency by significantly reducing rates of alertness decrements for both outbound and return flights.

This reduction was particularly noticeable for cruise phases and could be attributed to a drop in sleep pressure and monotony in the cockpit.

3.1 - Results

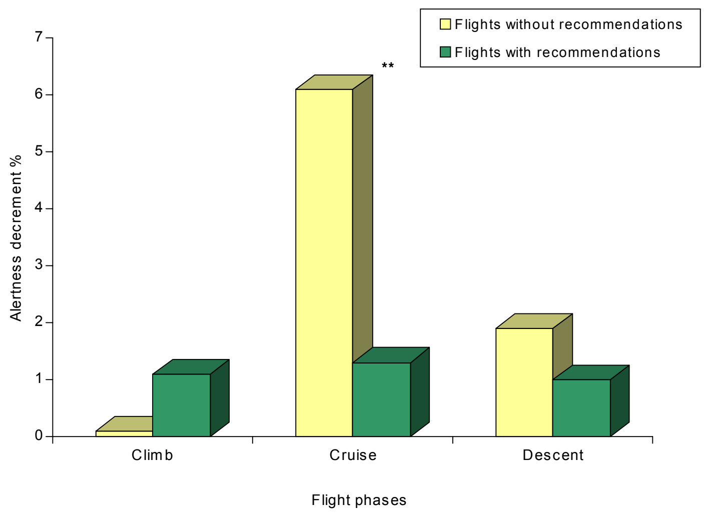
3.1.1 - Long-haul transatlantic rotations

Outbound flights - Europe ⇨ North America



** significant at $p < 0.001$

Return flights - North America ⇨ Europe



** significant at $p < 0.001$

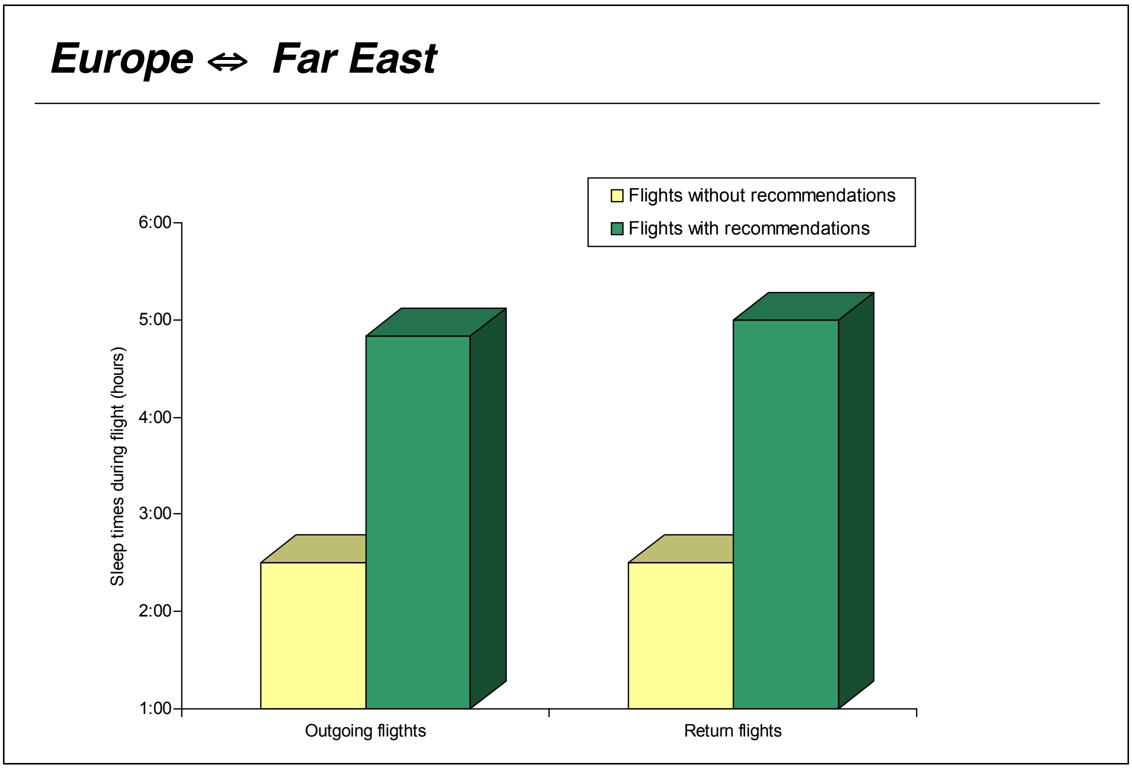
The alertness decrement percentage (%) was determined for each flight period. It was calculated taking into account the effective active presence of pilots in the cockpit.

3.1.2 - Very long-haul flights to Asia with augmented crew

3.1.2.1 - Sleep duration and quality during flight

The recommendations contribute towards:

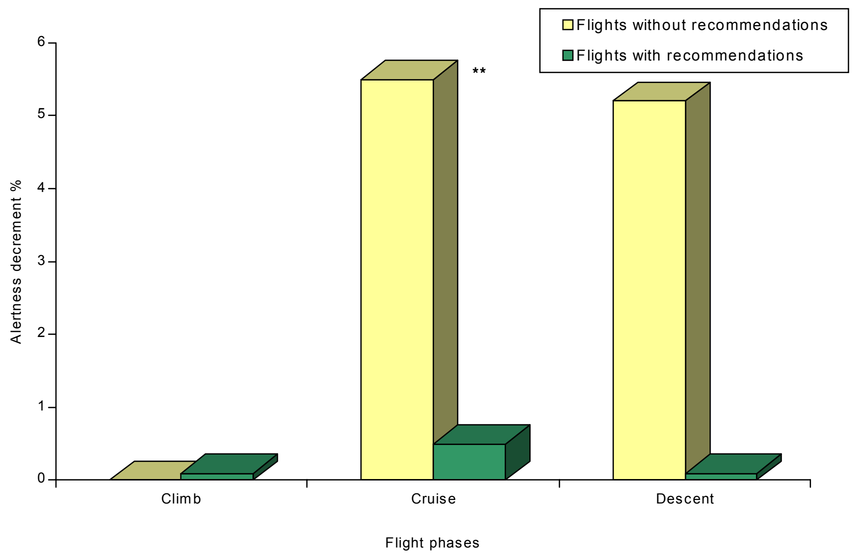
- better distribution of sleeping times, irrespective of rest schedule,
- significant increases in sleep duration and quality during in-flight rest periods.



3.1.2.2 - Alertness decrement percentages during flight

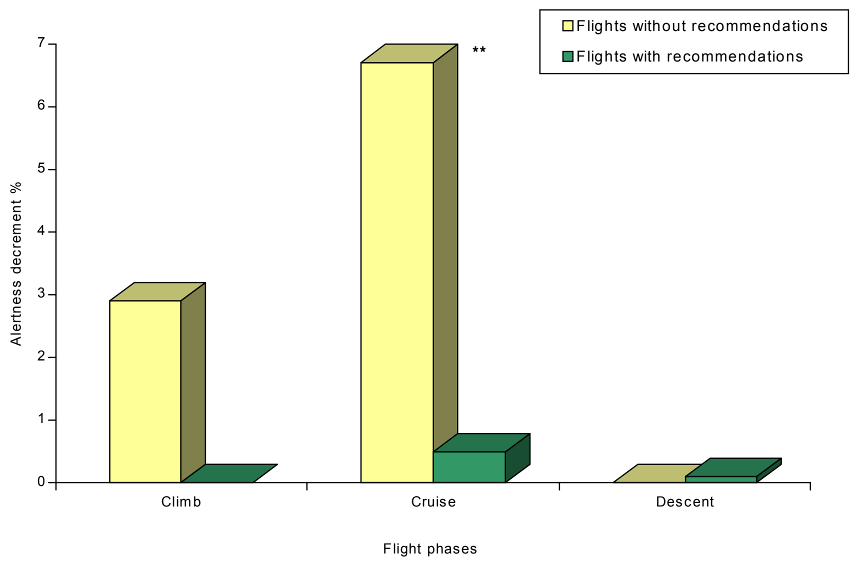
As with flights made with basic non-augmented crew, recommendations reduced the alertness decrement percentages both for the outbound and return flights. This reduction can be attributed to an increase in sleeping times during in-flight rest periods and to a reduction in monotony in the cockpit.

Outbound flights - Europe ⇨ Far East



** significant at p < 0.001

Return flights - Far East ⇨ Europe



** significant at p < 0.001

The alertness decrement percentage (%) was determined for each flight period concerned. It was calculated taking into account the effective active presence of pilots in the cockpit.

4 - PARALLEL COMPANION STUDIES

Companion studies on crew workload and crew observation were carried out in parallel to the ambulatory monitoring work described in the above. Initiated with minimum crew studies as from the early 1980's, crew workload was first estimated by means of subjective rating and subsequently resulted in an objective measure to be described in 4.1. Likewise, the observation of crew functions and activities was first performed by paper and pencil, subsequently complemented by coding grids and ultimately resulted in a dedicated computer software to be described in 4.2.

4.1 - Airbus Workload Measure

The Airbus Workload Measure is based on a statistical model that predicts the rating a pilot would have given on the seven point Airbus Rating Scale (values two through eight). This scale is the core of the Airbus dynamic workload assessment technique which was used for the certifications of the A300 FF, A310 and A320 aircraft. The Minimum Crew Campaign of the A320 certification in January 1988 was the first opportunity to use the Airbus Workload Measure in parallel with actual pilot ratings to demonstrate the workload characteristics of a new aircraft. It showed excellent correspondence between the Airbus Workload Measure values and the actual subjective quotations given by the pilots during the certification flights. The whole AWM-project resulted in a patent held by Airbus, Dunlap & Associates and the Laboratory of Adaptation Physiology at Cochin Faculty of Medecine in Paris.

The success of the Airbus Workload Measure in the A320 certification led to its use in this ongoing study of vigilance and workload in long range airline flights on a variety of aircraft types. In turn, this led to an agreement to use it as the primary workload measure during the A340 Minimum Crew and Route-Proving Campaigns which were conducted in late 1992.

A specific value of the Airbus Workload Measure for one pilot at a particular second of flight is calculated from a combination of aircraft flight parameter data, such as airspeed, angle of attack and roll angle, heart rate variability data on *both* pilots and flight status measures such as whether or not a checklist was being run by the crew. The flight status data are derived from observations of the crew either directly or via video and audio from the cockpit and recorded on paper or by using the Aircrew Data Logging System (ADL).

4.2 - Aircrew Data Logging System

The Aircrew Data Logging System (ADL) is a computer-based tool to be used by observers to create a record of selected system events. The ADL record forms a timeline of the observed events which can be integrated with other time-based records of system events as well as with external time-based records.

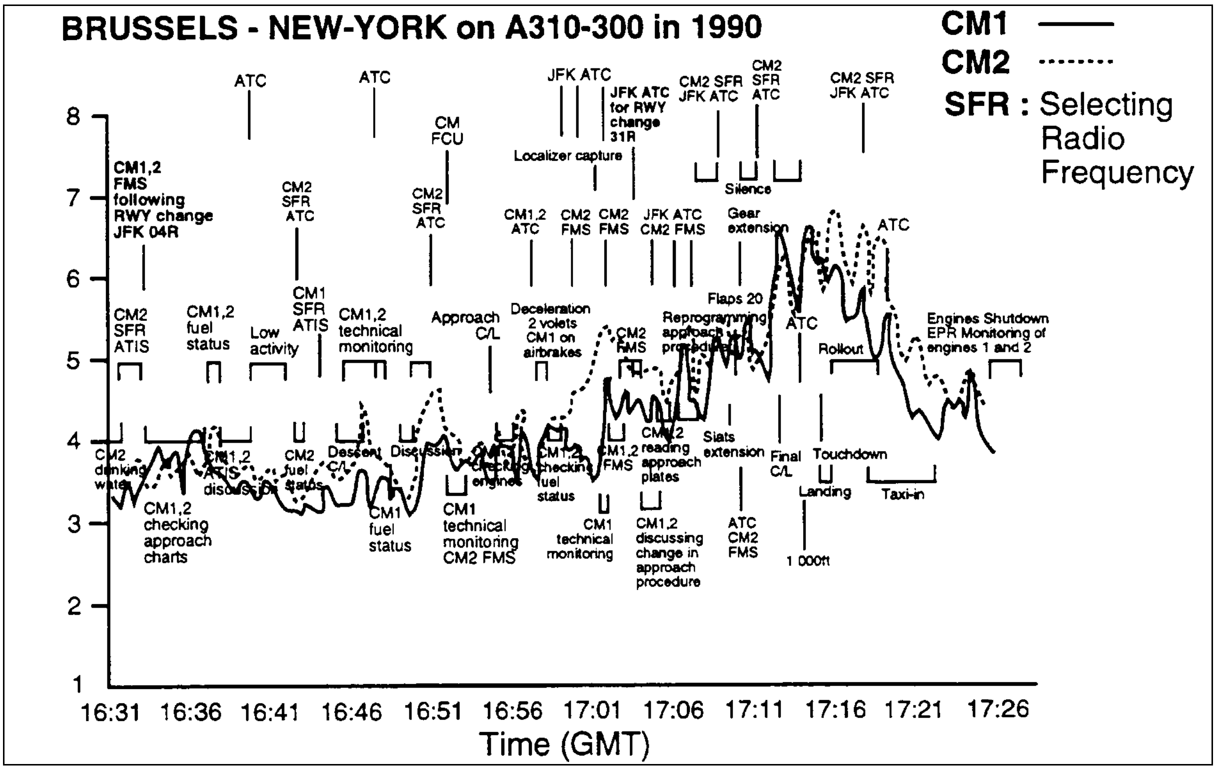
Because it is computer based, ADL is a highly structured system, and this structure directly affects how and how well it can be applied to a system of interest. In our case this consisted in defining a script involving variables pertaining to crew behaviours, vigilance and alertness, crew activity and flight functions.

ADL, which runs on a standard notebook computer, was developed to support the preparation of a narrative description of each flight, the collection of the status data needed by the Airbus Workload Measure and the collection of information required to analyze a data base of physiological measures taken on those pilots who volunteered.

4.3 - Results from Workload Measurement

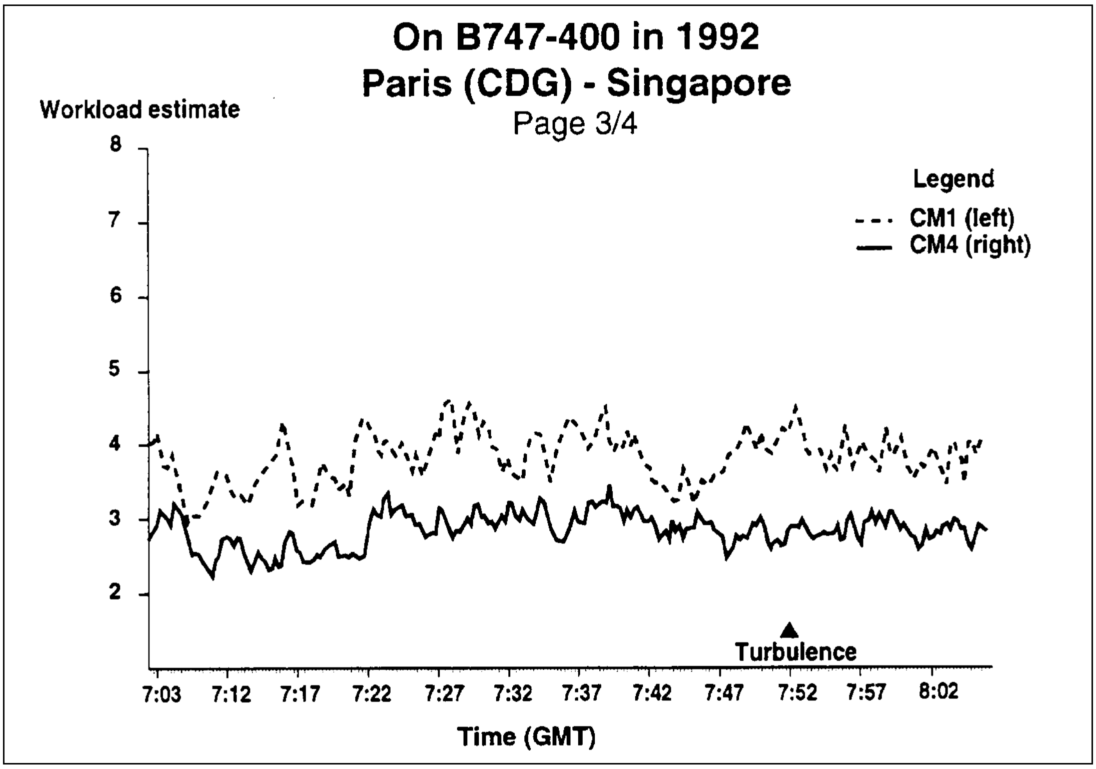
Examination of crew workload timelines shows several interesting patterns. First, the high workload imposed on pilots from flying into busy or unfamiliar airports and at the end of long night-time flights is suggested by many of the landings.

Measuring crew workload in airline operations: approach & landing example



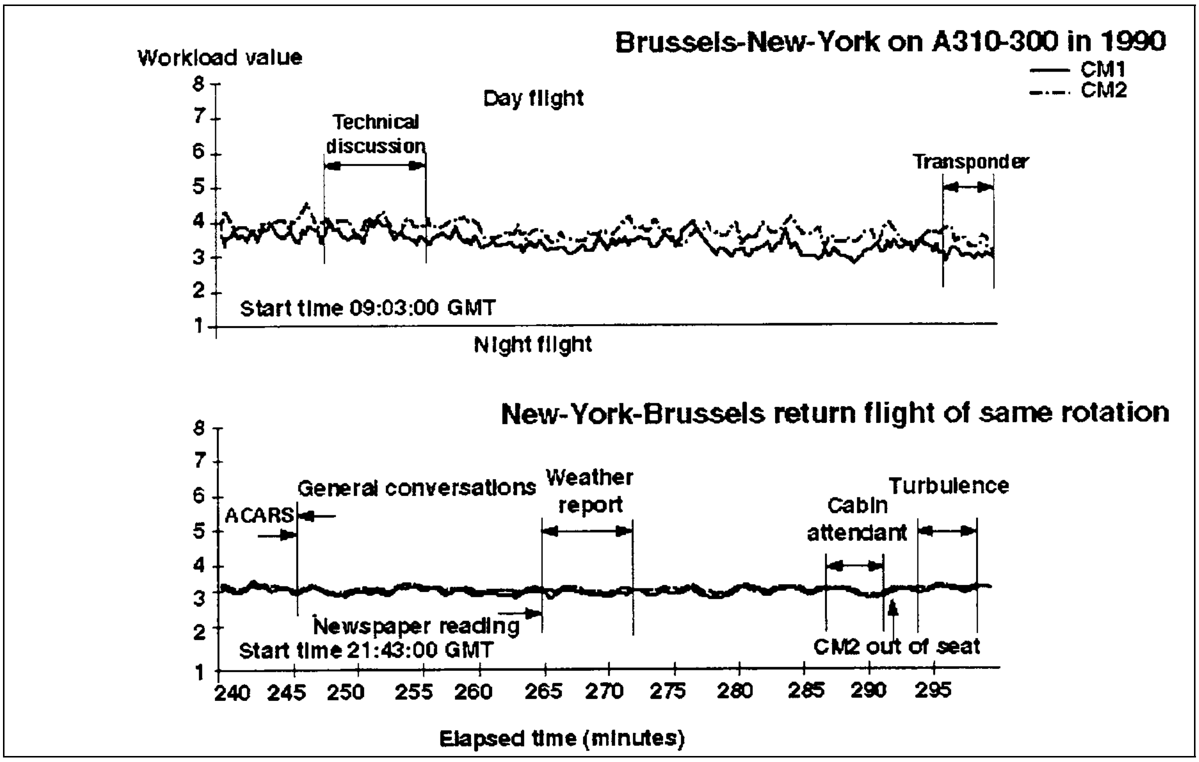
Second, there are several periods of relatively higher workload evident in some of the timelines. These do not appear to correlate with logged stressful events. They may be the result of additional transient data artifacts which eluded the various screens in the processing programs. Alternatively, they could be real periods of elevated subjective mental workload which are internally generated by the pilots as a result of cognitive activities (related or unrelated to the flight).

Measuring crew workload in airline operations: cruise segment example



Third, the cruise portions of those flights occurring at night seem to show a lower second-to-second variability of workload than the corresponding parts of day-time flights even though the average level of workload is about the same.

Measuring crew workload in airline operations: cruise segment example



This is indicated by their relatively flat timeline curves compared with the "sawtooth" appearance of the timelines for the daytime flights. This suggests that workload variability measures may be a viable predictor of episodes of low crew alertness. Underload may represent the shedding of "discretionary workload" (e.g. loss non-flying tasks, no conversation) which pilots may choose not to generate. This can result in reduced activation levels and increased chances of alertness decrement.

4.4 - Results from Aircrew Logging

Timewise logging of flight events to produce a narrative description of the flights allowed to regroup sequences where both crew-members PF and PNF would actively cooperate.

Two categories emerged:

- long regroupings or **blocks** where both pilots would execute strings of coordinated tasks linked with increased cross-monitoring (e.g. descent preparation),
- short regroupings or **knots** where both pilots would promptly act in concert with each other in short transactions (e.g. navigation monitoring after an ATC message).

- These operational stimuli cause a flight to be structured around a series of blocks and knots where vigilance and cross-monitoring can be expected accrued as compared to routine conditions. These formal meeting periods or points, distinguish themselves from periods, where crew-members' interaction is more lax.

Overall sequence regroupings were found to be naturally related to operational requirements (ATC, FMS, fuel, navigation, systems), key events (weather, traffic, incidents/failures) and crew resource management behaviours (communications, decision-marking and planning, workload and vigilance management).

Comparing workload measurements with a subset of flights where alertness measures (EEG/EOG) were recorded allowed us to observe that:

- alertness decrements would tend to concur with flat workload curves and be located between blocks and knots discussed in the above, with little or no crew conversation,
- variable workload profiles would rarely concur with decreased alertness encounters.

The combined workload and reduced alertness data effectively suggest that periods of high and highly variable workload often seem to prevent or stop brief alertness decrements. Extended periods of low workload are often punctuated by low alertness episodes. Workload for both crew-members appear to decrease during extended periods of low alertness associated with planned rest or napping.

Flights do really consist of a succession of blocks and knots where workload continually increases and subsides; high peak being dealt with until they return to normal, unless situations or particular flight phases militate against this.

Afterwards alertness decrements may arise until the progressive accumulation of new potential tasks whose regrouping into sequences will, in turn, suspend the alertness phenomenon. These crew regulation cycles are inevitable and need to be managed. Contrary to some expectations, levels of crew-member cross-monitoring are not necessarily continuously maintained.

This is how the observation of alternating crew-member activity patterns led us towards the concept of active/non-active monitoring cycles since these were proven to exist implicity. But the process had to be formalized to result in a practical recommendation: active/passive vigilance largely explained in the other sections.

4.5 - Practical Procedures

Possible remedies in crew-generated workload are defined as operational countermeasures and relate to the following:

- Long-range navigation monitoring such as:
  - flight log updating
  - navigation chart plotting (FMS position)
  - course and distance between waypoints
  - IRS drift rate monitoring
  - crosschecking position BRG and/or DME dist with navaids.
- Long-range fuel monitoring such as:
  - extra fuel monitoring (FMS)
  - secondary flight plan/reclearance (ATC)
  - step prediction (ATC)
  - ETP monitoring (ETOPS)
  - weather en route/altitude winds (ACARS or HF)
- Systems monitoring
  - pre-advisory parameter trend checks on ECAM system display pages (every 30 minutes)
  - zooming function (electronic library system). w

4.6 - Practical Procedures recommended on A340

Based upon the preceding results, the following procedures are now available for cruise operations in the flight crew operating manual of the A340.

They were developed for this aircraft having in mind the low workload/reduced alertness context prevailing in cruise. And they provide practical guidance to support the active/passive vigilance recommendation. Dedicated adaptation to other aircraft types remains necessary however.

CRUISE

– **ECAM MEMO** . . . . **REVIEW**

– **ECAM SYS PAGES** . . . . **REVIEW**

Periodically review S/D pages and in particular :

ENG : Oil press and temperature

Note : *Oil quantity variation is not linear during the cruise. A rapid decrease can be noted especially at the beginning of the flight.*
This is due to an oil temperature decrease leading to a longer oil transit time in the sumps (more oil retained in the sumps).

BLEED : Check BLEED parameters
ELEC : Check parameters, GEN loads
HYD : Check fluid quantity. Green sys is lower than on ground following L/G retraction.
COND : Check duct temperature compared with zone temperature. Avoid large differences for reason of comfort.
FLT CTL : Note any unusual surface position.
FUEL : Check fuel distribution, trim tank quantity and CG.

– **FLIGHT PROGRESS** . . . . **CHECK**

Note : *VLS shown on PFD ensures 0.3 g buffet margin, and therefore no additional margin is necessary in cruise.*

Flight progress must be monitored in the conventional way.
When overflying a waypoint ;
· Check track and distance to the next waypoint.
· Check Fuel : Check FOB (ECAM), fuel prediction (FMGC) and compare with the computer flight plan or the in cruise quick check table (3.06.20).

– **STEP FLIGHT LEVEL** . . . . **AS APPROPRIATE**

(Refer to 3.05.15)

– **NAVIGATION ACCURACY** . . . . **CHECK**

Navigation accuracy must be monitored, particularly when any of the following occur :
· IRS only navigation
· LOW accuracy is displayed on PROG page or
· NAV ACCUR DOWNGRAD message appears.

Note : *If HIGH accuracy is displayed on PROG page, the FM accuracy meets the EN ROUTE criteria.*
Nevertheless it is recommended to perform a check periodically when Navaids are available. It allows the FM position error to be quantified.

Methods for accuracy check :
· Manually tune VOR (VOR/DME or ADF) that is within range on RAD NAV page and select associated needles on ND.
Check that the needle (raw data) overlies the corresponding blue navaid symbol (FM computed) and that the DME distance is equal to the distance in between the a/c symbol and the navaid symbol on the ND.
· or insert VOR/DME (VOR-ADF) ident in BRG/DIST TO field on PROG page and compare the computed BRG (DIST) with the Raw data on the ND. This last method allows the FM error to be quantified.

If the check is positive (error ≤ 3NM EN ROUTE) : FM position is reliable.
– ND ARC or NAV and managed lateral guidance may be used.

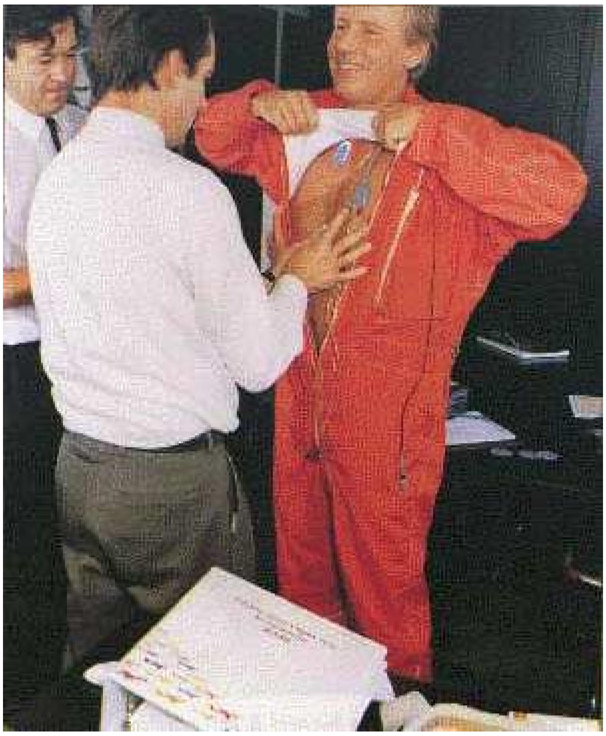
If the check is negative (error > 3NM EN ROUTE) : FM position is not reliable.
– Refer to raw data for navigation and monitor it.
– If a gross mismatch between display and real position is detected : disengage MANAGED NAV mode and use Raw data navigation (possibly switch to ROSE VOR so as not to be mislead by FM data).

– **RADAR TILT** . . . . **ADJUST**

Cruise (middle alt up to 20 000 ft)	: A near zero degree tilt setting should be adjusted. Should two different ranges be selected on both NDs it is recommended to set a down tilt with the shorter ND range (in order to monitor and detect weather activity) and a near zero tilt with the longer ND range (in order to monitor course changes).
Cruise (high altitudes)	: A slight downward tilt is recommended.

– **CABIN TEMP** . . . . **MONITOR**

Regular attention should be paid to the ECAM CRUISE page so that passenger cabin temperatures may be monitored and adjusted if requested by cabin crew.



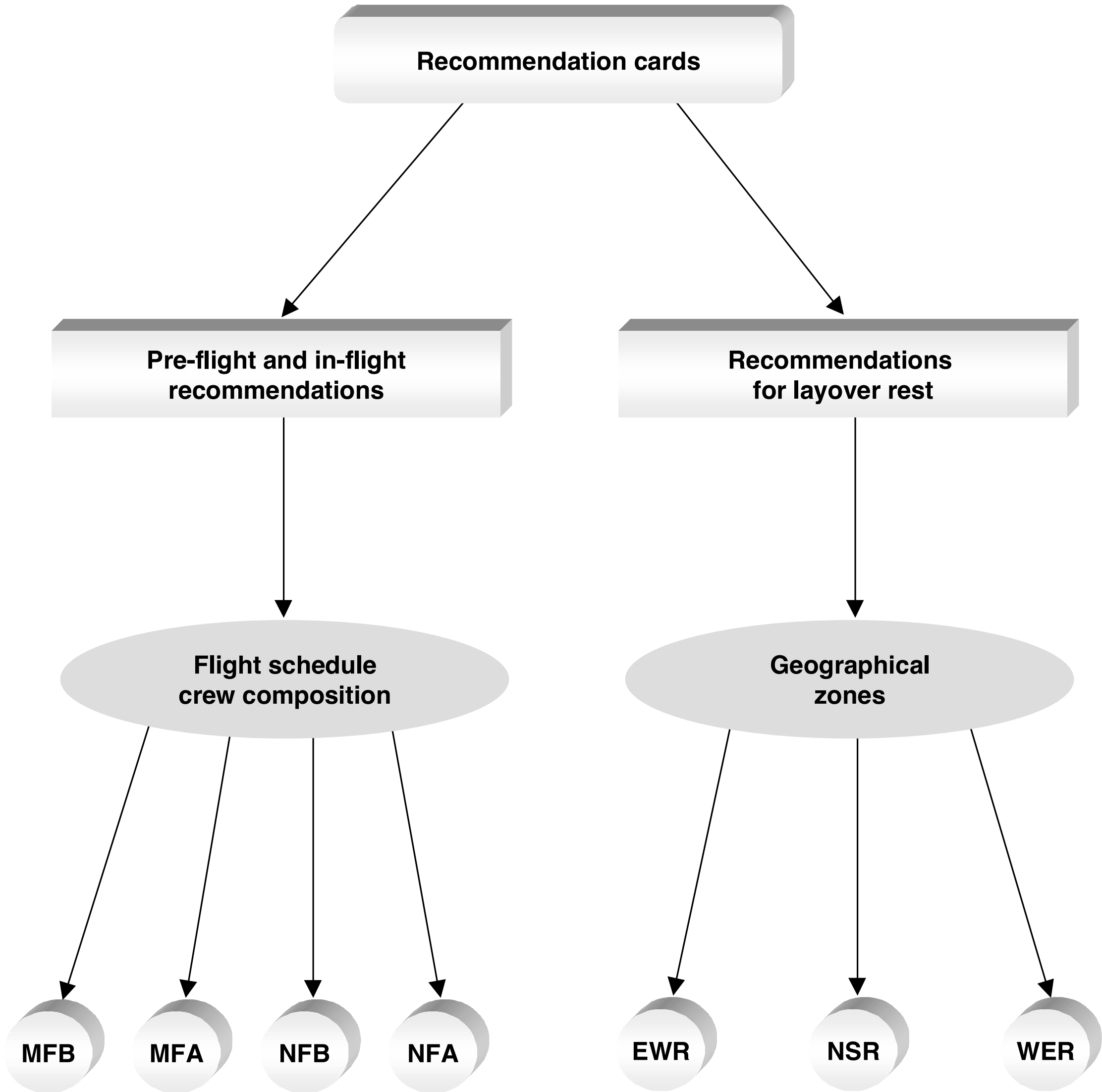
Preparing Pierre Baud for ambulatory recording before the A340's maiden flight

The A340 on its first climbout on October 25th, 1991

Double logging from remote video on board A340 route proving flight at Air France

Landing at Quito with Lufthansa in A340 route proving campaign

III – USE OF RECOMMENDATIONS CARDS



Cards organization and layout

1 - CARDS ORGANIZATION

The cards which follow contain practical recommendations directly applicable to rotations that you will make. They take into account most situations that you may encounter on a long-haul network, composed of commercial and cargo flights.

These cards are organized according to two main categories:

- recommendations for pre-flight rest and flights,
- recommendations for layover rest.

For each of these categories, you will find a diagram to rapidly locate the card to be considered. These cards are identified by means of a code consisting of letters and a number.

1.1 - Pre-flight and in-flight recommendations

For these recommendations, two factors are taken into account:

- flight schedule: morning (6am – 12am), afternoon (12am – 5pm) or evening (after 5pm),
- crew composition, basic or augmented, corresponding to long-haul flights and very-long-haul flights respectively.

The comparison of these factors led to the creation of four card types equally valid for the outbound and return flights:

- **MFB**: **M**orning or afternoon **F**light with **B**asic non-augmented crew,
- **MFA**: **M**orning or afternoon **F**light with **A**ugmented crew,
- **NFB**: **N**ight **F**light with **B**asic non-augmented crew,
- **NFA**: **N**ight **F**light with **A**ugmented crew.

1.2 - Recommendations for layover rest

These are three categories, depending on time difference with regard to Base Time (BT).

- East-West Rotations (**EWR**) : time difference travelling, equal to or greater than BT – 4,
- North-South Rotations (**NSR**) : small time difference between BT – 3 and BT + 3,
- West-East Rotations (**WER**) : time difference travelling, equal to or greater than BT + 4.

A card organization diagram is given for each rotation category. On each diagram, three factors are presented according to the difficulties involved: layover time, outbound flight schedule and return flight schedule. For EWRs and WERs, the layover time was considered as being the most important factor as it determines the jet-lag effect to be faced. For NSRs, the outbound and return flight schedules are important because they allow to determine the more active parts of the layover to be determined, and rotations requiring diurnal rest with daytime sleep to be identified.

2 - CARD DESCRIPTION

2.1 - Pre-flight and in-flight recommendations

Each card (**MFB**, **MFA**, **NFB**, **NFA**) contains the following information:

- identifier
- main flight characteristics,
- recommendations for pre-flight rest period,
- recommendations for flight activity management. For flights with augmented crews, a schematic illustrating the text is given on the left side of the card.

2.2 - Recommendations for layover rest

Each card consists of three parts:

- written recommendations,
- a schematic illustrating these recommendations,
- a space reserved for personal notes.

The *written part* includes:

- card identification,
- the main characteristics of the rotation,
- the recommendations themselves.

The *schematic* represents time periods:

- usual for sleep at home periods (“sleep gates”),
- recommended for layover sleep,
- recommended for exposure to light, for long layovers only,
- recommended for meals and snacks.

Note that the schedules on the cards are given for information purposes only (BT – 6 for **EWR** sheets, BT + 7 for **WER** sheets, BT for **NSR** sheets).

These time slots must therefore be adapted to fit the destination of your flight.

BT = Base Time (departure of rotation)

3 - EXAMPLE OF THE WAY TO USE THE RECOMMENDATIONS CARDS

The example given below applies to a real rotation of the Paris-New York (BT – 6) – Paris type:

- outbound flight departure time: 10am, Paris time,
- 24 hours layover,
- return flight departure time: 8.30pm, New York time.

The card to be selected is shown shaded.
In this example, Paris is the base.

A. Choice of geographical zone according to Time Zone Change (TZC)

TZC ≥ BT - 4
BT – 3 ≥ TZC ≤ BT + 3
TZC ≥ BT + 4

B. Choice of pre-flight and in-flight rest card

MFB	Outbound flight
MFA	
NFB	Return flight
NFA	

C. Choice of layover rest card

Transatlantic
EWR1
EWR2
EWR3
EWR4
EWR5

IV – PRACTICAL RECOMMENDATIONS

GEOGRAPHICAL

TIME ZONES

East-West Rotations (EWR)

Time Zone Change (TZC) ≥ BT – 4

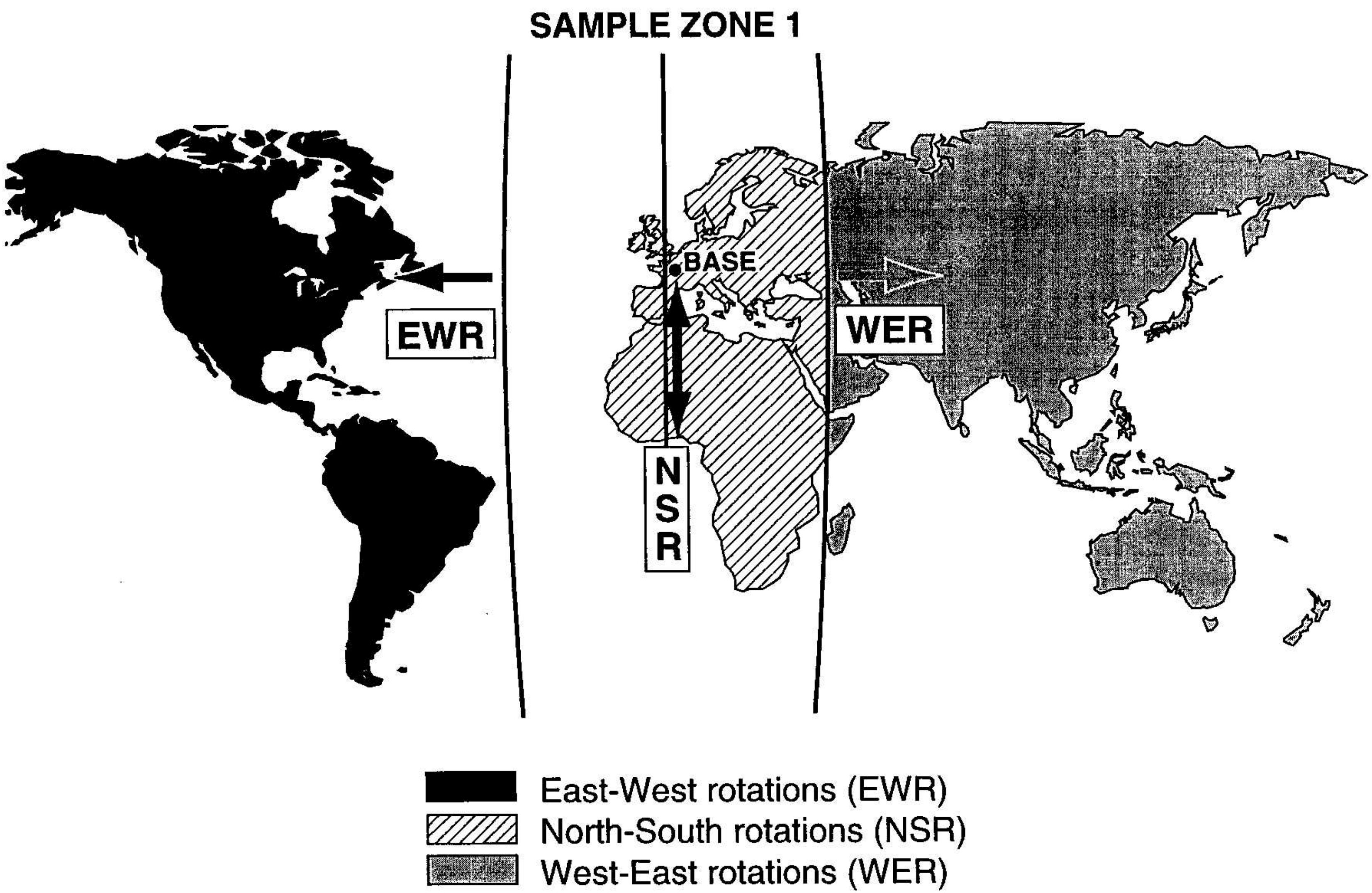
North-South Rotations (NSR)

BT – 3 ≥ TZC ≤ BT + 3

West-East Rotations (WER)

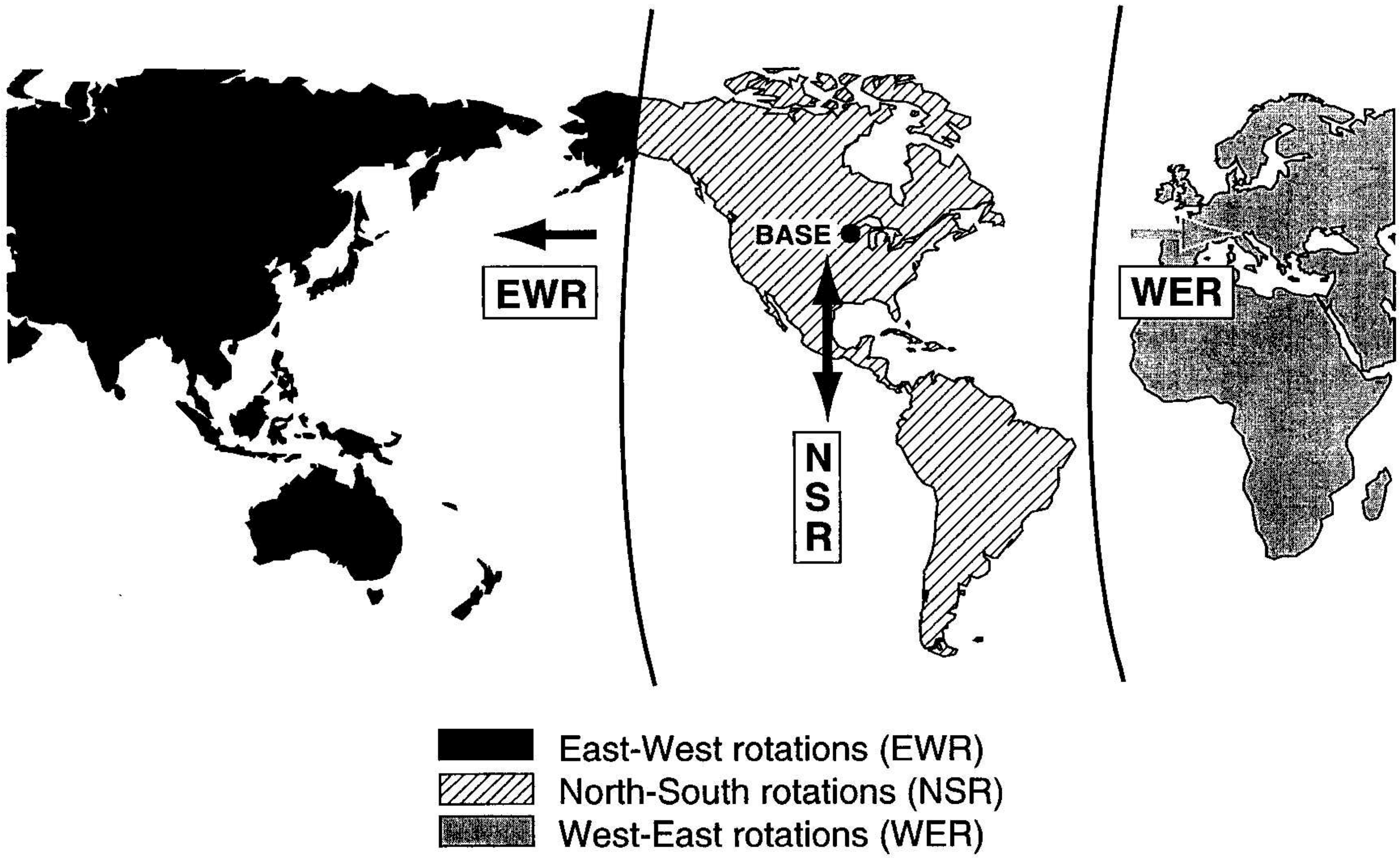
TZC ≥ BT + 4

Geographical zone delimitations for European and African crews

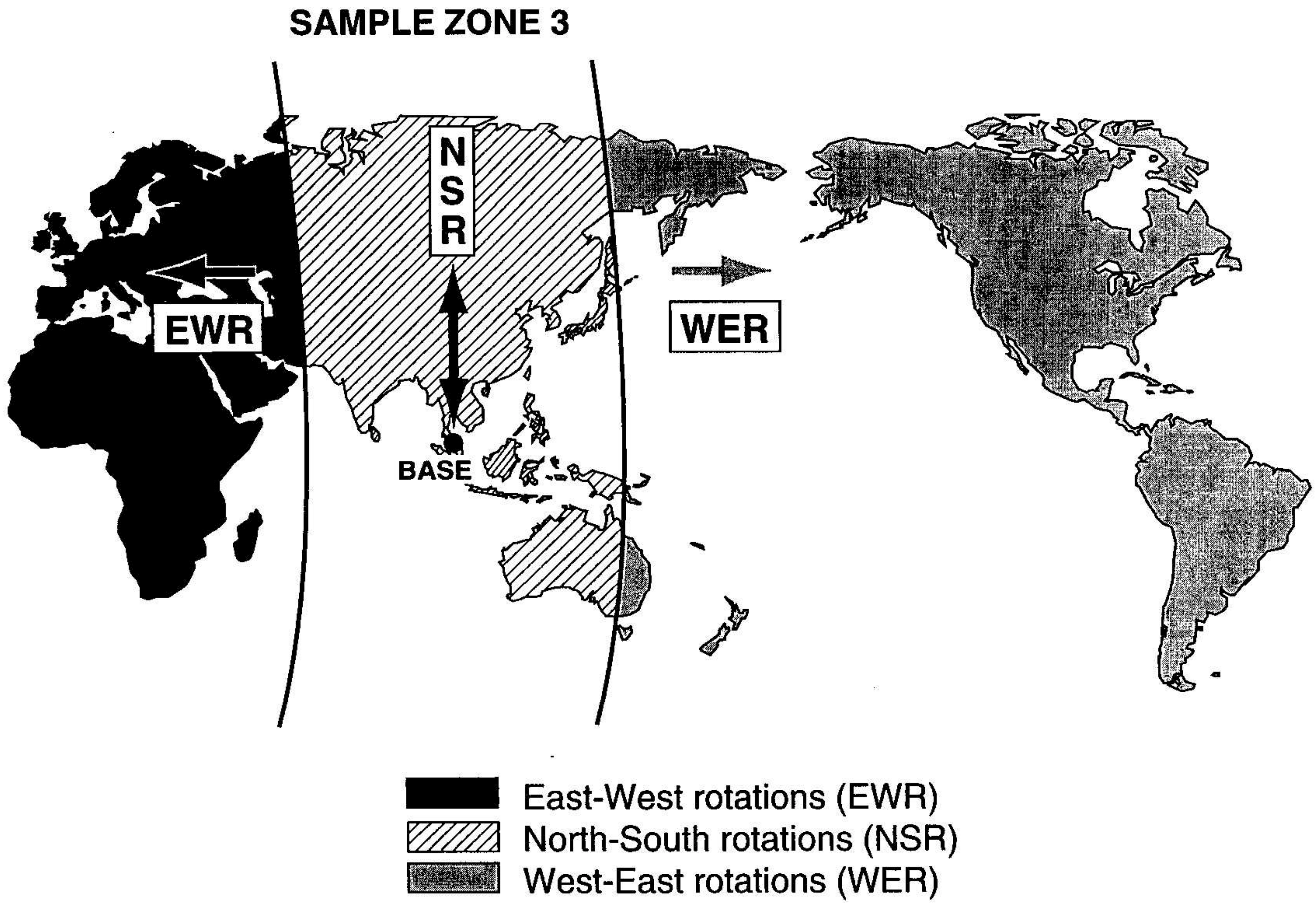


Geographical zone delimitations for North & South American crews

SAMPLE ZONE 2



Geographical zone delimitations for Asian and Australian crews



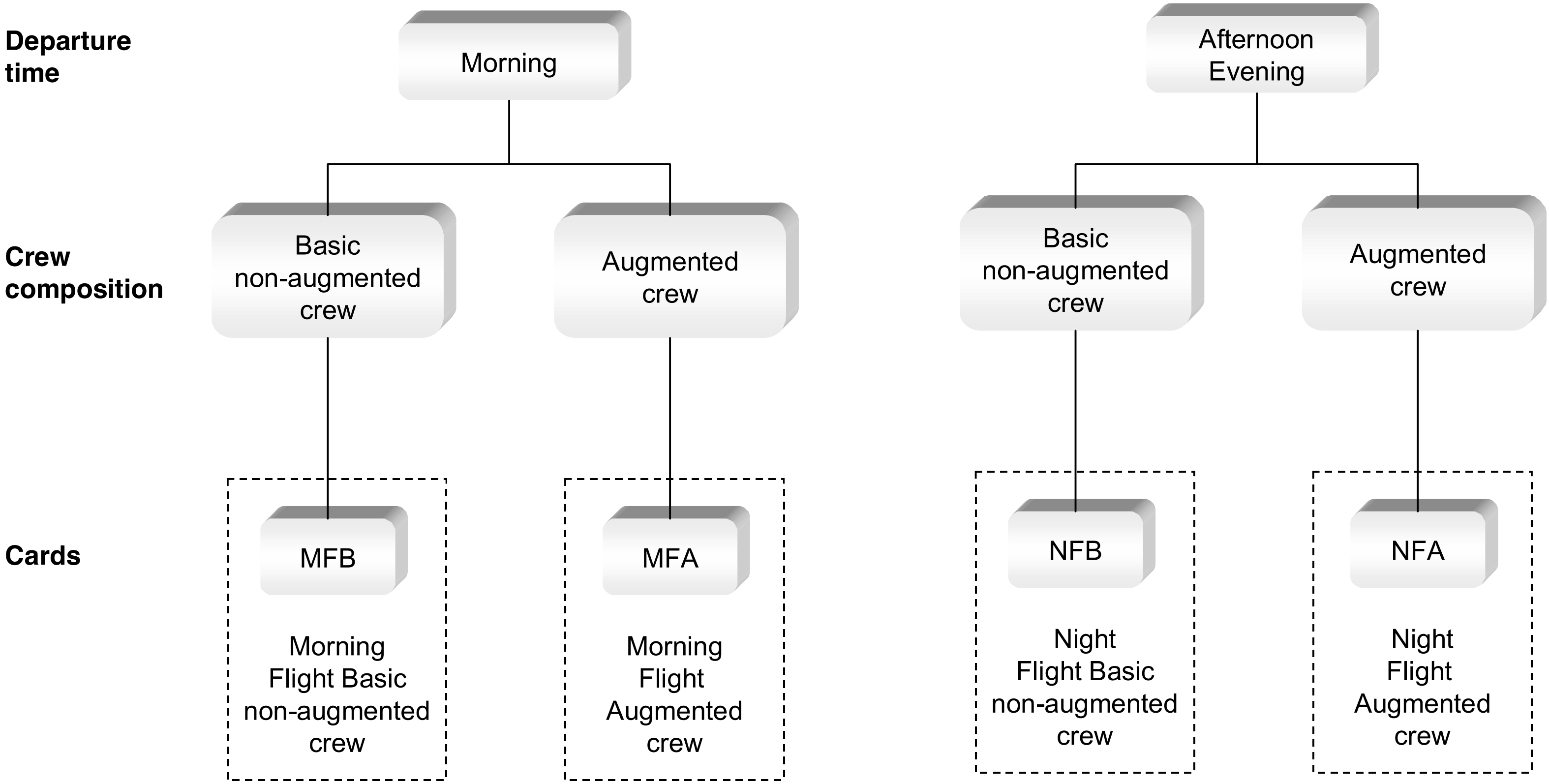
RECOMMENDATIONS FOR:

PRE-FLIGHT REST PERIOD

Outbound and return flights: basic crew and augmented crew.

RECOMMENDATIONS FOR THE HOURS PRECEDING THE FLIGHT AND DURING FLIGHT

Choice of card according to rotation



CARD MFB

Main characteristics of the flights concerned

Schedule	**Morning**
Crew composition	**Basic crew**

AIM:
- TO LIMIT SLEEP LOSS RELATED TO EARLY WAKE-UP,
- TO BREAK MONOTONY DURING FLIGHT

RECOMMENDATIONS FOR THE DAY BEFORE DEPARTURE

☞ During the day: normal activity, exposure to daylight in the afternoon, avoid drinking coffee, tea, etc.

☞ Do not take a nap during the day, if possible.

☞ In the evening: light meal, hot shower, avoid drinking coffee and tea, go to bed as early as possible.

RECOMMENDATIONS FOR FLIGHT

☞ Do alternate passive vigilance and active vigilance phases to break flight monotony. Degree of monotony varies according to flight. For example, it is fairly high for transatlantic destinations.

The **active vigilance** phases are characterized by:

- verbal exchanges and tasks related to flight management,
- varied motor activities associated with mental tasks, e.g. navigation (FMS) and systems (ECAM/EICAS) management,
- no meals during this period.

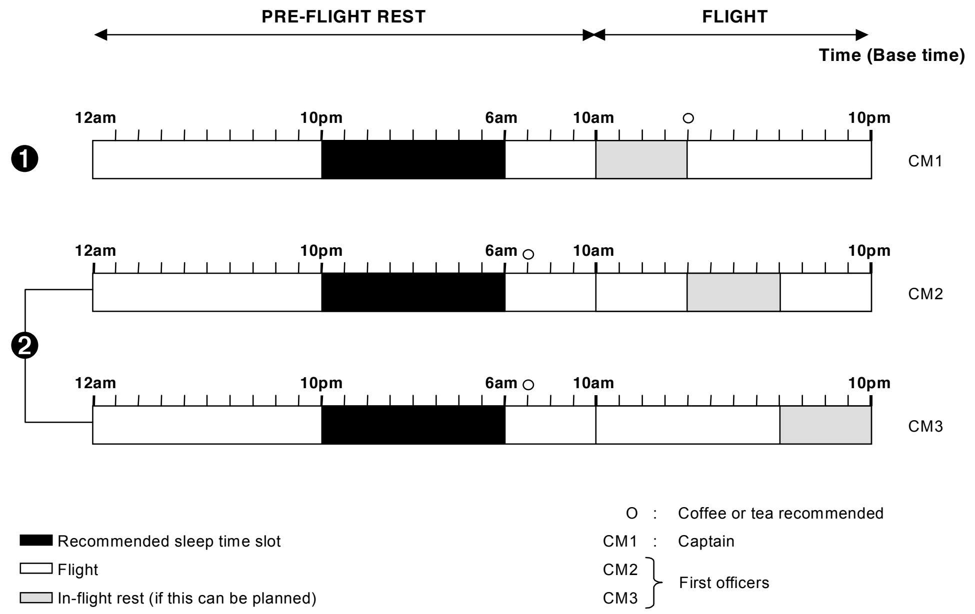
The **passive vigilance** phases are characterized by a more dispersed supervision of the flight:

- promote the eating of meals or snacks, if possible at the start of these phases,
- encourage activities not related to the flight (e.g. reading papers).

Optimum alternation between passive vigilance an active vigilance is between 20 and 40 minutes depending on flight context. This alternation is mainly justified during the quiet cruise periods. The end of each **active-passive vigilance phase must be expressed verbally to** the other crew-member so that he will positively know which phase you are in.

☞ Avoid taking your meals at the same time as the other crew member since this favours simultaneous reductions in alertness. Do the same thing for drinks and snacks.

Typical MFA card



PERSONAL NOTES

Time slots given in these recommendations are only suggestion. They are always given in local time for the layover concerned.

CARD MFA

Main characteristics of the flights concerned

Flight schedule	**Morning**
Crew composition	**Augmented crew**

AIM:
- **TO MANAGE SLEEP ACCORDING TO RESTS TAKEN DURING FLIGHT, WHEN THESE CAN BE PLANNED IN ADVANCE,**
- **TO BREAK MONOTONY DURING FLIGHT**

RECOMMENDATIONS FOR THE DAY BEFORE DEPARTURE

The day before departure, avoid taking a nap in the day and going to bed late. Get up as early as possible on the morning of departure.

For drinking coffee or tea, the recommendations are different according to the rest schedule during the outbound flight, if planned in advance:

❶ Rest during the first part of the flight: in general, this part of the flight is the most unfavourable for sleep, avoid drinking coffee or tea on the morning of departure,

❷ **Rest during the second or third part of flight**: in order to delay sleep pressure, **you are recommended to drink coffee or tea** on the morning of departure.

CARD MFA (cont'd)

RECOMMENDATIONS FOR FLIGHT

1. REST

☞ Some schedules are less adequate for sleep than others, especially in the first part of flight (morning) when times for getting asleep are generally high. This difficulty can be overcome by planning **a longer rest period during the fist part of the flight**. This should be approximately **1 hour more** than the one taken during the middle or last part of flight.

2. ACTIVITY

☞ Do alternate passive vigilance and active vigilance phases to break monotony.

The active vigilance phases are characterized by:

- verbal exchanges and tasks related to flight management,
- varied motor activities associated with mental tasks (e.g. navigation (FMS) and systems (ECAM/EICAS) management),
- no meals during this period.

The passive vigilance phases are characterized by a more dispersed supervision of the flight:

- promote the eating of meals or snacks, if possible at the start of these phases,
- encourage activities not related to the flight (e.g. reading papers).

Optimum alternation between passive vigilance and active vigilance is between 20 and 40 minutes depending on flight context. This alternation is especially justified during the quiet cruise periods. The end of each **active vigilance-passive vigilance phase must be expressed verbally to the other crewmember** so that he will positively know which phase you are in.

☞ Avoid taking your meals at the same time as the other crewmember since this favours simultaneous reductions in alertness. Do the same for drinks and snacks.

CARD NFB

Main characteristics of the flights concerned.

Flight schedule	**Afternoon or evening**
Crew composition	**Basic crew**

AIM:

- TO DELAY SLEEP PRESSURE RELATED TO NIGHT FLIGHT AS LONG AS POSSIBLE

RECOMMENDATIONS FOR THE 24 HOURS BEFORE THE FLIGHT

☞ In the evening: light meal, hot shower, **avoid drinking coffee or tea, etc**.

☞ On the morning of departure:
- avoid getting up very early in the morning,
- try to take a **nap before leaving for the airport** (if possible, at the beginning of the afternoon),
- after the nap: you **are recommended to drink coffee or tea**.

RECOMMENDATIONS FOR FLIGHT

☞ Do alternate passive vigilance and active vigilance phases to break the monotony of the flight.

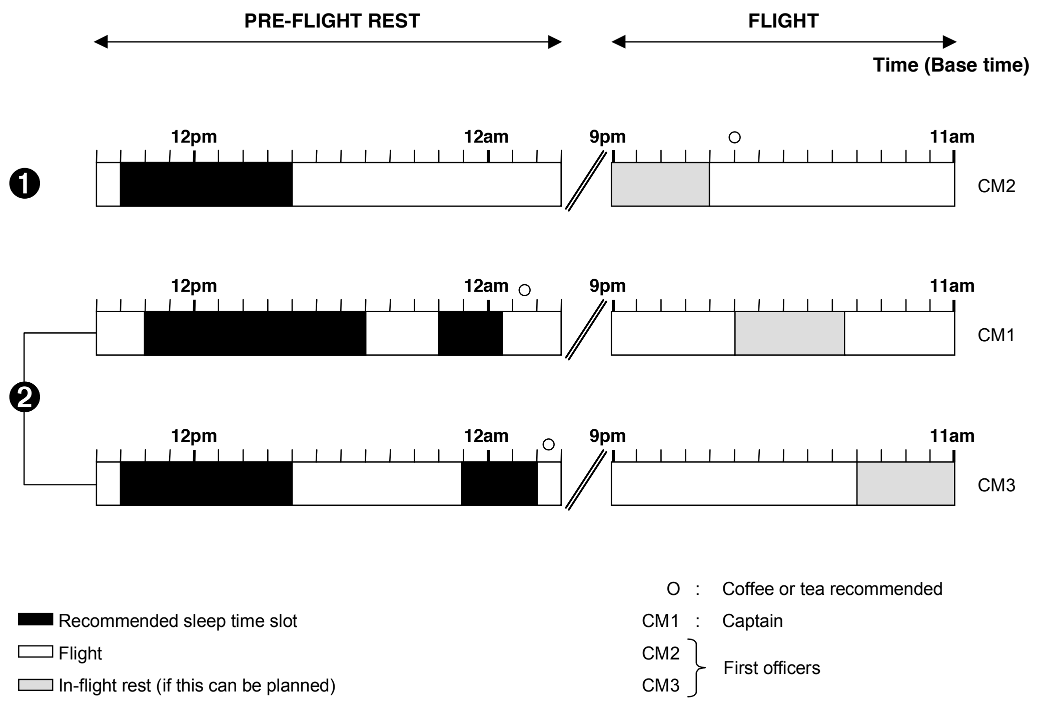
The active vigilance phases are characterized by:
- verbal exchanges and tasks related to flight management,
- varied motor activities associated with mental tasks (e.g. navigation (FMS) and systems (ECAM/EICAS) management),
- no meals during this period.

The passive vigilance phases are characterized by a more dispersed supervision of the flight:
- promote the eating of meals or snacks, if possible at the start of these phases,
- encourage activities not related to the flight (e.g. reading papers),
- take a short nap which will delay sleep pressure.

Optimum alternation between passive vigilance and active vigilance is between 20 and 40 minutes depending on flight context. This alternation is mainly justified during the quiet cruise periods. The end of **each active vigilance-passive vigilance phase must be expressed verbally to the other crewmember** so that he will positively know which phase you are in.

☞ Avoid taking your meals at the same time as the other crewmember since this favours simultaneous reductions in alertness. Do the same thing for drinks and snacks.

Typical NFA card



PERSONAL NOTES

Time slots given in these recommendations are only suggestions. They are always given in local time for the layover concerned.

CARD NFA

Main characteristics of the flights concerned

Flight schedule	**Afternoon or evening**
Crew composition	**Augmented crew**

AIM:
- **TO MANAGE SLEEP ACCORDING TO RESTS TAKEN DURING FLIGHT, WHEN THESE CAN BE PLANNED IN ADVANCE,**
- **TO BREAK MONOTONY DURING FLIGHT.**

RECOMMENDATIONS FOR THE DAY BEFORE DEPARTURE

These differ according to your rest schedule during flight, if planned in advance:

❶ **Rest during the first part of flight**: in general this part of the flight is the most unfavourable for sleep. You must therefore prepare for this by applying the following recommendations:

- go to bed as early as possible on the day before departure (light evening meal and hot shower before going to bed to favour rapid onset of sleep),
- get up as soon as you wake up,
- expose yourself to daylight,
- **avoid drinking coffee or tea**,
- **avoid taking a nap**.

With this rest organization which favours a long sleep on the day before departure (no sleep loss) and a long wakefulness period during the day, you should not have too many difficulties in falling asleep during your in-flight rest.

❷ **Rest during the second or third part of the flight**: you will be in the cockpit during take off and the first part of cruise. Sleep pressure must therefore be delayed by applying the following recommendations:

- go to bed at normal time,
- get up as soon as you wake up,
- **take a nap in the afternoon, around 1pm – 3pm**,
- **drinking a moderate amount of coffee or tea is recommended after the nap**.

CARD NFA (cont'd)

RECOMMENDATIONS FOR FLIGHT

1. REST

☞ Some schedules are less favourable for sleep, especially during the first part of the flight (late afternoon or early evening) when times for getting asleep are generally high. This difficulty can be overcame by **planning a longer rest period during the first part of the flight**. This should be approximately overcome **1 hour more than** the one taken during the middle or last part of flight.

2. ACTIVITY

☞ Do alternate passive vigilance and active vigilance phases to break flight monotony.

The **active vigilance** phases are characterized by:

- verbal exchanges and tasks related to flight management,
- varied motor activities associated with mental tasks (e.g. navigation (FMS) and systems (ECAM/EICAS) management),
- no meals during this period.

The **passive vigilance** phases are characterized by a more dispersed supervision of the flight:

- promote the eating of meals or snacks, if possible at the start of these phases,
- carry out activities not related to the flight (e.g. reading papers),
- take a short nap which will delay sleep pressure.

Optimum alternation between passive vigilance and active vigilance is between 20 and 40 minutes depending on flight context. This alternation is mainly justified during the quiet cruise period. The end **of each active-passive vigilance phase must be expressed to the other crewmember** so that he will positively know which phase you are in.

☞ Avoid taking your meals at the same time as the other crewmember since this favours simultaneous reductions in alertness. Do the same thing for drinks and snacks.

RECOMMENDATIONS FOR:

LAYOVER REST

East-West Rotations (EWR)

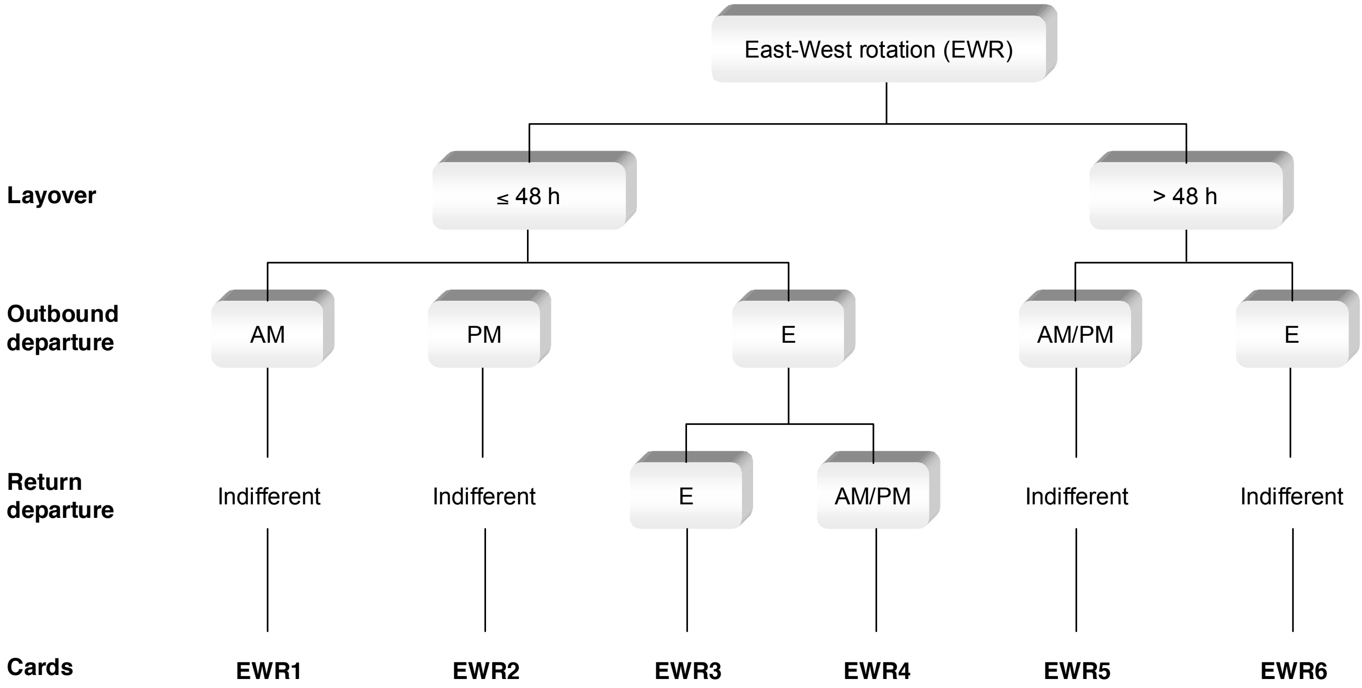
North-South Rotations (NSR)

West-East Rotations (WER)

EAST-WEST ROTATIONS

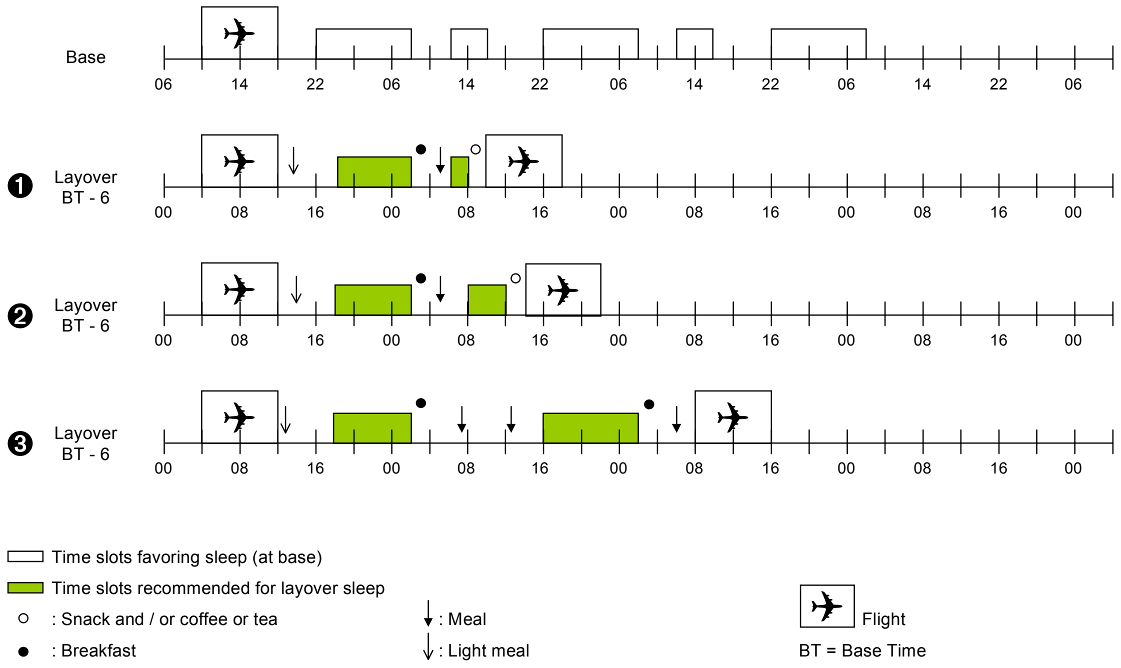
(EWR)

EAST-WEST ROTATIONS



AM : *Morning*
PM : *Afternoon*
E : *Evening*
EWR : *East-West rotations*

Typical rotation EWR1



PERSONAL NOTES

Time slots given in the recommendations are only suggestions. They are always given in local time for the layover concerned.

CARD EWR1

Main characteristics of rotations concerned

Outbound Flight schedule	**Morning**
Time zone change	**≥ BT - 4**
Layover time	**≤ 48 h**
Return flight schedule	**Morning, afternoon or evening**

AIM:
TO AVOID ADJUSTING TO LOCAL TIME OF LAYOVER STATION

RECOMMENDATIONS

- ☞ On the first day, upon arrival at the hotel: light meal, but **avoidance of coffee, tea, etc., and of napping**.
- ☞ If the hotel does not provide around-the-clock room service, make necessary arrangements for night breakfast (adequate food and beverage supplies).
- ☞ After a hot shower, **go to bed from 6 pm onwards**, local time.
- ☞ Upon waking up, (which should be during the course of the night) have breakfast.
- ☞ In the morning, eat a solid meal corresponding to lunch, base time.

If the return flight is:

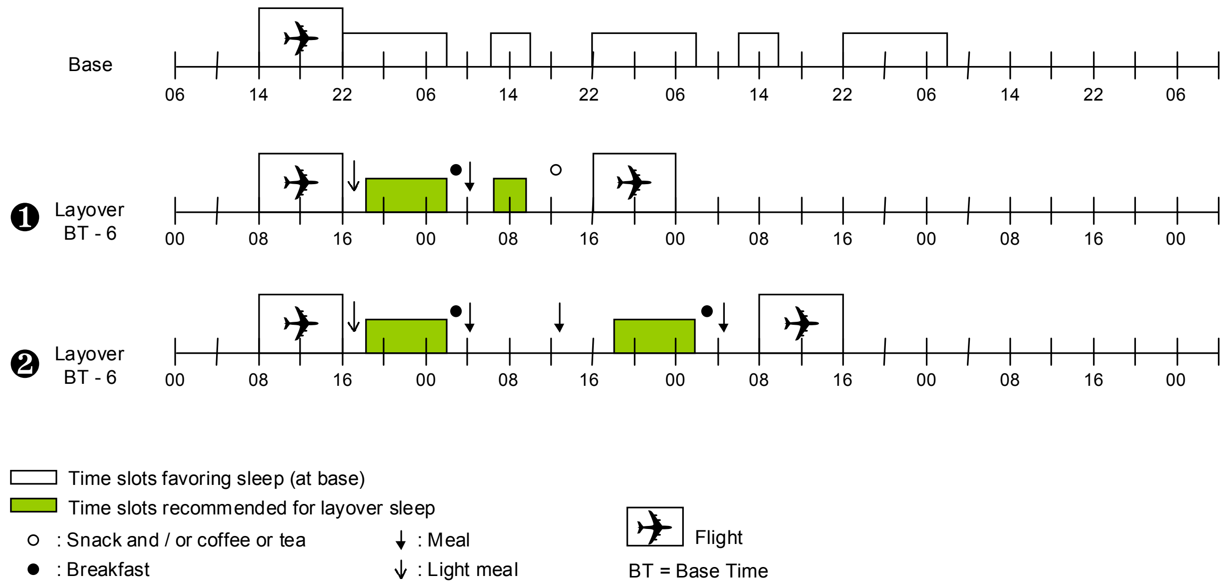
❶ **In the morning of the same day***: unless rest is planned in the first part of the return flight (augmented crew)*, take advantage of waiting times during hotel-airport transfers to relax or take naps even very short ones**. Drinking small amounts of coffee or tea is recommended after the nap**;

❷ **In the afternoon or during the evening of the same day**: *unless rest is planned during the first part of the return flight (augmented crew)*, take a nap as long as possible. This nap will be facilitated when taken at a body time favourable to sleep (early afternoon, base time**). Drinking moderate amounts of coffee or tea is recommended after the nap**;

❸ **The following morning**, approximately 45 hours after arrival, recommendations given for the first day remain applicable.

Take a short nap, however, if you feel the need, unless rest is planned during the first part of the return flight (augmented crew).

Typical rotation EWR2



PERSONAL NOTES

The slots given in these recommendations are only suggestions. They are always given in local time for the layover concerned.

CARD EWR2

Main characteristics of rotations concerned

Outbound Flight schedule	**Afternoon**
Time zone change	**≥ BT - 4**
Layover time	**≤ 48 h**
Return flight schedule	**Morning, afternoon or evening**

AIM:
TO AVOID ADJUSTING TO LOCAL TIME OF LAYOVER STATION

RECOMMENDATIONS

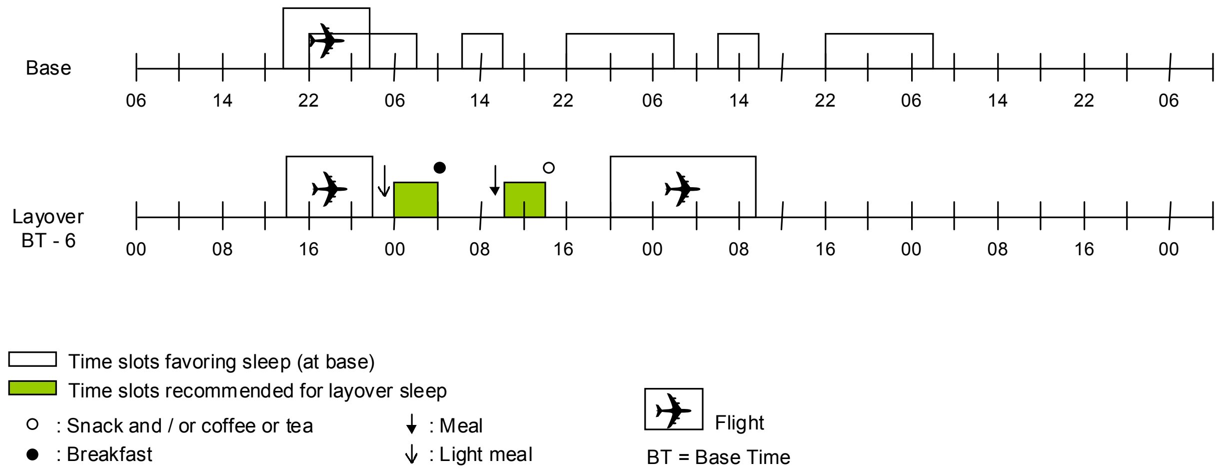
- on the first day, upon arrival at the hotel: light meal, but **avoidance of coffee, of tea, etc., and of napping**,
- if the hotel does not provide around-the-clock room service, make necessary arrangements for night breakfast (adequate food and beverage supplies),
- after a hot shower, go to bed from 06pm onwards, local time,
- upon waking up, which should be during the course of the night, have breakfast,
- in the morning, eat a solid meal corresponding to lunch, base time.

If the return flight is:

❶ In the morning or during the evening of the same day: *unless rest is planned during the first part of the return flight (augmented crew)*, take a nap as long as possible. This nap will be facilitated when taken at a body time favourable to sleep (early afternoon, base time); **drinking small amounts of coffee or tea is recommended after this nap**.

❷ **The following morning**: the day before departure, do not take a nap or limit its duration, maximum 30 minutes; apply the recommendations described for the first day. If you feel the need and time permits, take a nap after lunch, *unless rest is planned during the first part of the return flight (augmented crew)*.

Typical rotation EWR3



PERSONAL NOTES

Time slots given in these recommendations are only suggestions. They are always given in local time for the layover concerned.

CARD EWR3

Main characteristics of rotations concerned

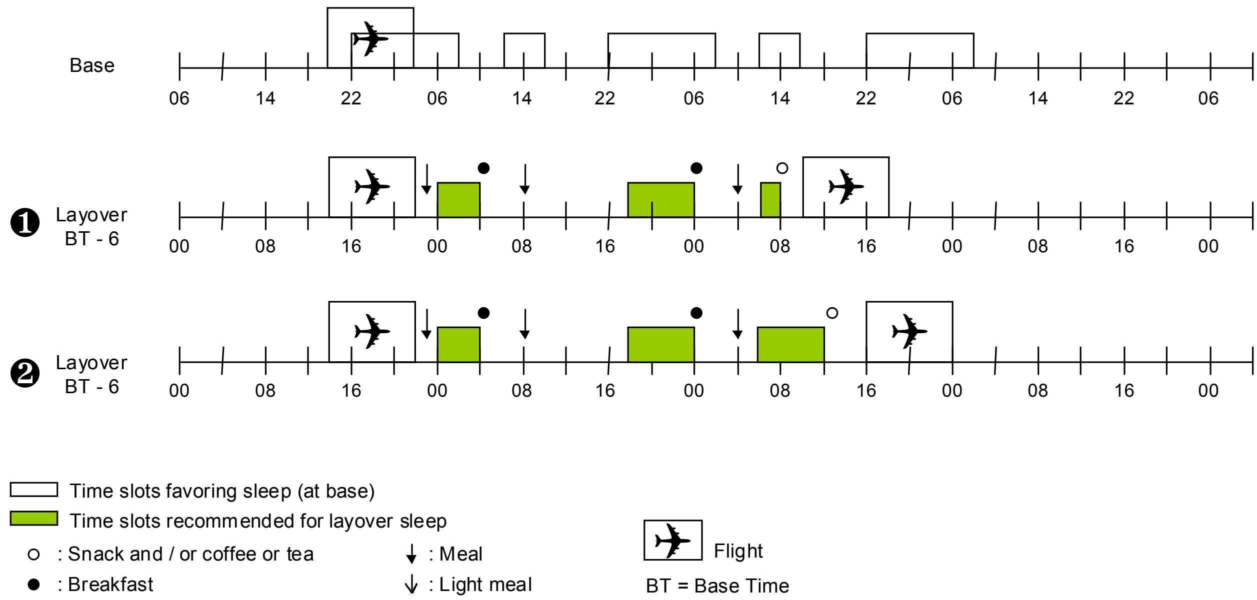
Outbound Flight schedule	**Evening**
Time zone change	**≥ BT - 4**
Layover time	**≤ 48 h**
Return flight schedule	**Evening**

AIM:
TO AVOID ADJUSTING TO LOCAL TIME OF LAYOVER STATION

RECOMMENDATIONS

- ☞ on the first day, upon arrival at the hotel: light meal, but **avoidance of coffee, of tea, etc.**,
- ☞ if the hotel does not provide around-the-clock room service, make necessary arrangements for breakfast (adequate food and beverage supplies),
- ☞ after a hot shower, go to bed as soon as possible,
- ☞ upon waking up (which should be fairly early in the morning) have breakfast,
- ☞ in the morning, have a solid meal corresponding to lunch (base time). After lunch, *unless rest is planned during the first part of the return flight (augmented crew)*, take a nap as long as possible. This nap will be facilitated when taken at a body time favorable to sleep (early afternoon, base time). **Drinking moderate amounts of coffee or tea is recommended after the nap**.

Typical rotation EWR4



PERSONAL NOTES

Time slots given in these recommendations are only suggestions. They are always given in local time for the layover concerned.

CARD EWR4

Main characteristics of rotations concerned

Outbound Flight schedule	**Evening**
Time zone change	**≥ BT - 4**
Layover time	**≤ 48 h**
Return flight schedule	**Morning, afternoon**

AIM:
TO AVOID ADJUSTING TO LOCAL TIME OF LAYOVER STATION

RECOMMENDATIONS

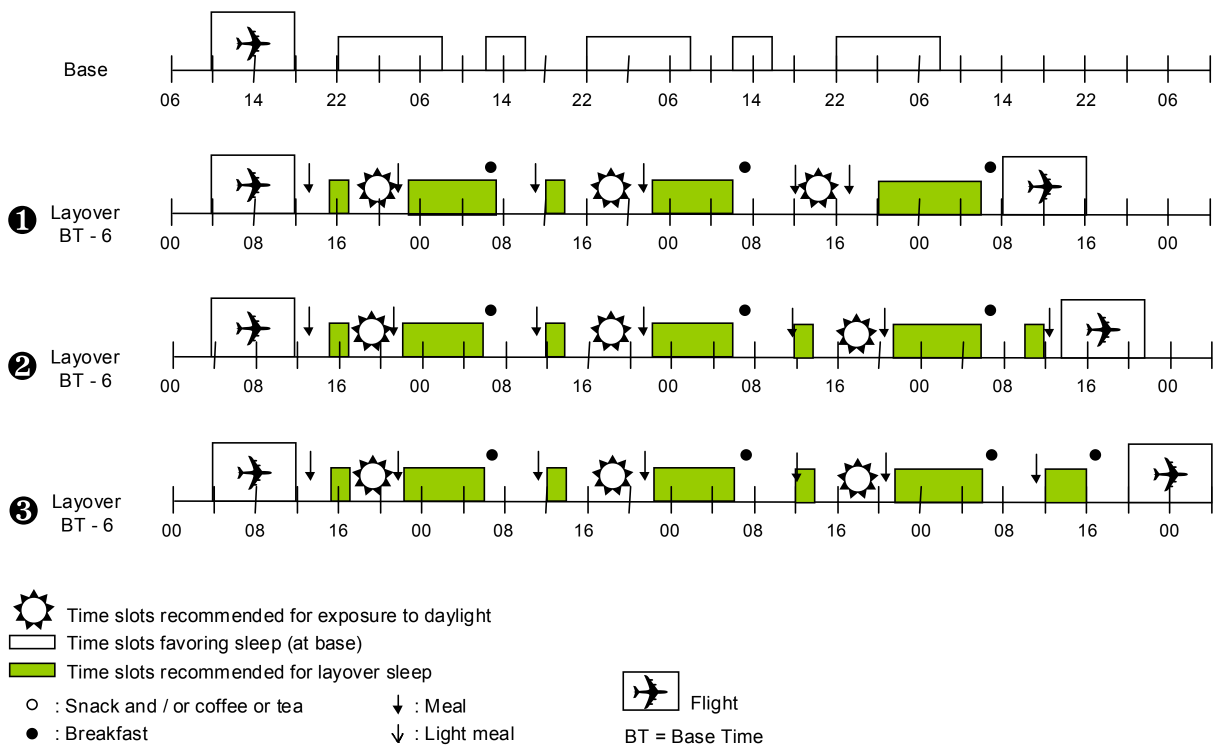
- on the first day, upon arrival at the hotel: light meal, but avoidance of coffee, tea, etc.,
- if the hotel does not provide around-the-clock room service, make necessary arrangements for a snack,
- after a hot shower, go to bed as soon as possible,
- upon waking up (which should be fairly early in the morning) have breakfast,
- in the morning, have a solid meal corresponding to lunch (base time),
- avoid taking a nap during the day. If you feel the need, take a nap limited to 30 minutes,
- If the hotel does not provide around-the-clock room service, make arrangements for breakfast,
- after a hot shower, go to bed as soon as possible,
- upon waking up (which should be during the course of the night) have breakfast,
- in the morning, have a solid meal corresponding to lunch (base time).

If the return flight is :

❶ **In the morning** : *unless rest is planned in the first part of the return flight (augmented crew),* **you should drink coffee or tea during lunch**. Take advantage of waiting times during hotel-airport transfers to relax or take naps, even very short ones,

❷ **In the afternoon**, *unless rest is planned during the first part of the return flight (augmented crew)*, try to take a nap as long as possible in the morning. **Drinking coffee or tea is recommended** after waking up.

Typical rotation EWR5



PERSONAL NOTES

Time slots given in these recommendations are only suggestions. They are always given in local time for the layover concerned.

CARD EWR5

Main characteristics of rotations concerned

Outbound Flight schedule	Morning, afternoon
Time zone change	≥ BT - 4
Layover time	> 48 h
Return flight schedule	Morning, afternoon or evening

AIM:
TO ADJUST YOURSELF TO LOCAL TIME AT LAYOVER STATION

RECOMMENDATIONS

- ☞ On the first day, upon arrival at the hotel: light meal, and a **small amount of coffee or tea recommended** ; cold shower,
- ☞ avoid taking a nap or limit its duration (maximum 30 minutes),
- ☞ in the afternoon, expose yourself to daylight,
- ☞ in the evening, meal, hot shower, then go to bed from 10pm onwards,
- ☞ upon waking up, try to stay in bed until at least 6 or 7am,
- ☞ in the morning, have breakfast,
- ☞ have a meal around midday, **possibly drinking coffee or tea**,
- ☞ in the early afternoon, try to take a nap of two hours maximum,
- ☞ in the afternoon : **exposure to daylight and** light physical exercise (walk, etc.),
- ☞ in the evening : evening meal at local time, go to bed from 10pm onwards,
- ☞ same recommendations for the following days.

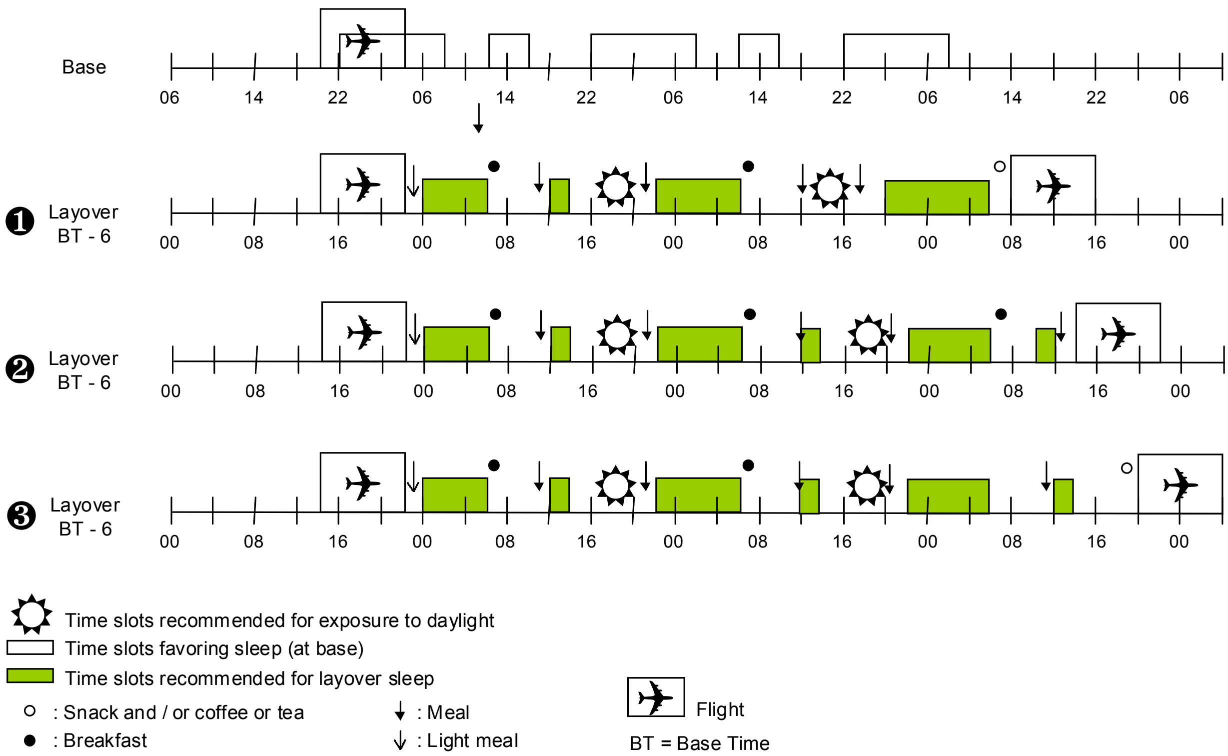
If the return flight is :

❶ **In the morning:** the day before, do not take a nap in the afternoon so that you will fall asleep as early as possible. *Unless rest is planned in the first part of the return flight (augmented crew),* you can drink coffee or tea during breakfast. Take advantage of waiting times during hotel-airport transfers to relax and take naps, even very short ones.

❷ **In the afternoon**: the day before, go to bed from 10pm onwards. If flight schedule permits, take a nap, *unless rest is planned during the first part of the return flight (augmented crew).* After this nap, **you should drink a moderate amount of coffee or tea**.

❸ **In the evening**: take a nap as long as possible in the early afternoon, *unless rest is planned during the first part of the return flight (augmented crew)*. After this nap, **you should drink a moderate amount of coffee or tea**.

Typical rotation EWR6



PERSONAL NOTES

Time slots given in these recommendations are only suggestions. They are always given in local time for the layover concerned.

CARD EWR6

Main characteristics of rotations concerned

Outbound Flight schedule	**Evening**
Time zone change	**≥ BT - 4**
Layover time	**> 48 h**
Return flight schedule	**Morning, afternoon or evening**

AIM:
TO ADJUST YOURSELF TO LOCAL TIME OF LAYOVER STATION

RECOMMENDATIONS

- ☞ upon arrival at the hotel, have a light meal then go to bed **without drinking coffee, tea, etc**.,
- ☞ upon waking up, try to stay in bed until 6 or 7am,
- ☞ in the morning, have breakfast,
- ☞ have a meal around midday, **possibly drinking coffee or tea**,
- ☞ in the early afternoon, try to take a nap of two hours maximum,
- ☞ in the afternoon : **exposure to daylight** and light physical exercise (walk),
- ☞ in the evening: evening meal at local time, go to bed from 10pm onwards,
- ☞ same recommendations for the following days.

If the return flight is :

❶ **In the morning:** the day before, do not take a nap in the afternoon so that you will fall asleep as early as possible*. Unless rest is planned in the first part of the return flight (augmented crew)*, you **can drink coffee or tea** during breakfast. Take advantage of waiting times during hotel-airport transfers to relax and take naps, even very short ones.

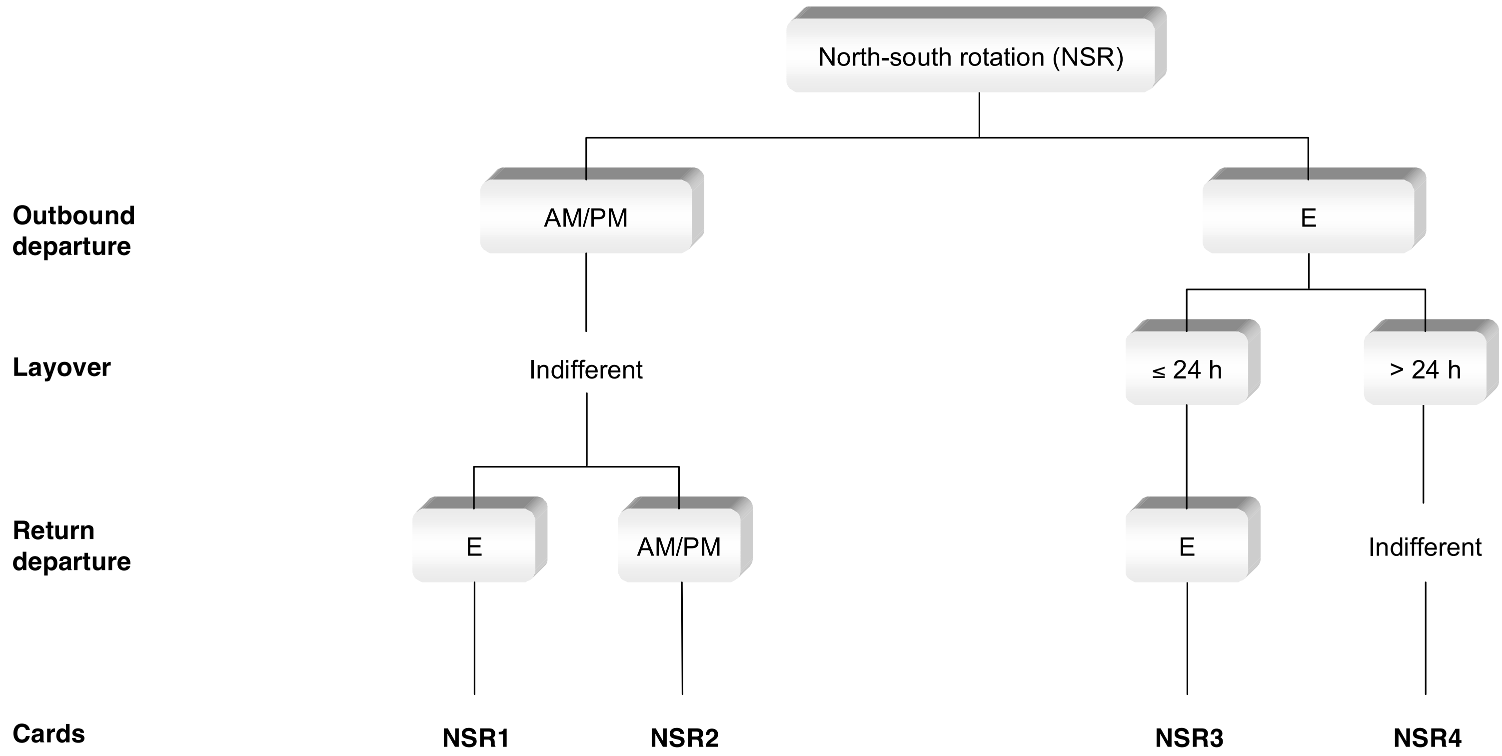
❷ **In the afternoon**, go to bed the day before from 10pm onwards. If flight schedule permits, take a nap, *unless rest is planned during the first part of the return flight (augmented crew)*. After this nap, you **should drink moderate amounts of coffee or tea**.

❸ **In the evening** : take a nap as long as possible in the early afternoon*, unless rest is planned during the first part of the return flight (augmented crew)*. After this nap, **you should drink a moderate amount of coffee or tea**.

NORTH-SOUTH ROTATIONS

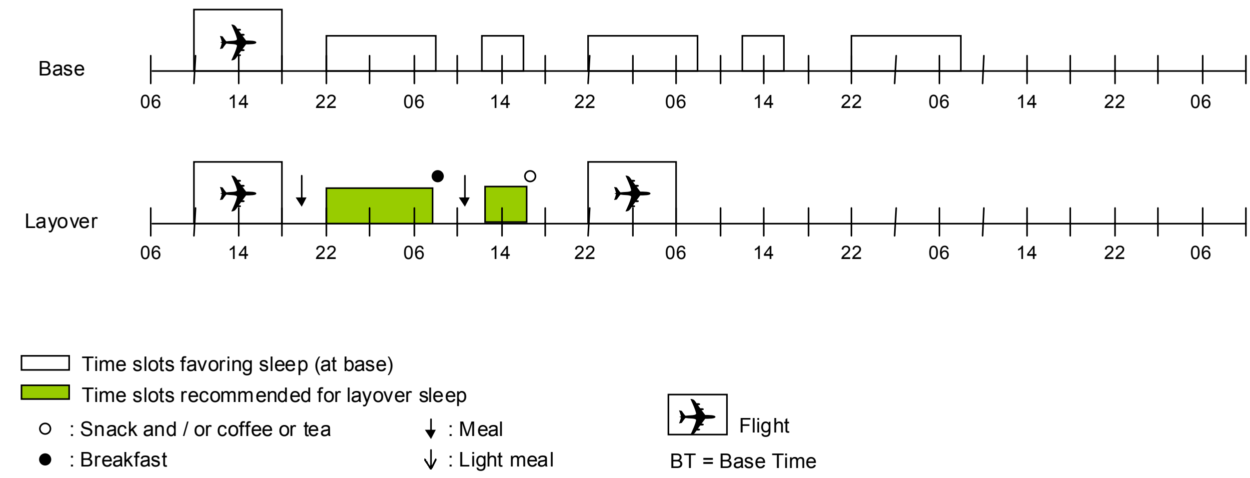
(NSR)

NORTH-SOUTH ROTATIONS



AM	:	*Morning*
PM	:	*Afternoon*
E	:	*Evening*
NSR	:	*North-south rotations*

Typical rotation NSR1



PERSONAL NOTES

Time slots given in the recommendations are only suggestions. They are always given in local time for the layover concerned.

CARD NSR1

Main characteristics of the rotations concerned

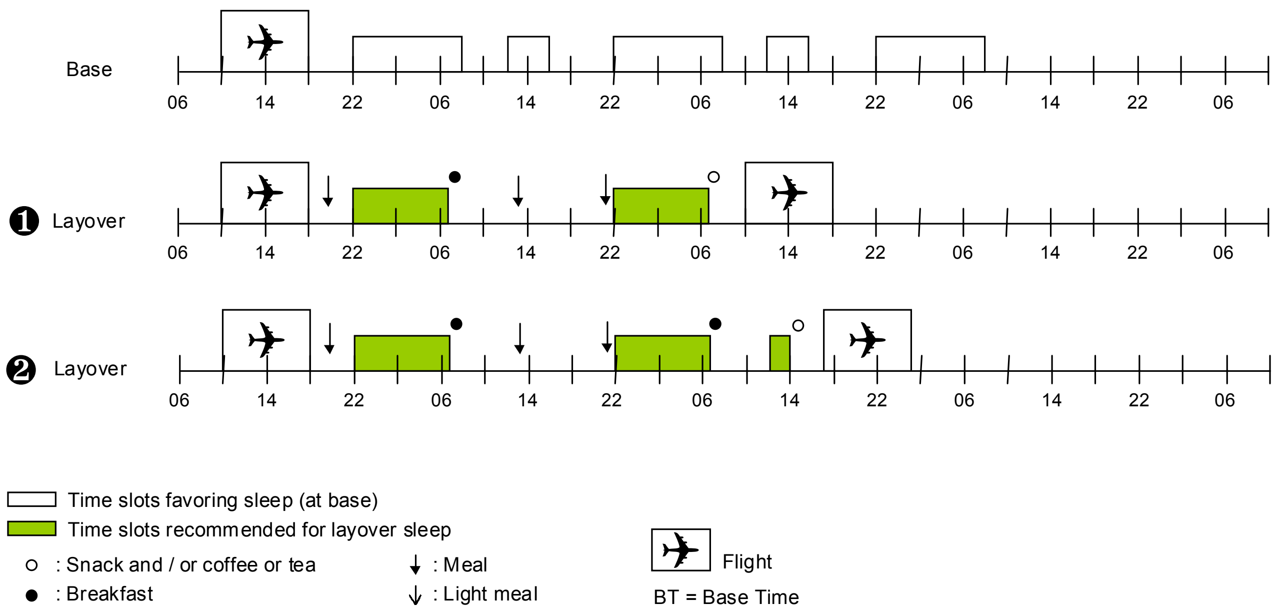
Outbound Flight schedule	**Morning or afternoon**
Time zone change	**BT – 3 ≥ TZC ≤ BT + 3**
Layover time	**Indifferent**
Return flight schedule	**Evening**

AIM:
KEEPING NORMAL REST-ACTIVITY CYCLES

RECOMMENDATIONS

- ☞ on the first day, upon arrival at the hotel: hot shower and evening meal, avoid drinking **coffee, tea, etc.**,
- ☞ go to bed as early as possible,
- ☞ breakfast at normal time, **possibly drinking coffee or tea**,
- ☞ same recommendations for the following days, if layover continues,
- ☞ on the day of departure, lunch at normal time, **avoiding coffee, tea, etc.**,
- ☞ *unless rest is planned during the first part of the return flight (augmented crew)*, take a nap as long as possible early in the afternoon to get ready for the night return flight. After this nap, you **should drink moderate amounts of coffee or tea**.

Typical rotation NSR2



PERSONAL NOTES

Time slots given in these recommendations are only suggestions. They are always given in local time for the layover concerned.

CARD NSR2

Main characteristics of the rotations concerned

Outbound Flight schedule	**Morning or afternoon**
Time zone change	**BT – 3 ≥ TZC ≤ BT + 3**
Layover time	**Indifferent**
Return flight schedule	**Morning or afternoon**

AIM:
KEEPING NORMAL ACTIVITY-REST CYCLE

RECOMMENDATIONS

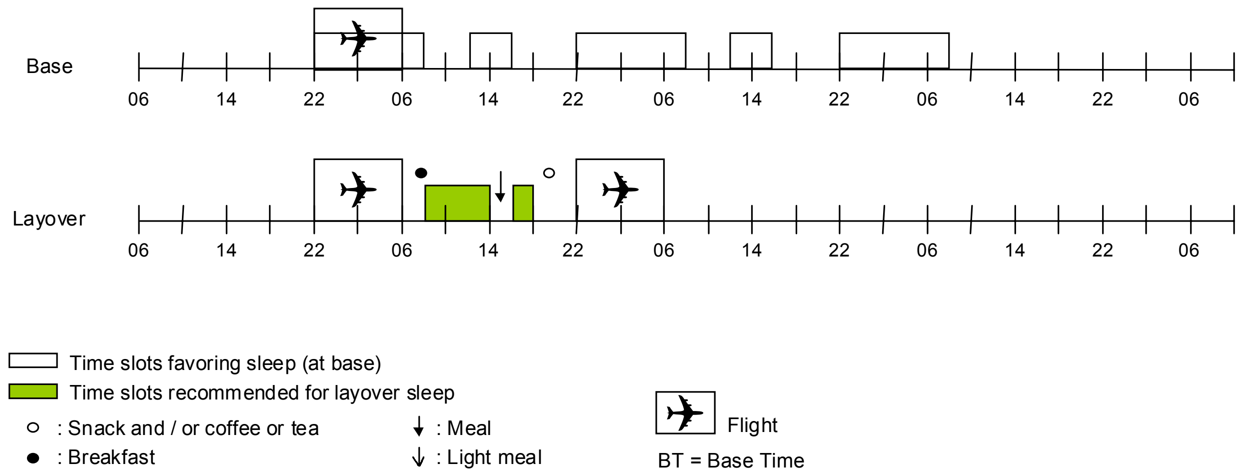
- ☞ on the first day, upon arrival at the hotel: hot shower and evening meal, **avoid drinking coffee, tea, etc.**,
- ☞ go to bed as early as possible,
- ☞ same recommendations for the following days, if layover continues.

If return flight is:

❶ **In the morning:** *unless rest is planned in the first part of the return flight (augmented crew)*, it is recommended to drink **moderate amounts of coffee or tea** during breakfast. Take advantage of waiting times during hotel-airport transfers to relax or take naps, even very short ones.

❷ **In the afternoon: avoid drinking coffee or tea** during breakfast. *Unless rest is planned during the first part of the return flight (augmented crew)*, take a nap as long as possible in the early afternoon, flight schedule permitting. Upon waking up, you **should drink moderate amounts of coffee or tea**.

Typical rotation NSR3



PERSONAL NOTES

Time slots given in these recommendations are only suggestions. They are always given in local time for the layover concerned.

CARD NSR3

Main characteristics of the rotations concerned

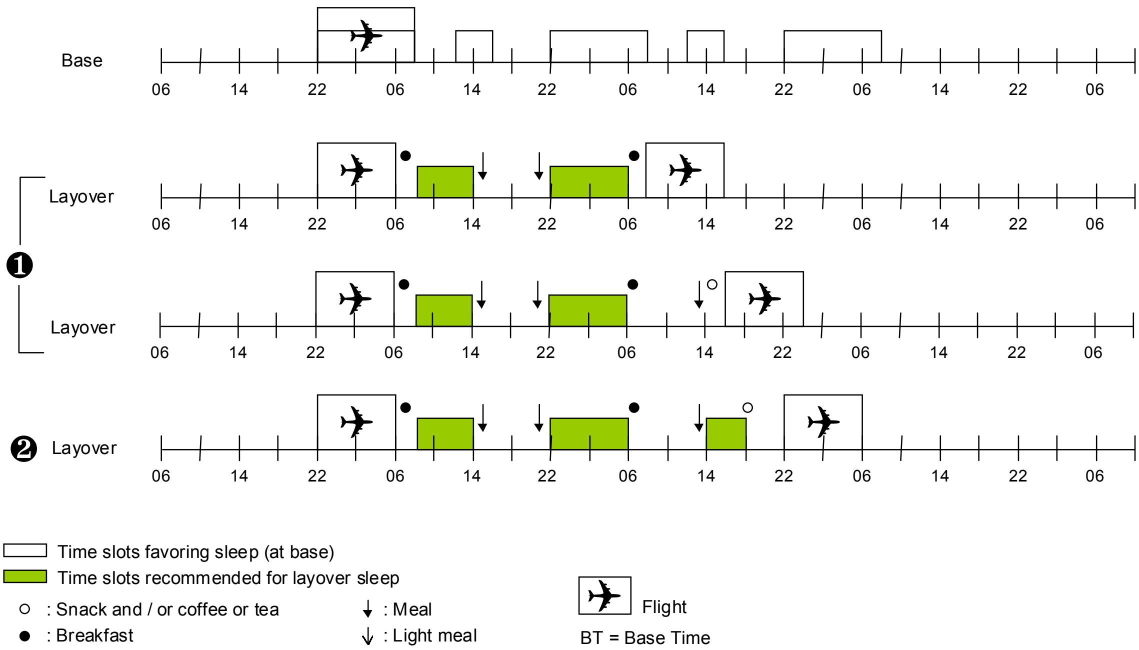
Outbound Flight schedule	**Evening**
Time zone change	**BT – 3 ≥ TZC ≤ BT + 3**
Layover time	**< 24 h**
Return flight schedule	**Evening**

AIM:
TO PREPARE YOURSELF TO COPE WITH THE EFFECTS OF SLEEP LOSS CAUSED BY NIGHT FLYING

RECOMMENDATIONS

- this rotation is one of the cases which most adversely affects the duration and qualify of your sleep. You must therefore pay special attention to your preparation on the days preceding departure. For this, refer to the recommendations concerning pre-flight rest periods (Cards **NFB** or **NFA**),
- upon arrival at the hotel, **you must absolutely avoid drinking coffee or tea**, having breakfast,
- after a hot shower, go to bed as early as possible. As much as possible, **isolate yourself from outside light and noise**,
- if you wake up at the end of the morning, have a meal. *Unless rest is planned during the first part of the return flight (augmented crew)*, go back to bed early in the afternoon for as long a nap as possible. After this nap, you **should drink moderate amounts of coffee or tea**.

Typical rotation NSR4



PERSONAL NOTES

Time slots given in these recommendations are only suggestions. They are always given in local time for the layover concerned.

CARD NSR4

Main characteristics of the rotations concerned

Outbound Flight schedule	**Evening**
Time zone change	**BT – 3 ≥ TZC ≤ BT + 3**
Layover time	**< 48 h**
Return flight schedule	**Morning, afternoon or evening**

AIM:
TO PREPARE YOURSELF TO AS BEST COPE WITH THE EFFECTS OF SLEEP LOSS CAUSED BY NIGHT FLYING

RECOMMENDATIONS

- ☞ this rotation is one of the cases which most adversely affects the duration and quality of your sleep. You must therefore pay special attention to your preparation on the days preceding departure. For this, refer to the recommendations concerning pre-flight rest periods (Cards **NFB** or **NFA**),
- ☞ upon arrival at the hotel, you **must not drink coffee, tea, etc.** with breakfast,
- ☞ after a hot shower, go to bed as early as possible. As far as possible, **isolate yourself from light and noise**,
- ☞ after your spontaneous wake-up which should occur sometime in the early afternoon, it is recommended that you have a meal, **drinking moderate amounts of coffee or tea**,
- ☞ avoid taking a nap so as not to affect sleep during the following night ; take some light physical exercise (walk),
- ☞ in the evening, take your meal at a normal time, **avoiding coffee, tea**, etc. After a hot shower, go to bed at normal time.

If the return flight is :

❶ **In the morning or afternoon**: *unless rest is planned in the first part of the return flight (augmented crew),* you should **drink moderate amounts of coffee or tea during** breakfast. Take advantage of waiting times during hotel-airport transfers to relax or take naps, even very short ones ;

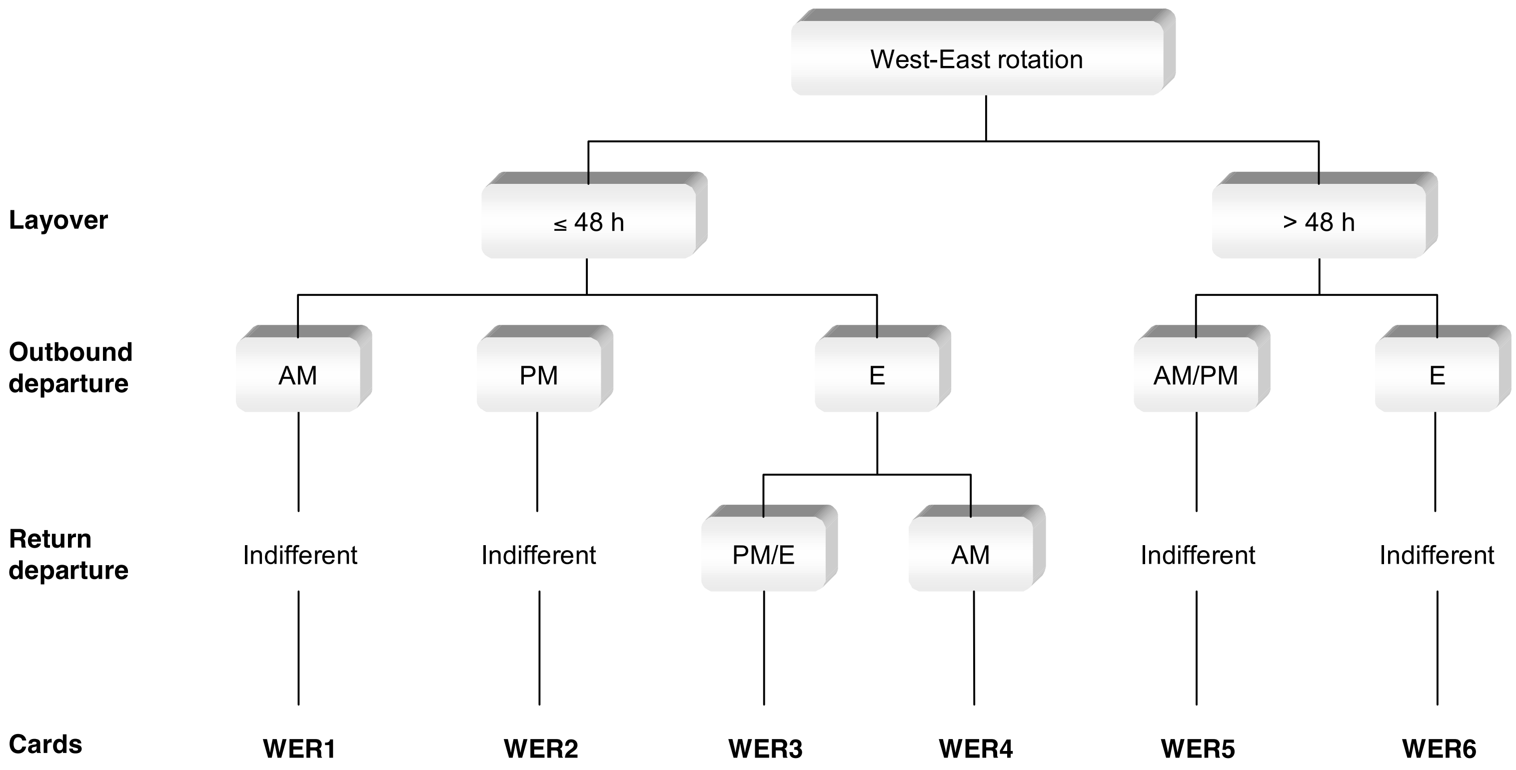
❷ **In the evening** *: unless rest is planned in the first part of the return flight (augmented crew),* you can drink coffee or tea during breakfast. After lunch taken at normal time, avoid drinking coffee or tea take a nap as long as possible, *unless rest is planned during the first part of the return flight (augmented crew)*. Upon waking up, you **should drink small amounts of coffee or tea**.

WEST-EAST ROTATIONS

(WER)

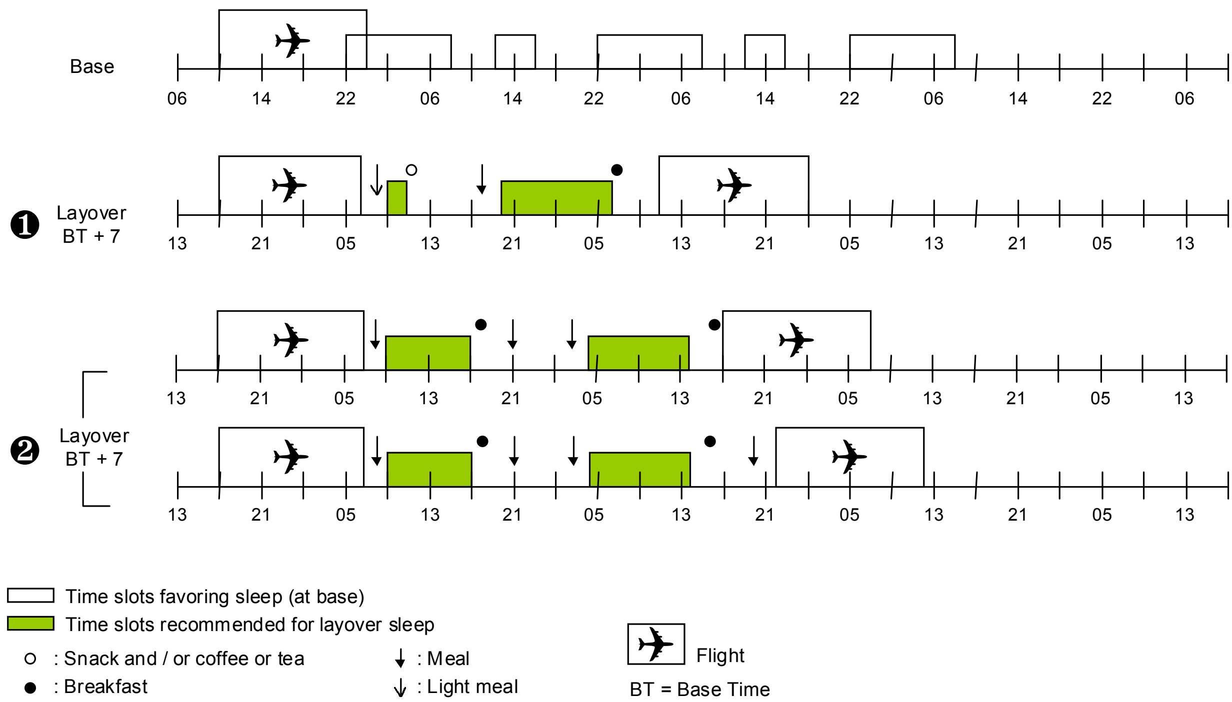
WEST-EAST ROTATIONS

Choice of card according to rotation



AM	:	*Morning*
PM	:	*Afternoon*
E	:	*Evening*
WER	:	*West-East rotations*

Typical rotation WER1



PERSONAL NOTES

Time slots given in these recommendations are only suggestions. They are always given in local time for the layover concerned.

CARD WER1

Main characteristics of the rotations concerned

Outbound Flight schedule	**Morning**
Time zone difference	**≥ BT + 4**
Layover time	**≤ 48 h**
Return flight schedule	**Morning, afternoon or evening**

AIM:
TO AVOID SYNCHRONIZATION WITH LAYOVER STATION LOCAL TIME

RECOMMENDATIONS

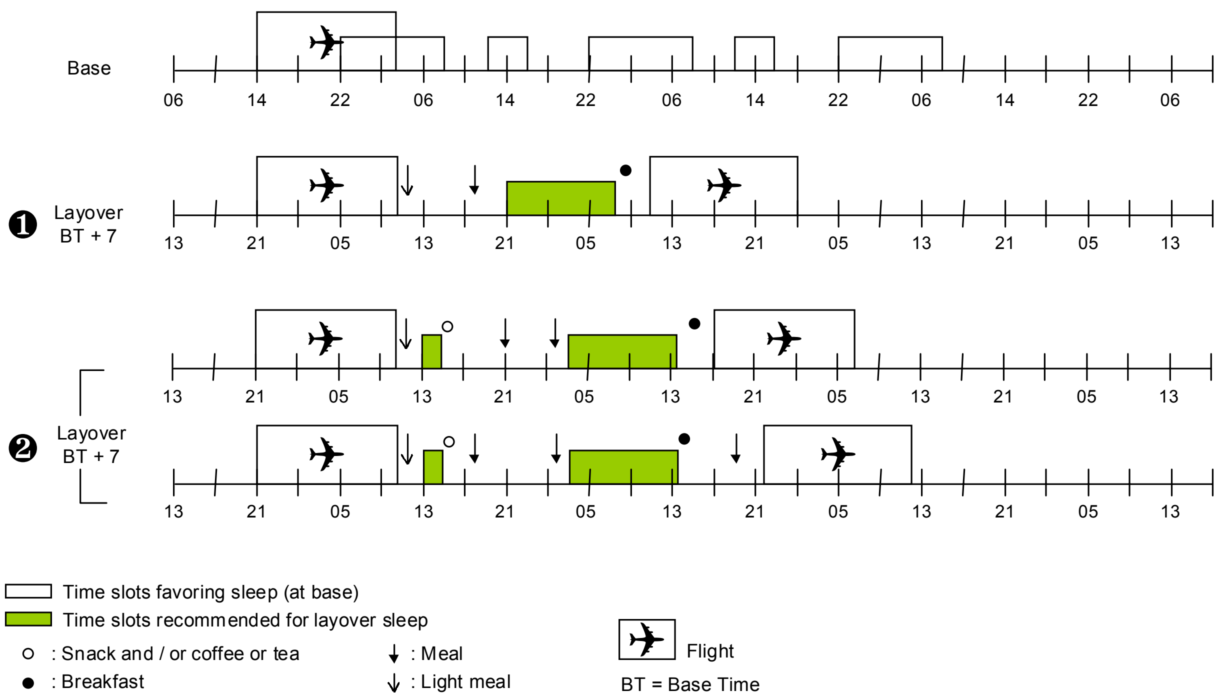
❶ **If the return flight is in the morning:**

- on the first day, upon arrival at the hotel: cold shower and light meal, **it is recommended to drink coffee or tea**. If you feel the need to take a nap, limit its duration to 1 hour maximum,
- evening meal around 8pm, **avoid drinking coffee, tea, etc.**,
- take a hot shower, then go to bed at around 9pm. Sleep onset will be made easier by the fact that you are in a time zone favourable to sleep (early afternoon, in base time),
- **upon waking up** : *unless rest is planned in the first part of the return flight (augmented crew)*, it is recommended to **drink coffee or tea during** breakfast. Take advantage of waiting times and of hotel-airport transfers to relax or take naps, even very short ones.

❷ **If the return flight is in the afternoon or evening:**

- upon arrival at the hotel: hot shower, meal, **avoid drinking coffee or tea**, go to bed as early as possible,
- upon waking up: breakfast, **it is recommended to drink coffee or tea**, favour light physical exercise, walk, etc.,
- lunch around 9pm and evening meal as late as possible,
- go to bed as late as possible so that you will be asleep at a time corresponding to your normal bedtime (in base time),
- **upon waking up** : *unless rest is planned in the first part of the return flight (augmented crew)*, **it is recommended to drink coffee or tea during breakfast**. Take advantage of waiting times and of hotel-airport transfers to relax or take naps even very short ones.

Typical rotation WER2



PERSONAL NOTES

Time slots given in these recommendations are only suggestions. They are always given in local time for the layover concerned.

CARD WER2

Main characteristics of the rotations concerned

Outbound Flight schedule	**Afternoon**
Time difference	**≥ BT + 4**
Layover time	**≤ 48 h**
Return flight schedule	**Morning, afternoon or evening**

AIM:
TO AVOID SYNCHRONIZATION WITH LAYOVER STATION LOCAL TIME

RECOMMENDATIONS

❶ **If the return flight is in the morning:**

☞ on the first day, upon arrival at the hotel: light meal, it is recommended to drink a moderate amount of coffee or tea,

☞ cold shower and avoid taking a nap, in the afternoon, favor light physical exercise (walk),

☞ evening-meal around 8pm, avoid drinking coffee, tea, etc.,

☞ go to bed at around 9pm after a hot shower. Sleep onset will be made easier by the fact that you are in a time zone favourable to sleep (early afternoon, in base time),

☞ upon waking up: *unless rest is planned in the first part of the return flight (augmented crew)*, it is recommended to drink coffee or tea during breakfast. Take advantage of waiting times and of hotel-airport transfers to relax or take naps, even very short ones.

❷ **If the return flight is in the afternoon or evening:**

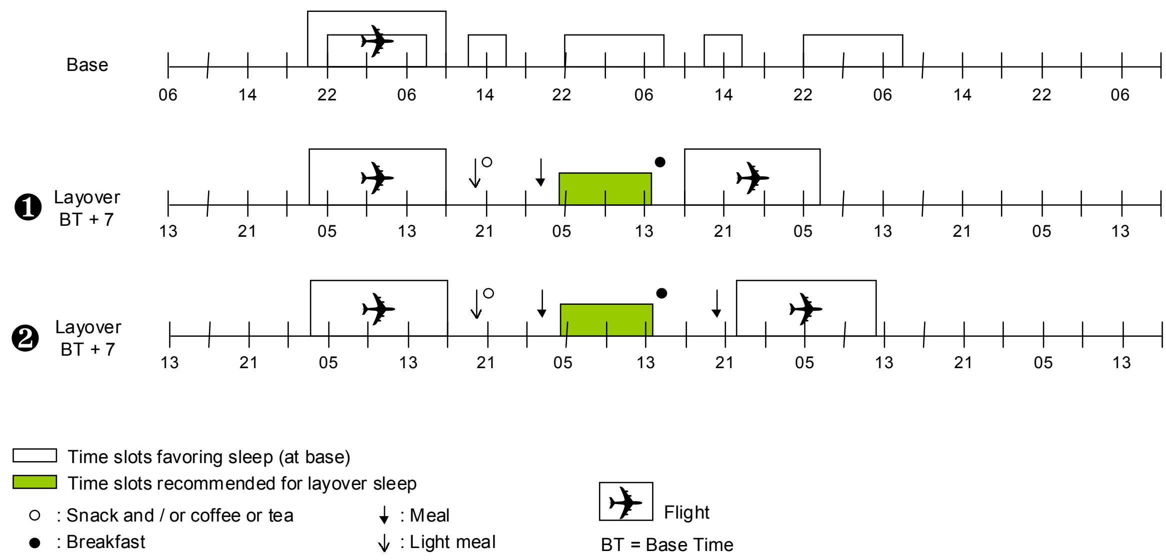
☞ upon arrival at the hotel: cold shower, light meal, **it is recommended to drink coffee or tea**. If you feel the need to take a nap, limit its duration to 1 hour maximum,

☞ lunch around 9pm and evening meal as late as possible,

☞ go to bed as late as possible so that you will be asleep at a time corresponding to your normal bedtime (in base time),

☞ **when you wake up**: *unless rest is planned in the first part of the return flight (augmented crew)*, **it is recommended to drink coffee or tea** during breakfast. Take advantage of waiting times and of hotel-airport transfers to relax or take naps even very short ones.

Typical rotation WER3



PERSONAL NOTES

Time slots given in these recommendations are only suggestions. They are always given in local time for the layover concerned.

CARD WER3

Main characteristics of the rotations concerned

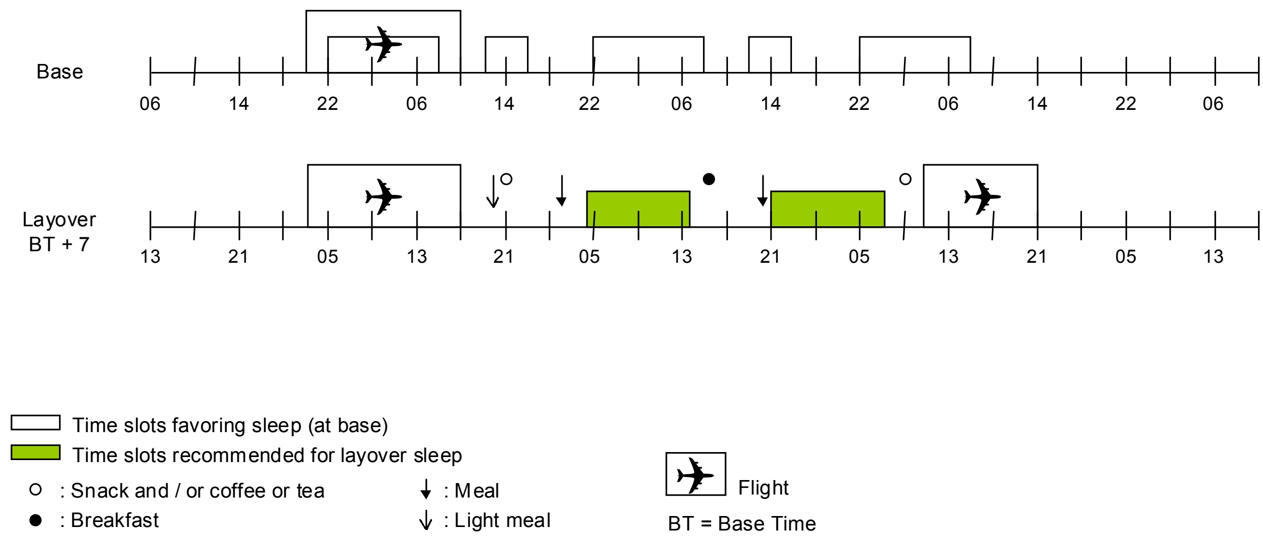
Outbound Flight schedule	**Evening**
Time difference	**≥ BT + 4**
Layover time	**≤ 48 h**
Return flight schedule	**Afternoon or evening**

AIM:
TO AVOID SYNCHRONIZATION WITH LAYOVER STATION LOCAL TIME

RECOMMENDATIONS

- ☞ upon arrival at the hotel: light meal, cold shower, avoid taking a nap, **it is recommended to drink coffee or tea**,
- ☞ favour light physical exercise, walk, etc.,
- ☞ evening meal as late as possible,
- ☞ go to bed as late as possible so that you will be asleep at a time corresponding to your normal bedtime (in base time),
- ☞ **when you wake up**: *unless rest is planned in the first part of the return flight (augmented crew)*, **it is recommended to drink coffee or tea during breakfast**. Take advantage of waiting times and of hotel-airport transfers to relax or take naps, even very short ones.

Typical rotation WER4



PERSONAL NOTES

Time slots given in these recommendations are only suggestions. They are always given in local time for the layover concerned.

CARD WER4

Main characteristics of the rotations concerned

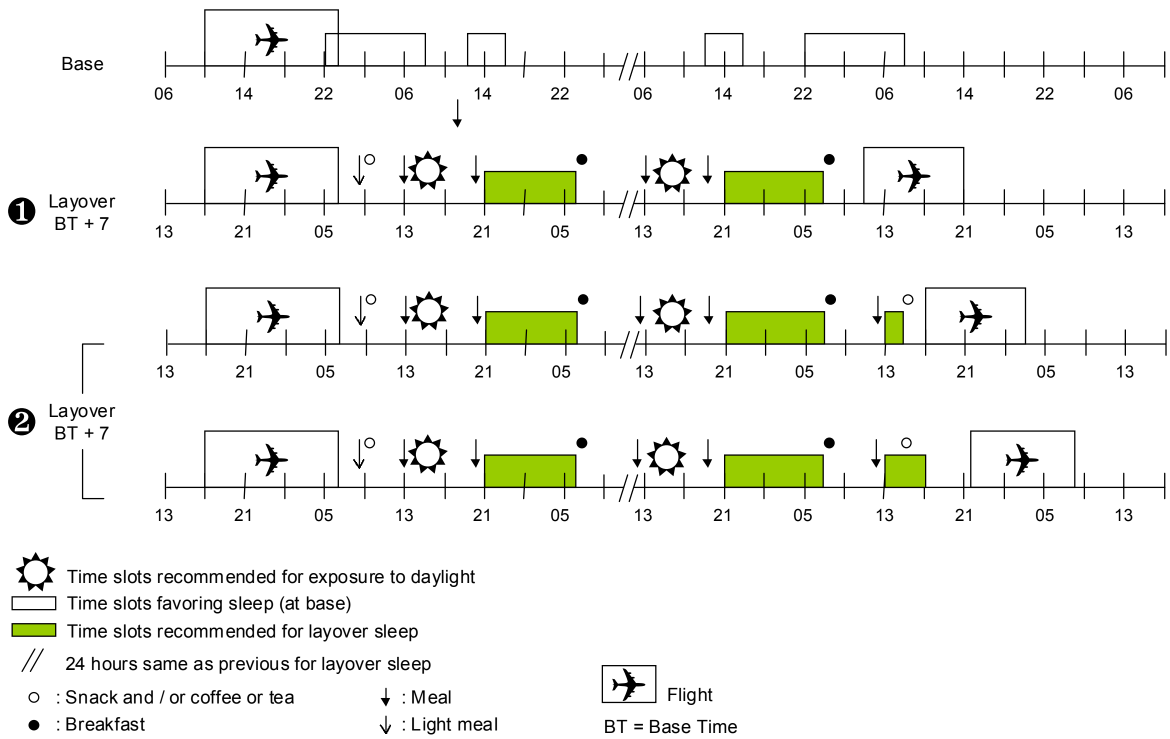
Outbound Flight schedule	**Evening**
Time difference	**> BT + 4**
Layover time	**≤ 48 h**
Return flight schedule	**Morning**

AIM:
TO AVOID SYNCHRONIZATION WITH LAYOVER STATION LOCAL TIME

RECOMMENDATIONS

- ☞ upon arrival at the hotel: light meal, cold shower, avoid taking a nap, **it is recommended to drink coffee or tea**,
- ☞ evening meal as late as possible,
- ☞ go to bed as late as possible so that you will be asleep at a time corresponding to your normal bedtime (in base time),
- ☞ when you wake up: breakfast, **it is recommended to drink coffee or tea**, favour light physical exercise, walk, etc.,
- ☞ lunch around 8pm,
- ☞ take a hot shower, then go to bed at around 9pm. Sleep onset will be made easier by the fact that you are in a time some favourable to sleep (early afternoon, in base time),
- ☞ **when you wake up**: *unless rest is planned during the first part of the return flight (augmented crew)*, **it is recommended to drink coffee or tea** during breakfast. Take advantage of waiting times and of hotel-airport transfers to relax or take naps, even very short ones.

Typical rotation WER5



PERSONAL NOTES

Time slots given in these recommendations are only suggestions. They are always given in local time for the layover concerned.

CARD WER5

Main characteristics of the rotations concerned

Outbound Flight schedule	**Morning or afternoon**
Time zone change	**≥ BT + 4**
Layover time	**> 48 h**
Return flight schedule	**Morning, afternoon or evening**

AIM:
TO ADJUST YOURSELF TO LOCAL TIME AT LAYOVER STATION

RECOMMENDATIONS

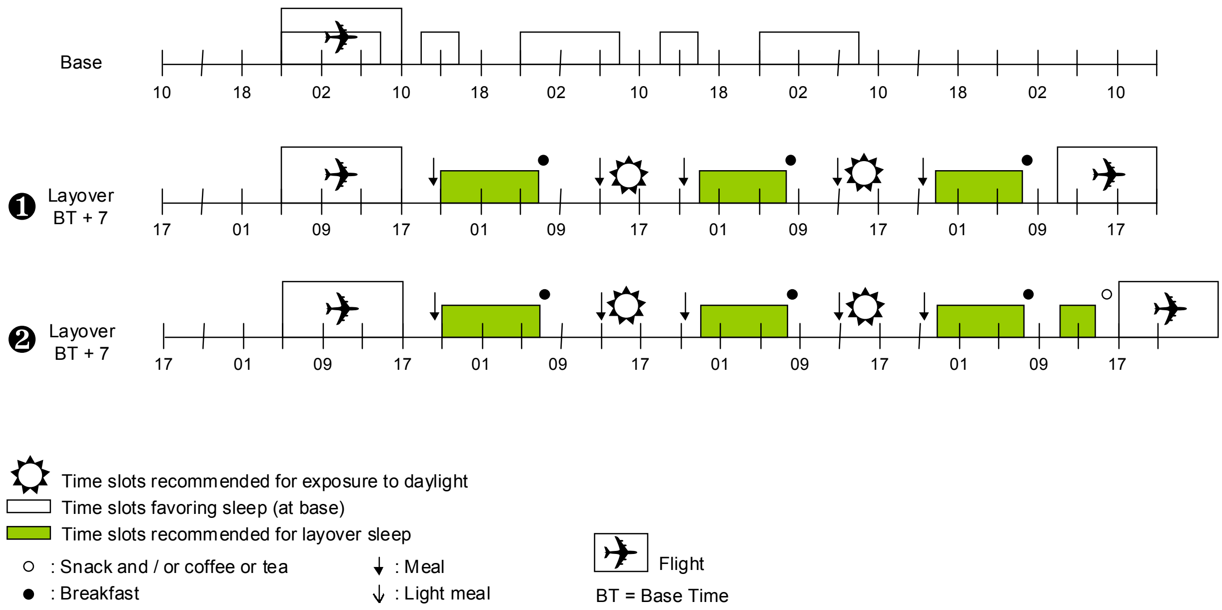
- ☞ on the first day, try taking meals at local times. Upon arrival at hotel: cold shower, light meal, **drinking coffee or tea being recommended**, opting for light physical exercise (walk),
- ☞ around 12pm, **meal with coffee or tea recommended**,
- ☞ between **1pm and 5pm**, physical exercise (walk) **and exposure to daylight**,
- ☞ evening meal from 8pm onwards, **avoid drinking coffee, tea, etc.**,
- ☞ hot shower and go to bed from 9pm onwards, time zone favourable to sleep onset (early afternoon, in base time),
- ☞ upon waking up: have breakfast, **drinking coffee or tea being recommended**,
- ☞ same recommendations for the following days.

If the return flight is:

❶ **In the morning**: *unless rest is planned during the first part of the return flight (augmented crew), you can drink coffee or tea during breakfast.* Take advantage of waiting times during hotel-airport transfers to relax or take naps, even very short ones.

❷ **In the afternoon or evening**: *unless rest is planned during the first part of the return flight (augmented crew)*, take **a nap as long as possible after lunch**. After this nap, **drinking moderate amounts of coffee or tea is recommended.**

Typical rotation WER6



PERSONAL NOTES

Time slots given in these recommendations are only suggestions. They are always given in local time for the layover concerned.

CARD EWR6

Main characteristics of the rotations concerned

Outbound Flight schedule	**Evening**
Time zone change	**≥ BT + 4**
Layover time	**> 48 h**
Return flight schedule	**Morning, afternoon or evening**

AIM:
TO ADJUST YOURSELF TO LOCAL TIME AT LAYOVER STATION

RECOMMENDATIONS

- ☞ on the first play, try to have meals at local times. Upon arrival at hotel: evening meal, **avoiding coffee, tea, etc.**,
- ☞ hot shower and go to bed from 9pm onwards, time zone being favourable to sleep onset (early afternoon, in base time),
- ☞ upon waking up: breakfast, **drinking coffee or tea being recommended**,
- ☞ around 12am, meal, **coffee or tea being recommended**,
- ☞ **between 1pm and 5pm**, physical exercise (walk) and exposure to daylight,
- ☞ same recommendations for the following days.

If the return flight is:

❶ **In the morning**: *unless rest is planned during the first part of the return flight (augmented crew),* you can drink coffee or tea during breakfast. Take advantage of waiting times during hotel-airport transfers to relax or take naps, even very short ones.

❷ **In the afternoon or evening**: *unless rest is planned during the first part of the return flight (augmented crew)*, **take a nap as long as possible** after lunch**. After this nap, drinking moderate amounts of coffee or tea is recommended**.

V – SYNTHESES

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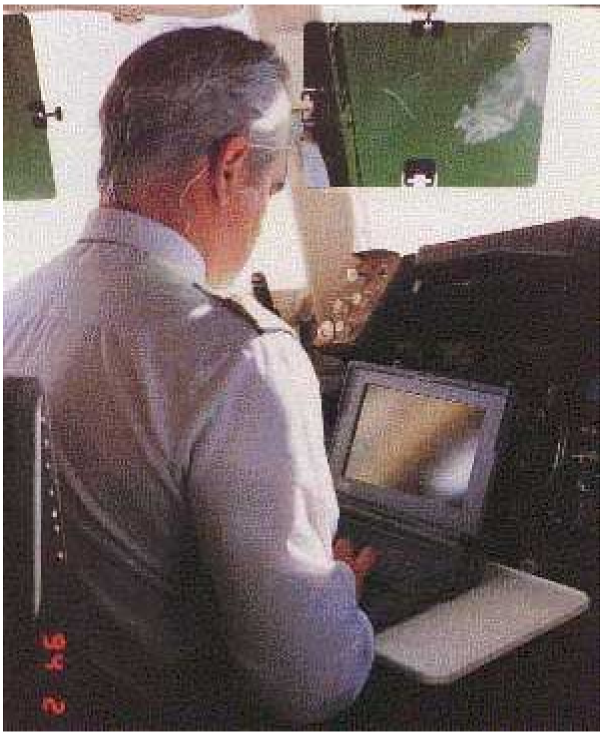
Night flight with UTA to Singapore on B747-400 in 1990.

Recording wist activity throughout the flight.



Assessing crew performance through double task test at Air France in 1994.

Validating recommendations on crew rest and alertness at Air France in 1994.

I - ALERTNESS LEVELS AND DECREMENT

Behavioral continuum	Vigilance or attention levels	Efficiency
Strong emotion	Dispersed and diffused attention	Poor, loss of control, disorganized behavior
Attentive alertness (active wakefulness)	Selective attention prone to variations, concentration, anticipation	Good : efficient, selective and quick reactions. Behavior suitable for serial responses
Relaxation or alertness decrement (diffused alertness)	Attention wavering, not concentrated	Good for routine reactions and creative thought. Bad for monitoring tasks
Drowsiness	Limit condition, mental pictures, dreaming	Poor, uncoordinated behavior, unstable, loss of time references
Light sleep	Considerably reduced awareness	None
Deep sleep	Total disappearance of vigilance	None

Taken from Defayolle et al., 1971

1 - DEFINITIONS

Alertness levels also called wakefulness or level of arousal, or central nervous system activation, represent a continuum from hyperexcitation to deep sleep. In other words, there is no difference in the nature of these levels, they only differ by their magnitude of activation. The notion of alertness level must be distinguished from that of performance level. The alertness level is only a component of the performance level. It constitutes a necessary but insufficient condition. The other condition being the volontary investment by the operator, i.e. the maintenance of a certain attention or vigilance.

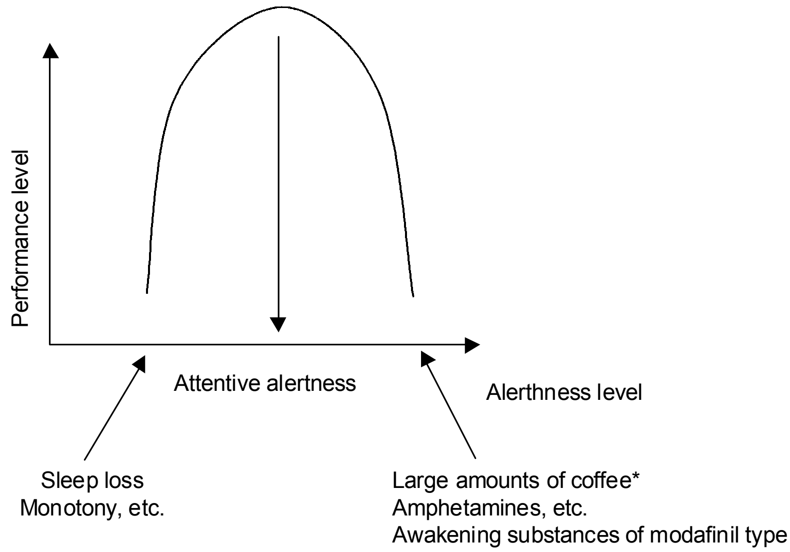
Each alertness level is associated with a probability of reaching a certain efficiency level. This means that being awake does not necessarily ensure an optimum efficiency level: too high a level (strong emotion) disorganizes attention, too low a level (drowsiness) does not allow attention to be fixed on any pertinent information.

An optimum efficiency level can be reached from a wakefulness level called "attentive alertness".

Relaxation, dispersed alertness or **alertness decrement**, are not consciously perceived. Change of state is reversible: return to attentive alertness is possible following a modification in activity or environment. This alertness decrement state can be facilitated through monotony. In case of sleep pressure, this condition rapidly turns into drowsiness. In alertness decrement situations, the ability to detect rare or unexpected signals is impaired.

A nonlinear relation exists between wakefulness level and performance. This relation is shown on the following figure:

Alertness level and performance



* Formally not recommended for crews

Taken from Schimiatke, 1976

II -FATIGUE

The notion of fatigue must be distinguished from alertness decrement and from the need for sleep. In fact, fatigue may appear with a high alertness level.

It can be defined as "a set of manifestations generated by intense and prolonged work extending beyond a certain limit". These manifestations are accompanied by a "feeling of fatigue", and a less favourable relation between efficiency and the effort required to accomplish it. In other words, to maintain equivalent performance, the tired subject must make greater efforts. Pushed to the extreme, a very high workload performed during prolonged periods, interrupted by very short rests, may lead to the development of an exhaustion phenomenon. This phenomenon causes asthenic type pathological reactions.

Distinction should be made between three sorts of fatigue:

- sensorial fatigue: auditive, visual,
- muscular fatigue,
- mental fatigue.

Sensorial fatigue and muscular fatigue are relatively well defined. These can be objectified and measured. Mental fatigue however is more difficult to characterize and to assess. It must be attributed to the highly subjective character of fatigue: one feels "tired", but it is sometimes difficult to translate this sensation into objective manifestations. Indicators therefore remain essentially subjective. Performance tests can however show degradation in those mental functions (memory, attention, etc.) that are related to fatigue.

One of the main characteristics of fatigue lies in the fact that it is a phenomenon that progressively builds up with time (fatigue accumulation). Fatigue is not necessarily related to an excessive workload, to rest which is too short or even to disturbed sleep.

A given task may generate feelings of fatigue for certain subjects and lead to no particular fatigue whatsoever in others. This refers us back to the psychological aspects of motivation and satisfaction in the task to be accomplished. For these aspects, great inter-individual differences are observed.

Recovery from fatigue, i.e. return to a rested condition, is also poorly known and is associated with inter- and intra-individual differences.

Thus, in certain cases and for certain subjects, recovery seems to be very long in spite of sufficient sleep of satisfactory quality.

These aspects must therefore be subject to in-depth research in order to determine all factors influencing level of fatigue and its manifestations and consequences.

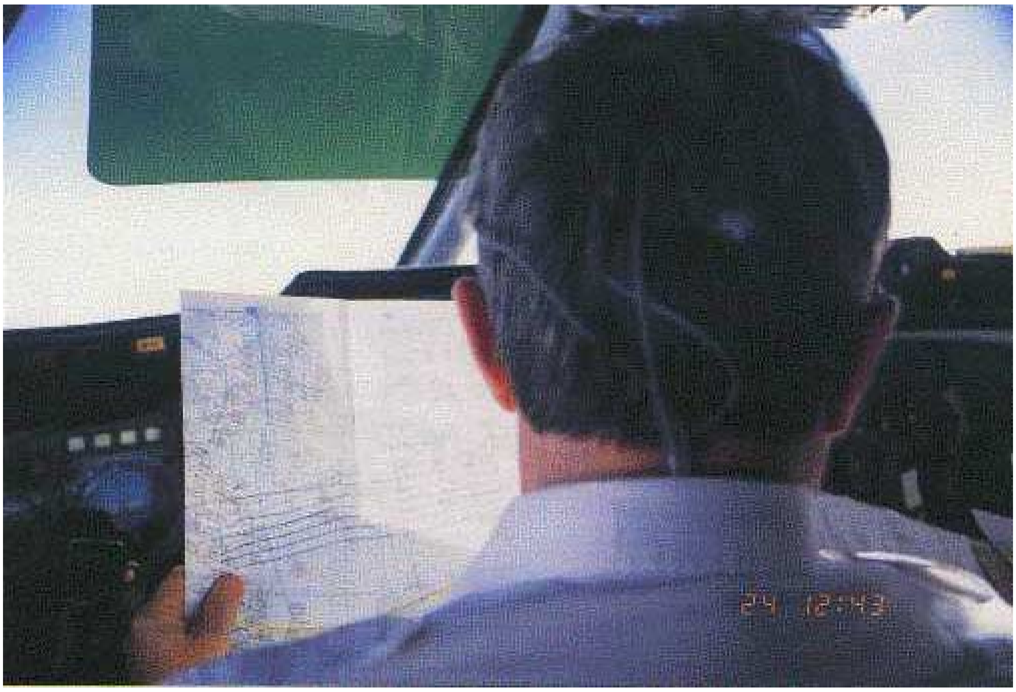
In particular, the accumulation of fatigue remains unexplored even if it is of capital importance in aviation. Moreover, there is a lack of documented studies on the consequences of successive jet lags when operating in opposite directions over long periods of time.

In spite of the fatigue aspects which are still poorly known, certain manifestations (i.e. ↓ lowering, decrement or decrease, ↑ rising, increment or increase) have been identified <u>in the physiological and psychomotor fields</u>.

In the physiological field	In the psychomotor field
↓ in body temperature	↓ in memory
↓ in muscular force or strength	↓ in communications skill
↓ in binocular vision	↓ in ocular tracking (following objects with eyes)
↓ in volume of circulating blood	↓ in attention span
↓ in muscular glycogen (energy stores)	↓ in personal care
↑ in blood sugar (glucose)	↓ in activity
↑ in pupil response time to light (in natural reflex of the eye to light)	↓ in muscular control and coordination
↑ in visual accommodation time	↓ in cooperativeness
↑ in eye fatigue	↓ in acceptance of criticism
↑ in heart rate	↑ in reaction time
	↑ in irritability, anxiety, depression
	↑ in errors and omissions
	↑ in decision making

Taken from J. MARKLE, 1984

Checking navigation performance on ETOPS flight with Air France B767 in 1994.



Plotting North Atlantic navigation track at UTA on DC-10 in 1990.

Observing crew activity alternation modes at UTA on DC-10 in 1990.

Validating Active / Passive crew alternation at Air France on A340 in 1994.

III – MONOTONY

1 - DEFINITIONS

The alertness level can be greatly influenced both by the environment and by the activity of the subject himself;

The environment and the type of task determine the degree of monotony of the situation as it can be defined as "the characteristics of a task in which the sensorial stimulations remain almost constant and extremely repetitive". In fact, there are two concepts in the notion of monotony:

- the state of monotony,
- the monotonous nature of the task.

The state of monotony corresponds both to a <u>subjective</u> feeling and to <u>physiological</u> and <u>psychological</u> manifestations.

The subjective feeling manifests itself as boredom, as disinterest in the work to be done and as a feeling of drowsiness.

From a physiological point of view, a reduction in the activation of the central nervous system is observed. During a monotonous task, the electro-encephalogram (EEG) shows a marked increase in the alpha and theta rhythms typical of a reduction in wakefulness level. A reduction in the heart rate of about 30% and a reduction in blood pressure are also observed.

Taken to the extreme, monotony can lead to psychological disorders causing stress and acute fatigue. The stress would be related to the constant effort required to maintain a sufficient level of arousal to execute the task.

2 - FACTORS INCREASING THE DEGREE OF MONOTONY

2.1 - Environment

Generally speaking, all situations lacking sensorial stimulations or with stimulations which largely remain constant, lead to a state of monotony favourable to a reduction in wakefulness level irrespective of the time of day and this, even when there is no sleep loss.

Several environmental factors can reduce alertness levels
• Repetitive or low-intensity sensorial simulations • Reduced visual field • Restriction in the liberty of movement (no change in postures) • Rare social interactions • High temperature • Low lighting intensity

2.2 - Monotonous tasks

Distinctions should be made between two types of monotonous tasks:

- repetitive activities,
- monitoring continuous processes.

Repetitive activities are associated with work mechanization and especially its fragmentation into simplified operations. The degree of monotony of these tasks can be influenced by different factors:

- low number of actions to be repeated per time unit,
- simplicity of the actions,
- imposed rhythm.

The development of supervisory activities is to be seen in relation to the development of automation. The degree of monotony of these tasks is mainly influenced by:

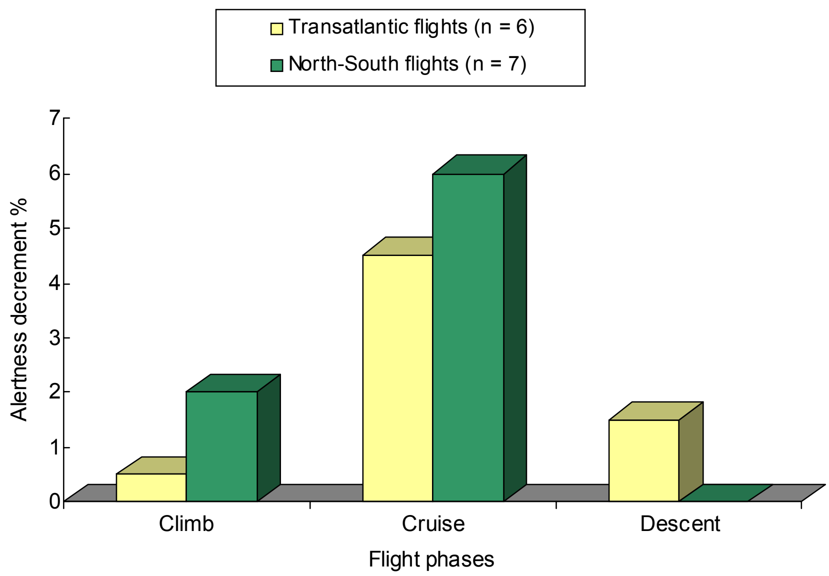
- a reduced visual field (night flying, observing cathode ray tubes),
- the small amount of useful information received per unit of time.

3 - MONOTONY AND LONG-HAUL FLIGHTS

Monotony is one of the most important constraints in aviation, primarily during long-haul flights. This constraint might be accentuated when these flights are made on new-generation glass cockpit aircraft.

This was studied from experiments conducted by LAA and Airbus in real flight situations with voluntary crews from several participating airlines. Variations in alertness levels in flight were assessed from electro-encephalograms (EEG) and electro-oculograms (EOG). Crewmembers activities and behaviours were simultaneously observed by means of an Aircrew Data Logging System. Sleep duration and quality before the rotation, during layover and after the rotation were also determined from recordings made with wrist actometers and from sleep logs (see chapter II).

Long-haul flights



Taken from DOC AA 302/93

Results indicate that alertness decrement occurrences may be very frequent, even during daytime flights, without previous sleep loss.

Results also show that alertness decrement rates are higher during north-south flights than during transatlantic flights, especially for the cruise phase. This difference may be due to the very high monotony of cruise phases during north-south flights for which radio contacts are rare. However, for Asiatic rotations, the high number of ATC communications contributes towards limiting reductions in the alertness level.

these alertness decrements may occur simultaneously for both pilots. This can be attributed to potentially highly synchronized activities between the two pilots. Observing activities and behaviours shows that certain actions, such as reading technical documents or passively supervising systems, favour these reductions in alertness. Inversely, motoric tasks associated with a cognitive activity, such as interacting with the FMS (Flight Management System), reactivate the pilots' alertness level. **Also, the mutual knowledge that pilots have of themselves, the aircraft and the route may have a negative influence on alertness.**

These results reflect the effect of monotony towards reducing the alertness level.

4 - REDUCING THE EFFECT OF MONOTONY

Some laboratory and field research is available to document developed solutions for alleviating the effects of monotony on an operator's alertness. The following methods were deemed efficient:

- introducing short breaks during the task (10 minutes every 30 minutes),
- introducing a different task,
- task execution rate set by the operator.

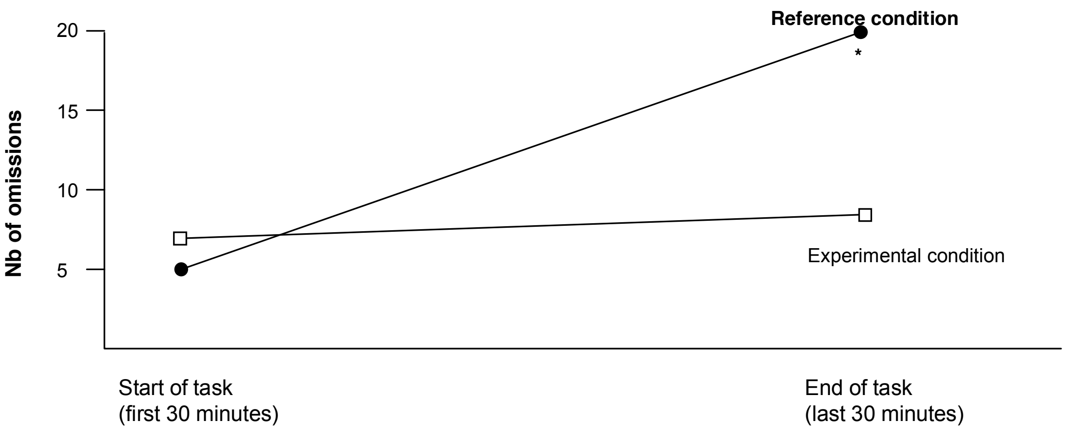
Another method consists of altering the task execution process without modifying its nature. This solution was shown to be well-founded by experimental laboratory research (Cabon, 1992). The task used in this experiment was a critical signal supervision and detection task requiring the use of "automatic" processes. its duration lasted 4 hours.

In order to break the monotony of the task, subjects were forced to use "controlled" processes during short periods. These processes required greater attention than the "automatic" processes. This situation (experimental condition) was compared with a condition in which the subjects only used the automatic processes (reference condition). As a result of this daytime experiment, the following results were observed between start and end:

- similar performance (number of omitted signals) **under experimental conditions**,
- significant decrease in performance **under reference conditions**.

When the experiment was held at night, significant reductions were observed irrespective of the conditions.

Reducing the effect of monotony



* Significant difference at p<0.001

Taken from Cabon, 1992

These experimental results show that the effects of monotony can be attenuated by modifying the nature of the task, its duration, its execution rhythm and also the response execution process.

The principle for breaking monotony by alternating "automatic" and "controlled" cognitive processes was transposed to real situations involving military air surveillance operators (Cabon, 1992).

Field research carried out with nuclear power plant control room operators confirmed possibilities for practical uses of this solution when monitoring automated processes (Cabon, 1992).

This method was transposed to real long-haul flight situations within the context of validating recommendations. In these recommendations, it is specified that pilots should alternate passive and active vigilance phases.

Active vigilance periods are characterized by:

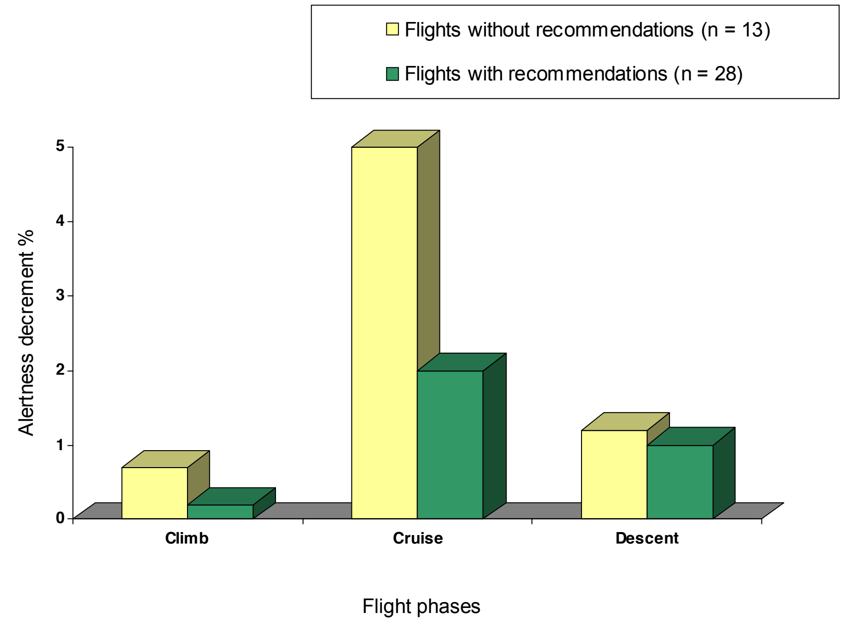
- tasks and verbal exchanges related to flight management,
- varied motor actions associated with mental tasks involving electronic interfaces (FMC, ECAM/EICAS for example),
- no meals during this period.

During the passive vigilance periods, we suggest favouring:

- activities not related to the flight (reading of papers for instance),
- more dispersed supervision of the flight,
- meals or snacks,
- napping.

It is proposed that pilots alternate these periods at a frequency between 20 to 40 minutes according to flight context. This alternation is mainly justified during calm cruise periods with no strategic changes in flight plan. Also, pilots are asked to verbally express the end of each phase in order to inform the other crew member.

Long-haul flights



Taken from DOC AA 302/93

Results demonstrate that alertness decrement rates are lower for flights with recommendations, irrespective of the flight phase. Observing crews' activities shows that this reduction can be attributed to crew activity management conducive to reduced flight monotony.

IV - CIRCADIAN RHYTHMS

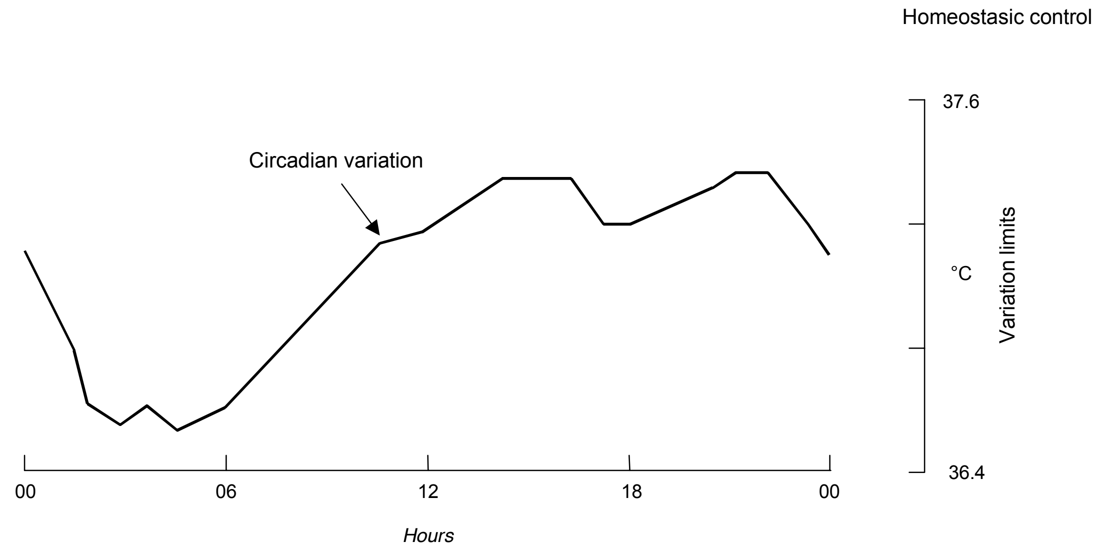
1 - CONSTANCY AND RYTHMICITY

1.1 - Definitions

Human functioning has two main regulatory modes: circadian (circa: about, dies: day) and homeostasic (homeo: constant, stasis: level).

Vital functions pass through a maximum and a minimum during a period of 24 hours (circadian variation). These variations are within limits beyond which the organism would be in danger (homeostatic regulation).

Stability and variation



Example of circadian and homeostasic control of body temperature (°C)

1.2 - Manifestations

The homeostasic process manifests itself in individual life through sensations such as hunger, thirst, fatigue, drowsiness, etc. Satisfying these needs restores the internal balance needed to maintain physical and mental integrity.

Circadian regulation is reflected by a diurnal increase and a nocturnal decrease in the individual's functional capabilities. It is at the origin of sleep disorders, disturbances in the biological rhythms and mental performance when the rest-activity cycle is modified or after rapidly crossing many time zones.

2 - BIOLOGICAL RHYTHMS

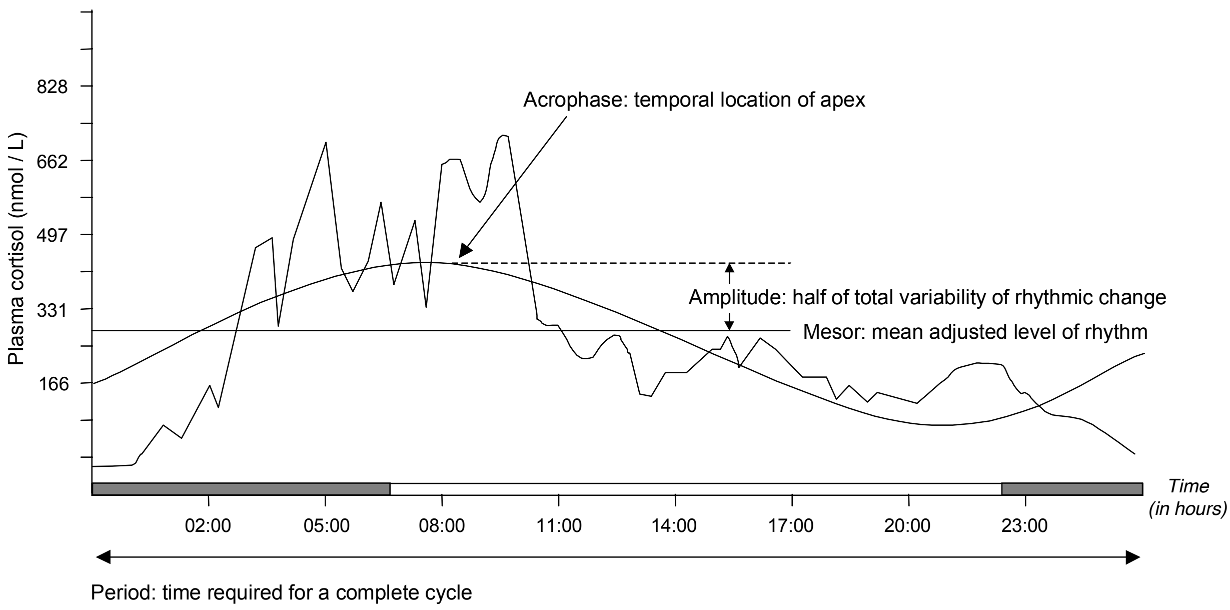
2.1 - Definitions

Vital activities which characterize cells, tissues, organs, individuals and even populations, do not occur evenly or randomly in time, but have a daily maximum and minimum.

A rhythm can be defined as being the periodic recurrence of a sequence of events occurring in the same order during the same time interval.

Four parameters characterize a biological rhythm: period, mesor, amplitude, acrophase.

Biological rhythms



Characteristics of circadian fluctuations of plasma cortisol over a period of 24 hours (taken from Nelson, 1979)

A rhythm is called ultradian, circadian or infradian when the period is lower than, equal to or greater than 24 hours respectively.

2.2 - Temporal structure

Peaks of the different variables are not randomly distributed. On the contrary, a time-related or "temporal structure" organization exists for the distribution of the acrophases over 24-hour periods.

The Various vital functions have strong phase relations between the ascending and descending parts of their rhythms.

The alteration of these phase relations is at the origin of the disorders related to jet lag and shift work.

Chronobiology is defined as being "the study of the temporal structure of each living being and that of its alterations".

2.3 - Origin

Circadian rhythm periods are close to those of the earth's rotation.

One is therefore led to think that these rhythms strictly and rigorously depend on environmental variation, i.e. day-night alternation, darkness-daylight, heat-cold, rest-activity, etc.

Under constant environmental and behavioural conditions (experiment called "constant routine") biological rhythms do persist.

We are therefore left to conclude that an internal mechanism regulates body function. This mechanism is simply known as the biological clock.

2.4 - Implications

In certain cases, choosing the best time to administer a drug allows its therapeutical effects to be optimized and its secondary effects reduced. For example, as the acrophase of cortisol secretion is located around 8am, administering corticoids (drugs chemically similar to cortisol) in phase with its peak secretion reinforces their actions. Another example is the time duration over which an antihistamine drug will act; the effective time is doubled if the drug is administered at 7am rather than 7pm.

The effects of various toxic agents (heavy metals, organic solvents, carbon oxides) vary considerably over a period of 24 hours. At certain times, a toxic agent can cause substantial lesions, whereas the same dose received at another time in the 24-hour cycle would be much less harmful. These temporal differences in the intensity of toxic effects are most often correlated with the capacity of the liver and the kidneys to "detoxicate" blood of these harmful substances.

3 - CIRCADIAN RHYTHMS OF PERFORMANCE

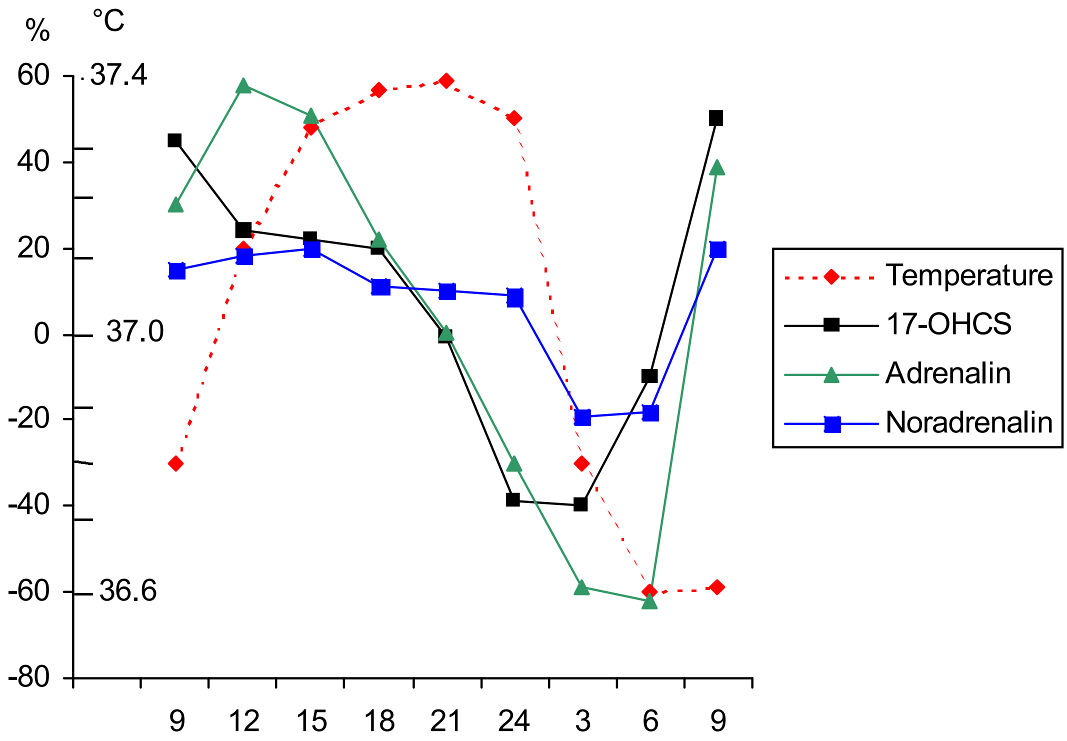
3.1 - Description

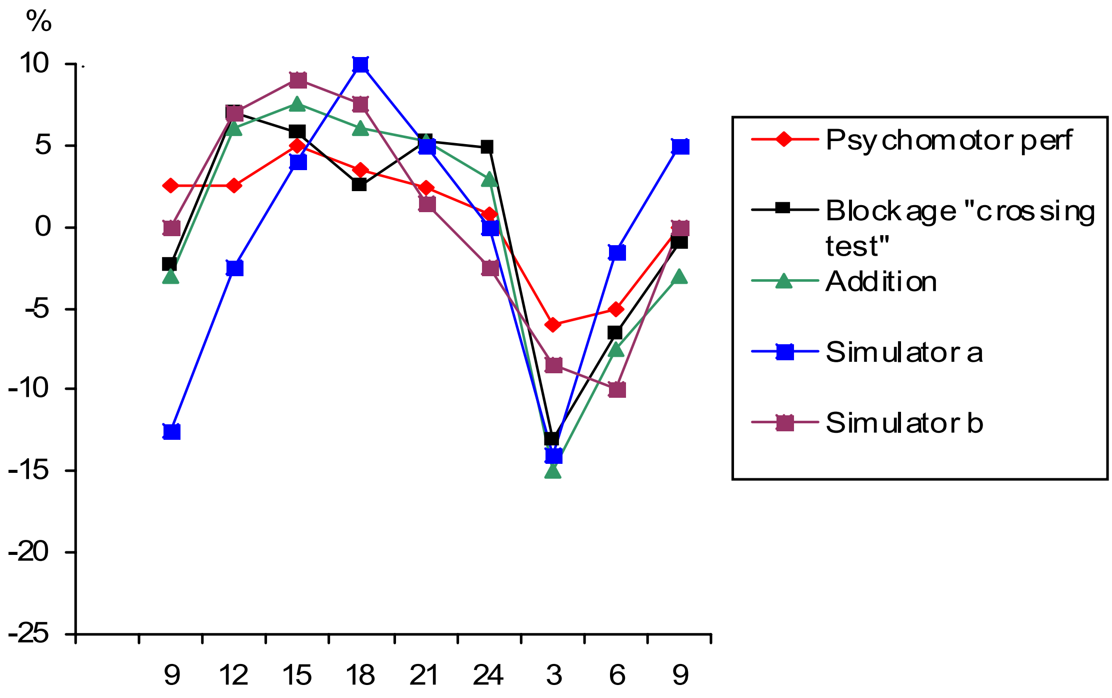
Operators engaged in any given tasks do not always react in the same way at different times of day and night. Similar to biological functions, perceptual and mental functions are subject to rhythmic variations over a 24-hour span.

Performance in trials demanding sustained attention improves during the morning to reach a maximum in the middle of the afternoon then starts to decline towards the evening to reach a minimum during the night.

A degradation in performance is sometimes observed early in the afternoon. This phenomenon, called the "post lunch dip" effect, occurs even when meals are not eaten.

Circadian variations in efficiency are, in most cases, highly correlated with variations in body temperature except in the early afternoon where this is paradoxically not paralleled by a similar decrease in temperature.





Examples of the circadian rhythms of physiological and psychological functions (taken from Klein and Wegmann, 1988)

3.2 - Modulation of circadian variations

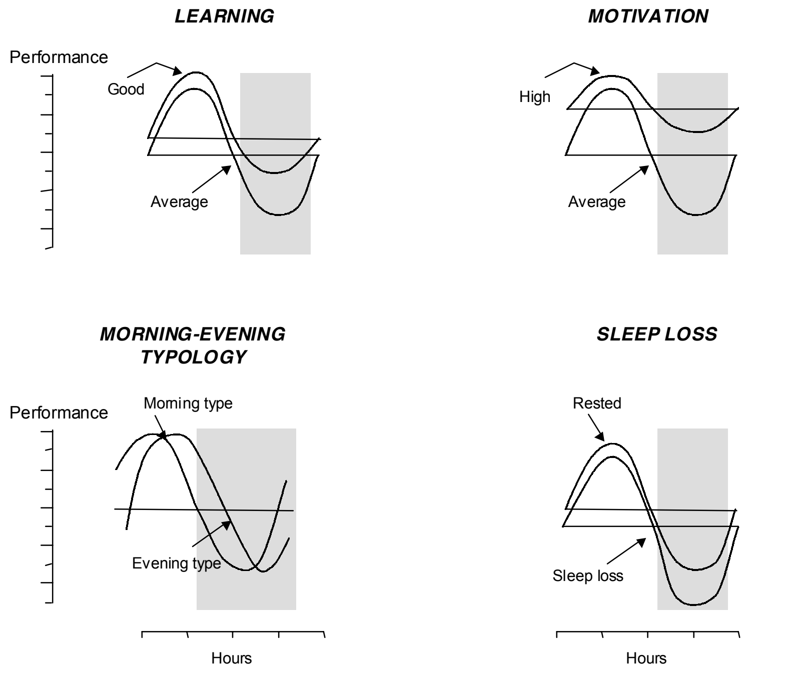
Circadian rhythmicity can be compensated for by exerting a greater effort: the reduction in performance controlled by circadian rhythmicity can be compensated for if the operator is able to mobilize more of his resources.

The ability for mobilizing resources varies according to:

- the type of task,
- the individual
- motivation,
- learning,
- knowledge of performance results.

Increasing the mobilization of the operator's capabilities, operational adaptation, change from a low activity state to an active mobilization state, when forseeable or random events occur, causes physiological problems and has long-term medical consequences for the operator.

Modulation of circadian variations



Schematic representation of the factors modulating performance circadian rhythm (taken from Klein, 1976)

4 - SLEEP LOSS AND PERFORMANCE

4.1 - Definition

Partial sleep loss can be either attributed to a reduction in sleep time amounting to several hours (going to bed late, getting up early) or to a fragmentation of the sleep period.

Deterioration in performance related to sleep loss is generally indicated by omissions in test or in supervisory monitoring processes, i.e. periods of non-response to a critical signal. These periods correspond to episodes of drowsiness or reduced alertness levels.

Monotonous supervisory tasks are those which are the most affected by sleep loss. They present a low sensorial stimulation level, constant or repetitive, but requiring constant alertness.

4.2 - Manifestations

Signal detection: the capability to detect rare and low-level signals drops as sleep debt increases.

Rational critical analysis of situations: individuals with a sleep debt will have a tendency to accept raw sensorial impressions without critical analysis. During situations favouring the appearance of sensory illusions, or even visual and auditive hallucinations, a subject, even well-trained, will loose all ability to rationally criticize a situation and will act in an inappropriate manner. Sleep debt reduces the possibilities for critical analyses of increased sensory impressions.

Psychomotor learning: sleep loss can represent an important stress factor capable of inhibiting recently acquired automatisms and of archaic reactions which had disappeared under the recent learning effect.

The table below summarizes the main effects of sleep loss on mental processes and mood as well as on tasks most altered by sleep debt.

Effects on mental processes:

- lack of concentration,
- periods of inattention,
- reduction in alertness level,
- slow actions,
- alteration in short-term memory,
- loss of critical analysis and advocacy,
- interpretation errors,
- visual illusions,
- disorientation.

Effects on mood:

- sensation of fatigue,
- depressive state,
- irritability,
- loss of interest in people and events,
- increasing and irresistible longing for sleep.

Most altered tasks:

- sustained tasks,
- tasks without stimuli,
- routine work,
- supervisory monitoring tasks,
- insufficiently learnt tasks,
- tasks with high workload,
- tasks requiring complex decision-making.

(after British Army Personnel Research Center, 1986).
Cited in Lagarde, 1990

4.3 - Modulation of the effects of sleep loss

Noise: in normal situations, noise has too-high an activation effect leading to a reduction in efficiency, but it facilitates efficiency when associated with sleep loss (Wilkinson, 1963). Sleep loss reduces the cerebral activation level, noise moves this level towards the optimum.

Alcohol: associated with a sleep deprivation, reduces the wakefulness level and, in parallel, degrades mental performance.

Moderate physical exercise: increases cerebral activation.

Validating Active/Passive crew alternation at Air France on A340 in 1994

Validating Crew Rest on board with dedicated sleep bunks on A340

V – SLEEP AND NAPPING

1 - SLEEP

1.1 - Description – Normal sleep

Sleep onset is a periodic phenomenon which occurs every day at almost the same time.

Sleep generally starts at the end of the day, when the body temperature begins to drop and it continues so for 6 to 8 hours.

Spontaneous awakening occurs during the ascending part of the thermal cycle, that is 2 to 3 hours after the thermal minimum which, on average, takes place around 5am.

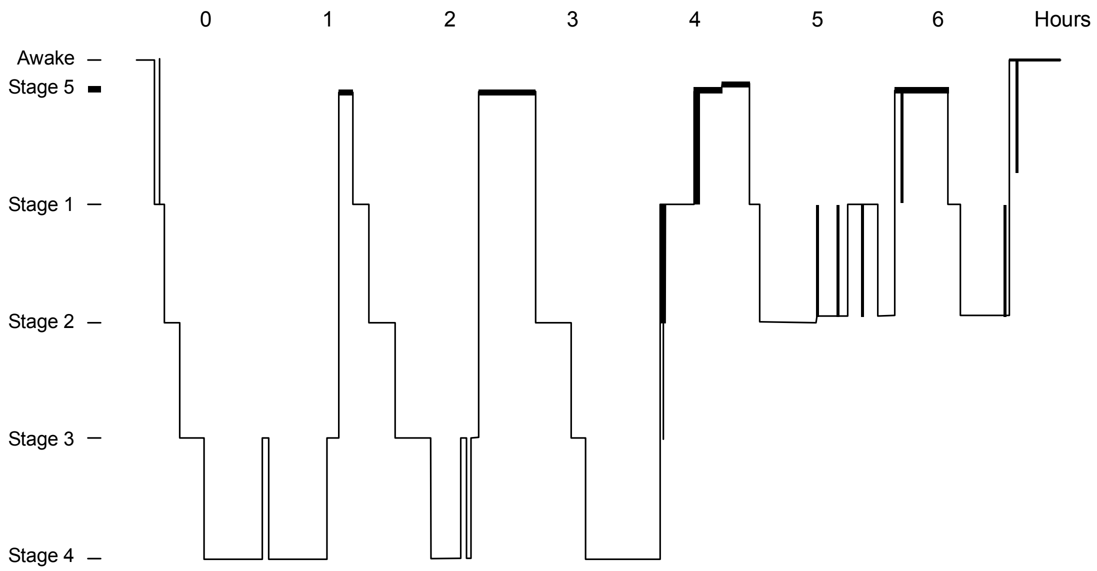
The polygraphic study of sleep, recording of cerebral activity, muscular tone and eye movements, allows the various increasing depth stages to be separated:

- Stage 1: sleep onset,
- Stage 2: light sleep,
- Stages 3 and 4: deep slow-wave sleep,
- Stage 5, Rapid Eye Movement (REM) sleep.

	Minutes	Percentage
Wake time	12	3%
Stage 1	48	12%
Stage 2	159	39%
Stages 3 and 4	117	28%
Stage 5	76	18%
Total	412	100%

Sleep composition and organization (Benoit, 1984)

Sleep



Example : hypnogram of a normal night (taken from O. Benoit, 1984)

After sleep onset, the subject progresses through Stages 2, 3 and 4. He remains for a certain time at Stage 4, whereafter sleep becomes lighter with a return to Stage 2 which leads to the first REM phase. This terminates the first sleep cycle.

A normal night's sleep includes 4 to 5 cycles depending on total sleep time. The REM stage occurs every 90 to 120 minutes.

Deep slow-wave sleep (Stages 3 and 4) occurs mainly in the first half of the night.

The REM sleep episodes are longer during the second half of the night.

1.2 - Spontaneous variations between individuals

1.2.1 - Sleep time: short and long sleepers

Average sleep time is between 7 and 8 hours.

It is accepted that the minimum and maximum sleep time limits are 4 hours and 11 hours respectively.

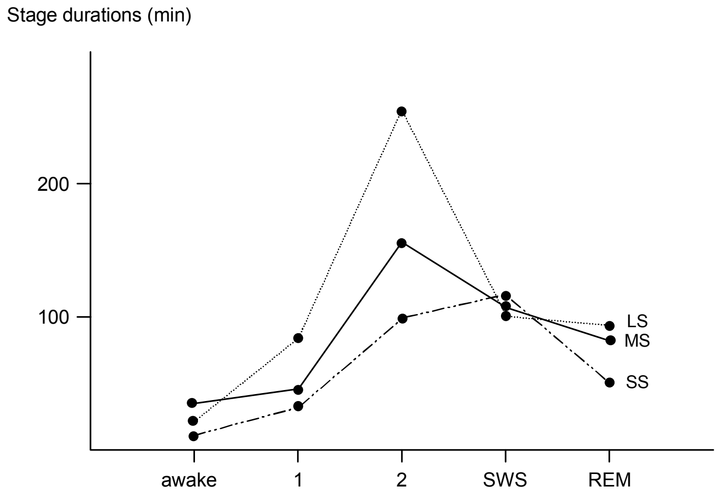
Sleep times of less than 5 ½ hours are recorded with short sleepers. Long sleepers sleep for more than 9 ½ hours.

Short and long sleepers represent less than 5% of the total population.

The difference between short and long sleepers is mainly explained by the differences in Stage 2 and REM sleep.

Long sleepers have more awakenings, more light sleep and more REM sleep stages but almost the same amount of deep slow-wave sleep (Stages 3 and 4) as short sleepers.

Spontaneous variations between individuals



Quantities of various sleep stages in short (SS), medium (MS) and long (LS) sleepers.

REM/ Rapid Eye Movement sleep ; SWS : Slow Wave Sleep (according to O. Benoit, 1984)

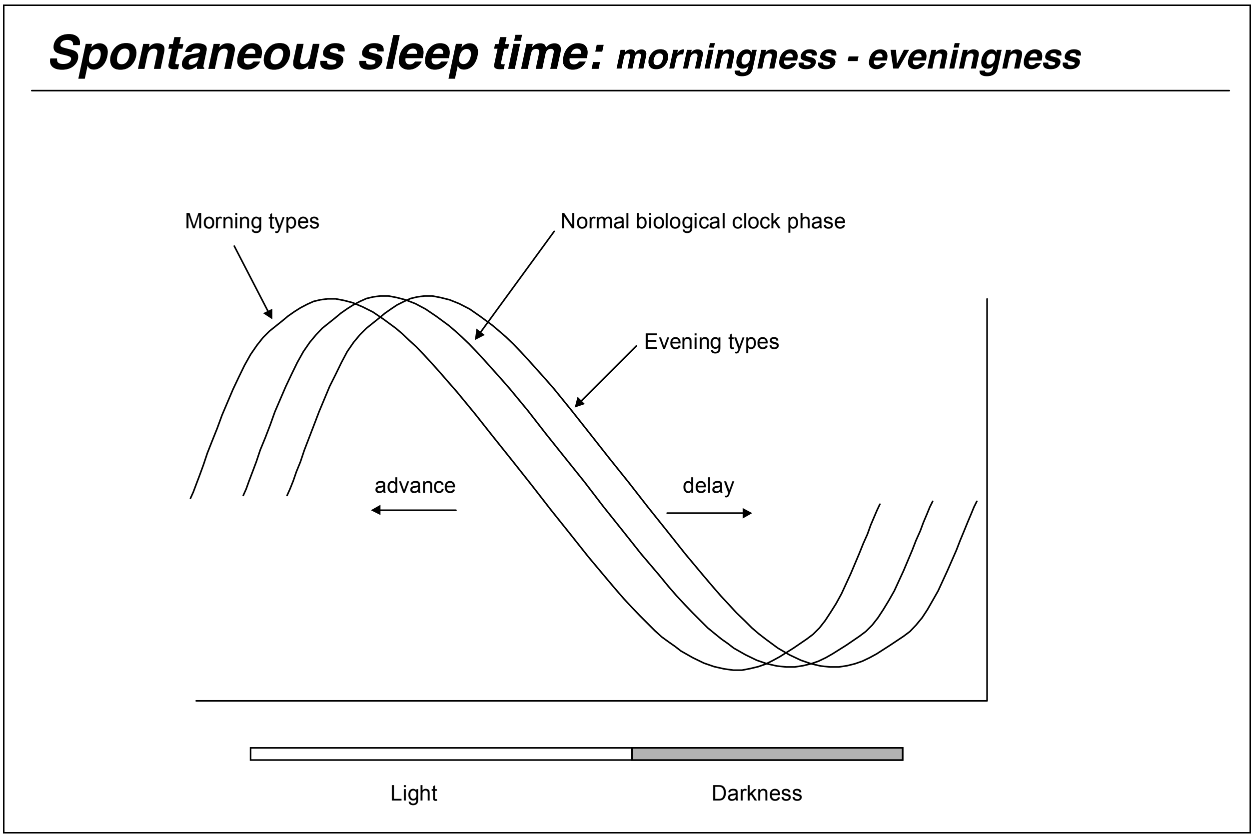
1.2.2 - Spontaneous sleep times: morningness – eveningness

The body temperature cycle is an excellent biological clock phase marker. It is said to be normal when the thermal minimum is around 5am, in advance when it occurs before, and delayed when it occurs after 5am.

Evening types have a biological clock phase which is delayed with regard to the environmental synchronizers, and morning types have a biological clock phase which is in advance of the environmental synchronizers.

Spontaneous sleep onset and wake onset are related to the biological clock phase. Advance in phase leads to early bedtimes and early rising. A delay in the biological clock leads to the opposite phenomenon.

Sleep onset times correspond, on average, to 10pm and 1am for morning types and evening types respectively.



These differences are less obvious during working days but become more marked during holidays and days-off: evening types delay their bedtimes considerably and extend rising times when social and professional constraints have less predominance than private ones.

1.3 - Functions

REM sleep is said to be involved in the restoration of attention, learning, memory, emotional balance and mood mechanisms.

Deep slow-wave sleep apparently allows reconstruction or maintenance of physical integrity: nocturnal increase in protein synthesis and cell division.

1.4 - Origin

It is sometimes implicitly assumed that nocturnal sleep onset is simply related to habit. However, when there are no "direct time givers (watch, radio, newspapers, etc.) or "indirect time givers" (lighting, noise, temperature, vibrations, etc.), an isolated subject maintains his wake-sleep cycle rhythmicity but with a period of around 25 hours instead of 24 hours. This shift leads to increasingly later rising times and bedtimes.

The persistence of the sleep-wake periodicity reflects the existence of an internal system, or biological clock, which functions autonomously and has its own frequency.

Under normal conditions, the circadian clock is driven or synchronized to a period equal to 24 hours by periodic variations called environmental synchronizers.

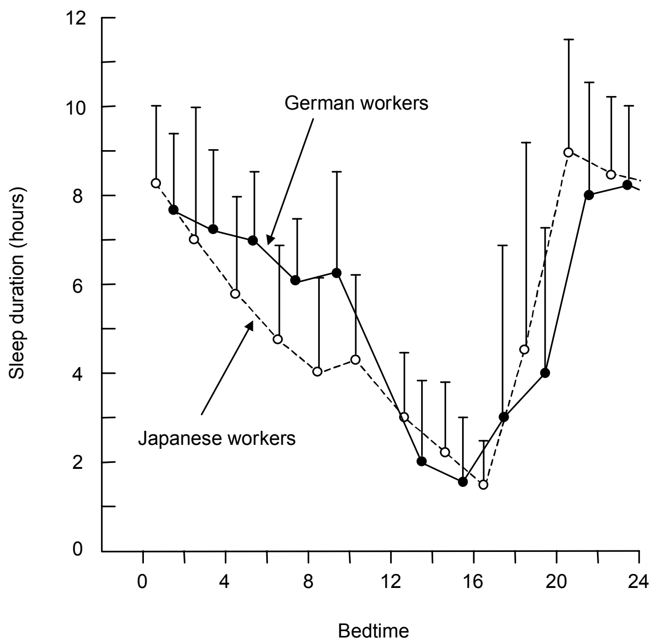
The 25-hour cycle suggests that when they are no constraints, human beings have a natural tendency to lag behind the environmental synchronizers.

Because of this spontaneous tendency, it is easier for a traveller to delay both his bedtimes and rising times after a westward flight than to advance them for an eastward flight.

1.5 - Relation between sleep and biological clock phase

Sleep latency, duration and composition depend on body temperature cycle where sleep onset is located.

Relation between sleep and biological clock phase



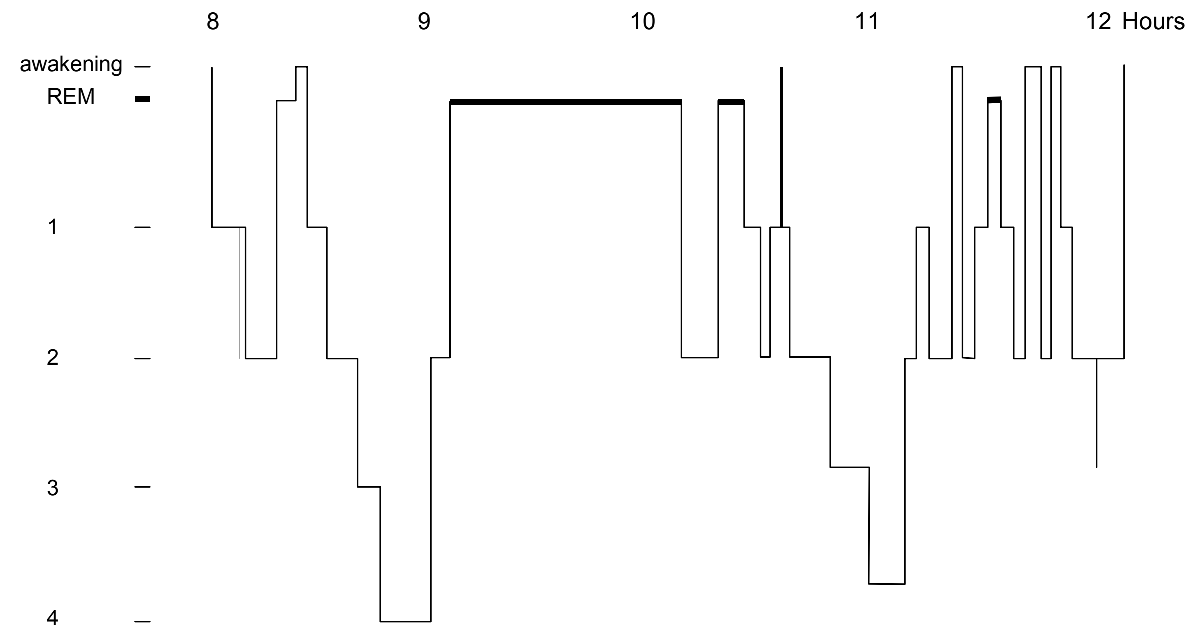
Variation in sleep durations as a function of bedtime for shift workers
(cited in Kogi, 1985)

1.5.1 - If sleep starts a little after maximum temperature, i.e. around 11pm

- sleep duration is long and awakening occurs during the ascending part of the thermal cycle,
- sleep architecture is normal:
  - REM stage occurs every 90 to 120 minutes,
  - REM sleep episode duration is higher in the second half of the night,
  - deep slow-wave sleep (Stages 3 and 4) is concentrated within the first half of the night.

1.5.2 - If sleep starts around the thermal minimum, i.e. around 5am

- drowsiness is extreme with low sleep latency,
- REM sleep is facilitated (reduction in latency of first episode and increase in its duration),
- sleep will be relatively short as wake-up occurs as soon as body temperature starts rising.



Morning sleep hypnogram
REM : Rapid Eye Movement sleep (taken form O. Benoit, 1984)

These data allow us to understand the shortness of a morning sleep (4 to 5 hours) observed after a sleepless night. In fact, morning sleep generally starts between 7am and 8am and ends when body central temperature becomes high, generally around 12am.

This situation is found in the case of a westward flight when sleep time is delayed towards physical local night. Sleep duration during the first night can sometimes be longer, as all the environmental factors lend themselves to this, but the sleep will have an abnormal architecture and will be punctuated by awakenings.

2 - NAPPING

2.1 - Definition

A nap corresponds to a period of sleep lasting between 20 minutes and 2 hours.

It plays a fundamental role in reducing sleep dept. It can act as a compensating phenomenon in case of sleep loss and allows fatigue to be overcome.

2.2 - Time zones favourable for naps

After a normal night's sleep, drowsiness presents a clear bimodal distribution with a peak in the middle of the afternoon as well as a nocturnal peak.

The nocturnal peak is called the "primary sleep gate" and the one in the middle of the afternoon the "secondary sleep gate".

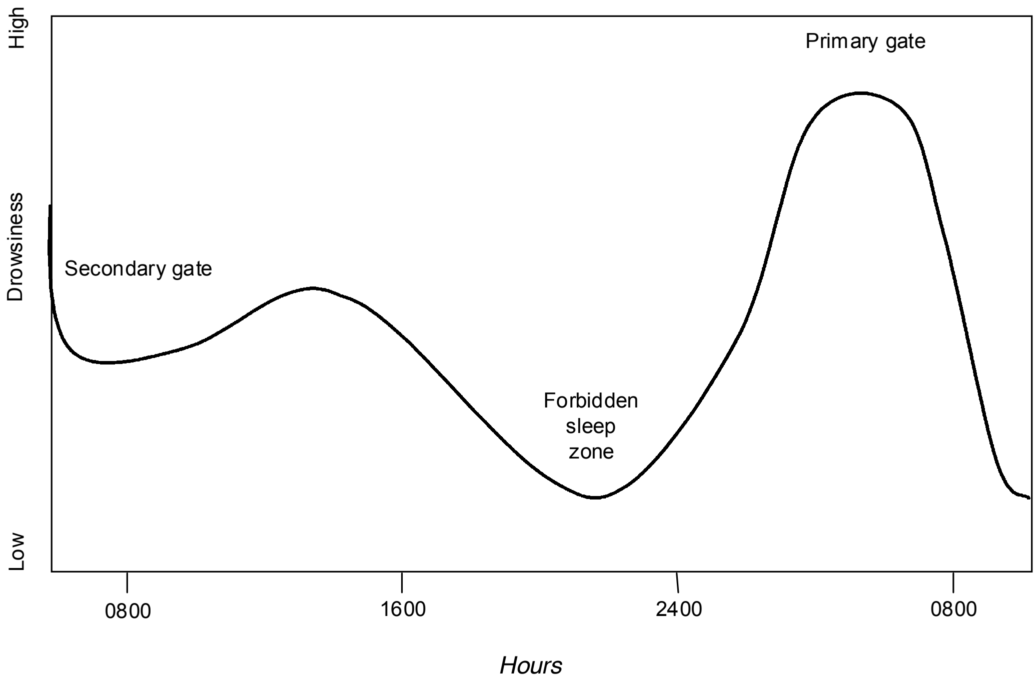
The zone of least drowsiness located between the secondary and the primary sleep gate is called the forbidden sleep zone.

Napping early in the afternoon is not simply related to a cultural phenomenon, climate or to a good meal. It is a manifestation of the spontaneous two-phase character of sleep inherent to all individuals.

The forbidden sleep zone explains the difficulties that a person can encounter when trying to go to sleep earlier as a preliminary measure for very early rising.

After sleep loss, the bimodal drowsiness structure remains very evident with, however, more marked morning drowsiness related to an immediate shortage phenomenon.

Napping



Schematic representation of time periods favouring sleep onset
Taken from Stampi, 1989

The wakefulness time preceding a nap seems to influence the amplitude of the peaks (higher drowsiness) but not their time of occurrence.

2.3 - Architecture

The composition and organization of the various sleep stages during the nap depend both on the time of day in which it is located and on its duration for subjects who slept normally during the previous night:

- The morning nap located between 8am and midday has an architecture similar to that of the second half of a nocturnal sleep. It is richer in REM sleep than the afternoon or evening nap (between midday and midnight). REM sleep onset during the morning nap will appear sooner than for normal sleep.

– The architecture of the afternoon or evening nap does not ressemble either the first or the second half of nocturnal sleep. It depends more on the length of the nap:
  - a nap of thirty minutes does not include REM sleep,
  - a nap of one hour can include a REM sleep period (small amount),
  - if length of nap is two hours or more, REM sleep occurs, at the earliest 50 minutes after nap onset and its duration is higher than that of the deep slow-wave sleep.

After a prolonged period of activity (e.g.: 30 hours) deep slow-wave sleep is predominant irrespective of the time of day in which the nap is taken.

2.4 - Effects of napping

2.4.1 - Nocturnal sleep following a nap

- diurnal nap:
  - the time slot in which the nap takes place determines the repercussions that will occur during the following night's sleep;
  - a nap at the start of the afternoon delays sleep onset and reduces the duration of the deep slow-wave sleep during the subsequent night;
  - the REM sleep predominant in the morning nap (8am to 10am) will neither influence the composition nor the duration of the subsequent night's sleep.
- nocturnal nap:
  - a nocturnal nap implicity supposes sleep loss,
  - the wakefulness period between the nocturnal nap and next night's sleep is increased,
  - sleep latency is low on the subsequent night,
  - sleep architecture is maintained (90-minute cycle),

- increase (rebound effect) in the duration of the various sleep stages:
    - the first nocturnal sleep will be very rich in deep slow-wave sleep without change or even with a reduction in REM sleep,
    - the REM sleep rebound occurs during the second night or even during subsequent ones.

It seems, therefore, that the need for deep slow-wave sleep takes precedence over the need for other types of sleep.

2.4.2 - Sleep inertia: immediate effect of taking a nap

2.4.2.1 - Definition

Sleep inertia leads to a transient state of disorientation or mental confusion upon waking up. It occurs irrespective of the time of day and even in subjects not suffering from sleep loss.

Temporary symptoms are a degradation in mental performance and an alteration in mood.

While its length normally varies from 5 to 15 minutes it can reach up to several hours in case of high sleep debts.

2.4.2.2 - Factors increasing sleep inertia

- Sleep stage in which wake-up occurs: sleep inertia is very high when awakening suddenly occurs during a deep slow-wave sleep phase.
- Length of deep slow-wave sleep: the longer the deep slow-wave sleep period, the higher the inertia.
- Length of previous wakefulness period: high sleep loss leads to an increase in the duration of the deep slow-wave sleep and, as a result, sleep inertia increases from 25 minutes to several hours.

- Nap time: in case of sleep loss (45 hours), an early morning nap (4am – 6am) leads to very high inertia which can last for several hours. However, inertia is attenuated to a great extent when the nap is taken in the afternoon (12pm – 2pm), even if sleep loss is higher (53 hours).

2.4.3 - Performance and mood: long-term effects

2.4.3.1 - Night time naps

After 17 hours awake, a nap of one or two hours, from 9pm onwards, prevents physiological nocturnal reduction in mental performance.

This effect lasts for several hours after the end of the nap.

After sleep loss of two or three nights, the nap leads to an immediate and long-term negative effect on performance. This nap is very rich in deep slow-wave sleep.

2.4.3.2 - Daytime naps

A nap improves performance in memory and reaction time tasks requiring sustained attention.

It has a positive effect on subjective feeling: the subject is more relaxed and less anxious.

A nap of 30 minutes or 2 hours has the same positive effects.

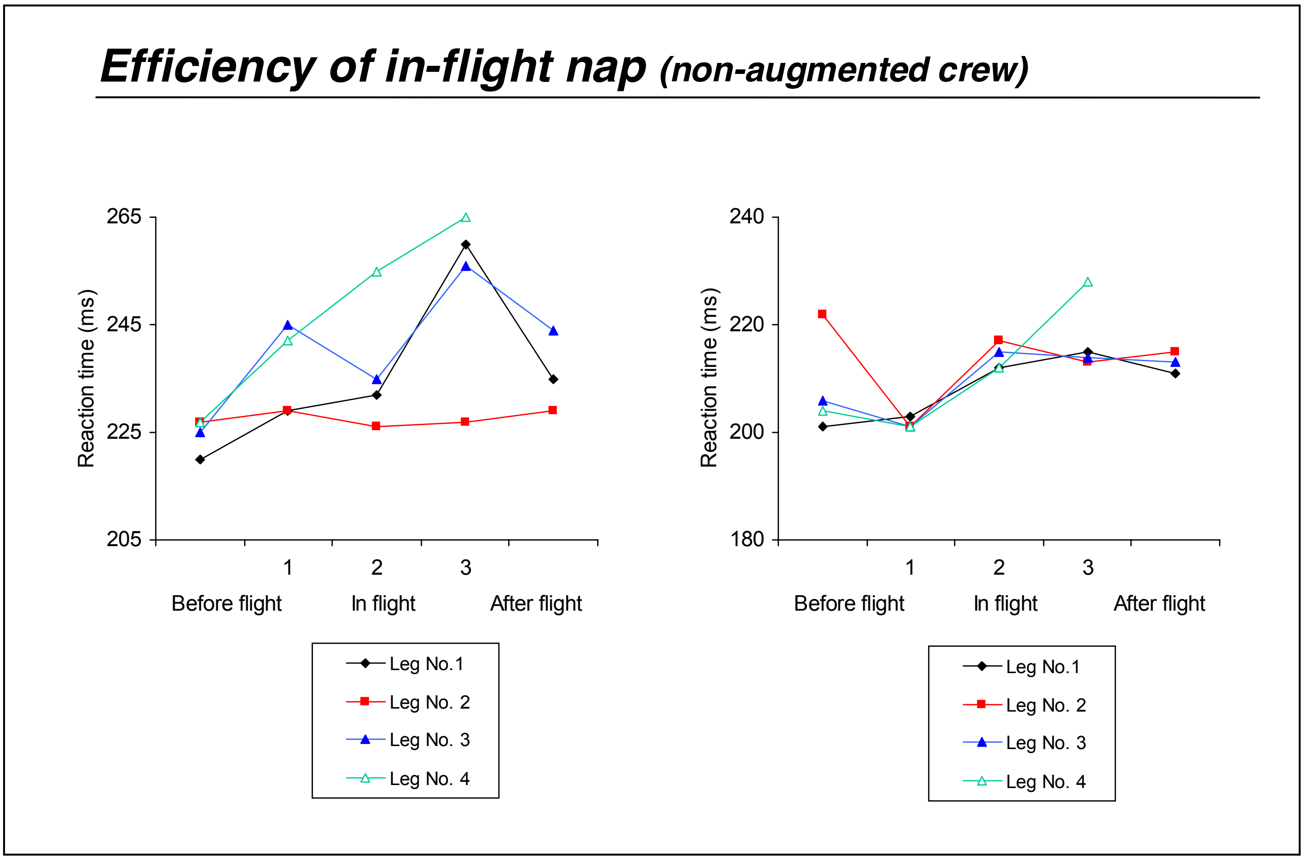
Some will maintain that the improvement in performance is not related to the nap but rather to the circadian increase in performance during the day.

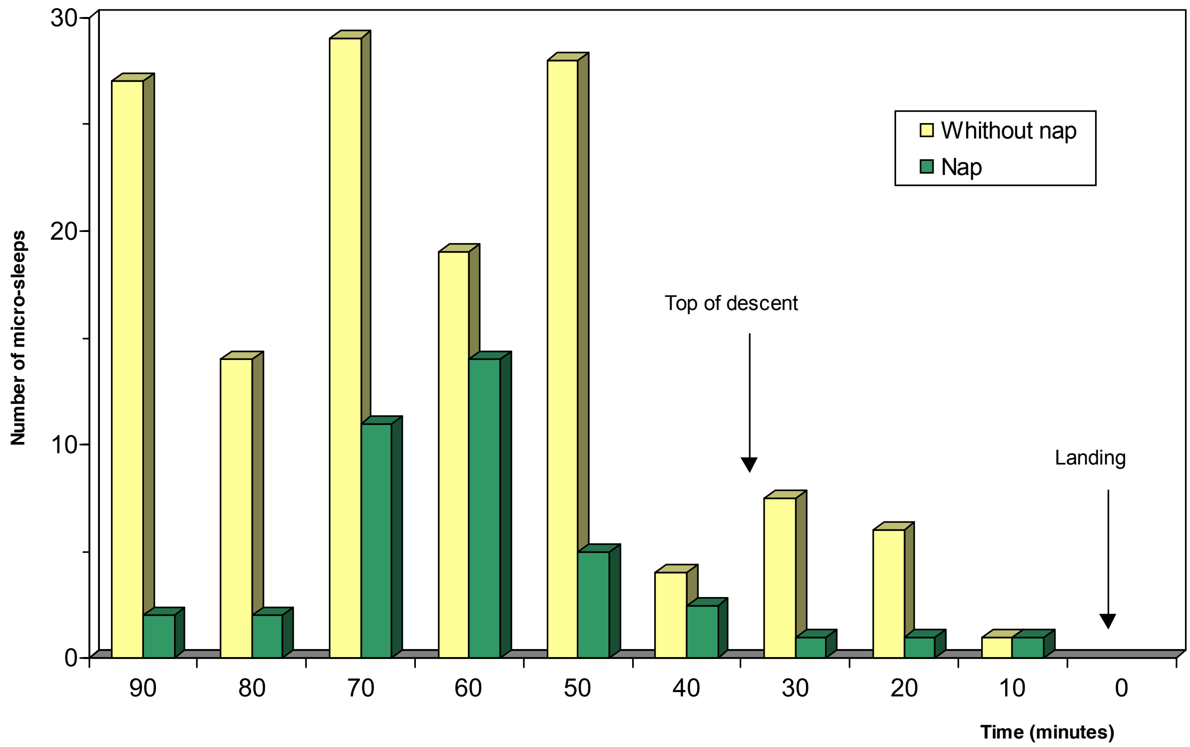
2.5 - Efficiency of in-flight napping (non-augmented crew)

In order to assess the effect of napping on the level of alertness with long-haul aircraft pilots, a study was conducted at NASA (Graeber et al., 1990). Naps of around 20 minutes were taken during flight and planned in order not to hinder correct flight progress: they had to be taken until one hour before descent at the latest.

Main conclusions drawn from this study can be summarized as follows:

- pilots, while resting at their seats, can quickly obtain short sleep periods of good quality;
- naps increased performance as assessed by reaction time tests;
- pilots of the "nap" group had 5 times less drowsiness episodes than the control group, indicating the efficiency of these naps in maintaining alertness during flight, in particular during those phases that require high involvement.

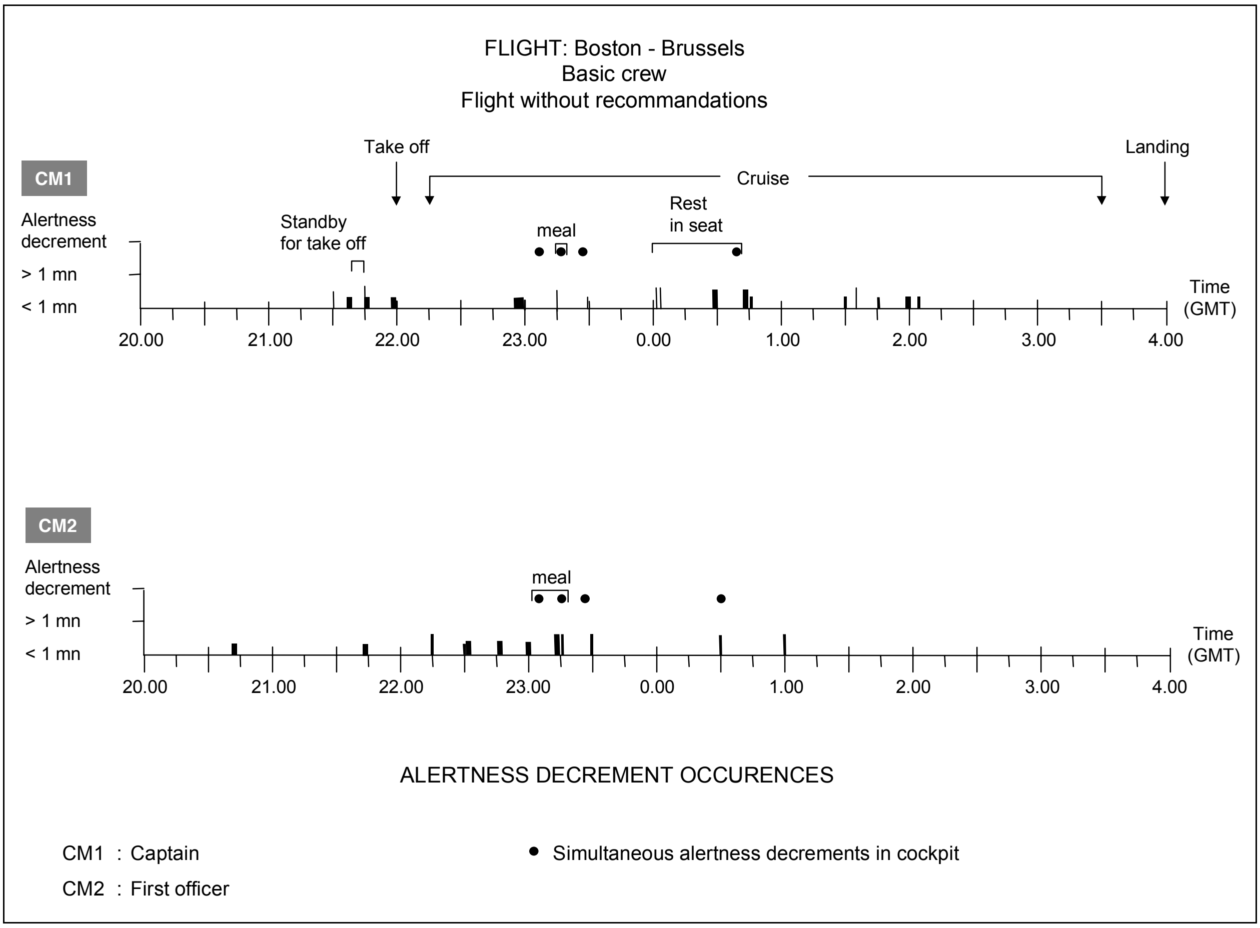




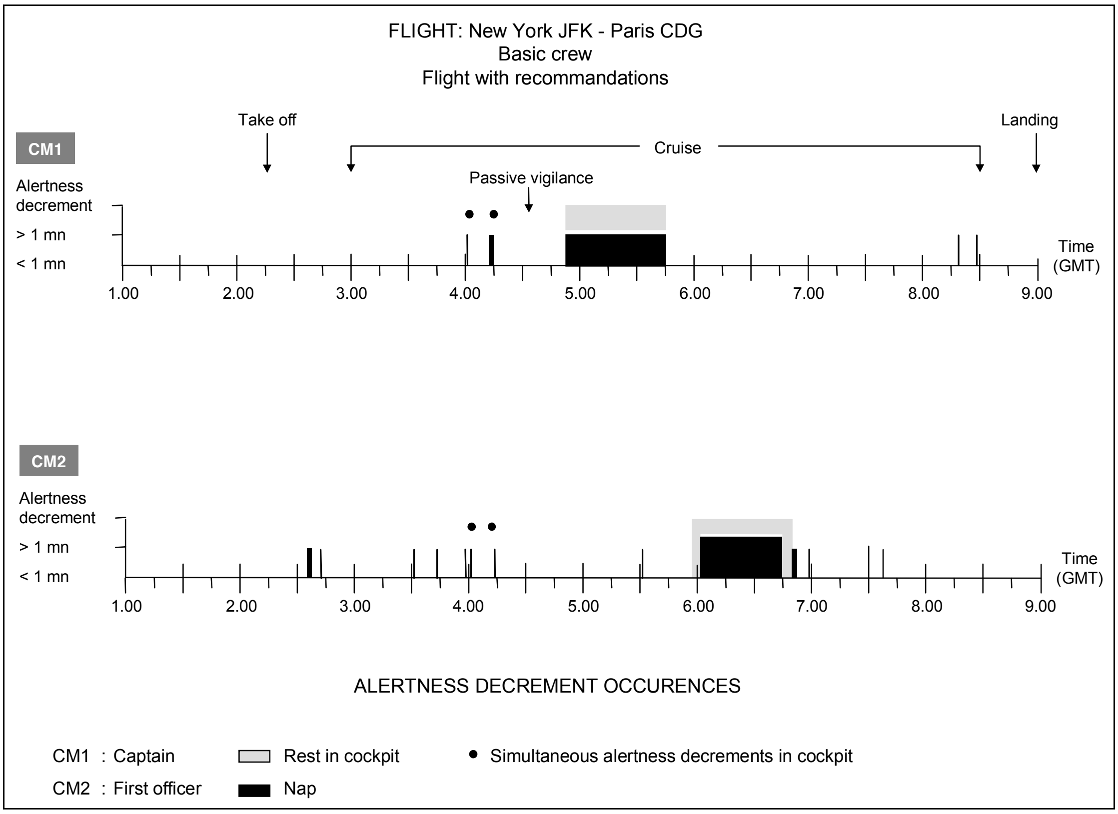
Comparison in number of micro-sleeps in “nap” group and “without nap” group at the end of a night flight (taken from Graeber et al., 1990)

Nap efficiencies were also documented by LAA during the validation phase of its practical recommendations for alleviating in-flight alertness decrements. One of these recommendations consisted of proposing alternation of passive vigilance-active vigilance phases (refer to "monotony"). It was suggested that pilots take a short nap in their seats while in the passive vigilance stage, having formally informed the other active crewmember of their temporarily remote status. The active/passive alternation scheme stems from earlier work that clearly documents alertness decrements to sometimes occur for both pilots simultaneously. This appears to be mainly related to high sleep pressure, particularly during night flights.

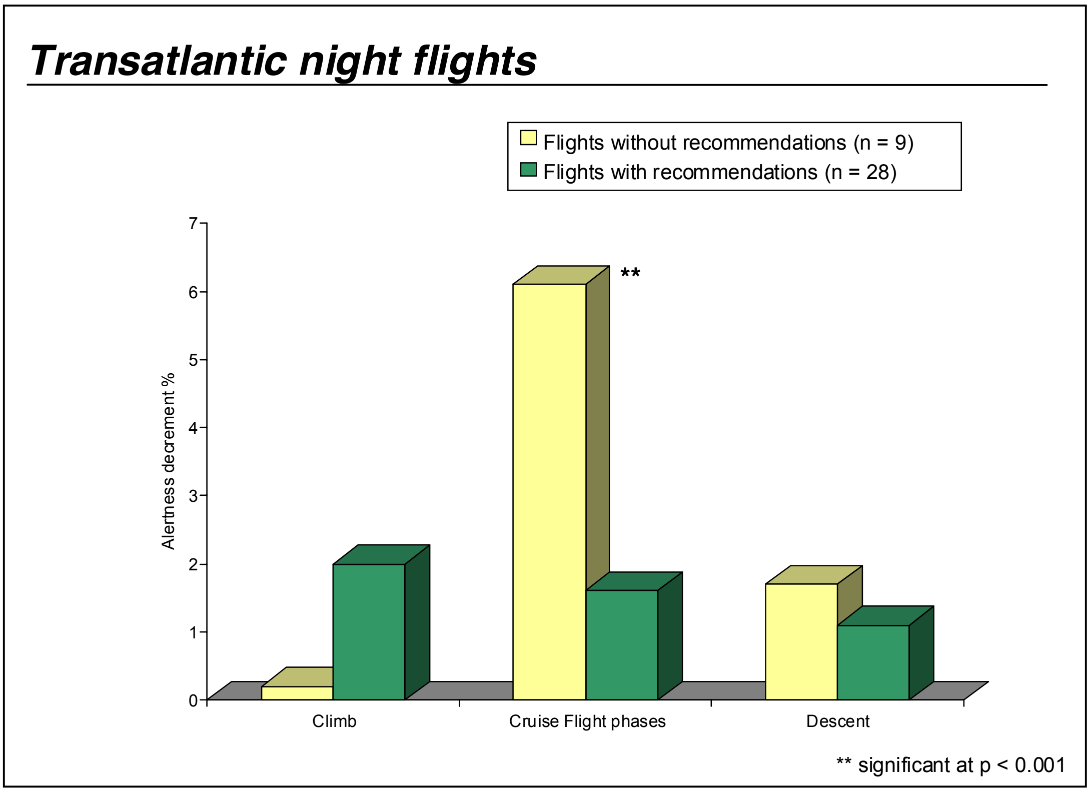
The results shown below concern transatlantic return flights, following short layovers of 24 to 48 hours.



During flights with recommendations, fairly frequent naps were taken. Naps lasted between 20 minutes and 90 minutes and significantly reduced the number of alertness decrements.



This leads to a global reduction in the alertness decrement rates, especially during cruise phases. We can also see that these naps have a beneficial effect on the alertness level during descent.



VI – JET LAG

1 - JET-LAG SYNDROME

1.1 - Manifestations

- High fatigue.
- Alertness, mood and performance disorders.
- Disturbed sleep.

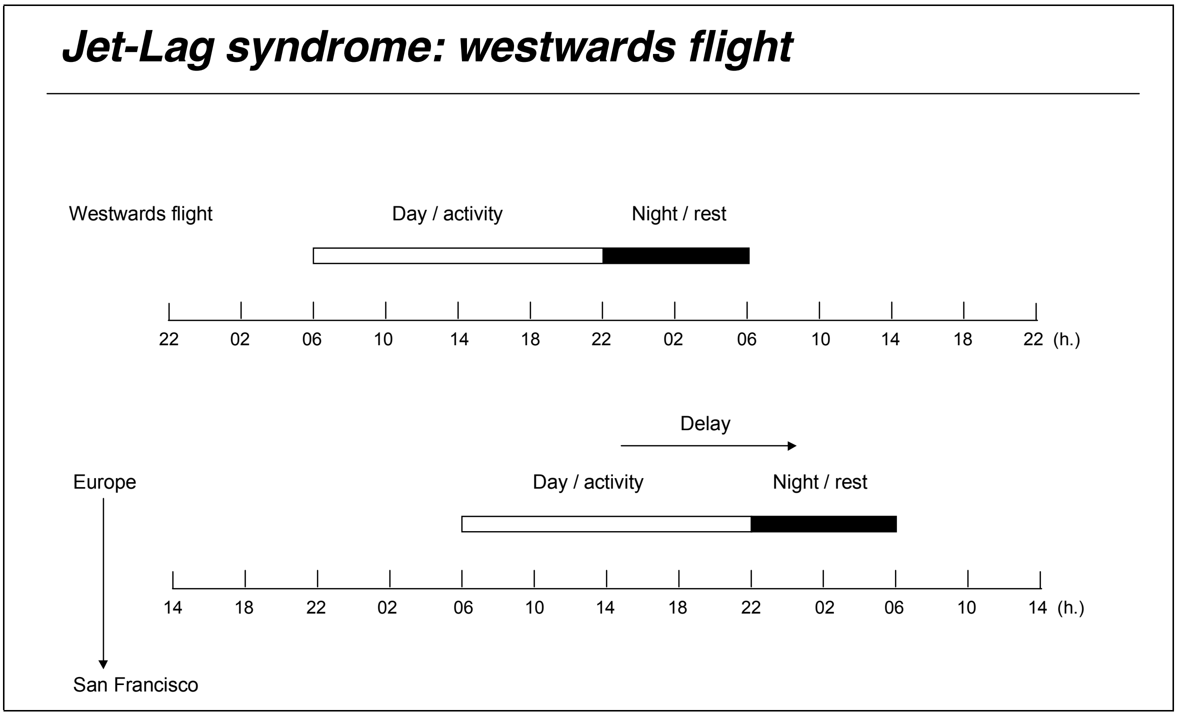
1.2 - Shifting environmental synchronizers

Free running is the natural tendency for 24-hour cycles to extend in the absence of external time-givers. This is why it is easier to delay bedtimes and rising times than to advance them.

1.2.1 - Westward flights

Delay of environmental synchronizers phase: dark-light alternation, rest-activity cycles, social rhythms, etc.

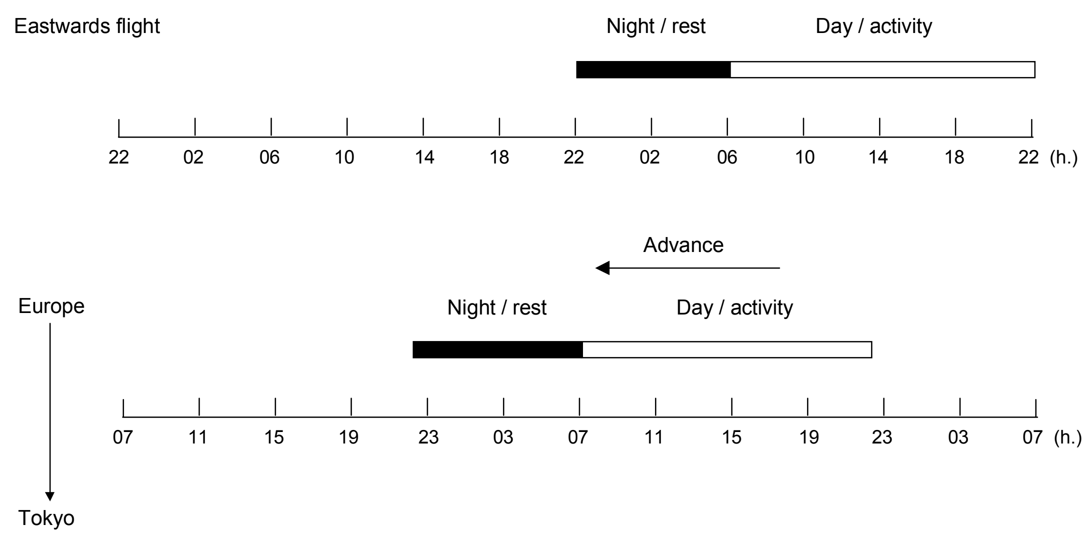
Synchronization to the new time requires going to bed and getting up at increasingly later times.



1.2.2 - Eastward flights

Adjustment to the new environmental synchronizer phase requires going to bed and getting up at increasingly earlier times.

Jet-lag induced by eastward flights is more difficult to overcome than jet lag induced by westward flights.



Jet-Lag syndrome: eastwards flight

1.3 - Schematization of psychophysiological adjustment steps

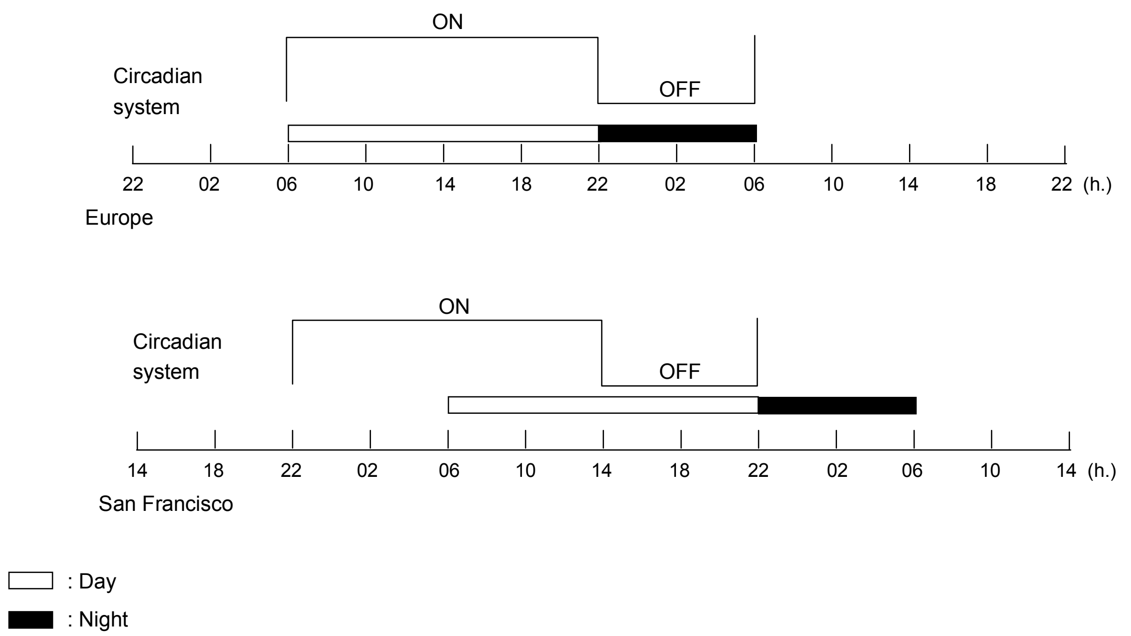
1.3.1 - Example: Westward flights

At 1 to 2 days after the flight, the circadian system and environmental synchronizers are out of phase.

Under normal conditions, the biological clock is in phase with the environmental synchronizers: the period of least efficiency (OFF) coincides with the nocturnal period, the period of maximum efficiency (ON) with the diurnal period.

Due to its inertia, the biological clock does not immediately adjust to the new time zone after having crossed several ones. The result is a sudden shift between local time in the country of arrival and the biological body clock which is still synchronized with home time.

Jet-Lag syndrome: ***schematization of the psychological adjustment steps***



At 3 to 4 days after flight: internal dissociation.

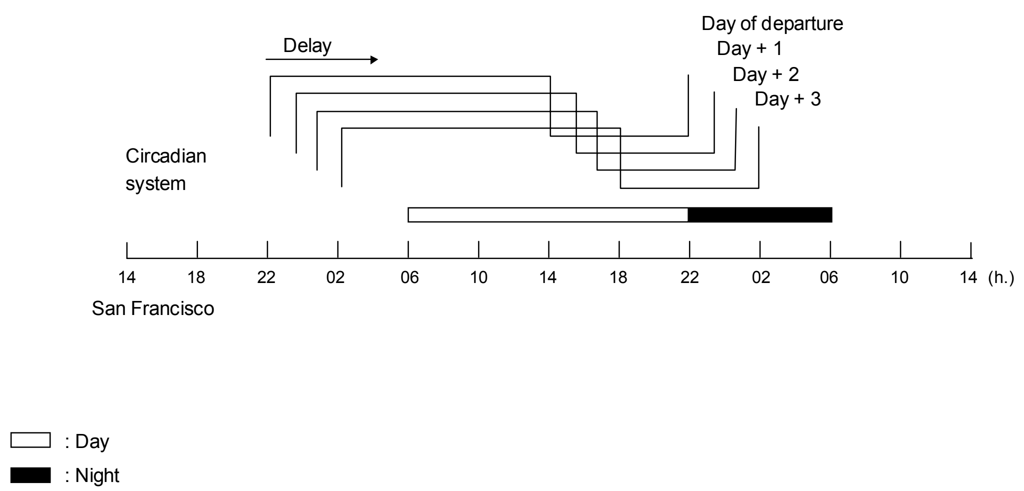
Progressive adjustment (by phase delay) of bedtimes and rising times and of psychophysiological functions.

Adjustment rate: 1 to 1.5 hours per day.

The psychophysiological functions adjust at various speeds: 1 week for temperature, 3 weeks for endocrine rhythms.

The result is a loss of harmony in the circadian system called "internal dissociation" and responsible for the jet-lag syndrome.

3 to 4 days after flight: internal dissociation

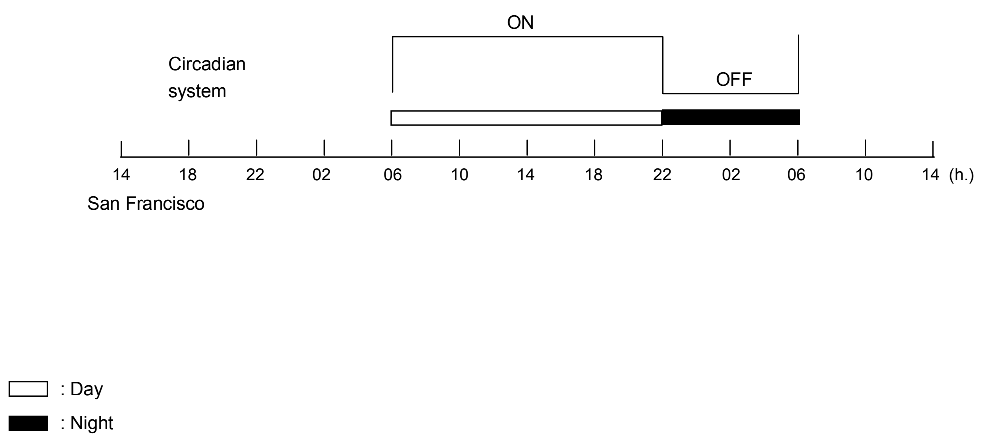


At 8 to 9 days after the flight: adjustment of the circadian system.

Synchronization between local time and biological time.

Synchronization between most parts of the psychophysiological functions.

8 to 9 days after flight: adjustment of the circadian system



1.4 - Layover and return to base

If layover time is short (< 48 hours), it is preferable not to adjust but to continue living according to home or base time.

The longer the layover, the more the body will adjust to the new time zone and the more difficult it will be to synchronize with home or base time after the return flight.

The rest period after the return flight to home or base must be at least equal to the previous layover period to allow for resynchronization.

2 - SLEEP DISORDERS

2.1 - Jet-lag

Changes in sleep-wake cycle times related to phase modifications in environmental synchronizers.

2.1.1 - Westward flights

- Bed time is delayed so that sleep period coincides with local physical night.
- The first night after arrival depicts several modifications with regard to normal sleep. There is more REM sleep in the first part than normal and this tends to be interrupted by awakening episodes in the second half. The result is diurnal sleepiness.
- Normal sleep is generally recovered itself after three nights.
- When layover is short (< 48 hours), it is preferable to keep normal bedtimes and rising times in order to avoid disturbances related to the first night.
- When the layover is long (> 48 hours), it is preferable to synchronize with local time by going to bed as late as possible as from the first night.

2.1.2 - Eastward flights

- The first night's sleep is sometimes better than normal, provided that the subject did not sleep during the flight and did not take a nap upon arrival. He or she will have accumulated a sufficient sleep debt to compensate for the jet-lag effects.
- These effects show themselves during the following nights by more unstable sleep with more interruptions.
- An improvement in the quality of sleep will occur after a period of around seven days.
- In Eastward rotations a short layover (< 48 hours) is therefore preferable in order to stay synchronized with home time.

2.2 - Night work and alternating work schedules

Changes in sleep-wake cycle times are related to work schedules.

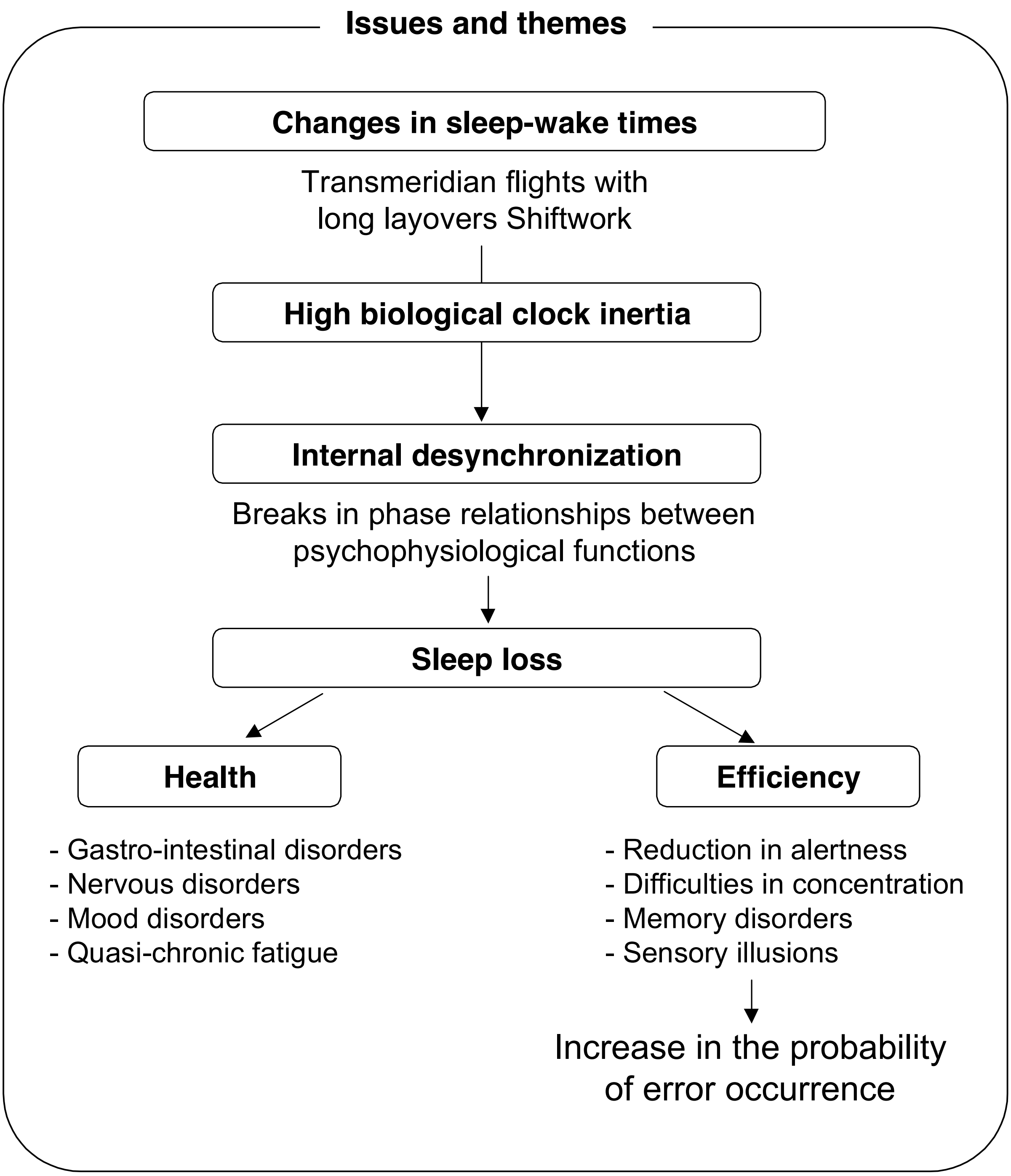
Coping with disturbances in sleep related to shift work is often more difficult than with those related to jet-lag. In fact, the environmental synchronizers, as stated earlier, tend to keep the circadian system on a par with standard time.

The result is a perpetual conflict between biological clock phase and the sleep period imposed by working hours.

Both quality and quantity of sleep taken during the day after a night shift are insufficient. Sleep occurs during a period of the day that is unfavourable to sleep both from a biological (ascending body temperature phase) and from an environmental point of view (light, noise, social rhythms).

Night sleep before a morning shift is shorter due to early wake-up. The zone of least drowsiness located at the start of the evening as well as social pressures do not lend themselves for sleep time to be advanced. Going to bed earlier serves no purpose as the onset of sleep will not be much earlier than usual.

3 - NATURAL PREVENTION OF DISORDERS RELATED TO CHANGES IN SLEEP-WAKE TIMES

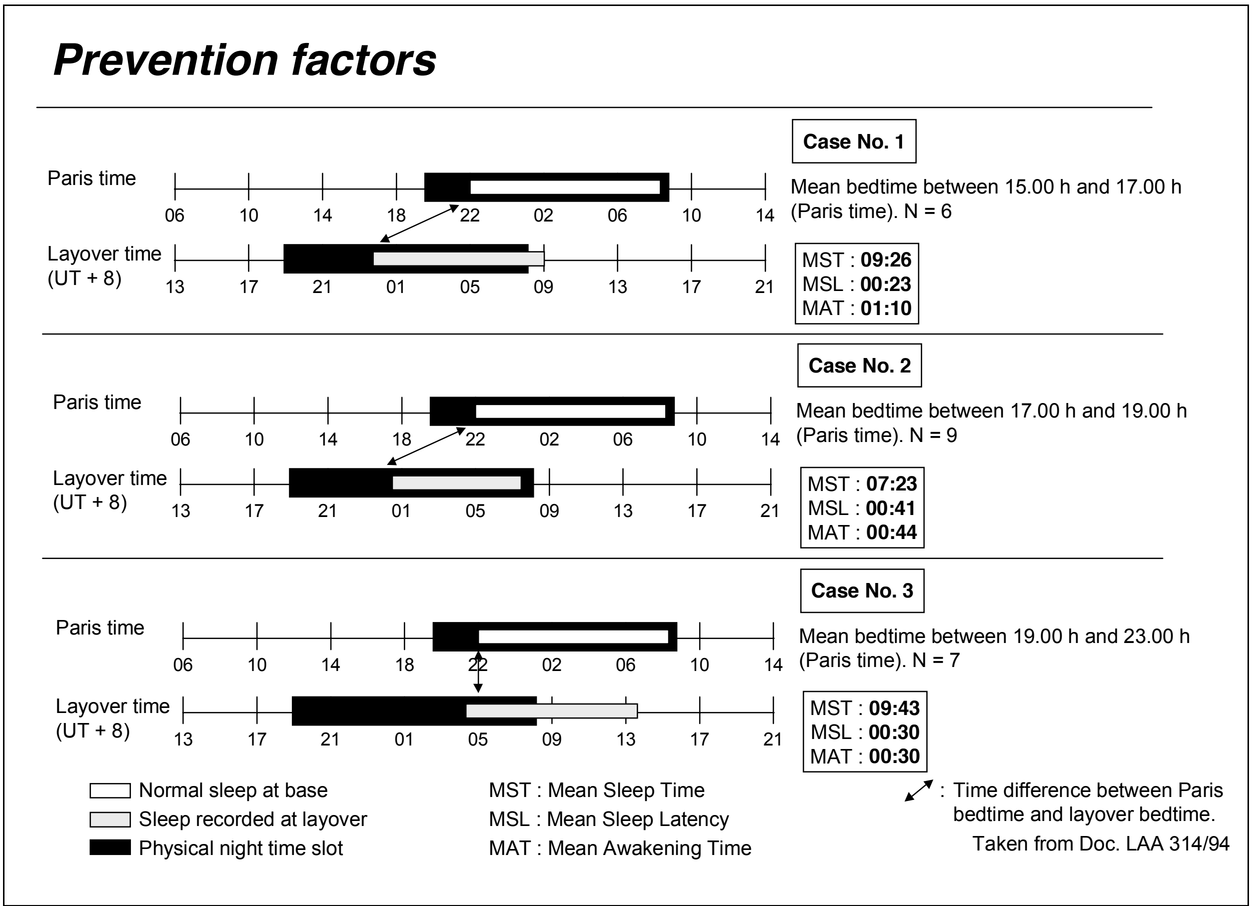


3.1 - Prevention factors

3.1.1 - Short layovers

During short layovers, biological rhythms do not have time to adjust to the new time zone. This type of layover requires specific management of rest-activity rhythms. One has to force one's self to keep bedtimes and meal times synchronized with home or base times, even if in opposition to local social rhythms.

Results obtained from our work with long-haul aircraft pilots show that those who attempted to synchronize with local time were either affected by a degradation in sleep quality (Case N° 1) characterized by high sleep latency and frequent awakenings, or by a reduction in sleep time (Case N° 2).



In Case N° 3, pilots maintained bedtimes synchronized with home or base times as put forward in the recommendations. It can be seen that sleep is indeed longer and of better quality.

3.1.2 - Long layovers

Biological clock inertia is the primary cause of disorders related to changing sleep-wake cycle times.

To prevent disorders of this type, the biological clock must be adjusted to the new sleep-wake cycle times. You must therefore harmonize the biological clock phase with that of the sleep period in as short a time as possible.

Natural factors should be used to favour this adjustment:

– exposure to light,

– social contacts (meals, leisure activities, etc.),

– moderate physical exercise.

In Chapter IV, the role of social contacts and of physical exercise in health care will be discussed.

Exposure to light represents, as will be seen, the most powerful factor in adjusting the biological clock to new time zones.

3.2 - Effects of light

3.2.1 - Basic information

Daily and seasonal changes in the length of day (photoperiod) are transmitted to the biological clock by means of melatonin, a hormone secreted by the pineal gland.

This hormone has a clearly marked circadian rhythm with total absence of secretion during daylight hours, production occurring during night-time only.

The longer the nights, the longer the secretion of melatonin and vice versa.

The period of least efficiency (OFF) coincides with maximum melatonin secretion.

Whenever going through a time zone change, the aim should be to induce a shift in the biological clock phase that is of the same amplitude and in the same direction as the normal sleep period.

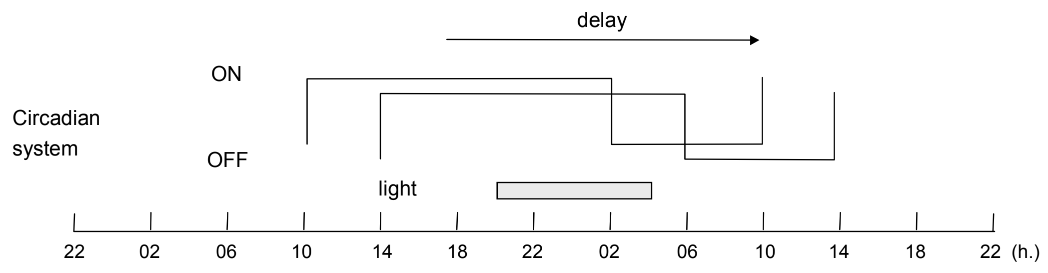
This would be accomplished by means of light, the result of its action on the biological clock being the movement of melatonin production towards the new sleep period.

This shift is accompanied by a similar shift in OFF period.

Shift direction is determined by the choice of light exposure range:

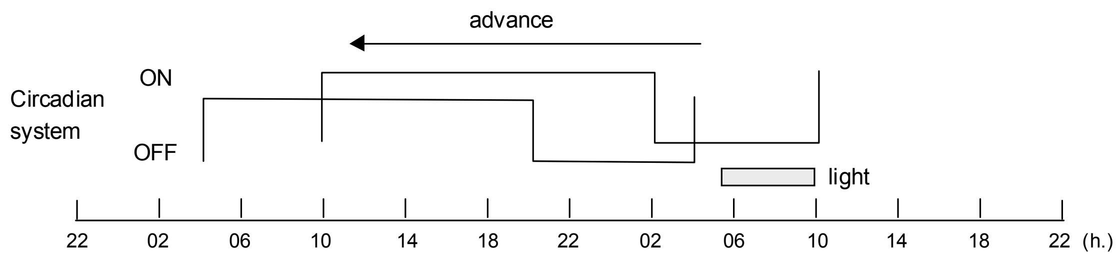
- Exposure to light in the evening or during the first part of the night (before 5am) delays the melatonin secretion phase.

Effects of light



- Exposure to light in the second part of the night (after 5am) advances the melatonin secretion phase.

Effects of light



- These shifts in the biological clock (delay and advance) can be attained using a light intensity of around 2500 lux.
- The sun's intensity at midday reaches around 100000 lux.
- Light intensity of a bedside lamp varies between 50 and 200 lux.

3.2.2 - Light application

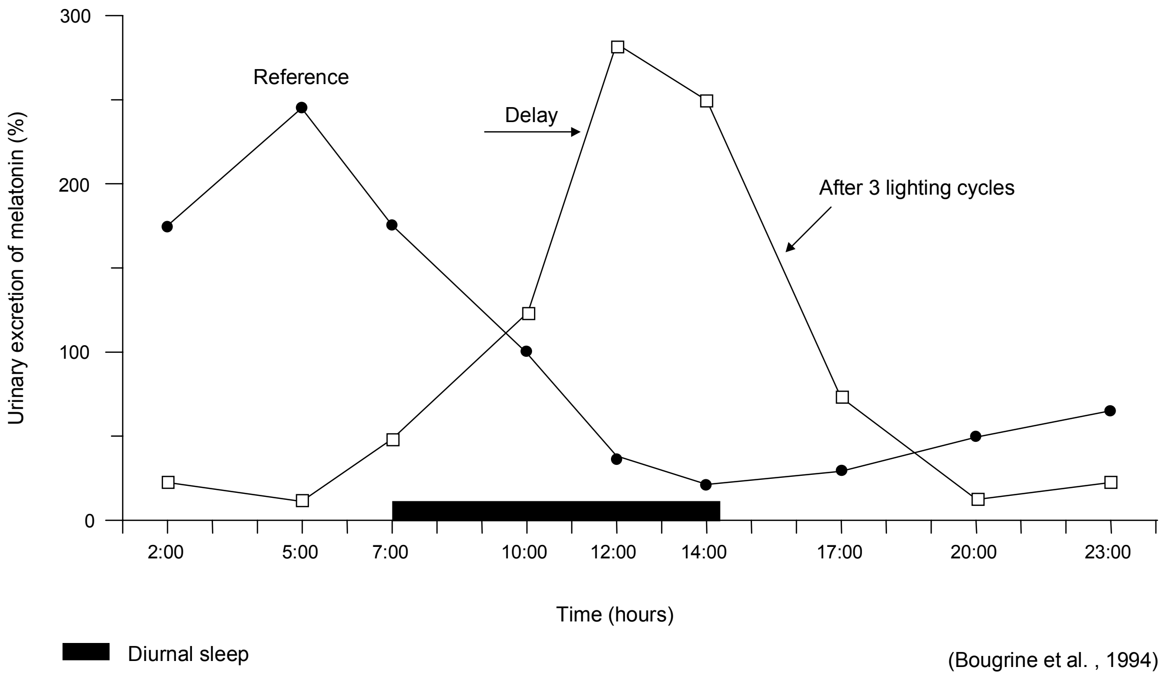
Example 1: westward flight or night work

Bedtime delayed 7 hours with regard to biological clock phase

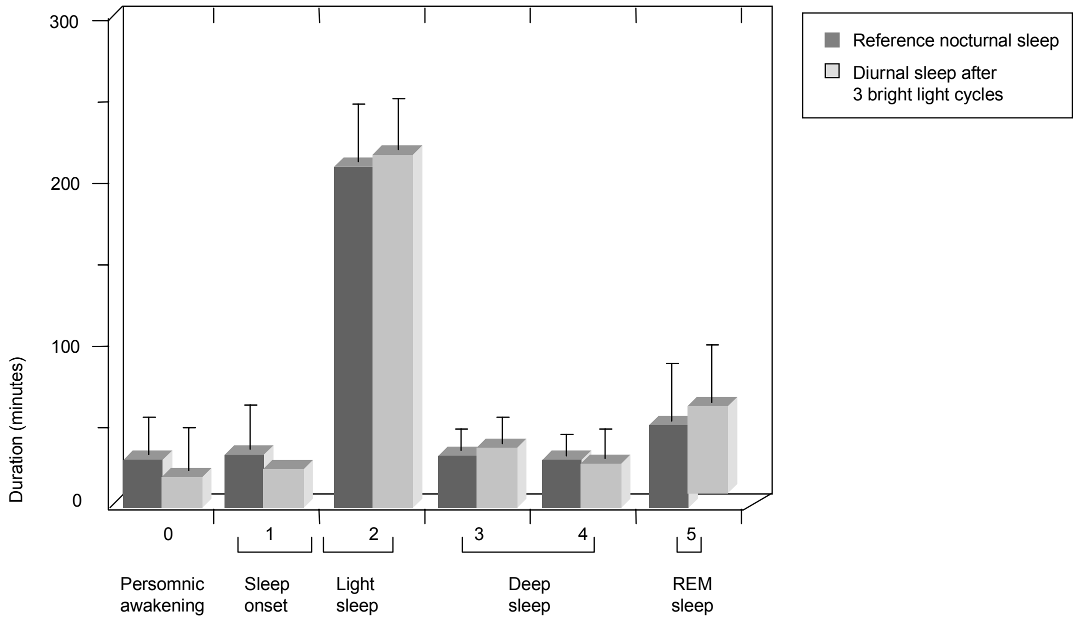
Results show the following after three lighting cycles between 2am and 5am at 2500-3000 lux:

- The biological clock adjusts completely to the new sleep times: melatonin secretion peak is moved from 5am to 12am.

Light application

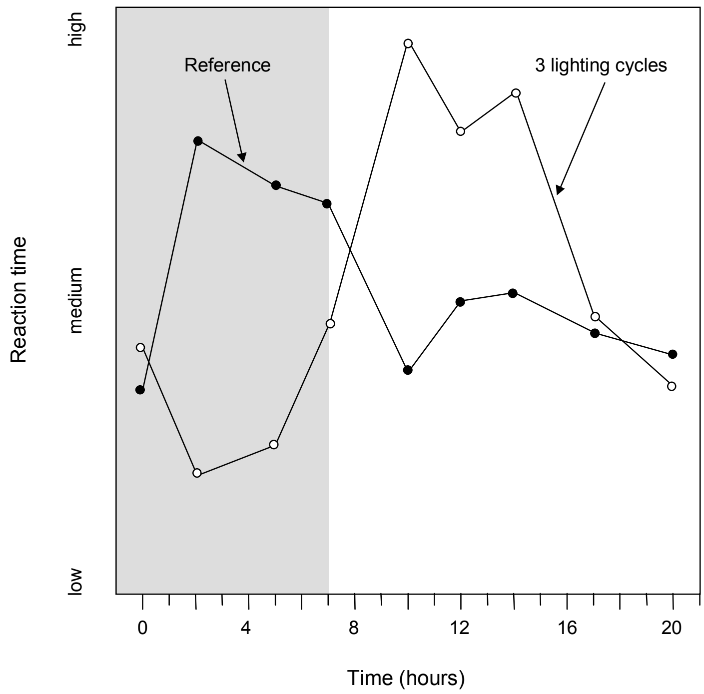


- Daytime sleep under these conditions is of the same quantity and quality as reference nocturnal sleep with perfect adequacy for each sleep stage.



(Bougrine et al. , 1994)

- Cognitive performance improves during the night. A complete inversion of the performance rhythm is observed with regard to the reference normally observed at night.



Psychomotor task requiring
a high alertness level
and a lot of attention.

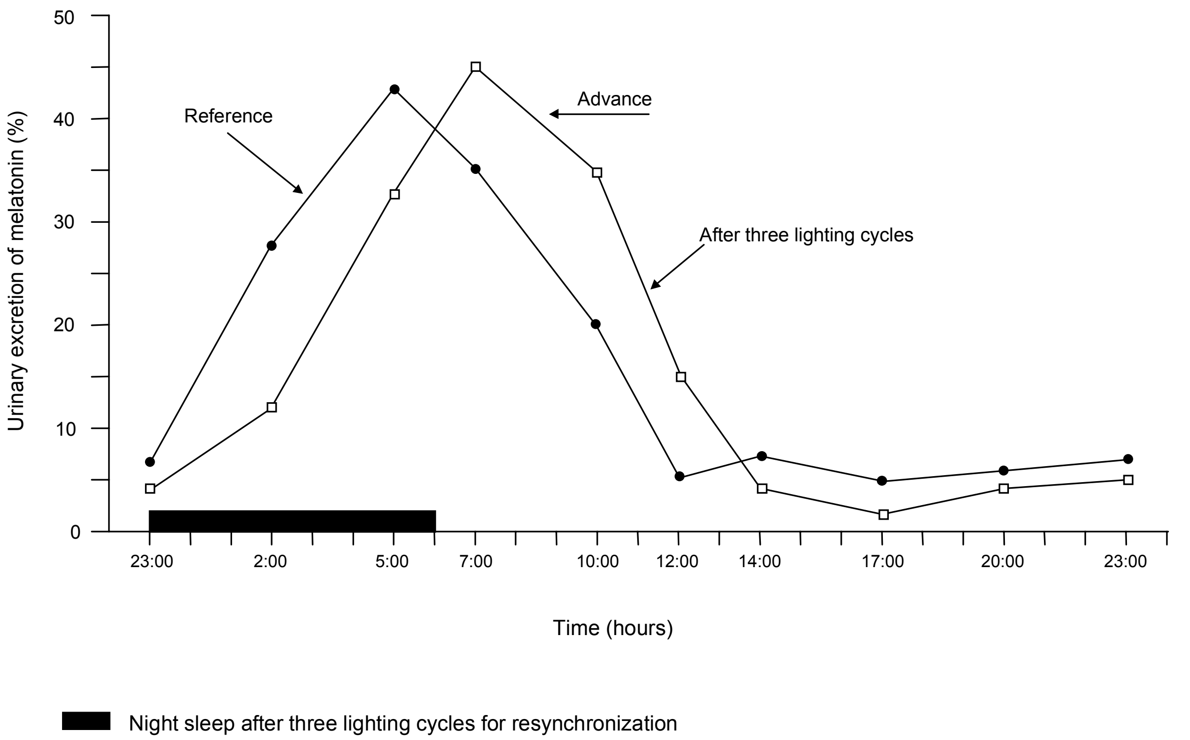
(Bougrine et al. , 1994)

Example 2: return to Europe from the US after a long layover or after a long series of night shifts

Bedtime is advanced by 7 hours with regard to biological clock phase

Three lighting cycles between 10am and 1am are able to advance the biological clock by some 5 hours. The remaining shift (2 hours) is related to the intrinsic difficulty of moving the biological clock phase forward.

Upon return to Europe from the US, it is good practice to schedule rest periods at least equal to those of the layovers and not set off again immediately eastwards.



(Bougrine et al. , 1994)

3.2.3 - Time periods favouring exposure to light during and after a long layover

Time slots are given in base time.

Exposure to light for three hours either continuously or discontinuously (e.g. by periods of 30 minutes) shows similar beneficial effects.

During layover following a westward flight (for example towards the US), exposure to light between 8pm and 5am.

During layover after an eastward flight (for example towards Asia), exposure to light between 5am and 10am.

Upon return to Europe after a long stay in the US, exposure to light between 10am and 3pm.

Upon return to Europe after a long stay in Asia, exposure to light between 1pm and 12pm.

VII – LIFE HYGIENE

1 - FOOD HYGIENE

- A gain or a loss in weight indicates inappropriate or wrong food habits.
- Lipid metabolism disorders are one of the most important factors in vascular risks.
- Irregular meal times can cause digestive disorders linked with the circadian rhythms of the digestive enzymes' activities.
- During night work, meals very rich in fats must be avoided as the stomach is accustomed to working less during night than in daytime.
- Food rich in carbohydrates contributes towards reducing arousal level during the second half of the night.
- Extra proteins can help in limiting the reduction in arousal level during night.
- A good meal taken just before bedtime may disturb sleep.
- When you sleep during the day (e.g. after a night flight or crossing several time zones), you may be awakened by hunger before having had sufficient amounts of sleep.
- A meal of more than 600 kilocalories, can cause drowsiness when taken during the night.
- It is preferable to eat snacks of fruit or dairy produce.
- Milk and dairy produce are rich in proteins that are found in all the tissues of the human body.
- Fresh fruit and fruit juice are good sources of natural elements which rapidly provide energy.

- During short layovers after transmeridian flights, it is preferable to eat meals at normal times. Example: if you are on a short layover (< 48 hours) in New York, eat a good meal at local breakfast time as, for your organism, breakfast time corresponds to your normal lunch time.
- However, during long layovers, eating meals at local times facilitates adjustment to local time in country of arrival.
- To facilitate adaptation after a transmeridian flight, breakfast and lunches should be rich in proteins (e.g.: meat, eggs, cheese, yoghourt) to stimulate arousal, evening meals rich in carbohydrates (e.g.: potatoes, pasta, rice,) to facilitate sleep.

2 - PHYSICAL EXERCISE

- To better combat stress, and for the sake of a better state of mind, you are recommended to raise your heartbeat to an "athletic rate" for twenty minutes three times a week.
- The minimum athletic rate corresponds to 180 heartbeats per minute less your age: 140 if you are 40, 130 if your are 50. Maximum rate is 220 beats per minute less your age.
- Using your leg muscles by cycling, swimming, jogging or walking quickly increases heart rate.
- The time at which physical exercise is taken affects the quality of the awakening and the sleep during the following night.
- It is essential not to tire yourself out by intense physical exercise before a flight, especially for evening or night flights.
- During night flight, light or moderate physical exercise (walking, various movements) attenuates the negative effects of sleep loss by increasing wakefulness level and reducing fatigue.
- Abnormally intense physical exercise during the afternoon leads to stress which reduces deep slow-wave sleep during the following night in sedentary subjects and increases it in sportsmen.
- When physical effort is moderate and exerted not too late in the day, fatigue and drowsiness are higher in the evening and sleep is of good quality.
- In order to facilitate adaptation during long layovers, take advantage of daylight exposure periods to undertake light (walking) or moderate physical exercise.

3 - PHARMACOLOGICAL MEASURES

3.1 - Soporific drugs

Soporific drugs come mainly from two classes of psychotropes: benzodiazepines and barbiturates.

Effects

- Sedative
- Hypnotic
- Anxiolytic
- Muscle-relaxant

Effects on sleep

- Increase in Stages 1 and 2
- Reduction in Stages 3 and 4
- Reduction in REM sleep

Secondary effects

- Memory disorders
- Reduction in attention
- Increase in nightmares
- Residual sedation upon awakening leading to a reduction in intellectual and psychomotor efficiency
- Feeling of weariness
- Empty-headedness
- Increase in reaction time

- Motor incoordination
- Confusion
- Sickness
- Dizziness
- Headaches
- Withdrawal symptoms at the end of long treatment or after high hypnotic doses: insomnia, irritability, anxiety, fits of panic, trembling, palpitations.

3.2 - Psychostimulating drugs

Distinctions can be made between three families of psychostimulating drugs: amphetamine substances, xanthine derivatives (caffeine, theophylline, theobromine), synthetic psychostimulating drugs.

Aims

- Prolonged wakefulness
- Without behavioural modifications
- Without performance deficiencies

Amphetamines: primary effects

- Increase in general arousal tonicity
- Euphoria
- Increase in psychomotor performance

Secondary effects

- Signs of anxiety
- Tendency to social isolation
- Aggravation of paranoiac signs
- Trouble with visual perception
- Anorexia
- Increase in heart rate

Xanthine: primary effects

Only small doses of caffeine are attractive as a psychostimulating drug.

- Stimulates level of arousal
- Reduces the sensation of fatigue
- Favours cognitive activities
- Increases respiratory capacities

Secondary effects

- Cardiac arrhythmia
- Increased diuresis
- Reduction in cerebral circulation
- Trembling
- Trouble in visual perception

The synthetic psychostimulating drug Modafinil, a recent formulation, seems to favour a good level of wakefulness with a minimum of immediate secondary effects. At present, Modafinil is used only for pathological cases and over-the-counter sales by drugstores is not authorized. The long-term consequences on health remain unknown. We absolutely advise against the use of this drug.

Self-medication

Self-mediation is a secular tradition in all civilizations. Unfortunately, times have changed for the followers of these practices. Indeed, up until the Second World War, pharmacopeia, i.e. the drugs and medicinal products that physicians could prescribe, included only a few active ingredients or, more exactly, these were generally highly diluted. This was the great era of herbalists and medicinal products. We can regret their fading away as, evidently, they still would have their place besides the synthetic drugs available today. The action of these drugs is, most of the time, remarkably strong. Misuse comprises a real danger. Moreover, these powerful synthetic products are quite often incompatible with others also on the market. These drugs possess ingredients whose coexistence within the body may lead to real disorders or even death.

Our generation is the first one to be confronted with this risk and we underline the need to accurately inform your physician of the medication you take. This means that the more or less licit procurement of a drug, the use of a product prescribed for someone else or dipping into the medicine cabinet to find a product prescribed some time ago, exposes you to real risks. If you regularly take a drug, do consult your doctor or pharmacist before using any other product obtained or in your possession that would seen to be suitable for a new illness or for even an temporary symptom.

We should also add a few words on hypnotic products, tranquillizers, sleeping pills, amphetamine substances and other psychotropes. In all cases, avoid using them before speaking to your physician and inform him of your profession. Each of these products has very precise effects and some must be considered as incompatible with a professional activity such as ours. Beware of these products, they may be extremely harmful and some are similar to narcotics because of the dependency they may entail. As for awakening substances, we suggest, as our knowledge stands at present, that you avoid them.

Modern-day drugs are extraordinarily efficient but they have a toxicity which is just as real. Beware! Do not take anything unnecessarily. It would be stupid to make yourself ill by trying to cure yourself.

VIII – FURTHER INFORMATION
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