

# Implementing Fatigue Risk Management System

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# [Managing fatigue in complex operational environments]

For every complex problem there is a simple solution...

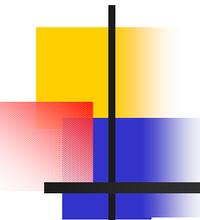
... and it is usually wrong

H.L. Mencken

# [making the paradigm shift]

Historically, most regulators have tried to manage fatigue by prescribing how many hours an individual is allowed to work.

In our view, good fatigue management is about **regulating, measuring** and **managing** the opportunity to obtain sufficient **sleep** rather than prescribing the hours that an individual works



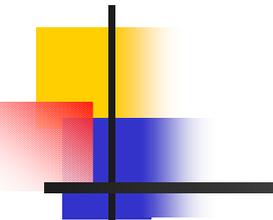
# Organisational Responsibility Model

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The first step was to create a shared responsibility model under an OH&S requirement to ensure a 'safe system of work'.

The employer is responsible for providing staff with a shift system that permitted sufficient opportunity to rest and recover. In determining this, the employer must acknowledge non-work activities and responsibilities of the employee

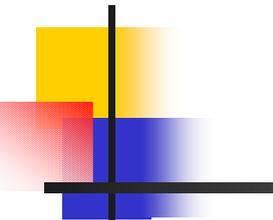
The employee is responsible for using the allocated time off to rest and recover. If this has not been possible they have a duty-of-care to notify the employer



# Organisational Responsibility

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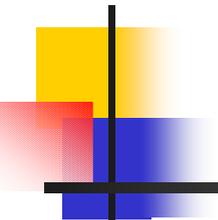
- Fatigue management policy with defined responsibilities and an accountable executive
- A competency based training and education program for all staff who are responsible for decisions that impact on the opportunity to obtain sufficient sleep.
- An auditable, quantitative methodology for determining that employees obtain sufficient sleep.



# Organisational Responsibility

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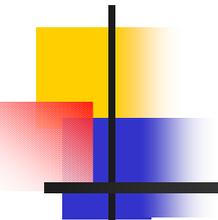
- Decision to avoid an ‘impairment’ based view of sleep because of ‘anthropological’ factors
- In defense environment [RAAF, Army, Navy] move to a model in which alertness is a ‘husbanded resource’
- Management policy was directed to ensuring that alertness was appropriately managed as a resource



# Defining Responsibility

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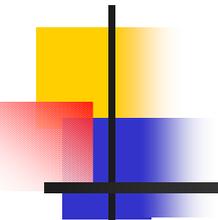
- [the start rule]  
Must obtain 5 hrs sleep in the 24hrs prior, and 12 hrs sleep in the 48hr prior to commencing work.
- [the finish rule]  
The period from wake-up to the end of shift should not exceed the amount of sleep obtained in the 48 hrs prior to commencing the shift



# Employee Responsibility

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- If start and finish rule is not met then employee must notify line manager and a decision process is then followed.
  - Additional sleep time
  - Alternate task
  - Sick leave
  - Performance management approach
- If employee fails to notify then they assume at least partial responsibility for any fatigue-related accident that occurs



# Management Responsibility

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- [the **start** and **finish** rules]

employer must demonstrate an appropriate methodology to ensure compliance with S/F rules or better [reasonable man test]

- Self-report eg. Sleep-wake diaries
- Objective eg. actigraphy
- Survey, stratified sampling or whole-of-system
- Paper and pencil or spreadsheet
- Full modeling approach [eg. Spencer & Stone, Folkhard & Akerstedt, Jewitt and Kronauer and Dawson & Fletcher]

How tired are they?

# *[development brief from industry]*

*1. model must be consistent with OH&S principles and practice for 'identifiable hazards' and 'risk management' [AS-4360]*

*2. model must be simple to understand and data-driven so employees have a sense of engagement and ownership*

*3. model can only use hours-of-work as an input*

*4. model must produce a quantifiable output with good psychometrics and calculate in 'real time' to 'coffee-time'*

*5. model need only produce a **better** description of safe hours of work than current prescriptive models - **does not need to be perfect**, just an improvement!!!!*

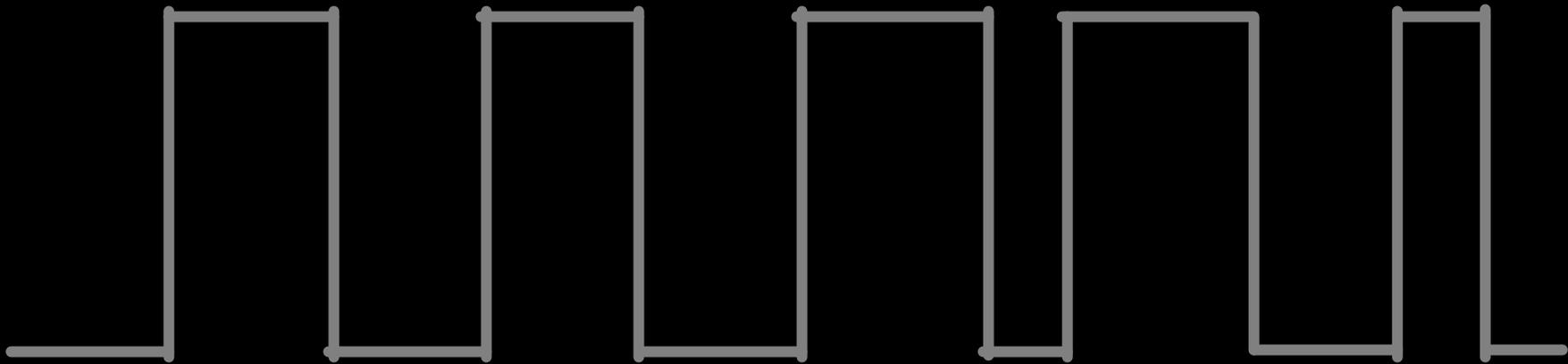
# Conceptual Basis for the Model

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The first step was to develop a universal quantitative description of schedules so we could compare different schedules/shifts.

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Work periods



Non-work periods

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Initially, we used a square wave function to express any shift as a sequence of binary work and non-work periods

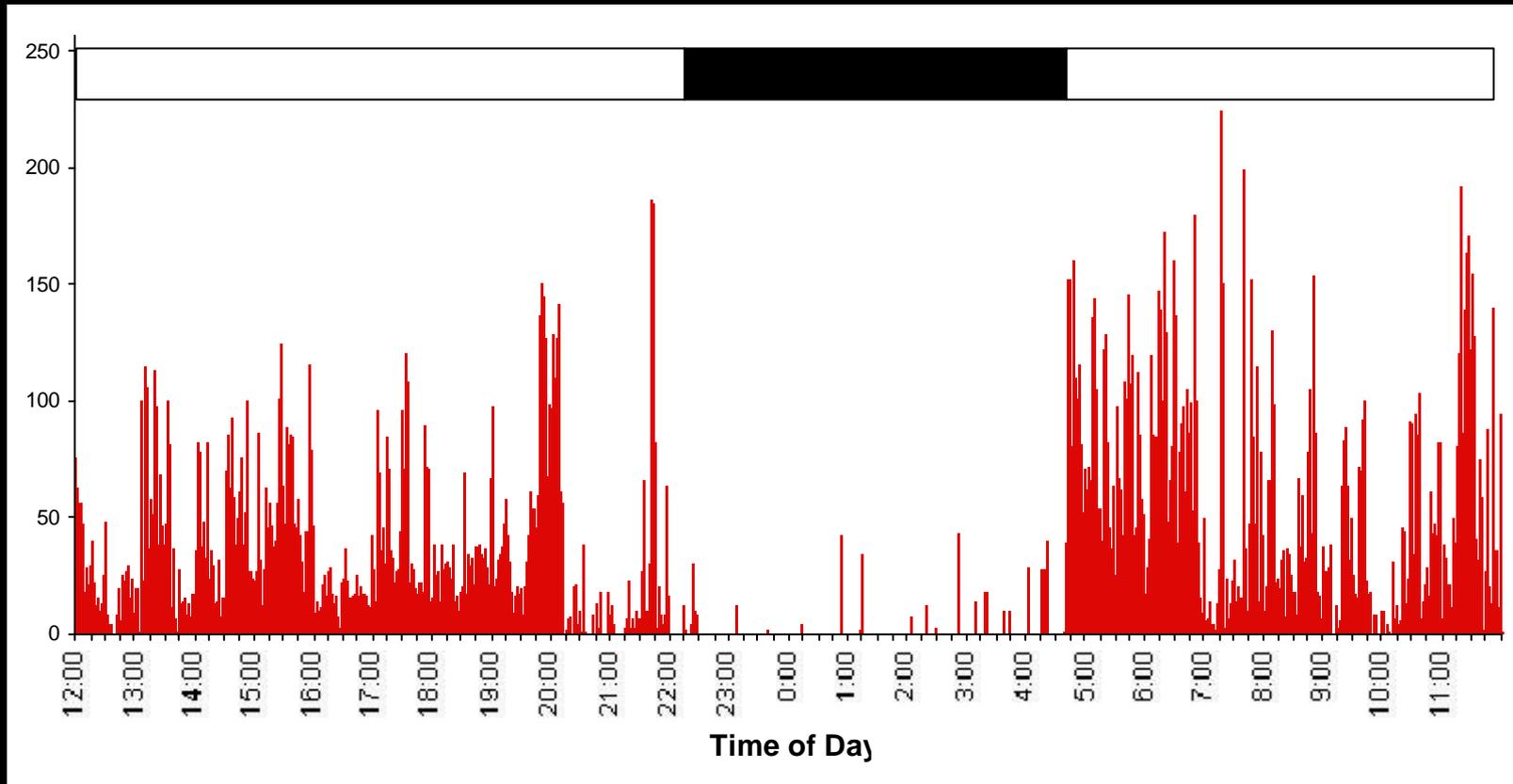
# [estimating sleep in the work place]

1. Duration and timing of shifts and breaks

2. Prior work history [7 days]

3. Biological limits to recovery

# Timing of Work and Sleep

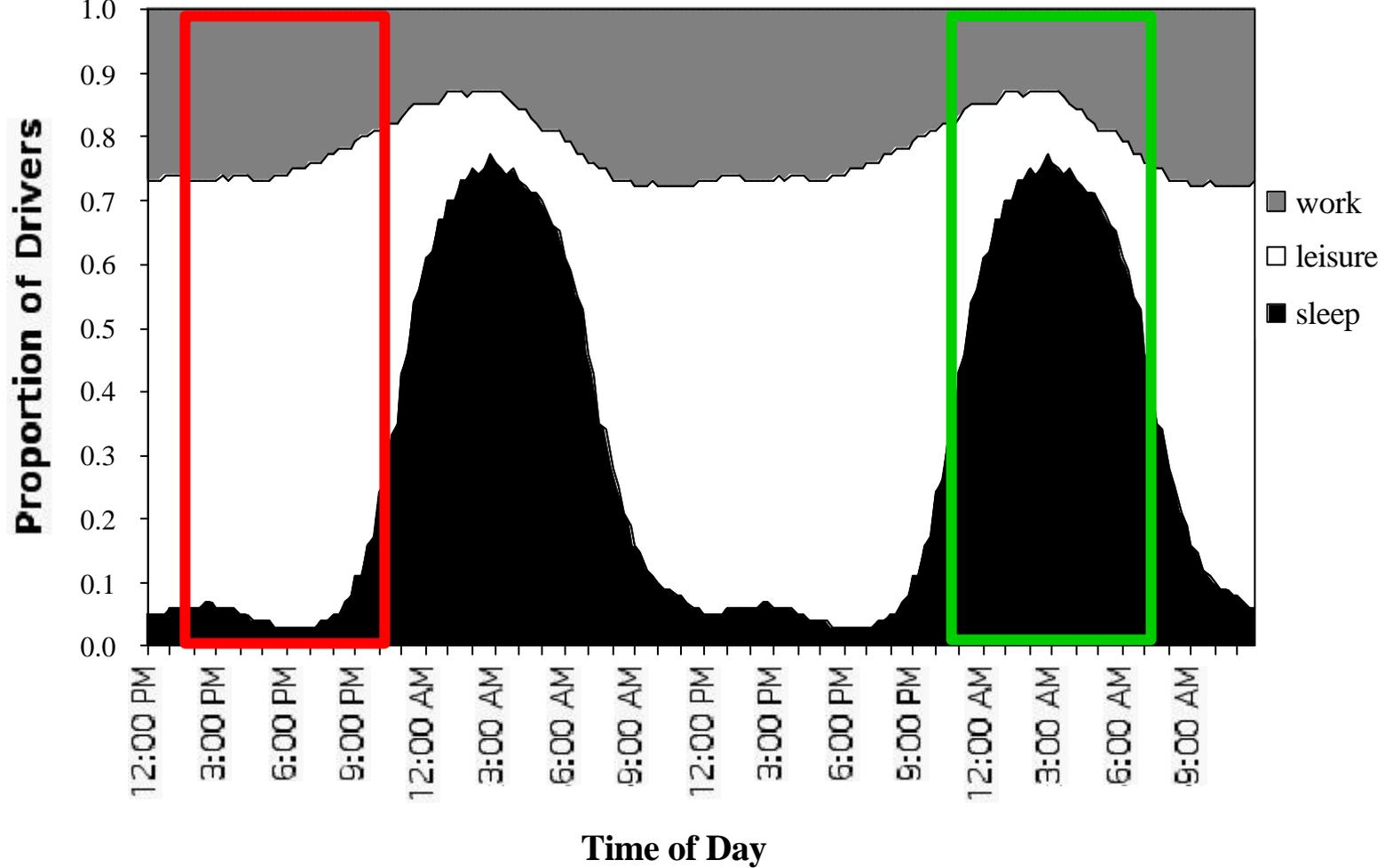


Work measured by time sheets  
Sleep measured by actigraphy

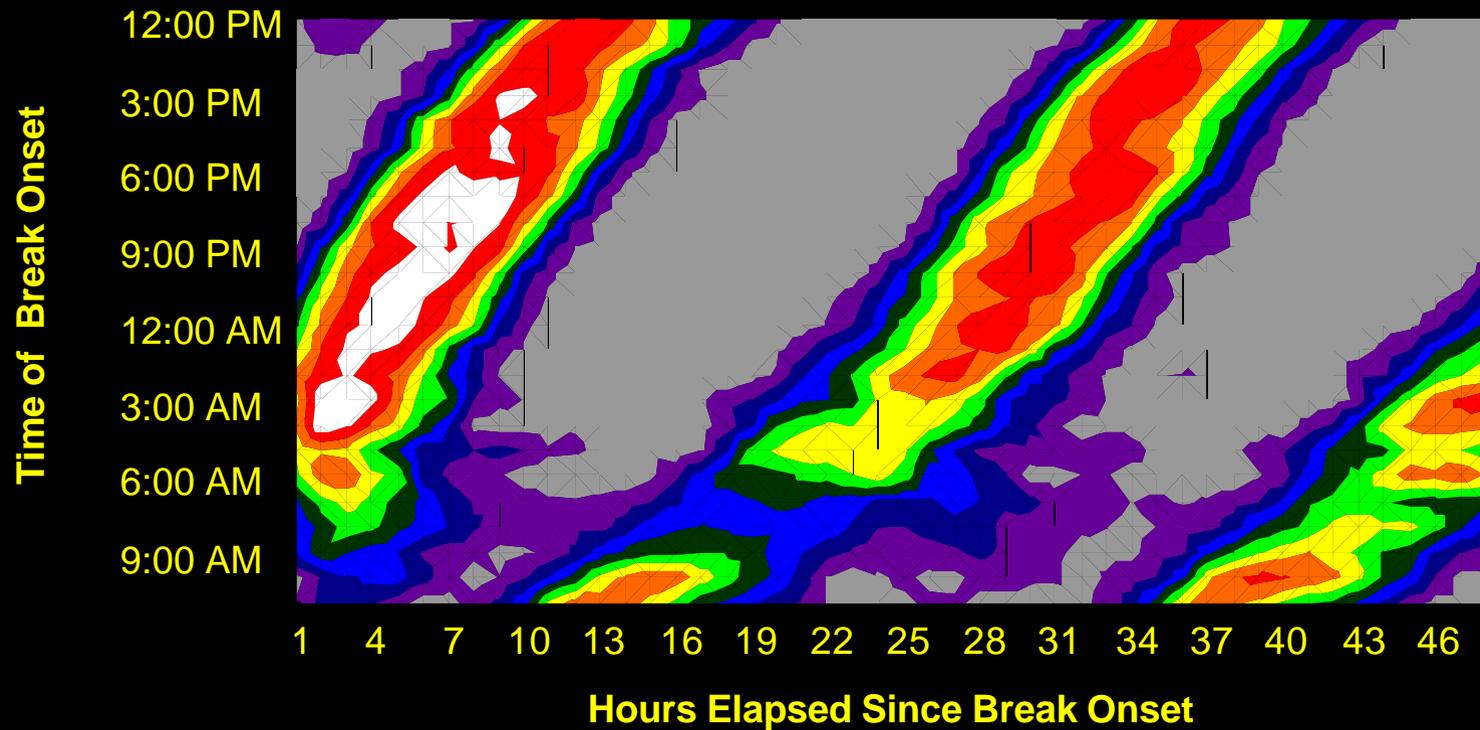
48 hours

8.5h break = recovery value of 1.2(h)

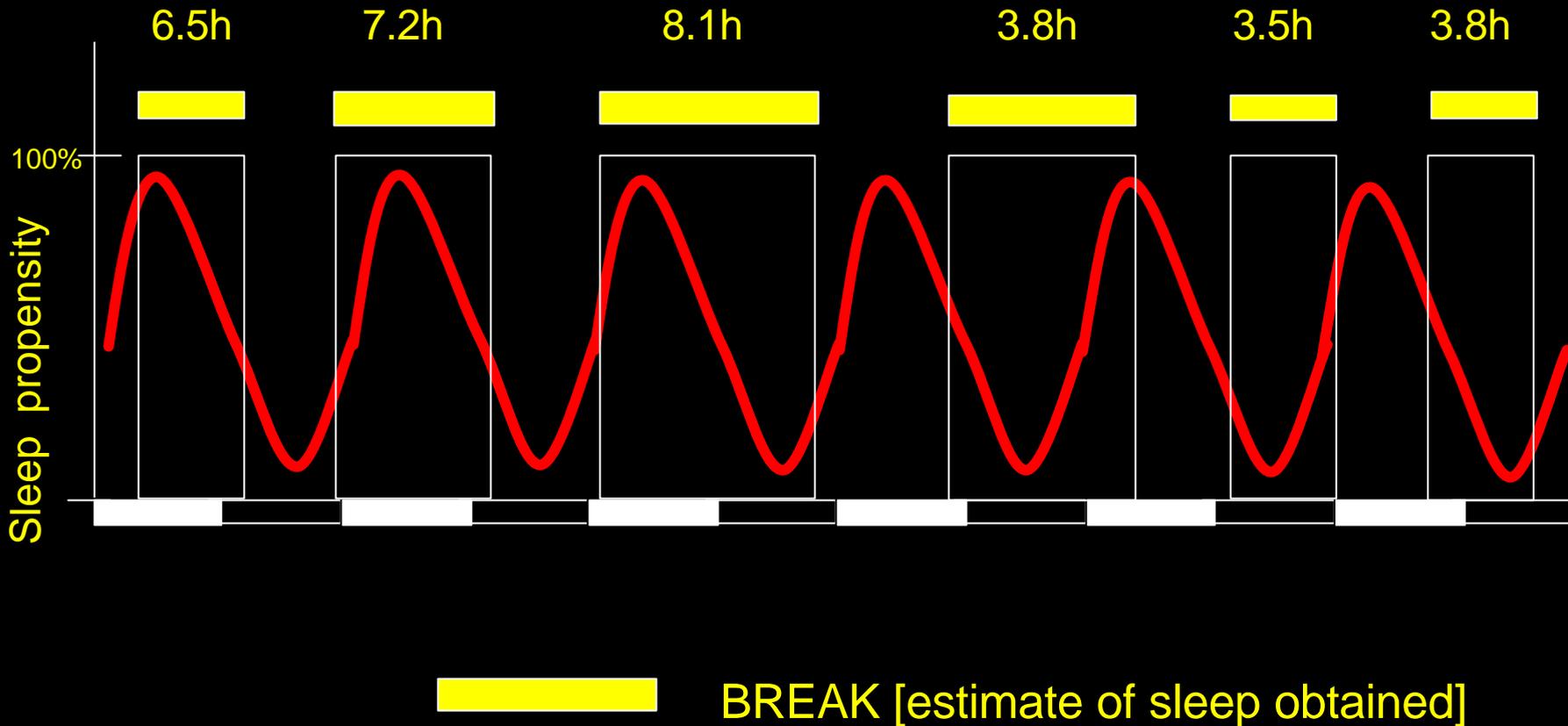
8.5h break = recovery value of 6.2(h)



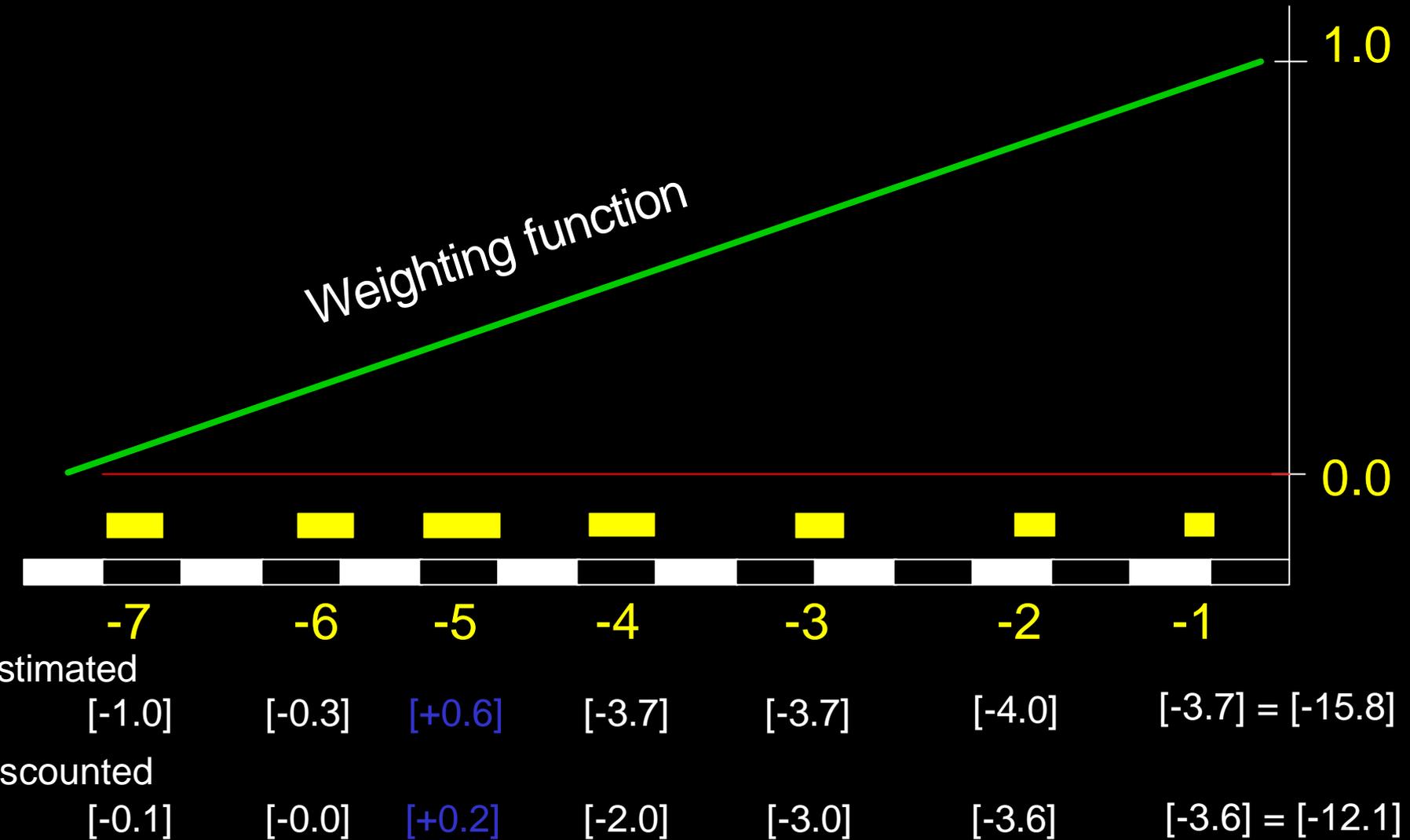
# Sleep Propensity



# Calculating the Sleep Debt

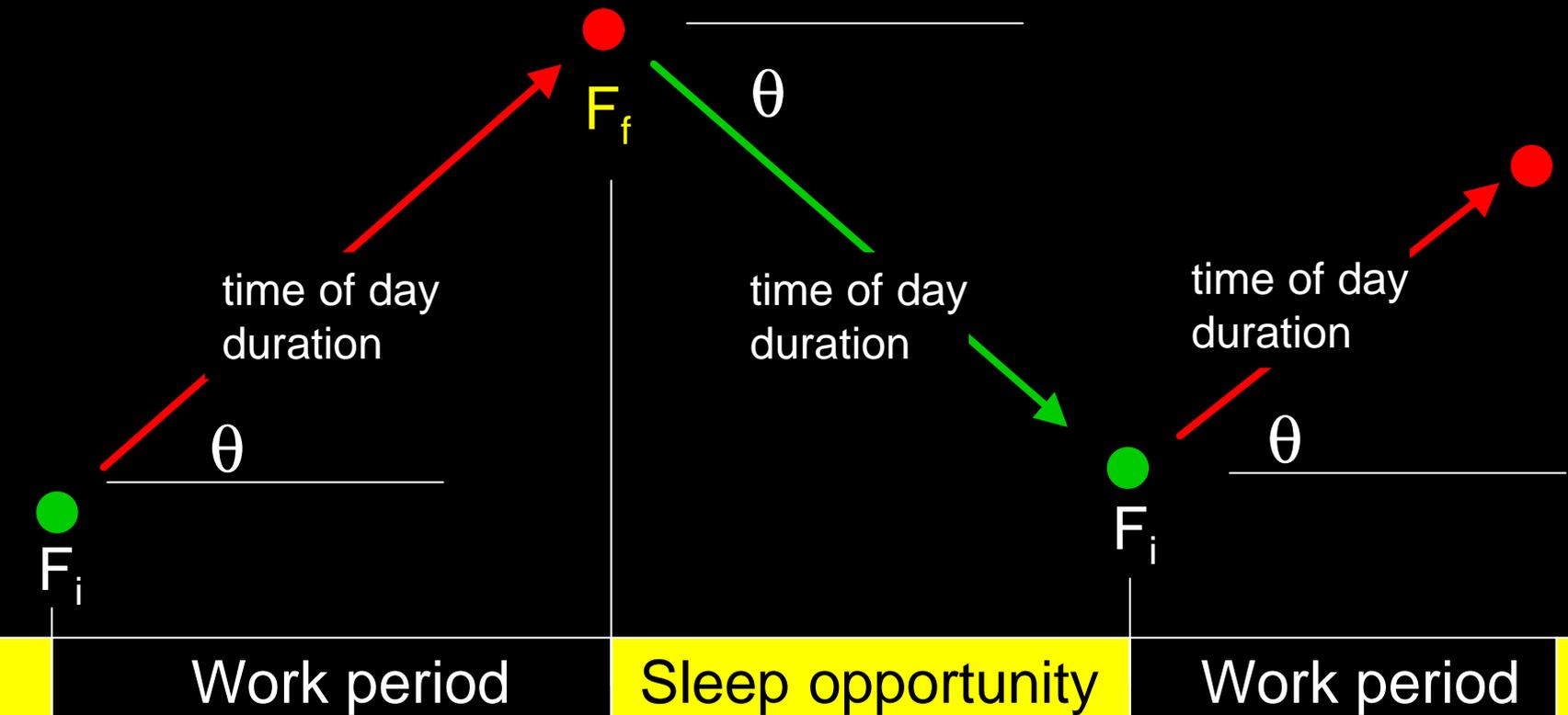


# weighted prior work history

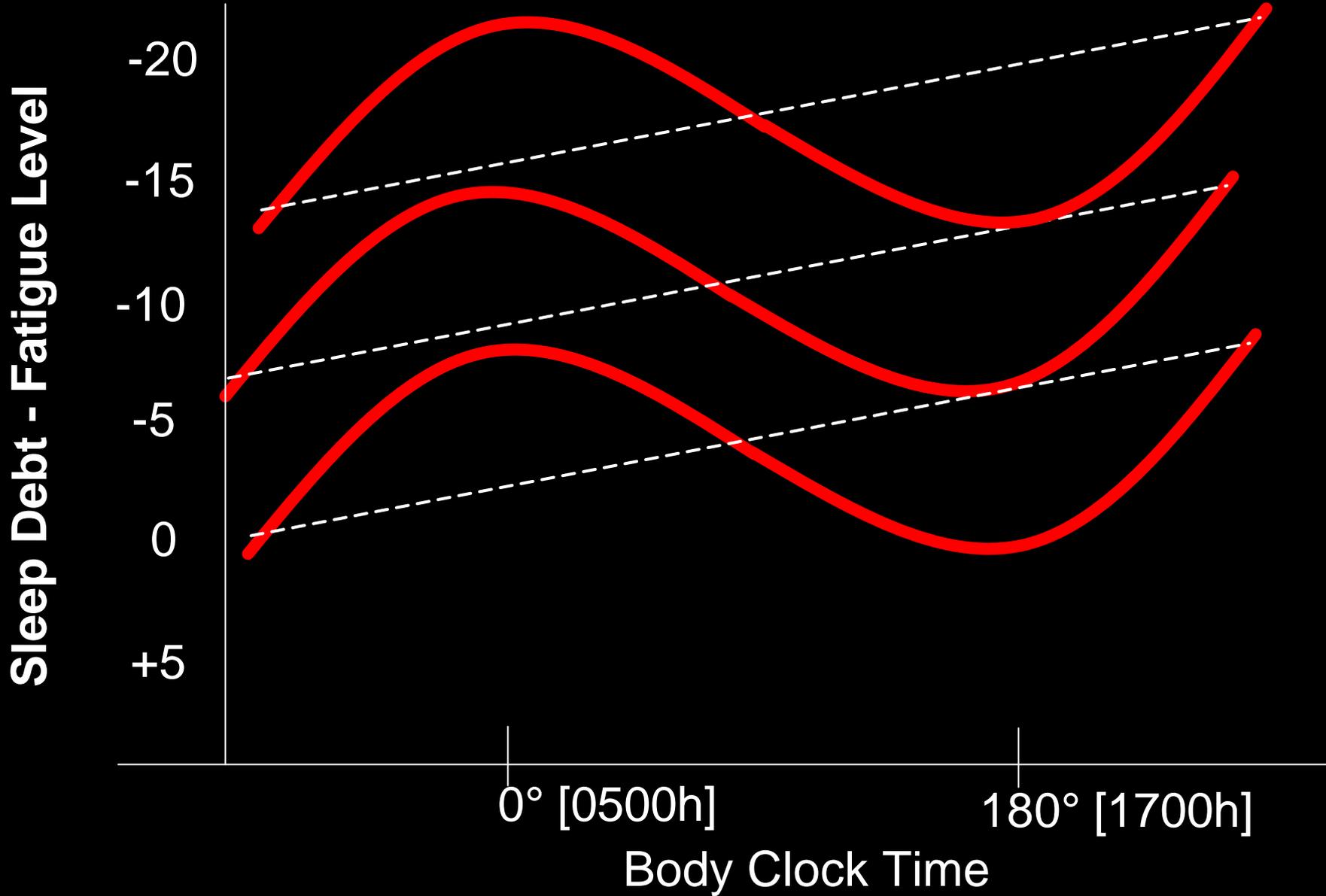


The fatigue score [initial sleep debt + prior wakefulness] accumulates and discharges as a function of the time-of-day and duration of the work/non-work sequence

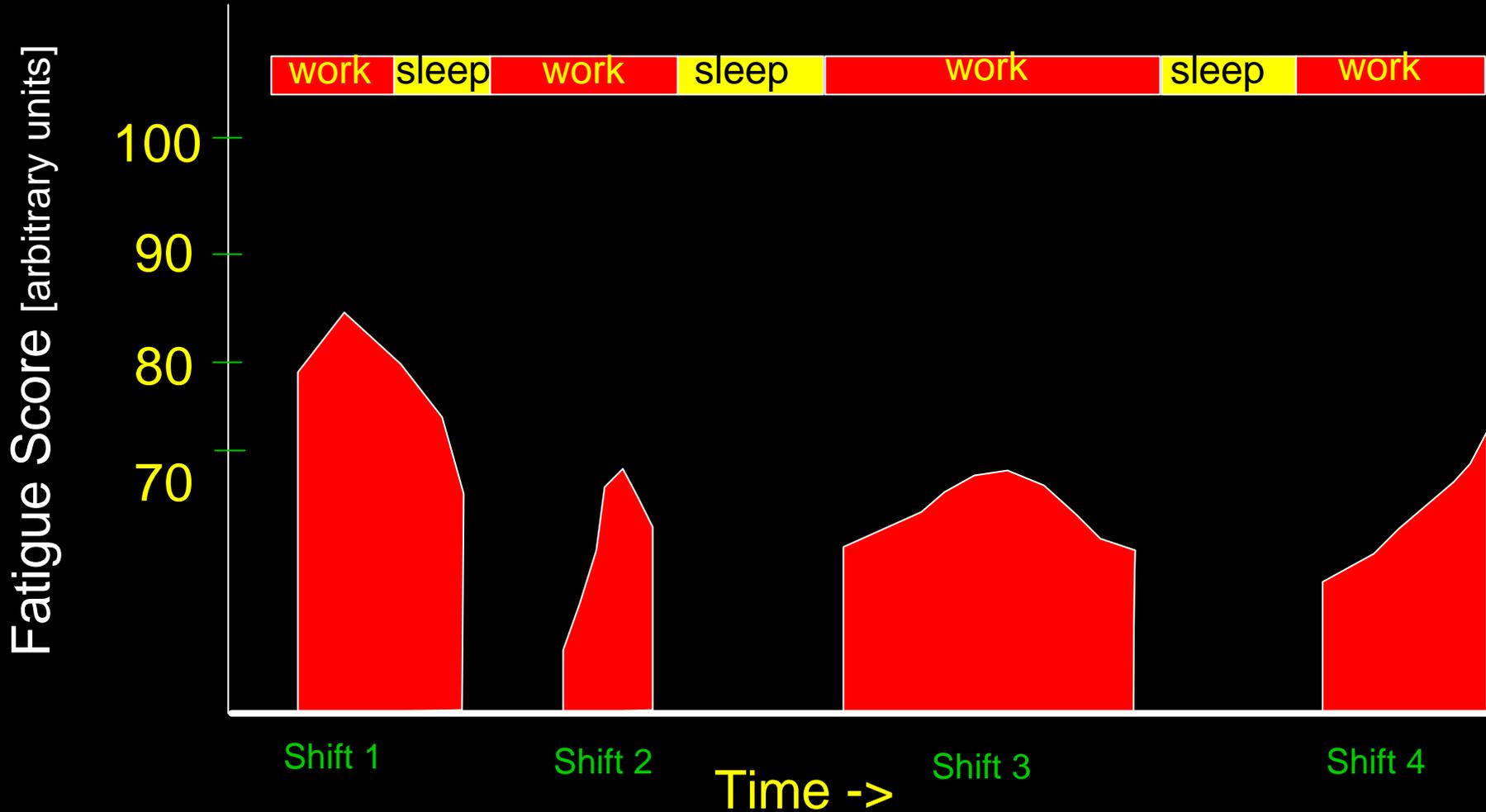
$$\text{Fatigue} = F_i + DF_{wp} \text{ where } F_{wp} = f(\text{duration, time of day})$$
$$\text{Recovery} = F_f - DF_{so} \text{ where } F_{so} = f(\text{duration, time of day})$$



# Calculating the fatigue trajectory



In effect, fatigue is a measure of the sleep debt accumulated over the prior 7 days and the subsequent fatigue trajectory during wakefulness



# Triangulating peak fatigue scores - what do they mean?



*computer-based modelling*

How tired is too tired?

# *Principle of Differential Task Risk*

Fatigue Score

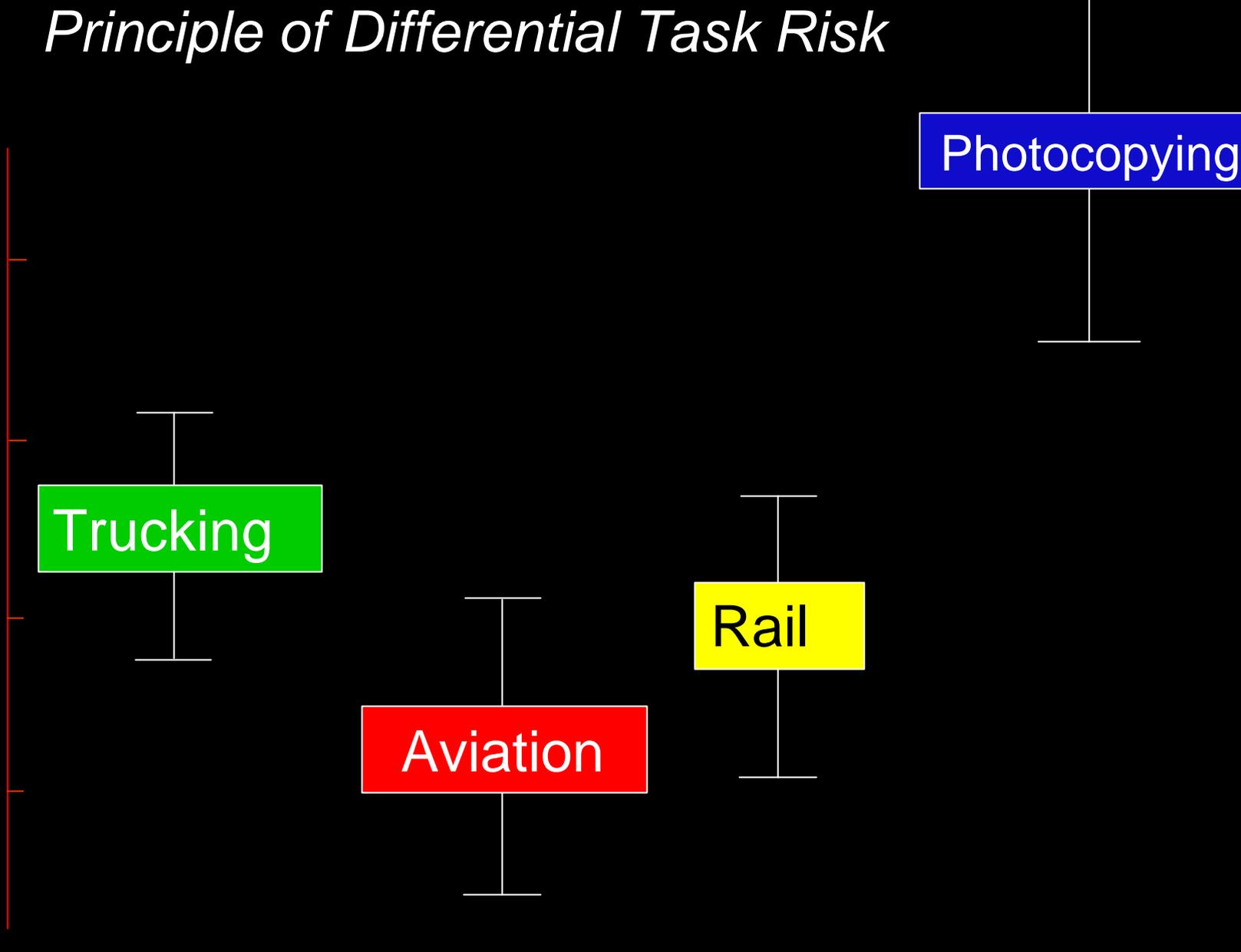
160  
120  
80  
40

Trucking

Aviation

Rail

Photocopying



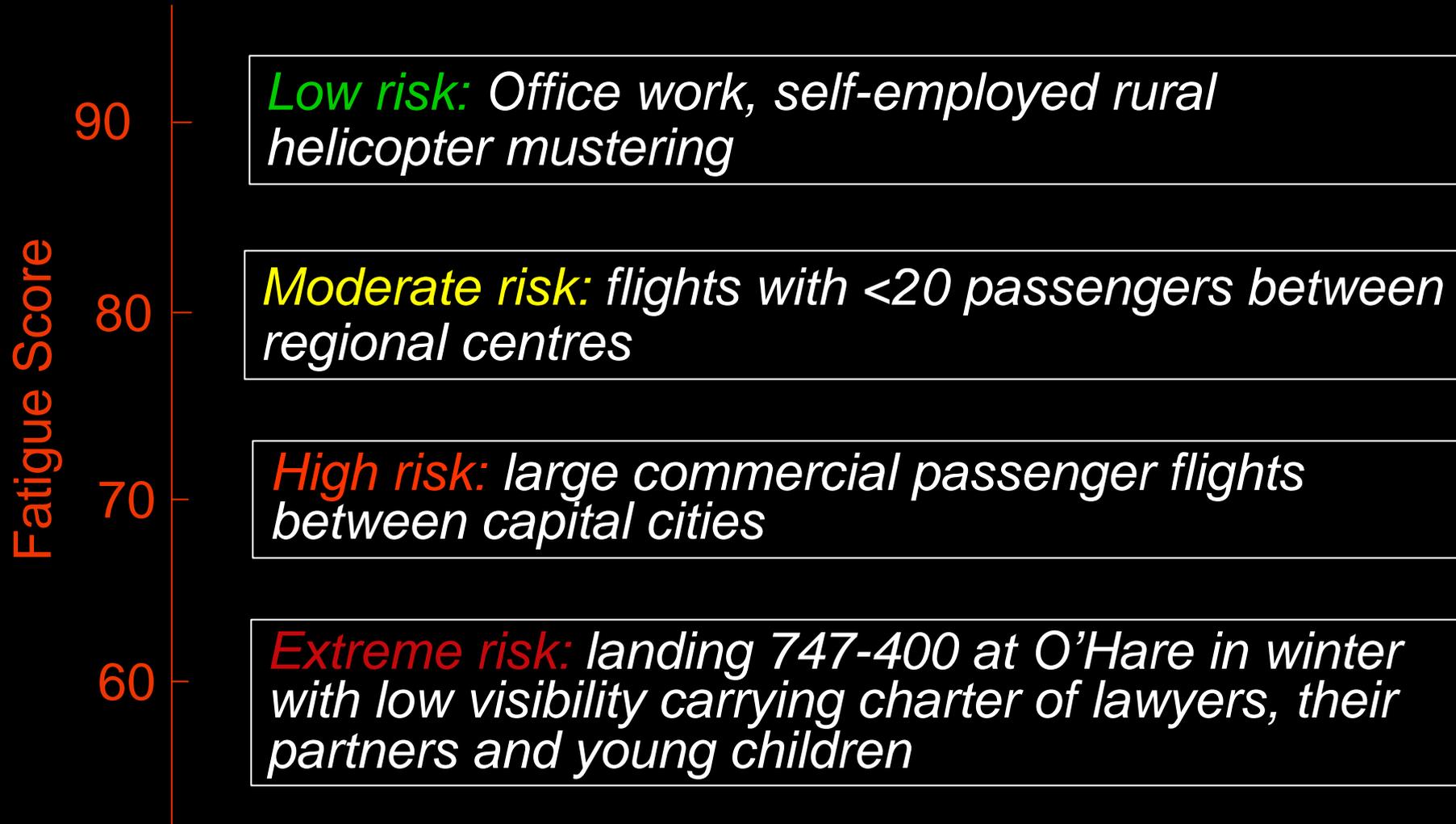
# AS/NZ 4360 Risk Assessment

likelihood

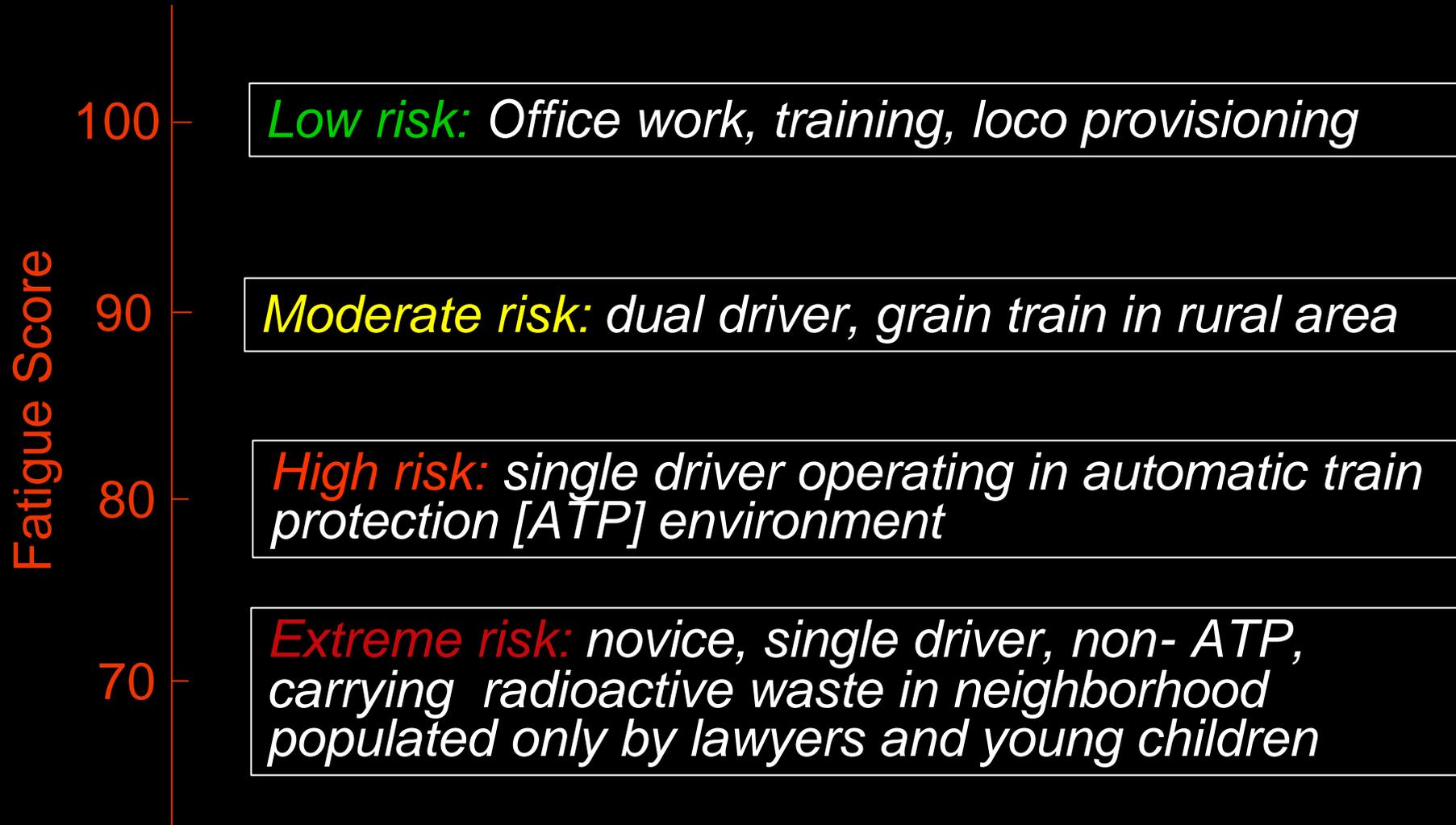
M	H	H	E	E
M	M	H	E	E
L	M	M	H	H
L	M	M	H	H
L	L	L	M	H

consequence

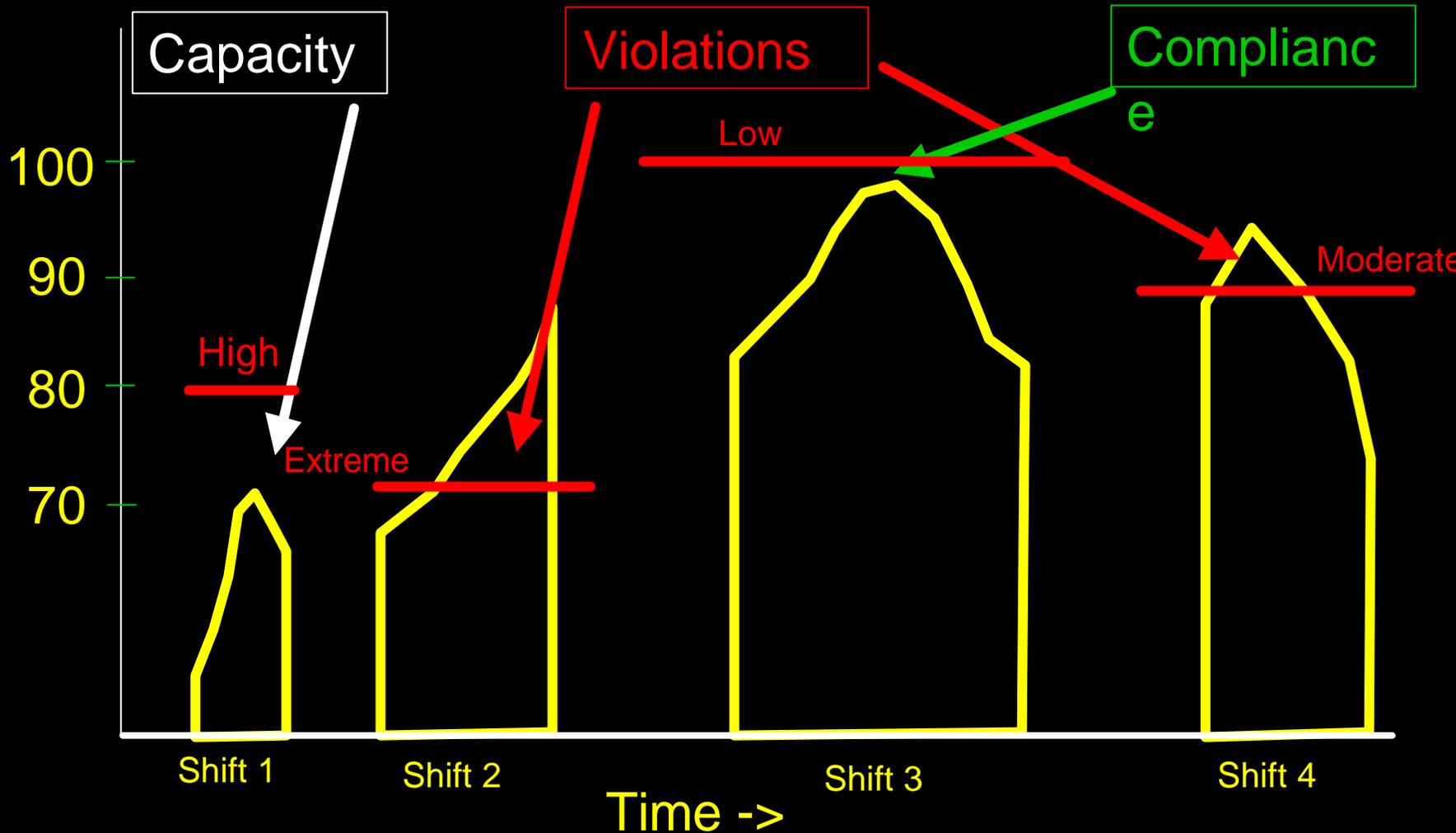
# Risk Assignment [commercial aviation]



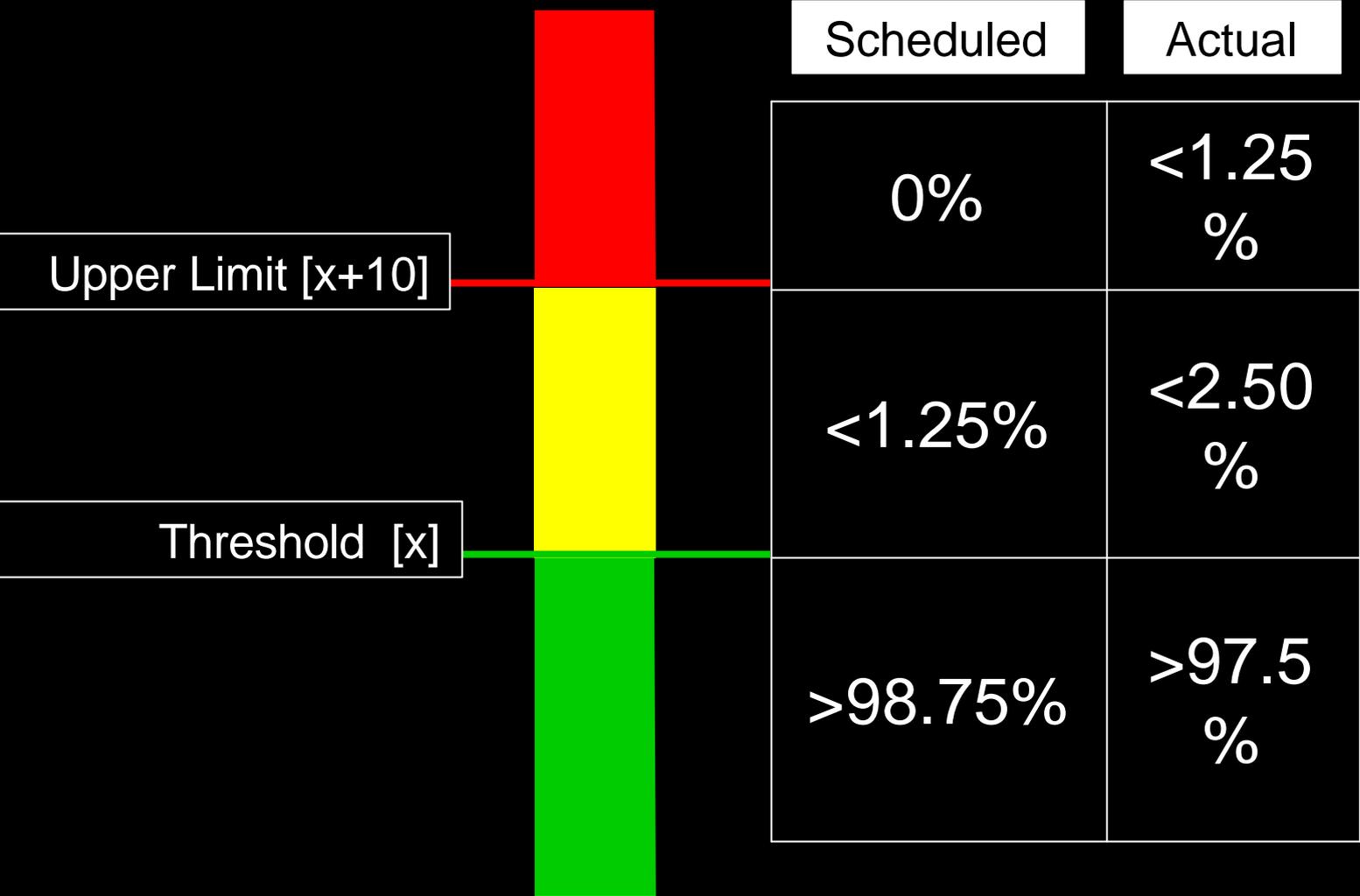
# Risk Assignment [freight rail example]



# Managing the Risks Associated With Fatigue



# Defining Compliance in an operational environment



# [a new way to approach fatigue risk reduction]

Traditional approach views fatigue management as a uni-dimensional process of altering shifts in a manner that reduces fatigue and therefore reduces risk

Using this approach we now have two strategies available

- fatigue reduction
- fatigue proofing

# [a new way to approach fatigue risk reduction]

## Examples of fatigue-proofing

- improve awareness
- improve coping strategies
- manage task sequencing
- use task rotation
- alter supervision
- build 'defended systems'

# [advantages of this model]

1. It is a simple pragmatic model. It is based on real sleep-wake data that takes into account typical social activities

2. It is easily understood by employees and because it can be based on actual data it can have high levels of ownership

3. It only requires hours-of-work as an input so is easily scaled from initial parameterisation to whole-of-business

4. Quantifies 'system risk' rather than individual fatigue

5. Very fast algorithm that can process large data sets quickly [4-8h to analyse 26M hours of work with P3 1.2GHz]

# [limitations to the current approach]

1. It is a simple pragmatic model. It is **only** designed for evaluating schedules typically found in actual workplaces

2. Fatigue is crudely inferred from estimated sleep debt in prior 7 days + prior wakefulness accrued in current shift ie. **no true physiological basis**

3. Based on sleep-wake data collected in the field which includes social activity. Thus, **not a good predictor** of many lab-based protocols [particularly extreme sleep restriction]

4. Current model **does not include circadian adaptation directly** Thus long sequences of nightwork can over-estimate fatigue at the end of the sequence and under-estimate when recommencing non-nightshift. **New** version includes simple adaptation module  $\sim 0.5 - 1.5$  hr/day

# Net Resources - Contact details

Fatigue software - [www.interdynamics.com/FAID](http://www.interdynamics.com/FAID)

Policy exemplars, competency-based training & education and legal reviews -

[www.unisa.edu.au/sleep](http://www.unisa.edu.au/sleep)

On-line training and education website-

[humantra.shiftwork.com.au](http://humantra.shiftwork.com.au)

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