

# Fatigue Management – Part 1

Presented by John Knowles  
OHS Consultant

Xchanging Healthcare and OHS Forum  
Date: 19 June 2014

## FATIGUE MANAGEMENT

### Topics

Definition and effects of fatigue

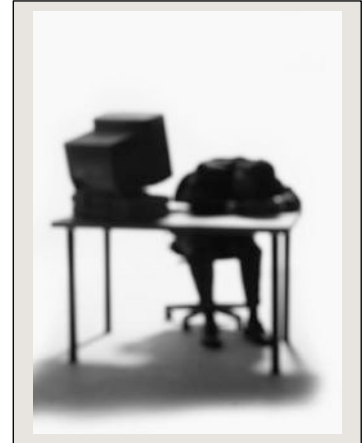
Circadian rhythm and sleep cycle

Sources of fatigue and further effects

Persons at risk

Age impacts, medical conditions

Fatigue risk management system



### BREAK

Defences in depth

Measuring fatigue – FAID, Prior Sleep Wake Model, VWA guide

Discussion – working under conditions of fatigue

Shift work and working at night

Driving, drugs and diets

Feedback sheets

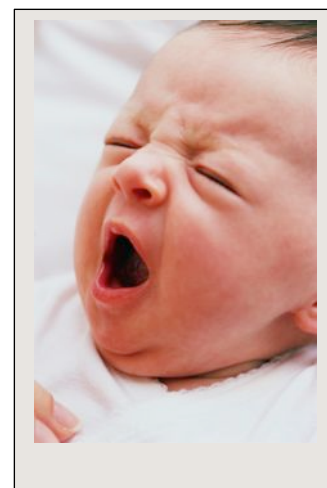
## NO AGREED DEFINITION OF FATIGUE

- Physical or mental weariness that results in reduced awareness.
- Acute or ongoing state of tiredness that leads to mental or physical exhaustion and prevents people from functioning within normal boundaries.
- Loss of alertness, which eventually results in sleep, a steady and predictable drop in brain function.
- Inability to function at the desired level due to incomplete recovery from the demands of prior work and other waking activities.

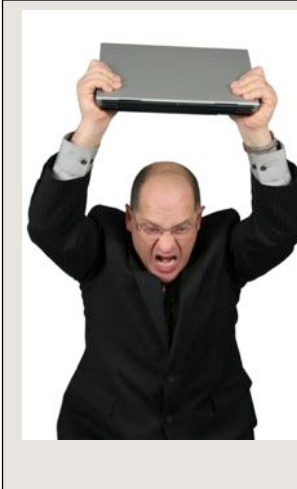
## HOW DO I KNOW IF I AM FATIGUED?

Any one or a combination of:

- constant yawning
- blurred vision
- sore or heavy eyes
- poor concentration
- daydreaming / hallucinations.



## EFFECTS OF FATIGUE

- Reactions to emergencies slowed
  - Reduced ability to communicate with fellow employees
  - Reduced work productivity
  - As quality of sleep declines – greater the drive for sleep
  - Involuntary microsleeps increase
  - As sleep decreases – it takes longer to complete tasks
  - Negative mood states increase  
(you become more cranky)
  - Ability to remember things declines
- 
- Ability to think creatively declines – more likely to keep performing ineffective solutions / actions
  - Not notice things happening around you.



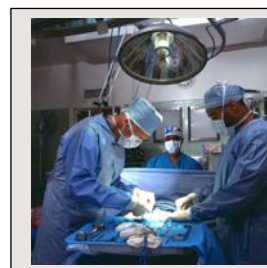
## AS PROFESSOR DREW DAWSON SAYS

### Difficulties

- Appreciating a complex situation while avoiding distraction
- Keeping track of events and updating strategies
- In remembering an event sequence
- Thinking laterally and being innovative
- Assessing risk and/or anticipating range of consequences
- Maintaining interest in outcomes
- Controlling mood and uninhibited behaviour –overreaction to negative messages
- Showing insight into one's own performance – can lead to over-correction
- Effective communication.

### Underlying mechanisms:

- Brain discards input on matters considered less important to perform the task – may focus on inappropriate elements of the task.
- Less transfer of information from short term memory to long term memory.



**IT'S ABOUT BOTH BEING AWAKE AND ASLEEP**



## AWAKE

- 17 hours of wakefulness results in the same behaviour as having 0.05% alcohol in your blood.
- 20 hours of wakefulness results in the same behaviour as having 0.10% alcohol in your blood.
- Two x 12 hour shifts is the same as having six x 8 hour shifts – in terms of the likelihood that you will crash your car.
- You are groggy and disorientated when you wake from sleep – but this is minimal after 7+ hours of continuous sleep.



## SLEEP

### If your work between midnight and 6 am

- Reduced quality of sleep – as not sleeping at optimum body temperature time
- Increases sleep debt (need for extra sleep) more than being awake at other hours
- Difficulty following health and medical requirements
- Reduced ability to be involved in family and social events.

## CIRCADIAN RHYTHM – YOUR BIOLOGICAL CLOCK



Get your day / night cycle read out at

[www.bbc.co.uk/science/humanbody/sleep/crt](http://www.bbc.co.uk/science/humanbody/sleep/crt).

### AVERAGE CIRCADIAN RHYTHM

Varies from 23.5 hours to 24.65 hours.

Reset every daylight morning.

Only effected by very bright artificial light – especially blue light.



'Typical' rhythm effects:

2 am Deepest sleep

6:45 am Sharpest rise in blood pressure

7:30 am Melatonin secretion stops  
(hormone associated with sleep)

10 am High alertness

2:00 pm to 4 pm Post lunch dip – tired - lower body temp

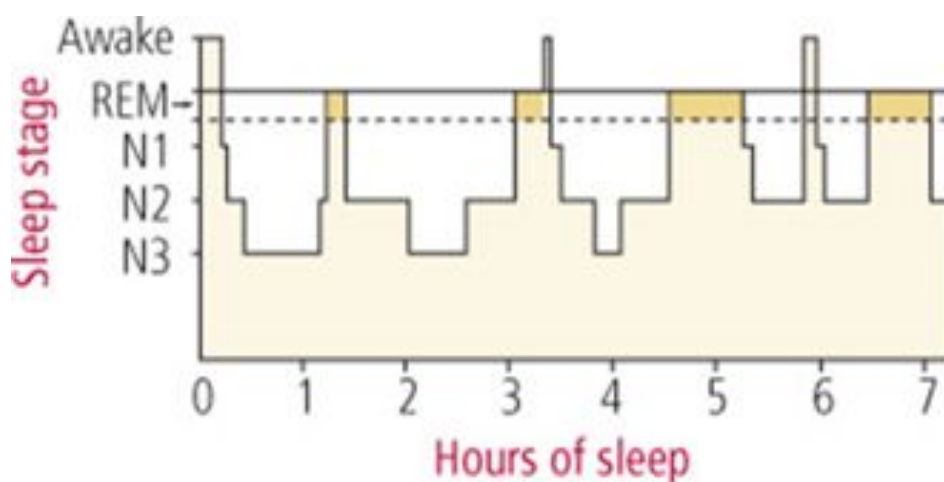
5:00 pm Greatest cardiovascular efficiency and muscle strength

7:00 pm Highest body temperature

9:00 pm Melatonin (hormone) secretion starts

11:30 pm Bowel movement suppressed

Metabolic rate slows.





## SLEEP CYCLE

### REM

- rapid eye movement, associated with dreams
- associated with learning, memory, strengthening neural pathways
- arm and leg muscles paralysed.

### Deep sleep, N3

- very difficult to wake people; feel groggy, disoriented for several minutes<sup>1717</sup>
- associated with physical repair and maintenance of the body.

## LARKS AND OWLS

**Larks** – alert about 2 hours earlier than standard rhythm, difficulty staying awake late at night.

**Owls** – alert late at night – about 2 hours later than standard rhythm, difficulty waking up early.

### Larks

- Best work 8 am to 9 am.
- Go to bed between 9 pm and 10 pm.
- Longer and more obvious afternoon dip.



## Owls

- If forced to work mornings – sleep deprived.
- Often suffer from sleep debt.
- Easily distressed.
- May suffer from poor heart function.



Some evidence can slowly train (move) circadian rhythm backward or forward (takes about 3 months).

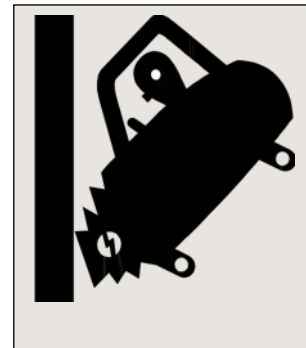
Average sleep needs	
Age	Hours
0 – 2 months	12 – 18
3 months to 1 year	14 - 15
1 to 3 years	12 – 14
3 to 5 years	11 – 13
5 to 12 years	10 – 11
12 to 18 years	8.5 to 10
18+ years	7.5 to 9

## SLEEP DEBT

- If your body needs 8 hours sleep and you only get 6 hours sleep Monday to Friday – you have built up (5 x 2 =) 10 hours sleep debt.
- Recovery sleep may be less than 10 hours, BUT the sleep needs to be long, deep sleep.
- 8 hours of sleep 'buys' you about 16 hours of alert wakefulness. Each additional hour of sleep 'buys' about 2 hours of alert wakefulness.
- Minimum 2 consecutive nights of unrestricted sleep may fully recover sleep debt.

### Victorian Transport Authority

- Vehicle accidents highest at 2 am
- Vehicle accidents lowest 6am to noon and 5 pm to 7:30 pm.



Distinguish RISK of accidents from FATIGUE

Health and Safety Executive (UK)

- risk peaks at 12 midnight.
- fatigue peaks at 5 am.

Williamson et al review 2011 – highest accident rate around midnight.

## EXAMPLES OF PEOPLE AT RISK DUE TO FATIGUE

Those who are awake for > 17 hours

Awake 17 hours plus = 0.05% BAC

Awake 20 hours plus = 0.1% BAC.

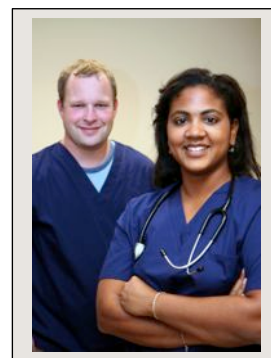
Shift workers.

e.g. Medical doctors – survey 2011,

One GP worked 43 hrs continuously

One doctor had a 120 hr working week

Average of all doctors 55.1 hr per week.



e.g. Police who work night shift then stay awake to give evidence in court.

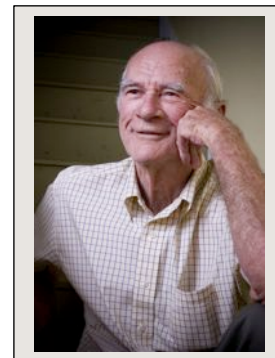
Those who work > 11 hours per day – Whitehall studies, increase likelihood heart attacks (17 yrs data).

Eg. Judges average 11 hour days  
one quarter of Magistrates > 11 hour days.

- New fathers – 36% more likely to have near miss at work and 26% more likely near miss on road (N=241).
- Truck & train drivers
  - Train drivers NSW – 2010 study, 2 weeks in March:  
24 drivers and 12 signallers fatigue score equivalent blood alcohol 0.05%.
- Airline pilots – jet lag (E-W) more than 2 time zones.

Confounding variables: age, sedentariness





## Age impacts

- As we get older it becomes physically more difficult to stay asleep across a sleep period without waking up.
- Along with other age related changes, the dreaded 'night time bladder' can cause more frequent awakenings across the sleep period.

Frequent awakenings can lead to increased sleepiness when you are awake.

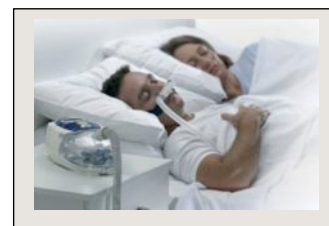
- Older individuals also find it more difficult to adjust to rotating shifts that begin and end at different times of the day.

HOWEVER, as we age - our past experiences, and the strategies we have developed to manage and cope with the demands of non-traditional hours, may help to counter some of the physiological effects of ageing.

## MEDICAL CONDITIONS

- Insomnia - can't get to sleep  
- affects about 3% Australians
- Narcolepsy - fall asleep involuntarily
- Chronic fatigue syndrome  
- sleepy despite extensive sleep time
- Restless legs syndrome - body movement when asleep (affects 2% to 5% Australians).





Source: PRESSTV article on CPAP

## **Obstructive Sleep Apnoea (OSA, OSAS)**

- Cost Aust economy \$5.1 billion pa.  
(Deloitte Access Economics 2013 *Reawakening the Nation*)
- 5% of middle aged population  
(males twice the incidence of OSA of women).
- Wake up and gasp breath up to 600 times a night – not aware of this.
- Associated excessive snoring.
- Risk factors: overweight, male.

2012 Universities study – 517 long-haul drivers

- 42% suffered from sleep apnoea.

Expert evidence to coronial inquiry, NSW – about 50% long haul drivers suffer from sleep apnoea.

National rail safety standards require all safety-critical personnel, including train drivers, to keep body mass index (BMI) under 40 – to avoid sleep disorders which would make them unable to perform the inherent requirements of the job. If BMI 35 + and additional factors or BMI 40 + MUST be assessed for possible sleep disorders.

## MAKING THE PARADIGM SHIFT

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

A fatigue management system should have:

1. A written fatigue management plan/policy for all reasonably foreseeable events.
2. Competency-based training and education programs for the identification and management of fatigue-related risk.
3. A quantitative methodology for ensuring that employees and other workers are not fatigued at both the individual and organizational level.
4. There should be a quantitative methodology for determining compliance with 1 – 3.

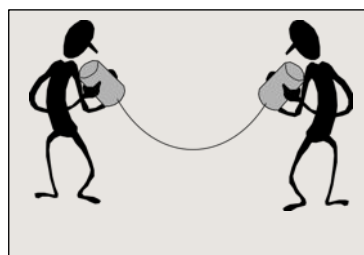
The *EMPLOYER* is responsible for providing employees and contractors with a work schedule:

- That does not require excessive wakefulness and
- Provides opportunities for sufficient sleep
- Policy and procedure backed up with education and competency training.

In determining this, the *employer* shall take into account normal **non-work activities and responsibilities** of the employee.

The *EMPLOYEE and CONTRACTORS* are responsible for using their allocated time from work to obtain sufficient sleep in order to work safely. If that does not occur, the *employee or contractor* must notify their employer that they have had insufficient sleep.

## BREAK



# Fatigue Management – Part 2

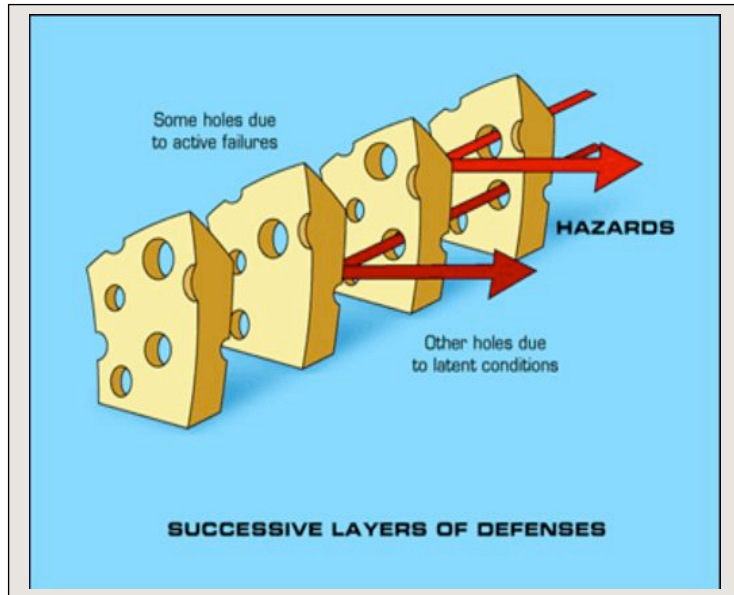
Presented by John Knowles  
OHS Consultant

Xchanging Healthcare and OHS Forum  
Date: 19 June 2014

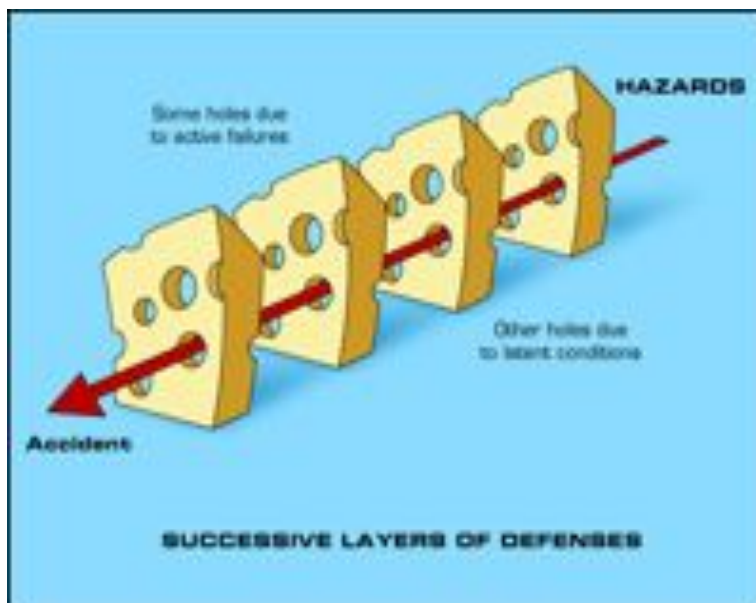


## DEFENCES IN DEPTH

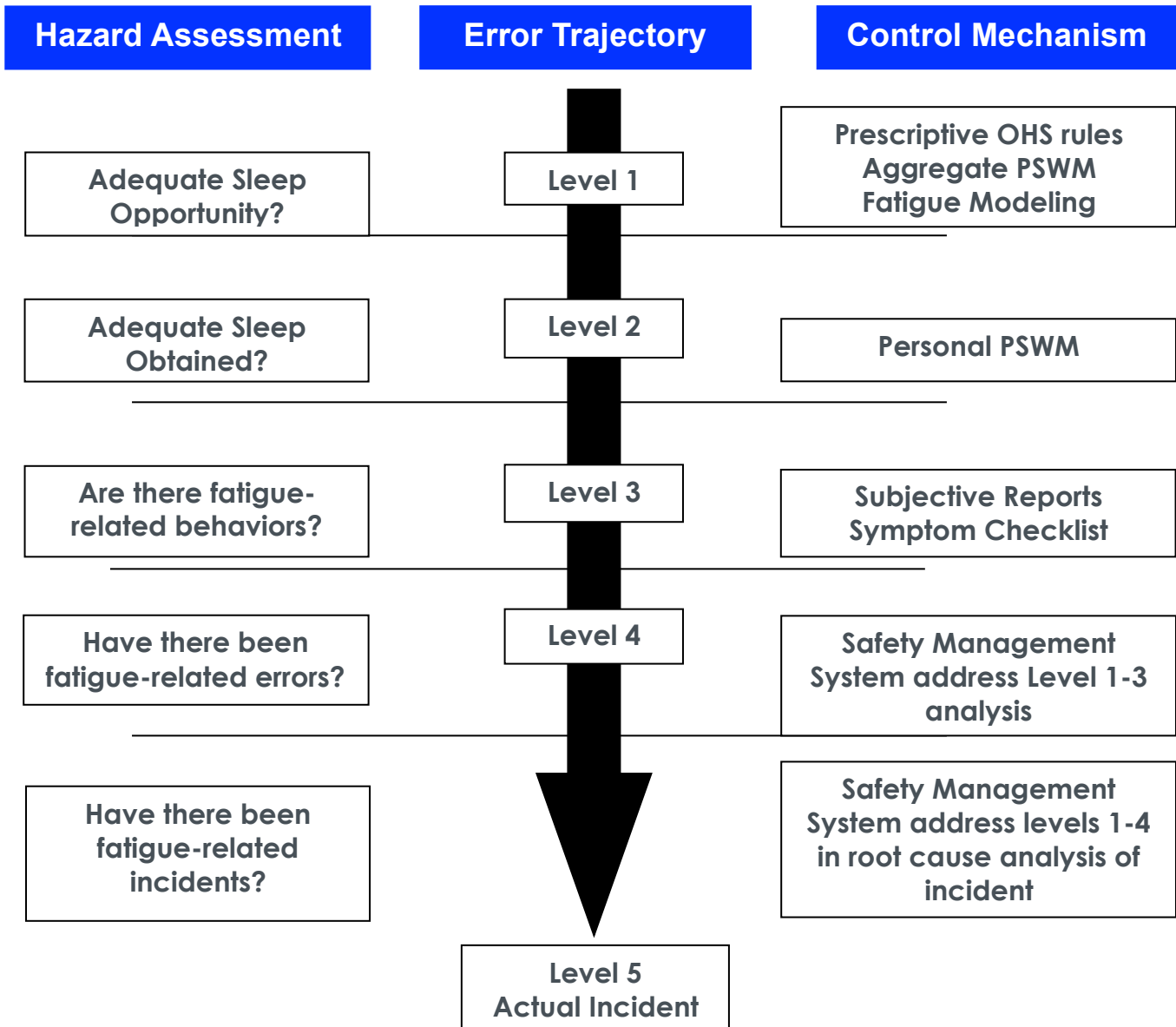
James Reason's OHS Swiss Cheese Model



Culture  
Policies  
Procedures  
Training  
Supervision



## Fatigue Risk Trajectory – Professor Drew Dawson



### Level 1 – sleep opportunities

Adequate sleeping opportunities:

- Working hours
- Rosters
- Overtime
- Split shifts
- Second job

Prescribed hours eg heavy transport, aviation

Aggregate Prior Sleep Wake Model or other fatigue risk assessment model

Safety critical tasks

Boring, repetitive tasks

### Level 2 – sleep obtained

Employee sleep reports, eg fatigue likelihood scores

Keeping track of sleep and waking  
Individual Prior Sleep Wake Model or similar

### Level 3 – fatigue related behaviours

Employees exhibiting symptoms:

- Difficulty concentrating
- Daydreams
- Falling asleep at work

Self monitoring

Supervisor monitoring

### Level 4 – records of fatigue related errors

Products or services not up to standard

Risk Based Decision Tree or similar

### Level 5 – Incident !

Single vehicle crashes to or from work

Injury from misuse of machinery

Root cause incident analysis



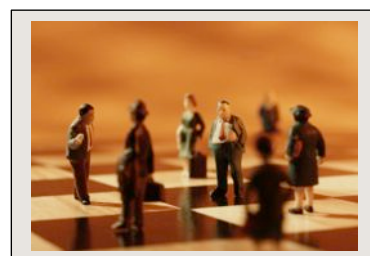
## CREATING A SHARED FATIGUE RISK MANAGEMENT STRATEGY

- FAID - Fatigue Audit InterDyne.
- SAFTE – Sleep, Activity, Fatigue and Task Effectiveness.
- FAST – Fatigue Avoidance Scheduling Tool.
- SAFE – System for Aircrew Fatigue Evaluation.
- CAS – Circadian Alertness System (truck and rail).

Sleepwake Predictor

(See Transport Canada, TP 14577, chapter 2  
[www.tc.gc.ca/eng/civilaviation/publications](http://www.tc.gc.ca/eng/civilaviation/publications))

Fatigue & Risk Index – Health and Safety Executive, UK  
([www.hse.gov.uk/RESEARCH/rrpdf/rr446g.pdf](http://www.hse.gov.uk/RESEARCH/rrpdf/rr446g.pdf) for the manual)



## FAID – FATIGUE AUDIT INTERDYNE – DEvised BY PROFESSOR DAWSON

Developed at Uni SA – used by:

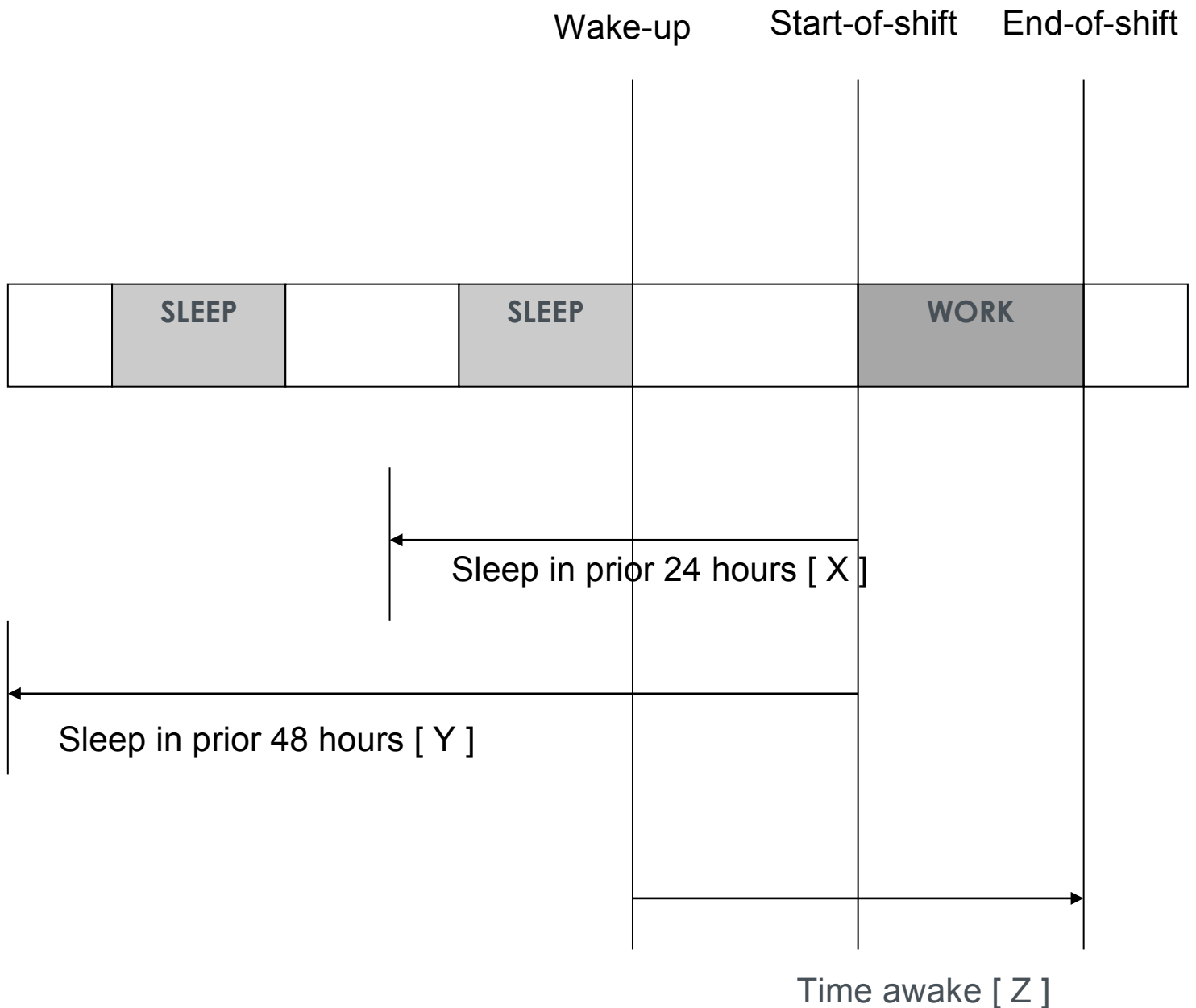
- Qantas
- Civil Aviation Safety Authority
- Australian Transportation Safety Bureau.

Computer version uses 7 day record of sleep and wake.

Follows – simplified version:



## PRIOR SLEEP WAKE MODEL (PSWM) – PROFESSOR DAWSON



Prior wake threshold – Prior to commencing work, an employee should determine whether the period from wake-up to the end of the shift exceeds the amount of sleep obtained in the 48 hours prior to commencing work.



Where that criterion not achieved – the organisation needs to implement appropriate hazard controls.

**X** = sleep in prior 24 hours

**Y** = sleep in prior 48 hours

**Z** = time since last sleep.

As prior sleep decreases and prior wake increases the likelihood of fatigue [symptoms, errors and incidents] also increases.

In general,

**X** should be greater than threshold [**5 hrs**]

**Y** should be greater than threshold [**12 hrs**]

**Z** should be less than Y.



**Why 5 hours?** – Dawson & McCulloch 2005

5 hours sleep or less = research demonstrates there is a definite impact on health and safety performance.

Based on 'night in bed' laboratories studies

- electroencephalograph measures of sleepiness and alertness
- reaction time
- vigilance tasks.

### How to calculate the fatigue likelihood score

<p>1. Add 4 points for every hour of sleep below the 24 hour prior sleep threshold [X] [threshold 5 hr sleep].</p>	<p>4 points for every hour <math>X &lt; 5</math> if <math>X = 3</math>, the score will = 8</p>
<p>2. Add 2 points for every hour of sleep below the 48 hour prior sleep threshold [Y] [theshold 12 hr sleep].</p>	<p>2 points for every hour <math>Y &lt; 12</math> If <math>Y = 11</math>, the score will = 2</p>
<p>3. Add 1 point for every hour of awake [Z] is more than [Y] .</p>	<p>1 point for every hour <math>Z &gt; [Y]</math> If <math>Z = 13</math> and <math>Y=12</math>, the score will = 1</p>
<p>4. Sum scores and refer to decision tree to determine appropriate response.</p>	<p><math>8 + 2 + 1 = 11</math></p>

### OR Risk Based Decision Tree – Canadian airlines

#### Step 1. Sleep in prior 24 hours

Sleep	< 2h	3h	4h	5+h
Points	12	8	4	0

#### Step 2. Sleep in prior 48 hours

Sleep	<8h	9h	10h	11h	12+h
Points	8	6	4	2	0

#### Step 3. Hours awake since last sleep

Add one point per hour awake greater than sleep in step 2

#### Step 4. Sleep in prior 24 hours

Add all scores together to determine your score



<u>Score</u>	<u>Control Level</u>
1 – 4	Self-monitoring
5 – 8	Supervisor monitoring
9 +	Don't start shift until fit for work

NOTE: Pilots usually have a first officer with them.

YOU would have to decide which score was associated with which control level in your industry or at your site.



Simpler guide: WorkSafe Victoria and WorkCover NSW 2008

*Fatigue Prevention in the Workplace, Appendix 2.*

## **DISCUSSION – WORKING UNDER CONDITIONS OF FATIGUE**

There will be times when work needs to be done, regardless of fatigue.

For example, driving several hours, doing the work, then driving back

What strategies do you have for your staff which:

- Increase task complexity for boring jobs.
- Decrease task complexity for high risk jobs.
- Additional checks (defences) for working when fatigued?



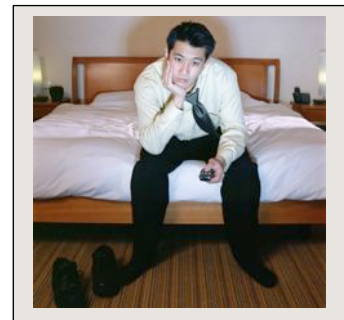


## SHIFT WORK AND WORKING AT NIGHT

### Medical effects of long term night work

- Cancer risk factor
- Gastro-intestinal problems  
(your gut slows down at night)
- High blood pressure
- Increased cardiovascular disease
- Irregular menstrual cycles
- Increased incidents diabetes
- Depression, anxiety.

Caution: are these cause-effect or only correlation relationships?



### WorkSafe / WorkCover recommendations

Avoid short shift changeovers especially finishing at 11 pm and starting again at 7 am.

Limit shifts to 12 hours including overtime.

Avoid high risk lengths of work:

- 12 hour night shifts
- 13 hours work plus work-related travel per shift
- 56 hours a week or more
- 624 hours over 3 months or more.

Reference: WorkSafe Vic/ WorkCover NSW 2008 *Fatigue Prevention in the Workplace*.



## Shift characteristics

Avoid split shifts (one shift split into two different times during a day).

If you cannot avoid split shifts –

- provide on-site catering and rest facilities
- Provide more breaks near end of shift
- Do not allow saving up rest breaks to leave early.

Night shifts –

- avoid demanding, monotonous and safety critical work
- Offer choice of permanent or variable shifts
- Older workers find permanent night shift difficult
- 2 to 3 consecutive night shifts should be followed by 2 to 3 rest days.

## Also

- Control overtime, shift swapping, on-call duties.
- If rotating shifts, they should rotate forward: morning shift, then afternoon shift then night shift.
- Set shifts ahead of time – provide certainty.

Further guidance: Health and Safety Executive (UK) 2006 *Managing Shiftwork*

Williamson and others 2011:

- Peak of accidents in the first half hour of a shift
- And then between the 2<sup>nd</sup> and 5<sup>th</sup> hour of the shift (but varies with task).



## Health and Safety Executive (UK) Fatigue Index Calculator takes account of:

- Day
- On duty
- Off duty
- Job type / breaks
- Commuting time
- Duty length
- Rest length
- Average duty per day.

Manual: [www.hse.gov.uk/RESEARCH/rrpdf/rr446g.pdf](http://www.hse.gov.uk/RESEARCH/rrpdf/rr446g.pdf)



## TIPS ON SLEEPING

- Your eyes, ears, nose etc monitor the environment even when you are asleep.
- Make the room dark, especially if sleeping during the day.
- Make sure there will be no sudden noises when you are asleep.
- Sleep at a temperature that suits you.
- If your thoughts keep you awake – have a pen and paper available to write down those thoughts (or to draw your pictures).
- If people tell you that you snore – you may wake up feeling tired – seek help from your GP or visit a sleep clinic.
- If your doctor prescribes any sort of drug or medicine – ask them about how the drug/medicine affects your sleep and fatigue levels.
- If you feel fatigued at work – make sure your supervisor is told and makes a note of it.

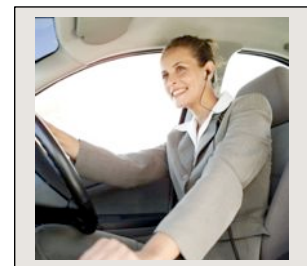


## TIPS ON DRIVING

- Have at least 7.5 hours continuous sleep before a long trip.
- Stop driving if you feel fatigued and have a nap (10 min nap leaves you more alert, after the nap, than 1 hours doze). Allow for a recovery period of up to 15 minutes after a sleep period of more than 45 minutes (Deep sleep effects).
- Always drive 2 up.
- Swap drivers every 1.5 to 2.0 hours of continuous driving.
- Drive no more than 12 hours in any 24 hours period.
- Permission is required from your Manager to drive between 12 midnight and 6 am.
- Report all near misses, incidents and accidents to your supervisor and keep a record of these.
- Technology: prefer technologies that monitor the control of the vehicle not monitor the driver's behavior.

### Driver fatigue symptoms

- variations in driving speed
- letting your vehicle drift out of lane
- difficulty remembering the last few kilometres
- impatience
- poor gear changing and use of other vehicle controls.



Also Part 1, page 3 symptoms.



## NAPPING

- Not a substitute for continuous, deep sleep.
- Not a substitute for recovery sleep for sleep debt.
- 10 minute nap leaves you more alert than 1 hour doze.
- Allow recovery period, up to 15 minutes - to overcome 'sleep inertia'.

Good if you feel tired !

## PHYSICAL FITNESS

- NHMRC recommends 30 minutes of exercise per day.
- Never too late to start – but start gradually.
- Better fitness =
  - Stay alert more
  - Resist fatigue more
  - Boosted energy levels
  - Increased strength
  - Increase well-being (you feel better).
- Don't exercise just before sleeping.
- Relax before you go to bed – including having a relaxing shower or bath.



Acknowledgement: Easy Guides 2008 *An Easy Guide to Shift Work, Managing your fatigue.*



## DRUGS

### Prescription drugs

- always check side effects
- drowsy or over alert
- dose-response may be affected by night shift.



### Sleeping pills

- miss out either REM sleep or deep sleep
- may have withdrawal symptoms, incl. anxiety.

**Illegal drugs** - no guarantee what is in them.

**Alcohol** - relaxes, but disturbs sleep.

**Nicotine** - stimulant.

### Caffeine

- not within 6 hours of bedtime
- stimulant, but body quickly adapts
- pregnant women limit to 200 mg per day.

## DIET

- Bowel moves very slowly after 11:30 pm
- Avoid heavy meals 2 to 3 hours before sleep time
- Have regular meal times
- High protein food – keeps you alert – breakfast
- High carbohydrate food – makes you sleepy – last meal before sleep
- We do not eat enough fruit and vegetables
- Avoid high fat and high sugar foods
- Many light meals better than few heavy ones.

**Please fill in a feedback sheet.**



## **Fatigue Management Reference List**

Ambulance Employees Australia 2008 *Survey Results, Victorian Paramedic Fatigue Survey*

Australian Medical Association 2005 *National Code of Practice – Hours of Shiftwork and Rostering for Hospital Doctors.*

Australian Medical Association 2006 *Safe Hours – Safe Patients, AMA Safe Hours Audit 2006*

BetterHealth Channel *Caffeine*, Fact Sheet, [www.betterhealth.vic.gov.au](http://www.betterhealth.vic.gov.au)

Circadian rhythm [www.bbc.co.uk/science/humanbody/sleep/crt](http://www.bbc.co.uk/science/humanbody/sleep/crt)

Civil Aviation Safety Authority 2004 *Flight Time Limitations – Pilots*, Civil Aviation Orders

Commission for Occupational Safety and Health 2004 *Code of Practice, Fatigue Management for Commercial Vehicle Drivers*, WA

Dawson, D and McCulloch, K. 2005 *Managing Fatigue: It's About Sleep*, *Sleep Medicine Reviews*, vol. 9, No.5, October pp.365-380

Deloitte Access Economics m/Sleep Health Foundation 2012 *Reawaking the Nation, The Economic Cost of Sleep Disorders in Australia*

Easy Guides 2008 *An Easy Guide to Shift Work, Managing your Fatigue*

Fatigue & Risk Index Manual – Health and Safety Executive, UK  
[www.hse.gov.uk/RESEARCH/rpdf446g.pdf](http://www.hse.gov.uk/RESEARCH/rpdf446g.pdf)

Health and Safety Executive 2006 *Managing Shiftwork*

Healthy Eating section of Australian Government, Department of Health & Ageing  
([www.healthyactive.gov.au](http://www.healthyactive.gov.au))

House of Representatives, Standing Committee on Communication, Transport and the Arts 2000 *Beyond the Midnight Oil, An Inquiry into Managing Fatigue in Transport*

House of Representatives, Standing Committee on Regional Australia 2013 *Cancer of the Bush or Salvation for our Cities? Fly-in, Fly-out and Drive-in, Drive-out Workforce Practices in Regional Australia*

National Transport Commission 2007 *Guidelines for Managing Heavy Vehicle Fatigue*

Queensland Government, Department of Natural Resources and Mines 2013 *QGN 16 Guidance Note for Fatigue Risk Management*

*TP 14572 – Fatigue Risk Management System for the Canadian Aviation Industry – An Introduction to Managing Fatigue* ([www.tc.gc.ca/eng/civilaviation/publications/tp14572-6038.htm](http://www.tc.gc.ca/eng/civilaviation/publications/tp14572-6038.htm))

Williamson, A., Lombardi, D.A., Folkard, S., Stutts, J., Courtney, T.K., Connor, J.L. 2011 The Link Between Fatigue and Safety, *Accident Analysis and Prevention*, 43, pp.498-515

WorkSafe Victoria 2006 *Queuing at Distribution Centres – Preventing Fatigue*

WorkSafe Victoria / WorkCover NSW 2008 *Fatigue Prevention in the Workplace*

[www.fadaysafe.com](http://www.fadaysafe.com)

[www.ntc.gov.au](http://www.ntc.gov.au)

[www.sleephealthfoundation.org.au](http://www.sleephealthfoundation.org.au)

[www.workcover.nsw.gov.au](http://www.workcover.nsw.gov.au)

[www.worksafe.vic.gov.au](http://www.worksafe.vic.gov.au)

[www.vicroads.vic.gov.au](http://www.vicroads.vic.gov.au)