

Fatigue Assessment: a scientific approach in the real world

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Fatigue Assessment in the workplace has traditionally been based on subjective self assessment as part of prescriptive control measures; however there is very little scientific evidence to suggest that people are able to make reliable judgements on their level of risk or safety and their ability to report fit for work. The Centre for Sleep Research led by Professor Drew Dawson has previously introduced the prior/sleep wake model that allows for a scientific measure of fatigue relative to the error trajectory of the task at hand. Whilst this model has been available for some time, it is only now through the Fatigue Calculator that it can be made easily assessable and usable by the workforce in operation as a hand held personal unit.

When implemented as a Broader Safety Management approach, the Fatigue Calculator provides for a scientific and legally defensible tool for self assessment. It allows for a prediction of fatigue throughout the entire shift and commute thereby providing an opportunity for preventative fatigue management.

FATIGUE IS EVERYONE' S BUSINESS

Combining alcohol and any high risk activity is now known to dramatically increase the likelihood of an incident or even fatality occurring. What about fatigue? Why is it that fatigue is EVERYONE'S BUSINESS?

The National Sleep Foundation of America conducted a Poll in 2008 regarding Sleep, Performance and the Workplace. The results of the Poll demonstrated:

- 32% of all respondents admitted to driving drowsy at least once per month during the past year
- 36% of those had nodded off or fallen asleep
- 2% of those who drove had an accident due to driving drowsy in the past year

What about Fatigue in the Workplace?

- 29% had fallen asleep or became very sleepy while at work
- Only 4% left work early, and 2% did not go to work because they were too sleepy
- YET 87% agreed that their current work schedule allowed them to get enough sleep
- BUT only 14% had missed a social event due to sleepiness.

Based on these figures it is reasonable to assume that 27 people out of 100 are operating in the workplace in a sleepy state, having possibly fallen asleep. Furthermore, it may also be surmised that a large percentage of those reporting to work in a sleepy state, were sleepy as a result of social activities, not due to the lack of sleep opportunity as a result of work activities.

As a result of these and many other factors involving peoples work and personal commitments, we have seen the following devastating effects in our region alone:

- During 2002 to 2008 29% of all fatal crashes within the Bowen Basin were a result of fatigue, 14.5% of fatal crashes in QLD were fatigue related
- During 2002 – 2006 60 road fatalities in the Bowen Basin were a result of fatigue.

YES! FATIGUE IS DEFINITELY EVERYONE'S BUSINESS

As Employer's and Managers and Supervisors in the mining industry, you all have legal responsibilities to manage fatigue in your workplace. You have a responsibility for providing your staff with a work schedule that does not require excessive wakefulness and provides the opportunity to obtain sufficient sleep. In determining this, the Employer should take into account normal non-work activities and responsibilities of the employee. This must be done from the view of what is reasonably expected.

- Is it reasonably expected that John Smith who has a family in Mackay will drive the 3 hours directly after work to get home to his family. YES IT IS!
- Is it reasonably expected that Steve White who is overweight and unfit, will have issues sleeping during the day in the CAMP accommodation facilities because of housekeeping and maintenance staff. YES IT IS!
- Is it reasonably expected that 21 year old Malcolm Well might go into Mackay and party on his weekend off and get very little sleep. YES IT IS!

This is a daunting task, both politically and operationally. How do you take into account the “non-work” activities of your employee? This paper will show you how you can legally, politically, and ethically achieve those results.

Your employees also have legal obligations and responsibilities to manage their personal activities and “non work” fatigue. Your employees are responsible for using their allocated time away from work to obtain sufficient sleep in order to report to work alert and maintain that alertness until they are in a safe environment (accommodation quarters, home, on the bus). If this has not been possible, the employee then has an obligation to notify their employer that they are not alert, and therefore **NOT FIT FOR WORK**.

It has already been mentioned that 86% of employees will not miss a social activity due to sleepiness. It can therefore accurately be assumed that there is a possibility that your employees aren't taking advantage of the opportunity to obtain enough sleep that you as employers are providing them. As managers you have a responsibility to ensure that all your employees, and the greater community are not harmed by an unsafe person in your employment.

The COMMUNITY as a whole also suffer from the side effects of Fatigue. When an individual drives on the road or engages in a high risk activity at work with a BAC of .05 or more, we as a community are all personally aware of the deadly effects it can have. It has now been shown through the work of the Centre for Sleep Research that:

“Depending on the task measured, 20 to 25 hours of wakefulness produces performance decrements equivalent to a BAC of 0.05 - 0.10%”

That is, high levels of fatigue produce performance decrements equivalent to or greater than levels of alcohol intoxication deemed unacceptable when driving, working and/or operating dangerous equipment. So, yes, it is also the Community’s business when someone is driving or working in a moderate, high or extreme fatigued state.

What effect does working in a high fatigue state have on our behaviour in the real world?

1. It controls our moods, and inhibits our behaviour.
2. It affects our abilities to show insights into our own performance
3. It creates an inability to remember event sequences?
4. It affects our ability to communicate effectively
5. It limits our ability to maintain interest in outcomes
6. We find it difficult to accurately assess risk
7. We find it difficult to think laterally and be innovative
8. Our abilities to keep track of events and update strategies is severely restricted

Now put this into perspective in your work environment, and think of the consequence of your employees’ inabilities to manage their behaviours in this way. Does this make you nervous?

PRESCRIPTIVE FATIGUE MANAGEMENT AND SELF ASSESSMENT

So how do we go about dealing with these issues? How do we ensure that our employees aren’t operating fatigued? Most employers have some form of Fatigue Risk Management System (FRMS). The rosters ensure you are providing your employees with a suitable opportunity for sleep, and you employ some form of prescriptive self assessment to ensure they are assessing, and thereby hopefully reporting their own personal fatigue levels if they become unsafe.

However prescriptive forms of self assessment do not rescind you as the Employer, the HSE Manager, the Production Manager or the Shift Supervisor from legal litigation if one of your employees is fatigued and an incident or fatality occurs as a direct result. WHY?

- Self assessment assigns no responsibility to an employee
- It assumes that compliance assures safety, which is not the case. This may lead to Complacency. “ We are compliant, we do not need to worry about”
- It does not address risk
- It does not provide risk mitigation when a compliant individual is fatigued
- It relies on subjective assessment of an internal psychological risk

In order to protect yourselves as Employers and Managers; and to protect your Employee's and the wider community from the legal, financial and health risks associated with fatigue in the workplace, we recommend you implement an effective FRMS as suggested by the Centre for Sleep Research (CfSR). An effective FRMS address's more than just your legal requirements, as "compliance does not assure safety".

Historically, most regulators have tried to manage fatigue by prescribing how many hours an individual is allowed to work. We have already shown that this alone is not an effective FRMS. In our view and that of the CfSR, good fatigue management is about regulating, measuring and managing the opportunity to obtain sufficient sleep rather than prescribing the hours that an individual works.

How do you implement a FRMS that "manages, measures and regulates" an employee's opportunity for sleep. How do you as employers ensure that your employees are using the opportunities you have provided them with to obtain sufficient sleep and still respect their personal rights and freedoms with respect to what they do with their personal time?

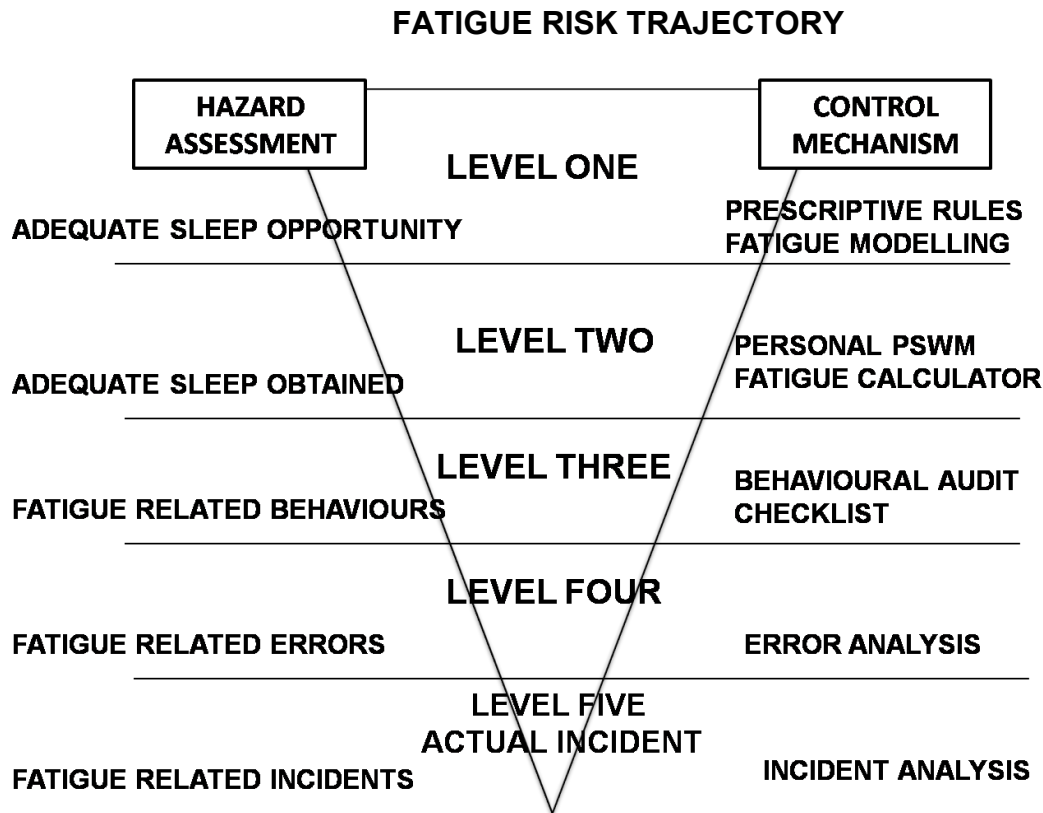
An effective FRMS should at a minimum:

- Be scientifically and legally defensible
- Discriminate between work and non-work related fatigue
- Be reported and auditable
- Address all reasonably foreseeable events
- Be appropriate to operator resource/risk profile

Professor Drew Dawson and the CfSR the University of South Australia have been answering that question for companies, and governments all over the world for many years. The solution they prescribe is to integrate the prior sleep/wake method (PSWM) into your FRMS.

The goals of the Prior Sleep Wake Method are to:

- Reduce fatigue-related accidents with acceptable impact on operational flexibility.
- Provide a scientifically and legally defensible framework with measurable outcomes
- Provide a risk-based framework
- Provide a rational migration path from 'award compliance' to an integrated Safety Management System (SMS) approach



The SMS methodology for fatigue risk management can be represented using Reason’s (1997)³⁸ hazard control framework. A fatigue-related accident or incident (FRI) is seen as only the final point of a longer causal chain of events or ‘error trajectory’. An examination of the error trajectory associated with a FRI will indicate that there are four levels of antecedent event common to any FRI. Thus, a FRI is always preceded by a fatigue-related error (FRE).

Each of the four steps in the general error trajectory for a FRI provides the opportunity to identify potential incidents and, more importantly the presence (or absence) of appropriate control mechanisms in the system. In order to minimise the effects of fatigue and manage both work and non work fatigue, an effective FRMS should encompass 5 Levels of protection against Fatigue. Each level presents an added layer of protection or a filter to minimise the occurrence of a FRI. The combination of all 5 Levels help ensure you are legally demonstrating all reasonable duty of care when managing fatigue in your workplace, by going beyond compliance towards SAFETY.

Effective management of fatigue-related risk requires a FRMS that implements task and organizationally appropriate control mechanisms for each point in the theoretical error trajectory. Where an organization fails to develop appropriate controls at each level of the hierarchy, it is unlikely that, overall, the system will be well-defended against fatigue-related incidents.

When implementing each level into a FRMS, integrate normal WHSO protocol. Conduct a risk assessment to determine if a risk or hazard with relation to fatigue exists? Implement appropriate control mechanisms to manage and minimise the hazard.

LEVEL ONE: Are you providing your employees with an adequate sleep opportunity? This level examines your rosters, your shifts, your breaks, your working hours and most importantly the breaks between shifts. There are a number of ways to control this hazard. Prescriptive rules, fatigue modelling such as FAID as developed by Professor Drew Dawson, are all effective means of ensuring your employees have adequate sleep opportunity.

However, the presence of adequate sleep opportunity is not a sufficient control mechanism to fatigue as a hazard on its own merits. You need to be able to ensure your employees are taking advantage of the sleep opportunity you are providing them, as can be REASONABLY EXPECTED.

LEVEL TWO: This is the level that this paper is focussed on, and the next evolutionary level in Fatigue Management within the workplace and the community as a whole. Is adequate sleep being obtained to ensure appropriate alertness for the specific task? What is adequate Sleep? How do we gather this data without violating our employees' privacy rights?

The PSWM provides the legal and scientific means of determining how much sleep is ADEQUATE sleep relevant to your specific industry, site, and individual job descriptions.

The new innovative product – The Fatigue Calculator - is the device that will enable you to collect this data and ensure your employees are obtaining adequate sleep and allow for appropriate control measures to manage inadequate sleep WITHOUT VIOLATING THEIR PRIVACY RIGHTS. You will not be asking them to report how much sleep they have had, or WHY they have not had adequate sleep. By providing them with a personal Fatigue Calculator you are equipping them with the tools to privately assess their sleep and notify their Fatigue Likelihood – rather than asking how much sleep they have personally had.

LEVEL THREE: At level 3 we need to ensure that employees who obtained what is considered, on average, sufficient sleep are not experiencing actual fatigue-related behaviors (e.g. due to sleep disorders, non-work demands or individual differences in sleep need). The use of symptom checklists or subjective fatigue scales is an example of control procedures at this level.

LEVEL FOUR: Similarly, we would need control procedures at level 4 to identify the occurrence of FRE that did not lead to a FRI.

LEVEL FIVE: Finally, an effective FRMS would require an incident analysis and investigation procedure to identify those occasions when all the control mechanisms failed to prevent an FRI.

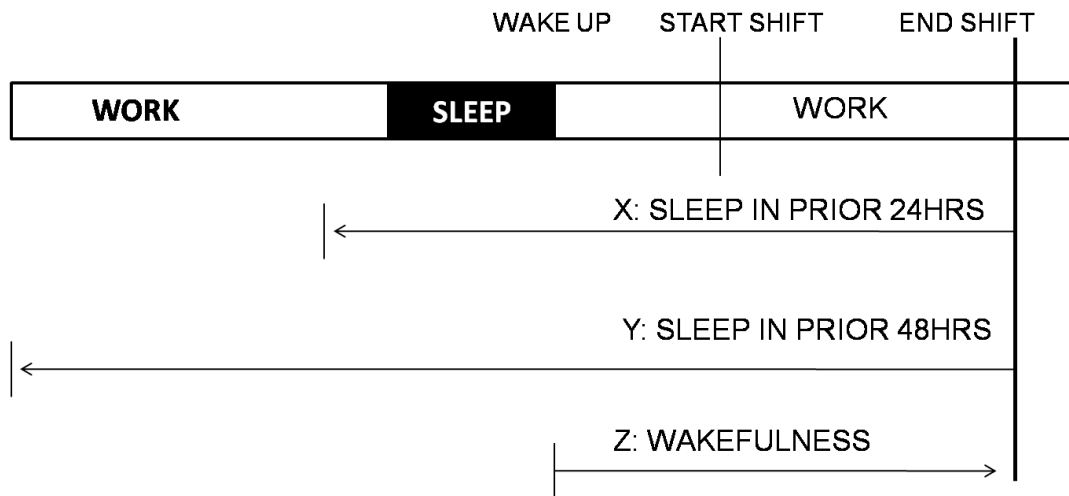
LEVEL TWO CONTROL MEASURE – PRIOR SLEEP WAKE METHOD

The PSWM as applies a complex algorithm to determine if an individual has obtained enough sleep for the expected period of wakefulness to maintain a suitably alert state for their specific task risk profile.

[sufficient sleep] Must obtain X hrs sleep in the 24hrs prior, and Y hrs sleep in the 48hr prior to commencing work

[excessive wake] 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

[hazard control] Non-compliance indicates that fatigue is likely to be a potential problem. In this situation the individual should calculate a fatigue likelihood score and notify their line manager and the organization should engage in an auditable fatigue risk reduction process



1. Add 2 points for each hour of sleep below the 24hr threshold
2. Add 1 point for each hour of sleep below the 48hr threshold
3. Add 1 point for each hour of wake beyond the 48hr threshold
4. Refer to organisational decision tree for predetermined response

FATIGUE LIKELIHOOD SCORE	COUNTERMEASURE
0 POINTS	No action required unless level 3+ factors reported
A – B Points	Document locally and work with local & self monitored countermeasures e.g. collegial checks, caffeine, self-managed breaks, task rotation, check routines
C – D Points	Document externally, Work with additional externally monitored CM's. e.g. Napping, external supervisory checks, task reassignment
G + Points	Document externally and immediately. Do not come to work/return home via assisted means

A critical aspect of the rules defined above is to create appropriate threshold values for the minimum sleep values for the prior 24 and 48 h to commencing work and the amount of wakefulness that would be considered acceptable. It is important to note that the thresholds could potentially vary as a function of fatigue-related risk within a workplace. For example, if a given task has either a greater susceptibility of fatigue-related error, or there are significantly greater consequences of a fatigue-related error, the threshold values may be adjusted to a more conservative level.

Within this framework, there are two main questions that should be asked. First, is the individual fit-for duty and acceptably rested to commence work? The second question is predicated on the answer to the first. That is, if an individual is acceptably alert to commence work, for what period of time can they be reasonably expected to work before fatigue subsequently creates an unacceptable level of risk?

Unlike subjective estimates of fatigue, prior sleep and wake are observable and potentially verifiable determinants of fatigue:

- Prior sleep and wake provide a way of integrating individual and organizational measures of fatigue (levels 1 and 2) since systems-based approaches can deal with probabilistic estimates of sleep and wakefulness, and individual employees can make clear determinations of individual amounts of actual prior sleep and wakefulness; and
- Prior sleep and wake measures can be set or modified according to the risk profile associated with specific tasks or workgroups.

LEVEL TWO CONTROL MECHANISM: The Fatigue Calculator

The Fatigue Calculator is a scientifically and legally defensible hand held unit that allows for personal self assessment of an individual's fatigue likelihood levels in almost any workplace environment.

Created in collaboration with the Centre for Sleep Research, the Fatigue Calculator applies the PSWM algorithm into a simple and easy to use device to enable any individual a tool to self assess their fatigue levels.

The Fatigue Calculator is the ***ONLY FATIGUE ASSESSMENT DEVICE*** in the world:

- That is based on the prior sleep wake method of Centre for Sleep Research and is therefore Scientifically and Legally Defensible; AND
- Is supported and endorsed by expert witness in coronial inquests relating to potential fatigue – Professor Drew Dawson; AND
- Is a LEVEL TWO CONTROL MECHANISM; AND
- Can forecast WHEN Fatigue will become a moderate, high or extreme likelihood event in an individual; AND

- Can positively impact organisational and family attitudes towards fatigue and sleep behaviours; AND
- Is inexpensive enough to implement with every employee providing a tool for assessment to ALL employees ALL of the time – not random assessment but consistent assessment; AND
- Can be integrated into any FRMS, any roster, any industry – we have yet to find an industry or task that the Fatigue Calculator cannot adapt to and assist in fatigue assessment; AND
- Meets the required rules of control mechanisms as an component of an effective FRMS:
 - Simple and practical to learn
 - Deals with specific individual on specific occasion
 - Developed consultatively
 - Provides an unambiguous risk based framework for decision making
 - Scientifically and legally defensible

PRESCRIPTIVE SELF ASSESSMENT	FATIGUE CALCULATOR ASSESSMENT
Assigns no responsibility to an employee	Assigns a shared responsibility between employer and employee
Assumes compliance assures safety	Goes beyond compliance to further ensure safety
Does not address Risk	Defines risk as a likelihood
Does not provide risk mitigation when a compliant individual is fatigued	Allows for implementation of risk mitigation
Relies on subjective assessment of an internal psychological risk	Is a scientific form of assessment

THE FATIGUE CALCULATOR

1. Based on prior sleep wake method – the Fatigue Calculator is supported and endorsed by the Centre for Sleep Research, which makes it legally and scientifically defensible
2. Portable, Easy to Use, accessible to all relevant personnel – the application of the PSW Method is now easy for all employees to use. They no longer are required to manually calculate their personal fatigue scores, but can use a simple calculator to do it for them.
3. Forecast when Fatigue likelihood will occur in a person’s shift. When done at the beginning of a shift, this allows for appropriate planning to both manage and mitigate the hazard whilst minimising the effect on production and operational activities.
4. Manages both work and non work fatigue – without personal obtrusion. When used in conjunction of an effective FRMS, and implemented with appropriate opportunity for sleep, it demonstrate all reasonable duty of care with regards to managing fatigue in your workplace.

5. Educates employees and the family unit on fatigue and sleep patterns. When taken home to work with the family unit, the Fatigue Calculator can assist in educating the family and changing culture. We are already seeing this happen in a number of cases.
6. Changes Organisational Culture. We are no longer relying on a prescriptive form of fatigue management, we are educating employees to manage their personal activities and manage their fatigue. Fatigue is being seen as a form of “FIT FOR WORK” by employees rather than a form of individual weakness.

The Fatigue Calculator is Available as:

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| • Portable hand-held unit : | available now |
| • iPick Kiosk : | available October 2009 |
| • Mobile application : | available October 2009 |
| • iTunes application for iPod and iPhone : | available January 2010 |
| • Web based application : | available October 2009 |

MB Solutions in partnership with Centre for Sleep Research and the University of South Australia

Providing the following services to the mining industry:

- Supply and implementation of the innovative Fatigue Calculator
 - ELearning training modules for the Fatigue Calculator
- Fatigue Management Training for Managers and Supervisors
- Fatigue Management Training for Operators and Employees

Please contact Natalie Tindale if you have any further queries regarding this paper/presentation or would like to discuss the above services.

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