

WAKE-UP TO DRIVER FATIGUE (DISTRACTION) MONITORING.....!

Enclosed Cabins- Fixed and Mobile Plant / Vehicles



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Operators, Regulators, Authorities-be it in relation to On-Road or Off-Road Vehicles- acknowledge the inherent risks of Driver Fatigue. Driver Fatigue (and Distraction) is implicated in approximately 60% of Mining accidents involving Haul Trucks and up to 30% of Road Crashes (On- Road Transport).

As a result, **live In- Cabin Fatigue (Distraction) Monitoring** is now more recognised by Industry as a critical component of their **Driver Fatigue Management** strategy for ensuring safer Drivers.

The NTARC / NTI Major Accident Investigation Report (2015) claims that between 2008 and 2013 that 15% of road **fatalities** were identified as being fatigue-related crashes, although the actual number could be much higher as it can be difficult to identify fatigue as a causal factor. Fatigue (and Distraction), when driving can affect anyone, whether operating a large Dump Truck on a Mine Site, Long Haul Truck or a Public vehicle.

According to the [Australian Automobile Association](#), 20% to 30% of severe single vehicle crashes in Australian areas involve the **driver being fatigued**.

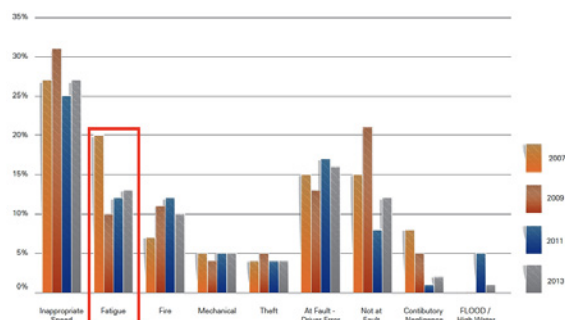


Figure 1: NTI 2015 Report- Accident Cause Investigation Finding

The [Centre for Accident Research & Road Safety - Queensland \(CARRS- Q\)](#) state causes of vehicular crashes from **Driver Fatigue** are as much as speeding and drink driving. However, Driver Sleepiness is particularly dangerous because it can happen to anyone, no matter how experienced a Driver they might be, a micro- sleep can occur and the Driver not even be aware of it. Micro- sleeps (sleep episodes) can be as brief as a few seconds.

In the USA, the [National Sleep Foundation's 2005 Sleep in America](#) poll, 60% of adult drivers say they have driven a vehicle while feeling drowsy in the past year, and more than one-third, (37%), have actually fallen asleep at the wheel! In fact, of those who have nodded off, 13% say they have done so at least once a month, 4% admit they have had an accident or near accident because they dosed off or were too tired to drive.

The Federal Government (2017) estimates road crashes cost the Australian economy \$27 billion / annum.

So, with the proliferation of statistical reports and studies from around the world there can be no misconceptions that **Driver Sleepiness (Fatigue) and Distraction** is one of the biggest killers on our roads (and off- road) that severely impacts workers, their families and the Australian economy.



What are the effects of Driver Fatigue?

At worst, drivers with sleep debt risk nodding off (micro-sleeps), yet fatigue can impair reaction time and decision making when behind the wheel, which increases the risk of being involved in an accident.

In general, Fatigue is extreme tiredness brought about by not enough rest over a period of time, whether from mental, physical exertion or illness and many other contributing factors. Ideally, each individual needs between seven and eight hours of good quality sleep each night. Those with less build up sleep debt, or sleep deficit.

If a driver falls asleep for just four seconds while travelling at a speed of 100 km/h, the car will have gone 111 metres without a driver in control.



Figure 2: At 4 Secs lack of Driver Attention / Alertness, at 100 km's / h= 111 metres travel distance

A study conducted by the **Adelaide Centre for Sleep Research** concluded that a person who has been awake for 17 hours faces the same risk of a crash as a person who has a BAC reading of 0.05 g/100ml. They are therefore twice as likely to have an accident as a person with a zero-blood alcohol content who is not fatigued.

Drivers who have been awake for 24 hours will have a driving performance similar to a person who has a BAC of 0.1 g/100ml. They are seven times more likely to have an accident.

The ultimate effects of Fatigue are **diminished concentration, longer decision making capability, reduced reaction times and micro-sleeps**.

Workers Fatigue vs Driver Fatigue?

As mentioned, there are many contributors to Fatigue including stress, long working hours, lack of (quality) sleep, medical condition (eg type II diabetes), monotonous tasking, activity type, environmental conditions, etc.

But there is a big difference between **Workers Fatigue** and **Driver Fatigue** and that of **High Risk** and **Low Risk** tasks and their associated level of risk.

A **low risk task** usually involves a task where there is little or no **kinetic energy** between a **human** and the **task** to hand. A fatigued worker (that is not operating equipment / vehicle), involved in a low risk task will most likely recognise that they are fatigued and so adjust their pace of work and take frequent rest periods to improve their concentration and to reduce potential errors.

Although accidents do occur, in general it is rare that one comes to serious harm (i.e. low risk tasks) being fatigued sitting in a chair in a maintenance office or working on isolated equipment- compared to driving or operating / controlling moving machinery (i.e. **high risk tasks**).

Contrarily, driving / operating moving machinery requires excellent judgment, quick decision making, concentration and complete awareness as an error usually creates a dangerous situation with serious outcomes as a result.

Also, Drivers / Operators have high productivity demands, meeting tight schedules, deadlines, etc which create situations where the Driver cannot take frequent rest periods / stops, interrupt their task, etc and so subjects them to additional risks compared to a general working (low risk) task.



Figure 3: Driver Fatigue- one of Australia's biggest killers

Driver (Operator) Fatigue- Enclosed Cabins.

Most Drivers of mobile plant / vehicles operate within Enclosed Cabins and so there are many additional Fatigue (and distraction) effects upon them that may not necessarily compromise a worker in an open environment / low risk tasks.

The importance of providing a **Quality Cabin Operating Environment** can not be over stated in any **Enclosed Cabin** of both Stationary / Fixed Plant (eg Crushers, Control Rooms, etc), Mobile Plant.

The Cabin is where the Driver / Operator spends most of their work time and it is this environment that will have the most significant effect (and ramifications) of Driver (Operator) Fatigue.

Cabin Thermal Conditions / HVAC Systems: Optimum thermal / humidity conditions inside a Cabin are essential to ensure reduced Driver Fatigue.

Many studies have been completed on the Driver Fatigue effects of a Cabin environment on Drivers with one such study "[Effects of moderate heat stress on driver vigilance in a moving vehicle \(2010\)](#)" depicting that the negative effect of heat stress on vigilance was statistically significant. In the test study at 27°C the overall proportion of missed signals (Driver response test) was 50% higher and response times were 22% longer than they were at 21°C.

Subsequently, the importance of ensuring that the vehicle HVAC is operating correctly can not be overlooked.

Enclosed Cabin Ventilation / Co2: Co2 concentration within a Cabin environment is one of the most significantly misunderstood and overlooked causes of Driver Fatigue.

Simply explained, one just asks the question *“when you are feeling doughy headed when driving what do you do?”*- “Oh.... I open the Window”. *“And why do you open the window?”*- the answer is always *“to let fresh air in”*- exactly.

You can also complete a simple test by turning the HVAC to Recirculation Mode, placing a \$300 Co2 Monitor on the passenger seat of your own Light Vehicle and within a few minutes the Co2 level in your car- with only a single occupant- can exceed many times the allowable levels (700- 1,000 ppm) and will continue to climb rapidly.

Cabins (both Fixed and Mobile Plant) are manufactured today to be even more sealed than ever before to enhance Cabin pressurisation (prevent entry of contamination), increase thermal efficiency, Operator comfort and lower noise levels.

And for the same reasons (entry of contamination / HVAC operation) above, Cabins no longer have windows that can be opened.

Consequently, Ventilation is diminished where air flow out of the Cabin (leakage)- needed to off-set Co2 due to Driver / Operators (s) natural respiration / depletion of oxygen- is no longer possible.

If the HVAC system is operated on 100% Recirculation Air and / or if the External Filter is blocked then again Co2 concentration will occur quickly (in minutes) which will cause sleepiness, loss of concentration / alertness, fatigue, micro-sleeps and eventual acidosis.

Many studies have been completed around the world on the effects of Co2 concentration in Operator Cabins of Fixed and Mobile Plant / Vehicles. As an example, a submission was provided by the [Australian Automotive Association to the Legislative House of Representatives Committee into Fatigue Management in Transport- 1999](#). The report (back 18 years ago) stated that “work completed by the Monash University Accident Research Centre (MUARC) on vehicle run off accidents may point to oxygen factor in otherwise unexplained accidents where they found that the HVAC was switched to **recirculation** in more than 33% of examined cases”.

Further reading about Fixed and Mobile Plant Environments can be viewed in our whitepaper [Breathing Easy-Enclosed Cabins of Mobile & Fixed Plant](#).

A Fatigue Pre- cursor / Sleeping Accommodation / Offices.

As a side- note, consider that inadequate quantity / quality of sleep will significantly contribute to Premature Fatigue. Consequently, it is worthwhile to also mention the effects of oxygen deprivation / Co2 concentration in Mine Site (or other) Sleeping Accommodation (and other Cabins- eg offices).

Modern Sleeping Accommodation design (like Mobile / Fixed Plant Cabins), has enhanced sealing for increased protection against noise, contamination and thermal efficiency and so they are now sealed **“tighter than a drum”**.

In addition, installed HVAC systems are designed to only provide 100% Recirculation Air- so basically when the Donga door is closed- there is no External “Fresh” Air supply at all to the Cabin and its occupant(s).

A study completed by Heike Neumeister-Kemp¹, Cedric Cheong¹, Kevin White¹, Peter Kemp¹ [“High carbon dioxide levels in “dongas” and hotel style accommodation- 2009”](#) is self-explanatory and clearly depicts Co2 in Sleeping Accommodation could be a pre-cursor for Fatigue, of any Worker utilising such accommodations- before they even start their work day.

Consideration should also be given to other facilities such as Maintenance Offices, Meeting Rooms, etc where there is no provision for adequate supply of external air and off- set of Co2. How many times have you dozed off in a meeting room or presentation with others- for no apparent reason?

Driver Fatigue (Distraction) Monitoring.

Another associated risk is Driver Distraction, with the primary cause being the use of mobile phones.

According to the **NSW Centre for Road Safety (2014)** the use of phones while driving has overtaken people not wearing seatbelts as one of the major causes of fatal car accidents, but the difficulty of collecting conclusive data about the role of distractions meant such accidents were under-reported.

Texting, surfing the internet or talking on the phone while driving is now one of the **top five causes** of fatalities on NSW roads, along with speeding, fatigue and drink driving, road safety.



Figure 4: Drivers using Mobile Phones now one of the top 5 causes of fatalities

Fatigue Monitoring- Technologies.

There have been many different technologies developed for monitoring Alertness and Fatigue. The predominant devices have been Smart Caps, Glasses and Driver Fatigue Cameras (DFM).

Some differences are:

- **Smart Caps / Glasses:** These are wearable type devices that usually also require a physical (cable) connection to a monitoring / data collection Hub. They require the user to “wear” the technology and cables / device can be damaged / disconnected or forgotten to be worn. Different sizing is required to fit the wearer and in the case of



glasses prescription types may need to be acquired for users. Caps require Fitment skills and adjustment. Driver ID needs to be provided by a separate device interface usually via the Vehicle Fleet Management System (if utilised)- swipe before ignition. These devices are not user discriminate- that is, can be worn by anyone. Also, such devices do not provide for Driver Distraction.

- **DFM Cameras:** These are remotely and permanently located inside the vehicle and usually mounted on the vehicle dashboard so as to clearly capture the face of the Driver. These devices use Infra- red frequencies and proven PERCLOS (percentage eye closure) algorithms developed in 1994 to monitor the eyelid blink rate / closure / movements of the Driver.

Additional proprietary algorithms are also used to “map” the face of the Driver to monitor such aspects as facial movements (eg yawning), head nodding, pupil dilation and distraction.



Figure 5: PERCLOS and Facial Mapping

DFM Camera technology has the following advantages over other types of devices:

- They are not wearable- the DFM is positioned remotely from the Driver, does not require interaction with the Driver and so will not be subjected to damage due to handling or be lost / misplaced.
- Are not dependant on the Driver (head size / need for prescription glasses)- nor require fitment skills.
- Can monitor for Driver Distraction- eg should the Driver move from view of the Camera an alert is sounded / recorded.
- Can identify the Driver by capturing / recording the camera view / Driver face on start- up- and continuously if required.
- If an event occurs the Drivers face is also recorded.
- Provided for full time image recording of the Driver and the inside of Cabin.

Driver Fatigue Monitoring Camera.

The use of a Driver Fatigue Monitoring Camera (DFM) has become the most popular device for monitoring Driver Fatigue and Distraction.

Some functions that should be considered when selecting for this technology are:

- **Fit- for- Purpose:** A simple and robust technology / device that will provide longevity and reliability in arduous operating environments.
- **Stand- alone System:** The DFM Camera should have the capability to relay data / images to telemetry / management system but also be used or operated independently as a stand- alone unit where In- cabin alerts (and recording) can be provided without telemetry.
- **Alerts / Warnings:** The DFM Camera should provide the Operator / Driver with clear audible and visual alerts for both Distraction and Fatigue.
- **Distraction / Fatigue:** In- built functionality to provide and distinguish between Distraction and Fatigue Events.
- **Image / Video Capture:** Can capture Still images and continuous Video streams for in- vehicle recording and / or telemetry transfer.
- **Operating Parameters:** Capable of setting Sensitivity and Speed related controls for various vehicle operations to enhance event capture and reduce false alarms. Eg Allow for extended head turning to check mirrors at low speeds without alerts.
- **Even Recording / Management:** Provide Telematics Fleet Management and a Web Based Portal for data collection / compliance management, analysis and reporting of all alerts / event.

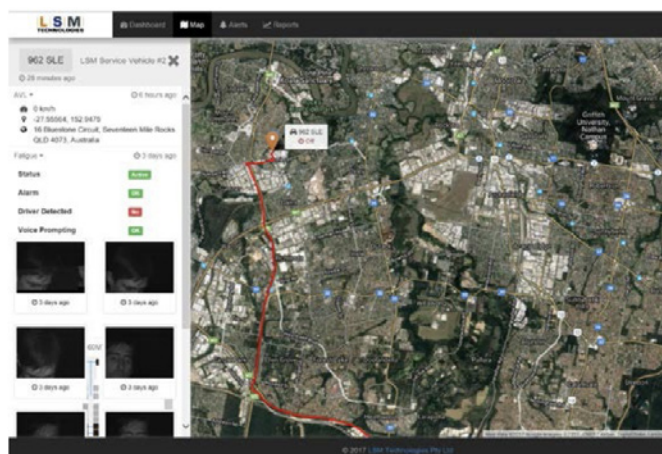


Figure 6: LSM Technologies- FSM™ Telemetry Web Based Monitoring event logging and records driver image snap shots- fatigue and / or distraction



LSM Technologies- Specialists

LSM Technologies primary focus is to be continuously proactive in offering decades of experience, expertise, research and OH&S mitigation control technologies / services.

Through working with Industry, OH&S Professionals, Legislators, Regulators and our clients we endeavour to surpass Australian / International Standards compliance and reduce our clients risk.

LSM Technologies as an industry champion committed to the on- going development, design and delivery of fit- for- purpose OH&S Technologies / Systems, to continually improving our client's objectives of enhanced Safety (Health), Equipment Damage Control and Productivity that best protects their Human and Equipment Assets. For further information please contact us or visit www.lsm.com.au

