



Fatigue knowledge—a new lever in safety management

by W.J. Theron* and G.M.J. van Heerden†

Synopsis

The purpose of the paper is to give an introduction to the concept of fatigue and its causes in the mining industry. By knowing the fundamental role it plays, together with its dynamics, can positively contribute to a mine's safety management system. The difference between physical and psychological fatigue will be addressed with a possible range of causes that could trigger fatigue. There are two main sources of fatigue: firstly, work-related fatigue which is associated with activities at the workplace; and secondly non-work-related fatigue. The shared responsibility between the employer and employee is also discussed as it involves factors that occur both in and outside the workplace. Employers have the responsibility to manage fatigue through using a risk management approach. Employees have the responsibility to ensure they get enough sleep, take sufficient and regular nutrition, are healthy and physically fit and come to work fresh and alert. The impact of the implementation of a fatigue management plan and procedures has the potential to eliminate employee fatigue or its causes, reduce the likelihood of fatigue occurring in the workplace, and counteract the effects of fatigue when it occurs. Factors considered when implementing a fatigue management system include: extended hours of work, shift work, time of day and work design.

Fatigue is one of the major role players (either causal or contributory) when it comes to causes of fatalities in the mining industry. Our main challenge in identifying whether fatigue played a role is the fact that it cannot be tested in post-mortems like drug or alcohol abuse. It is an aspect worth understanding and getting an organization sensitive to managing it properly to benefit both organizational as well as employee needs.

Keywords

Signs of fatigue: Causes of fatigue, circadian rhythms, the fatigue equation, fatigue management, fatigue affecting safety, fatigue fighting tips, lifestyle suggestions.

Introduction to fatigue

Fatigue is a feeling of weariness, tiredness, or lack of energy that does not go away when a person rests. People may feel fatigued—in body (physical fatigue) or mind (psychological fatigue). With physical fatigue, the muscles cannot do things as easily as they used to. With psychological fatigue, it may be difficult to concentrate for as long. In severe cases, a person might not feel like getting out of bed in the morning and doing his/her regular daily

activities. The question could be asked then what the causes are for being tired all the time. Most of the time, fatigue can be traced to one or more of a person's habits or routines. Fatigue can be a normal and important response to physical exertion, poor eating habits, emotional stress, boredom, or lack of sleep. In some cases, however, fatigue is a symptom of an underlying medical condition that requires medical treatment. When fatigue is not relieved by enough sleep, good nutrition, or a low-stress environment, it should be evaluated by a medical practitioner.²

Symptoms/signs of fatigue

According to Better Health Channel² fatigue can cause a vast range of other physical, mental and emotional symptoms including:

- Small errors, lapses and slips (dropping tools, picking up the wrong item, etc.)
- Chronic tiredness or sleepiness (not feeling refreshed after sleep—waking tired)
- Difficulty keeping your eyes open, head nodding and falling asleep at work
- Drowsy relaxed feeling (Yawning or visible drowsiness)
- Micro sleeps—falling asleep for less than a second to a few seconds, and being unaware that you have done so (usually due to sleep loss)
- Headache or dizziness
- Sore or aching muscles or alternatively muscle weakness
- Slowed reflexes and responses
- Impaired decision-making and judgement
- Moodiness, such as irritability

* Anglo Platinum, Mineral Resource Management.

† University of Pretoria, Department of Mining Engineering.

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- Impaired hand-to-eye coordination or blurry vision
- Appetite loss or reduced immune system function
- Short-term memory problems, poor concentration or hallucinations
- Reduced ability to pay attention to the situation at hand
- Low motivation.

A range of causes of fatigue

The Better Health Channel² also distinguishes between a wide range of causes that can trigger fatigue, including:

- *Medical causes*—unrelenting exhaustion may be a sign of an underlying illness, such as a thyroid disorder, heart disease or diabetes.
- *Lifestyle related causes*—feelings of fatigue often have an obvious cause, such as sleep deprivation, overwork or unhealthy habits.
- *Workplace related causes*—fatigue could be caused as a result of shift work, poor workplace conditions and work related stress.
- *Psychological causes*—fatigue is a common symptom of mental health problems, such as depression and grief, and may be accompanied by other signs and symptoms, including irritability and lack of motivation.

It is very important to remember that fatigue can also be caused by a number of factors working in combination.

Medical causes

Many diseases and disorders can trigger fatigue according to the Better Health Channel², including:

- Flu or glandular fever
- Anaemia or sleep disorders, such as sleep apnoea or restless leg syndrome
- CFS/ME (formerly known as chronic fatigue syndrome or myalgic encephalopathy)
- Hypothyroidism, hepatitis, tuberculosis or chronic pain
- Coeliac disease, Addison's disease, Parkinson's disease or heart problems
- HIV/Aids or cancer
- Certain medications.

Lifestyle related causes

Common lifestyle choices that can cause fatigue according to the Better Health Channel² include:

- *Lack of sleep*—typically a person needs between 7 and 8 hours of sleep each night. Some people try to get by on fewer hours of sleep (i.e. being awake for more than 17 hours).
- Sleep is the only effective long-term countermeasure to fatigue. Maintaining sufficient levels of sleep will prevent fatigue. The amount of sleep required by a person varies, with seven to eight hours of daily sleep considered the average for an adult. People who continually get less sleep than necessary for them will accumulate a sleep debt. For example, if a person who requires 8 hours of sleep has only 6 hours of sleep, then this person is deprived of two hours of sleep. If this occurs over four consecutive nights, the person will have accumulated an 8-hour sleep debt. Sleep debt leads to increased levels of fatigue.⁹

- *Too much sleep*—a person sleeping more than 11 hours per day can lead to excessive daytime sleepiness.
- *Alcohol and drugs*—alcohol is a depressant drug that slows the nervous system and disturbs normal sleep patterns. Other drugs, such as cigarettes and caffeine, stimulate the nervous system and can cause insomnia.
- Many workers rely on caffeinated drinks, such as coffee, to assist them to manage fatigue. However, these will contribute to sleep loss if used within 6 hours before sleep. This effect may be increased if combined with medications containing ingredients such as pseudoephedrine hydrochloride.⁹
- *Sleep disturbances*—disturbed sleep may occur for a number of reasons, for example, noisy neighbours, young children who wake in the night, a snoring partner, or an uncomfortable sleeping environment such as a stuffy bedroom.
- Sleep loss may also be caused by health conditions such as obstructive sleep apnoea which is a condition that occurs while sleeping, where the muscles of the throat relax and block the airway above the voice box. This causes breathing to stop until the brain registers a lack of breathing and sends a small wake-up call, which briefly wakes the sleeper before he drifts immediately back to sleep (usually the sleeper is not aware of having woken up). This process can repeat itself many times through the night, causing a person to feel fatigued during the day.⁹
- *Lack of regular exercise and sedentary behaviour*—physical activity is known to improve fitness, health and wellbeing, reduce stress, and boost energy levels. It also helps a person to sleep.
- *Poor diet*—low kilojoule diets, low carbohydrate diets or high energy foods that are nutritionally poor do not provide the body with enough fuel or nutrients to function at its best. Quick fix foods, such as chocolate bars or caffeinated drinks, offer only a temporary energy boost that quickly wears off and worsens fatigue.
- *Individual factors*—personal illness or injury, illnesses or injuries in the family, too many commitments (for example, working two jobs) or financial problems can cause fatigue.

Workplace related causes

Common workplace issues that can cause fatigue according to the Better Health Channel² include:

- *Shift work*—the human body is designed to sleep during the night. This pattern is set by a small part of the brain known as the circadian clock. A shift worker confuses his circadian clock by working when his body is programmed to be asleep.

Circadian rhythms, or the internal body clock, are the body's natural rhythms that are repeated approximately every 24 hours (Figure 1).

One's biological clock affects the daily rhythm of many physiological processes. Figure 1 depicts the circadian patterns typical of someone who rises early in morning, eats lunch around noon, and sleeps at night (10 pm). Although circadian rhythms tend to be synchronized with cycles of

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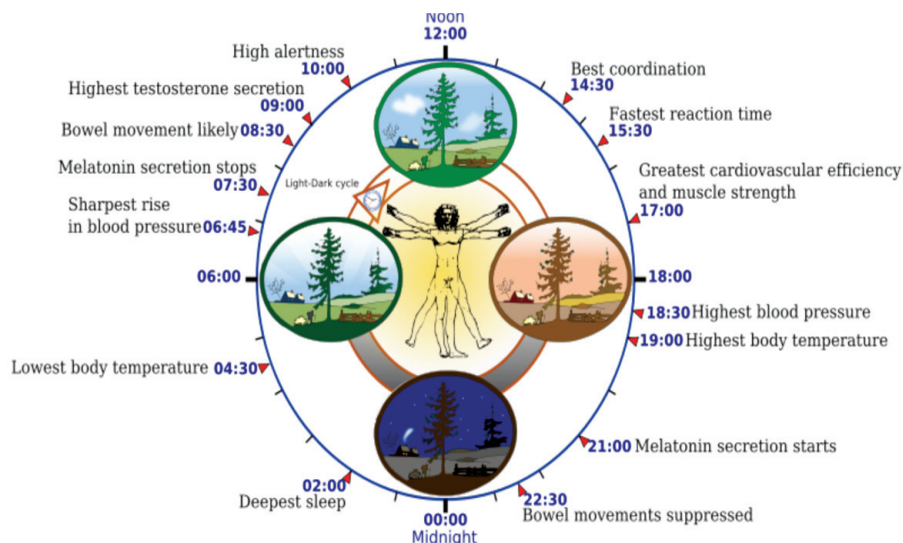


Figure 1—The biological circadian clock in humans

light and dark, other factors—such as ambient temperature, meal times, stress and exercise—can influence the timing as well.

Due to circadian rhythms, the human body is more awake during the day. The human body experiences a reduction in activity in the midnight to dawn period. This is a fundamental human characteristic and cannot be changed.

Work schedules that require people to be awake and active at night, or to work for extended periods of time, disrupt circadian rhythms. These disruptions affect the quality and quantity of sleep, affect task performance and may also contribute to a sense of personal dislocation and imbalance.

Incidents/accidents are more likely to occur at night, particularly during the period when the circadian cycle is at its lowest point (midnight to dawn) when a person would normally be sleeping.

Shift work and extended working hours can both affect on fatigue. Long hours and shift work patterns that disrupt the body's circadian rhythms often result in workers becoming fatigued.

Shift workers as a group tend to get significantly less sleep than those who work equivalent hours that do not intrude on the typical sleep period (11 pm–7 am). Sleep during the day is usually of poor quality due to circadian disruptions and environmental factors such as daylight, traffic and household noise.

If employers require people to work outside standard working hours, they are obliged to protect their health and safety from any adverse effects. The employer is also required to consult with workers when introducing changes to the workplace that could affect their health and safety, including changes to shifts.⁹

If a person does experience adverse health effects from shift work, he/she should speak to the supervisor, workplace health and safety representative or workplace health and safety officer about their concerns.

- *Poor workplace practices*—can add to a person's level of fatigue. These may include long work hours, hard

physical labour, irregular working hours (such as rotating shifts), stressful work environment (such as excessive noise or temperature extremes), boredom, working alone with little or no interaction with others, or fixed concentration on a repetitive task.

Extended working hours, particularly for shift workers, adversely affect the amount of time available for sleep and social activities. As work hours increase, the individual compensates by reducing the amount of time available for sleep and other activities. When a person work more than 48 hours a week, the increased competition between sleep and other activities results in sleep of a limited quality and length. The individual begins to accumulate a sleep debt, which causes fatigue levels to rise, and affects health and safety.⁹

- *Workplace stress*—can be caused by a wide range of factors including job dissatisfaction, heavy workload, conflicts with bosses or colleagues, bullying, constant change, or threats to job security.
- *Burnout*—can be described as striving too hard in one area of life while neglecting everything else. 'Workaholics', for example, put all their energies into their career, which puts their family life, social life and personal interests out of balance.
- *Unemployment*—financial pressures, feelings of failure or guilt, and the emotional exhaustion of prolonged job hunting can lead to stress, anxiety, depression and fatigue.

Psychological causes

According to the Better Health Channel² studies suggest that psychological factors are present in at least 50% of fatigue cases. These may include:

- *Depression*—this illness is characterized by severe and prolonged feelings of sadness, dejection and hopelessness. People who are depressed commonly experience chronic tiredness.
- *Anxiety and stress*—a person who is chronically anxious or stressed keeps his body in overdrive. The constant flooding of adrenaline exhausts the body, and fatigue sets in.

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- *Grief*—losing a loved one causes a wide range of emotions including shock, guilt, depression, despair and loneliness.

Difficulty of correct diagnosis

Since fatigue can present a vast range of symptoms and be caused by many different factors working in combination; diagnosis can be difficult. A medical practitioner may diagnose fatigue using a number of tests including²:

- *Medical history*—recent events such as childbirth, medication, surgery or bereavement may contribute to fatigue.
- *Physical examination*—to check for signs of illness or disease. The doctor may also ask detailed questions about diet, lifestyle and life events.
- *Medical tests*—such as blood tests, urine tests, X-rays and other investigations. The idea is to rule out any physical causes, for example anaemia, infection or hormonal problems.

Important factors to remember

- Fatigue can be caused by a number of factors working in combination, such as medical conditions, unhealthy lifestyle choices, workplace problems and stress.
- Fatigue is a known risk factor in motor vehicle and workplace accidents.
- Always refer to medical practitioners for diagnosis if suffering from chronic tiredness. They are qualified to deliver a reliable diagnosis.²

Fatigue affecting health

Fatigue can affect a person's health and increase the chances of having a workplace accident. Long-term effects of fatigue on health which are associated with shift work and chronic sleep loss may include: heart disease, diabetes, high blood pressure, gastrointestinal disorders and depression.

The factors that contribute to fatigue also disrupt an individual's circadian rhythms. Disruptions in circadian rhythms can also have a significant impact on the effectiveness of certain medications used for asthma and diabetes. The quality of our sleep is reduced as we get older. Lack of sleep can worsen depression and also affects people with epilepsy, increasing their risk of having a fit.⁴

The fatigue equation

According to Schutte⁸ total fatigue is the sum total of fatigue related to work-time arrangements, work and environmental factors, and personal factors as depicted in the equation below:

$$F_T = F_{SS} + F_{EW} + F_{PF}$$

where:

F_T = Total fatigue

F_{SS} = Fatigue caused by the shift system/duty rosters (working arrangements, circadian rhythm disruption, sleep deprivation)

F_{EW} = Fatigue caused by ergonomic, environmental and work factors (task requirements, physical work loads, workstation design, physical factors)

F_{PF} = Fatigue caused by personal factors such as insufficient/poor sleep, health status, nutrition status, personal lifestyle, social and domestic dictates.

This equation is not claimed to be a complete representation of all the factors that contribute to fatigue, but it points towards a need for a broad and holistic approach to manage this issue.

Fatigue management

The impact of the implementation of fatigue management procedures has the potential to eliminate employee fatigue or its causes, reduce the likelihood of fatigue occurring in the workplace, and counteract the effects of fatigue when it occurs. Factors considered when implementing a fatigue management system includes: extended hours of work, shift work, time of day and work design. Fatigue management is relevant to workers, employers, the self-employed and contractors.

'Being awake for 17 hours is equivalent to having a blood alcohol level of 0.05. Being awake for 20 hours is equivalent to having a blood alcohol level of 0.1.'⁶ Fatigue is one of the major role players when it comes to causes of fatalities in the mining industry. Our main challenge in identifying whether fatigue played a role is the fact that it cannot be tested in post-mortems like drug or alcohol abuse. It is an aspect worth understanding and getting an organization sensitive to managing it properly to benefit both organizational as well as employee needs.

Fatigue can significantly affect a person's capacity to function. The side effects of fatigue include decreasing performance and productivity, and increased potential for incidents/injuries to occur.

Fatigue management is a shared responsibility between the employer and employee as it involves factors that occur both in and outside the workplace. If a person is experiencing fatigue it is important to identify the factors that are contributing to the fatigue, discuss the issue with the employer, make changes as required (including sleeping patterns, workload, roster and lifestyle behaviours), and seek professional help if necessary⁷ (Table 1.)

The risk of fatigue is inherent in any work-time arrangement involving shift work, long hours of work, irregular hours, extended work hours and work that is physically or mentally demanding, repetitive or requires high vigilance. Fatigue can lead to incidents/injuries because it affects a number of key mental and physical abilities and can, for example, result in impaired concentration, poor judgement, reduced hand-eye coordination and slower reaction times. Industrial workers under thermal stress for extended periods become fatigued, physical fatigue has been identified as a causal factor in heat exhaustion and attributed to several physiological disturbances such as excessive cardiovascular strain and hyperthermia.

A number of accidents, which could be attributed to the loss of control due to the sleepiness of drivers, have been reported at mines where haul trucks are used. In view of the seriousness of these accidents, research was initiated to identifying the factors that affect driver alertness during mining operations. The objective is to develop a fatigue management programme that would address task- as well as

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Table 1
Responsibilities of employers and employees¹

	Employer	Employee
Educate	<ul style="list-style-type: none"> To ensure that employees are informed of the risks associated with fatigue and how to participate in controlling these risks. 	<ul style="list-style-type: none"> To be familiar with the risks associated with shift work Understand the importance of wellness and nutrition in reducing these risks.
Identify	<ul style="list-style-type: none"> To identify the risks associated with fatigue, including establishing and monitoring an ongoing system for identifying problems. 	<ul style="list-style-type: none"> To report problems with fatigue To recognize and report their own fatigue symptoms To contribute to establishing and monitoring reporting systems.
Assess	<ul style="list-style-type: none"> To assess the risks associated with fatigue To control the risks associated with fatigue, specifically Ensure that shift arrangements control the risk of fatigue Ensure that work arrangements do not contribute to fatigue problems or interfere unreasonably with employees, capacity to meet family and social commitments Provide training, information and supervision that support effective management of fatigue. 	<ul style="list-style-type: none"> To contribute to the assessment of risks To cooperate with control measures To contribute to the design and implementation of control measures To manage individual factors which affect fatigue, e.g. ensuring adequate rest between shifts Ensure that health factors are reported and thus do not inhibit the ability to work safely. This includes: <ul style="list-style-type: none"> Medication (chronic or other) Medical procedures that would affect fitness for work Immediate reporting of pregnancy/the need to breastfeed.
Control	<ul style="list-style-type: none"> Ensure that work systems are flexible enough to deal with factors influencing fatigue, e.g. allowing supervisors to reschedule tasks if fatigue becomes a problem Provide conditions that are conducive to sleep and where site accommodation is provided, supply a balanced diet Establish systems for thorough and regularly mandated medical examinations Implement systems to assess fitness for work prior to the shift as well as during the shift. 	

worker-related factors associated with worker fatigue. The impact of this implementation of fatigue management procedures in the mining industry has the potential to eliminate employee fatigue or its causes, reduce the likelihood of fatigue occurring in the workplace, and counteract the effects of fatigue when it occurs.

According to Schutte⁸ there is no 'one-size-fits-all' fatigue management programme available. Any fatigue management programme should address the unique needs of the operation in which it is to be implemented. It should be integrated into the normal operations, and it should encourage active participation from all stakeholders. It is, therefore, necessary to develop a culture in the organization in which everyone accepts that fatigue is a barrier to excellence in safe production and wellness, and that everybody needs to work together to overcome this barrier. The effective management of fatigue depends on the management of the organization's culture and on the promotion of self-management rather than on technological solutions. In view of the above it is important that a comprehensive approach be taken to address the issue of fatigue at mine sites.

In general, the goal of a fatigue management plan is to maintain and, where possible, enhance safety, performance and productivity in the operational setting, and manage the risk of fatigue in the workplace.

The recommended process of developing and maintaining a successful fatigue management plan consists of five interrelated elements:

- Securing and maintaining senior management commitment
- Developing policy and programme
- Managing fatigue

- Communicating the policy and fatigue management plan
- Monitoring, reviewing and modifying.

In order to make the fatigue management programme as practical and comprehensive as possible, emphasis needs to be placed on³:

- Structure and design of work-time arrangements (optimal design of shift system and rostering⁸)
- Ergonomics design of workplaces and tasks (ergonomics intervention taking abilities and limitations of workers into account⁸)
- Employee fitness for work
- Management processes for monitoring and controlling a worker's potential for fatigue
- Fatigue-related education and information (sleep management, education and training, lifestyle interventions, health screening and counselling⁸)
- Employee assistance programmes (nutrition⁸).

Fatigue affecting safety

Fatigue leads to poor judgement, poor performance on skilled tasks and slower reaction times. Fatigue stops a person from appreciating how serious a situation has become. It is harder to undertake complex tasks when fatigued.

Poor decision-making as a result of fatigue leads to incidents/injuries. Research has shown that the risk of work-related incidents/injuries and illnesses is increased in people working more than 60 hours a week, or working 12 hours or more in a day. Compared with an 8-hour shift, incidents/injuries rates are doubled after 12 hours at work. A 17% increase in incidents/injuries rates occur after the fourth day

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shift. There are also 30% more incidents/injuries on the fourth night shift compared with the first, unless other measures such as frequent rest breaks, are put in place.⁶

During the study the impact of fatigue in the workplace was investigated. This does not only include the impact on production targets but, very importantly, the impact on safety. With the end goal of zero harm in mind, the objective was to determine if there is a relationship between fatigue and current incidents and accidents experienced on mines. The important question that needs to be answered is: How many times have we actually explored in our investigations the aspects of fatigue? We refer to a lack of concentration or not identifying the hazards or poor judgement in some cases as the basic cause. Thus, by knowing the fundamentals of fatigue an additional lever can be pulled towards improving safety.

Safety consequences of fatigue

The safety consequences of fatigue include⁶:

- Decreased alertness and slowed reaction time
- Poor hand-eye coordination and higher error rates
- Poor communication
- Reduced vigilance and decision-making ability
- Poor judgement of performance, especially when assessing risks
- Being easily distracted during complex tasks
- Difficulty responding to emergencies
- Loss of awareness of critical situations
- Inability to remember the sequence of events.

Fatigue—the safety discussion

According to Mining Man⁵, worker fatigue is a topic not usually dealt with during on-the-job safety behaviour observations. It is a difficult thing to observe, and the very fact that someone is being ‘observed’ can tend to ‘wake’ him up and mask any behavioural signs of fatigue. Although we may not be able to observe any signs of fatigue, the causes and consequences of fatigue are certainly something that we should be discussing with our teams one-on-one, and the best time to do that is during a safety observation process.

Even if we do not observe any of these behavioural signs, we can still discuss fatigue as part of our observation. There are some convenient times and situations which can act as prompts to discussing fatigue:

- Last shift of the week/tour
- When people may be about to drive long distances at the end of the shift
- During any night shift or a shift where the person had a particularly early start
- At the end of a very long shift
- On jobs with repetitive work
- Working in hot and humid conditions
- Following an incident where fatigue was thought or known to be involved.

The key to a good safe behaviour observation is the discussion which you have with the person you have just observed. It is this discussion that really engages you both on the safety topic, and helps to embed thinking about managing hazards and preventing injuries.

Depending on the relationship between yourself and the person you are observing, it may or may not be appropriate to directly discuss whether he appears fatigued or not and what the causes might be. It is better to approach the topic in a more general way, something like this:

‘Hi, I’m doing my weekly safety observation and I noticed it’s quite warm here and there’s still quite a bit more material left to move. Given that’s it the middle of our first night shift, how are you feeling? What do you think some indicators might be if you start to get tired or fatigued and need a break?’ or

‘Hi. Following up from the near miss we had with that vehicle incident in the middle of the night last week, we are doing our safety observations this week on fatigue and how to manage it. What do you think are some of the things that can cause people to be fatigued at work?’

The discussion which follows on from these introductory questions should cover the person’s knowledge of:

- Factors which can cause fatigue
- Symptoms/Signs of fatigue
- Dangers of working or driving while fatigued.

The discussion can also cover what controls a person or work team are putting in place to manage fatigue, but in general the hazards of fatigue are best managed by prevention rather than managing it once it has set in. Some controls that are possible if a person is feeling fatigued include rest, changing jobs, working in cooler areas, avoiding working alone, and avoiding any high risk jobs or driving.

The responsibility of managing fatigue

Fatigue management is a shared responsibility and should be managed by both individuals and management at the workplace (Table II).

Work-related fatigue needs to be managed by employers or those in control of a workplace or business undertaking. This can be done using a risk management approach. (Table III).

Non-work-related fatigue factors are best managed by individuals.

As an employer we have a social responsibility that towards our communities and how we share knowledge. Should fatigue management and our sensitivity to the role of managing it properly not form a greater part of our responsibility to the extent where it can manifest itself as a positive tool on so many levels including safety?

Employees have the responsibility to ensure they get enough sleep, take sufficient and regular nutrition, health and physical fitness and come to work fresh and alert. But we need to give a way of enabling them to do just that: i.e.

Table II

Two main source of fatigue⁶

Work-related fatigue	Non-work-related fatigue
Extended hours of work Shiftwork Inadequate time between shifts for sleep Time of day Work design Second jobs	Commuting times Family and social obligations Community activities Emotional issues Age Health and fitness level

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Table III
Risk factors and control measures—employer⁶

Factors to consider	Control measures
Extended hours of work	<ul style="list-style-type: none"> • Ensure sufficient cover for workers who are on annual or sick leave. If overtime is necessary, plan for it so workers can schedule their activities around it. Note that exposure standards are based on 8-hour days—seek expert advice on noise and chemicals in the workplace if you have longer shifts.
<ul style="list-style-type: none"> • Work shift that is 8 hours long 	<ul style="list-style-type: none"> • Limit overtime to 4 hours
<ul style="list-style-type: none"> • Work shift that is 10 hours long 	<ul style="list-style-type: none"> • Limit overtime to 2 hours
<ul style="list-style-type: none"> • Work shift that is 12 hours long 	<ul style="list-style-type: none"> • Do not allow overtime
<ul style="list-style-type: none"> • Working a second job 	<ul style="list-style-type: none"> • Have a policy on second jobs—ensure that the worker understands the obligation to get sufficient sleep
Shiftwork	<ul style="list-style-type: none"> • Ensure the roster provides for a continuous 7 to 8 hours sleep in each 24 hours, and at least 50 hours sleep for every seven days • If on a rotating three shift roster system, forward rotation (day, afternoon to night shifts) is tolerated better
<ul style="list-style-type: none"> • Poorer sleep during the day for night shift workers, leading to an acute sleep debt on the first few nights • Cumulative sleep debt (e.g. less than 7 to 8 hours of sleep between each work shift over several shifts) • People who have had less than 5 hours sleep have an increased risk of a car accident when driving 	<ul style="list-style-type: none"> • Limit number of consecutive night shifts to four • End night shifts by 8 am • Ensure there is a minimum of 12 hours between consecutive shifts • Ensure that roster allows for at least 2 full nights sleep after the last night shift
<ul style="list-style-type: none"> • Accident risk increases by 30% by the fourth night shift • Accident risk increases by 27.5% on 12 hour shifts, compared with 8 hours on duty 	<ul style="list-style-type: none"> • Consider whether 12 hour night shifts are really necessary • Use additional control measures, such as two hourly breaks of at least 10 minutes duration • Have a room for workers to sleep before commuting home
Time of day	Minimize early morning starts before 6 am
<ul style="list-style-type: none"> • Early start times before 6am give workers less time to get adequate sleep as it is very difficult to go to sleep during the early evening (6–9 pm), as our internal body clocks are set for alertness 	<ul style="list-style-type: none"> • Avoid more than 5 consecutive early morning starts • Encourage car pooling or provide transport
Work design	Minimize safety critical tasks at circadian low points.
<ul style="list-style-type: none"> • Low alertness on night shift at 3–5 am, with increased accident risk 	<ul style="list-style-type: none"> • Avoid safety critical tasks during the early hours of the morning, have greater supervision, have regular breaks

Table IV
Risk factors and control measures—employees⁶

Factors to consider	Control measures
Recovering or preparing for work	<ul style="list-style-type: none"> • Have an afternoon nap before the first night shift
Personal factors affecting sleep	<ul style="list-style-type: none"> • Drink alcohol in moderation as it can disturb your sleep • Avoid caffeine after midnight when on night shift
Medical conditions affecting sleep, such as sleep apnoea	<ul style="list-style-type: none"> • Seek medical advice
Poor sleep environment	<ul style="list-style-type: none"> • Install heavy curtains that keep the light out • Reduce the volume of the telephone and the television—keep them in another room, not the bedroom • Insulate your house and/or have air-conditioning on to drown out background noise • Let neighbours and friends know if you are a shift worker and when you need to sleep so they do not mow lawns or visit at these times
<ul style="list-style-type: none"> • Poor sleep hygiene – watching television in bed, drinking coffee or alcohol or eating a heavy meal before going to bed • Poorer sleep quality, more fragmented and less deep restorative sleep in people over 45 years of age 	<ul style="list-style-type: none"> • Get into a routine for going to sleep (e.g. take a warm shower or relaxing bath before going to bed, listen to soothing music) • Avoid heavy meals, alcohol and tea or coffee before going to bed • Consider moving out of shift work if you find you are more a 'morning' person and cannot get enough sleep when on night shifts
Hectic social life	<ul style="list-style-type: none"> • Plan your social activities and ensure you get sufficient sleep before starting work
Second jobs	<ul style="list-style-type: none"> • Follow your employers' procedures about disclosure • Ensure you get adequate sleep in relation to both jobs

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education on nutrition including education to their spouses, transport arrangements to and from work and the basics of a proper sleep pattern (Table IV).

Fatigue fighting tips

According to the Better Health Channel² chances are that a person knows what is causing fatigue. And with a few simple lifestyle changes, it is likely that the person has the power to put the vitality back in his/her life. Consider these different ways to boost energy levels.

Dietary suggestions

Have a good look at diet—it is very important if a person wants more energy in his/her daily life. Suggestions include:

- *Drink plenty of water*—a dehydrated body functions less efficiently.
- *Be careful with caffeine*—1 or 2 caffeinated drinks (like coffee, tea or cola) per day boosts energy and mental alertness. However, heavy caffeine users (more than 6 drinks per day) are prone to anxiety, irritability and reduced performance.
- *Eat breakfast*—food boosts your metabolism and gives the body energy to burn. The brain relies on glucose for fuel, so choose carbohydrate-rich breakfast foods such as cereals or wholegrain bread.
- *Do not skip meals*—going without food for too long allows blood sugar levels to dip. Try to eat regularly to maintain your energy levels throughout the day.
- *Do not crash diet*—low kilojoule diets, or diets that severely restrict carbohydrates, do not contain enough energy for your body's needs. The reduced food variety of the typical crash diet also deprives the body of nutrients such as vitamins, minerals and trace elements.
- *Eat a healthy diet*—increase the amount of fruit, vegetables, wholegrain foods, low fat dairy products and lean meats in your diet. Reduce the amount of high fat, high sugar and high salt foods.
- *Do not overeat*—large meals can drain energy. Instead of eating three big meals per day, try eating six mini-meals to spread your kilojoule intake more evenly. This will result in more constant blood sugar and insulin levels. The person will also find it easier to lose excess body fat if he eats this way.
- *Eat iron rich foods*—women, in particular, are prone to iron-deficiency (anaemia). Make sure the diet includes iron rich foods such as lean red meat.

If you eat food and drink before going to bed it can affect your sleep quality. The timing of meals and the quality of foods you eat can affect your sleep, and may lead to digestive complaints such as heartburn, constipation and indigestion.

The following tips can help you prevent digestive complaints and may help you sleep better⁷.

When to eat and drink

- Wherever possible, keep to daytime eating patterns.
- When working a night shift try having two meals at regular times and a light meal in the middle of the night shift.
- Consider having your largest daily meal during the day.

- Do not have a big meal or drink too much liquid before sleeping.
- Eat a meal before 1 am as the effects of digesting a meal can decrease alertness in the second part of the night shift. It is better to eat before becoming fatigued at night.

What to eat and drink

- Alcohol lowers the quality of sleep and overloads the bladder. It is recommended that you do not consume alcohol in the last few hours prior to sleeping.
- Avoid drinks which contain caffeine (such as tea, coffee or cola) in the last few hours prior to sleeping.
- Eat light, healthy food that is easy to digest.

Sleep suggestions

It is important that shift workers get as close to the average amount of required daily sleep as possible, which is around seven to eight hours of continuous sleep each day.

Human beings are day-orientated. We are designed to work during the day and sleep at night. Also, there is more light and usually more noise during the day than at night—so the quality of sleep is likely to be poorer during the day than at night. It is therefore a good idea to do some forward planning to ensure your sleeping conditions are as favourable as possible. A common cause of fatigue is not enough sleep, or poor quality sleep. Suggestions include:

- *Get enough sleep*—adults need about eight hours sleep per night. Make the necessary changes to ensure you get a better night's sleep.
- *Limit caffeine*—too much caffeine, particularly in the evening, can cause insomnia. Limit caffeinated drinks to five or less per day, and avoid these types of drinks after dinner.
- *Learn how to relax*—a common cause of insomnia is fretting about problems while lying in bed. Experiment with different relaxation techniques until you find one or two that work for you; for example, you could think of a restful scene, focus on your breathing, or silently repeat a mantra or phrase.
- *Avoid sleeping pills*—sleeping pills are not a long-term solution because they do not address the causes of insomnia.

The following are suggestions how to avoid unwanted disruptions while trying to sleep during the day⁷:

- Use blinds or curtains with backing to reduce the level of light in the bedroom during the day—using heavy curtains and sound insulation on doors and windows can also reduce noise levels.
- Cool conditions can help in getting to sleep and staying asleep.
- A person should inform relatives and friends of his/her work schedule and sleep times to avoid unwanted disruptions.
- Use an answering machine, or turn the phone down to help minimize disturbances.
- Develop ways of 'unwinding' after the afternoon or night shift, e.g. take a walk or watch some television.
- Take a shower or a relaxing bath before going to bed.
- Go through all the normal rituals of going to bed as you would before a normal sleeping night.
- Avoid having a television in the bedroom.

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- Do not get upset if you cannot sleep straight away. Reading the paper or listening to music may help, but remember that rest in itself is important.
- Be cautious with using sleeping tablets, which may appear useful in the short-term, but can actually be quite harmful to health in the long-term.

Lifestyle suggestions

Suggestions include:

- *Do not smoke*—cigarette smoke contains many harmful substances. There are many reasons why smokers typically have lower energy levels than non-smokers. For example, for the body to make energy it needs to combine glucose with oxygen, but the carbon monoxide in cigarette smoke reduces the amount of oxygen available in the blood.
- *Increase physical activity*—physical activity boosts energy levels, while a sedentary lifestyle is a known cause of fatigue. Physical activity has many good effects on the body and mind. —A good bout of exercise also helps you sleep better at night.
- *Limit the time you sit down*—reduce sedentary behaviours such as watching television and using computers.
- *Seek advice*—if you have not exercised in a long time, are obese, aged over 40 years or have a chronic medical condition, always seek your doctor's advice and encouragement about the small steps you can take toward a more active lifestyle.
- *Seek treatment for substance abuse*—excessive alcohol consumption or recreational drug use contributes to fatigue, and is unhealthy and potentially dangerous.
- *Workplace issues*—demanding jobs, conflicts at work and burnout are common causes of fatigue. Take steps to address your work problems. A good place to start is to talk with your human resources officer.

Psychological issues

Studies suggest that between 50 and 80% of fatigue cases are mainly due to psychological factors. Suggestions include:

- Assess your lifestyle—for example, are you putting yourself under unnecessary stress?
- Are there ongoing problems in your life that may be causing prolonged anxiety or depression? It may help to seek professional counselling to work out family, career or personal issues.
- *Relaxation training*—constant anxiety drains the body of energy and can lead to burnout. Strategies include learning relaxation techniques, such as meditation or yoga, to help 'switch off' the adrenaline and allow the body and mind to recover.
- Modern life is the urge to drive ourselves to bigger and better heights. A hectic lifestyle is exhausting. Try to carve out a few more hours in a week to simply relax and hang out. If it is impossible to find a few more hours, it may be time to rethink your priorities and commitments.
- Have more fun—being preoccupied with commitments and pressures do not allow enough time for fun. Laughter is one of the best energy boosters around.

Coping with the mid-afternoon energy slump

Most people feel drowsy after lunch. This mid-afternoon drop in energy levels is linked to the brain's circadian rhythm and is 'hard wired' into the human body. Prevention may be impossible, but there are ways to reduce the severity of the slump, including:

- Incorporate as many of the above fatigue fighting suggestions as possible into your lifestyle. A fit, healthy and well-rested body is less prone to severe drowsiness in the afternoon.
- Eat a combination of protein and carbohydrates for lunch, for example a tuna sandwich.
- Carbohydrates provide glucose for energy.
- More good reasons to eat protein for lunch—the amino acid tyrosine allows the brain to synthesise the neurotransmitters dopamine and norepinephrine, which help keep your mind attentive and alert.
- Get moving. A brisk walk or even 10 minutes of stretching at your desk improves blood flow and boosts energy.

Important factors to remember

- Always see a medical practitioner to make sure that the fatigue is not caused by an underlying medical problem.
- Activity and nutrition are an important part of putting more energy into a person's daily life.

Existing barriers in the context of the South African mining industry

It is important to note that fatigue is a function of when you are awake and when you are suppose to be sleeping. Considering the circadian rhythms (internal body clock), one has to consider what it means being a South African mineworker:

- Predominantly the employee could stay in an informal settlement, facing hot summers and cold winters, without the basic needs like running tap water (warm or cold), sanitation or electricity. The accommodation (mostly single or double room) is usually shared with various family members and children.
- The employee could probably be the only breadwinner in the family.
- The employee's nutrition would be based on the basic need to survive, with food prepared in the most primitive way. The luxury of multiple meals per day does not exist.
- The employee's day usually starts at 3 am to catch to the first public transport to work. There could be various transfer points between the various standard routes before actually getting to work.
- The employee would clock in at work at around 6 am, where the actual shift for the day would start.
- At the end of the shift, the employee will have to wait for available public transport to take him/her back home. The employee could arrive home at 5 pm. Thus a normal working day from going to work to arriving back at home could be 15 hours.
- If the employee is a female, she would probable still have to perform the household duties.

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- The question remains: what could we as employers do to ensure that employees work optimally, daily, safely under these circumstances?

Conclusions

- From the work of Boshoff⁴, any ethical employer has the desire to provide a safe working environment for all employees, in which risks are appropriately managed. To protect the health and safety of employees, combat fatigue, increase productivity and prevent accidents, injury or damage to employees and equipment, it is necessary to develop a management plan to ensure that risks associated with operator fatigue are mitigated appropriately.
- Boshoff⁴ expressed that fatigue management is an ongoing process that requires careful supervision. The involvement of management in the management of fatigue is crucial to its success. It must therefore be emphasized that employees and management must act in the spirit of the law (i.e. the Mine Health and Safety Act; Act 26 of 1996) and take responsibility for the safety of fellow employees and other persons not employed by the mine.
- As an employer we have a social responsibility towards our communities and how we share knowledge. Employees have the responsibility to ensure they get enough sleep, take sufficient and regular nutrition, health and physical fitness and come to work fresh and alert. But we need to give a way of enabling them to do just that: i.e. education on nutrition including education to their spouses, transport arrangements to and from work and the basics of a proper sleep pattern.
- Fatigue may affect a person's ability to work safely. It must be identified, assessed and controlled like other hazards in the workplace.
- Importantly, fatigue impairs a person's judgment of his/her own state of fatigue. This means the effective management of fatigue should not be the responsibility of the employee alone.
- Both employers and employees have a role to play in making sure any risks associated with fatigue are minimized.
- The risk of incidents/accidents also increases with the length of shift. The risk of incidents/accidents generated by two 12 hour shifts is equal to the risk of six 8 hour shifts.
- Controlling fatigue requires cooperation between employers and employees. Control strategies need to be implemented to reduce the risk of incidents/accidents as a result of fatigue.
- The risk of fatigue is reduced when work schedules provide for sufficient good quality sleep. The most beneficial sleep is a good night's sleep of at least six hours, taken in a single continuous period. The restorative effects are less if the sleep is split between day and night time.
- Night shift workers are six times more likely to have incidents/accidents than day shift workers. The risk of incidents/accidents increases with the number of nights worked, with a 45% increase by the fourth night and 90% by the seventh night.
- People who work at night have trouble adjusting their body clocks. No matter how much sleep a person has

beforehand, he/she will feel sleepy between 1 am and 6 am.

- Information should be provided on how best to cope with night shift work by changing and improving the environment for work and sleep both at work and at home.
- Employees coming off night shift should also have the opportunity to recover any sleep loss before returning to work. There should be at least 24 hours off between shift changes to prepare for the new day or night shift.
- A fatigue management plan is a written document that provides information on the organization's approach to fatigue management and the procedures that are to be followed. It should cover the following areas:
 - Employee's fitness for work; education in fatigue management; managing incidents; and establishing and maintaining appropriate workplace conditions.
- In some situations the fatigue management plan will be made up of a number of policies and procedures that are already in other corporate documents. For example, fitness for work policies and procedures may be in human resource management manuals and relevant information on training may be in general safety induction manuals. Some policies and procedures that are used for fatigue management, such as policies on alcohol and drugs in the workplace and hazard and incident reporting procedures, may apply to a wide range of circumstances within the one organization.
- Where relevant policies and procedures exist, which have been developed in consultation with employees and safety and health representatives, they could be used for the fatigue management plan. To comply with the requirement to have a fatigue management plan, it would not be necessary to create documents especially for this purpose. The plan could identify and reference existing policies and procedures. This would be acceptable as long as the full range of items included in the list above was readily available and all are directly relevant to fatigue management.

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