Part 2: Impact of the roster on occupational health and safety

Introduction

The occupational health and safety risk hazards associated with work schedules – foremost among them fatigue – are now accepted as posing potentially serious risks for workplace safety, work performance and human health. Moreover, there is growing recognition of the detrimental, sometimes profound, impact that poorly designed work schedules can have for social and personal relationships and family life.

This Review found that the current work schedules in the Tasmanian mining industry – particularly the extended and intensive schedules– are currently impacting adversely across a number of health and safety key indicators, and are laying the groundwork for a range of future problems. In order to understand and put into context these findings we present a regulatory and conceptual framework and then examine the findings from the Review.

Part 2 is structured as follows:

2.1 Regulatory and conceptual framework for understanding risks associated with working hours

2.1.1 The regulatory framework for managing work schedules

a) Duty of care

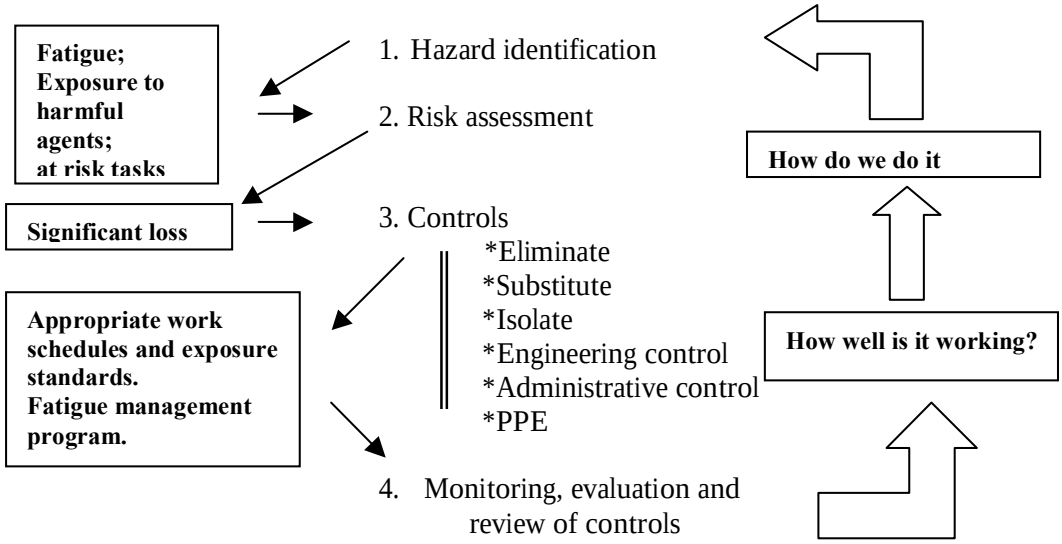
There is a general duty of care on employers to ensure that the work environment, equipment and work systems are safe. There is also an obligation on other workplace stakeholders to co-operate and comply with OHS management systems and regulation. Under performance-based legislation that now operates in all jurisdictions across Australia, there is a requirement that companies and organizations be able to *demonstrate* they are effectively managing hazards and the risks associated with them.

In other words, under self regulation, and in the absence of prescription, there is greater onus on companies to demonstrate that they are complying, rather than for the regulators to prove that they are not.

b) Risk management

The NSW Guidelines for Safe Mining, which most of the Tasmanian industry has now informally adopted[1], recommends that the most appropriate framework for doing this is the risk management approach that is now widely utilized across the mining industry. Moreover, there is a recognized risk management standard for undertaking risk management in mining (MDG 1010, DMR 1997). Outlined in guides such as these are a number of basic steps which are involved in this approach and are appropriate for the management of *most* workplace hazards, including fatigue. These basic steps are clearly set out in the DMR Guidelines which include hazard identification, risk assessment, development and implementation of controls and monitoring and review of controls. Diagram 2.1 provides an overview of this process

Diagram 1: Example of a risk management approach to work schedules



This is a continuous process of assessment, improvement and reassessment.

[1] The Tasmania Minerals Councils advised that the industry will be adopting the NSW Guidelines for Safe Mining with some minor modification sometime in 2002. At present it is recommended.

However, it is important to stress that it is not merely the process that is the desired outcome. Rather, the process is undertaken in order to identify the hazards and demonstrate the effectiveness of the controls.

- **Collaborative process**

Highlighted in all of the guides is the critical role of active consultation and informed participation of employees. Risk management, in order to be effective and successful, should be a collaborative exercise involving all of the workplace stakeholders who are involved in or affected by safety outcomes. While technical expertise and a sound understanding of the hazards and risks is vital, equally as vital is the involvement of workplace members who actually perform the work.

It is designed to be a flexible, yet systematic approach that requires sites to:

- Identify the particular hazards and the prioritise levels of risks that exist at their site
- Respond to hazards that may be generated by new or changed technology, changes in work practices or other work systems
- Respond to new information that may come to light about the increased or reduced risks of existing hazards
- Reassess the risks and appropriateness of the controls in light of new information and new developments about risk.

- **Duty of care approach implies more responsibility, not less**

This approach replaces the previous prescriptive OHS approach, but any notion that it implies a reduction of responsibility would be wrong.

By accepting, indeed advocating for greater freedom to manage hazards at a workplace level, industry has also accepted the greater responsibility that accompanies performance-based legislation. It cannot be too strongly stressed that this places a significant onus on companies to do more than assert that they are managing a particular hazard or assert that a particular hazard is not a risk at their workplace. They must be able to demonstrate that they have followed a demonstrable and auditable process by having an effective safety management system in place, and being able to provide evidence and records of hazard management. While the specific methods for doing so may vary depending on the particular hazard and the conditions and resources available at the site, the basic approach will remain the same.

The regulator's role is to require that management can demonstrate how they are managing hazards and risks effectively – especially core risks. The onus of proof is **not** on the regulators to show that hazards and risks exist. Rather the onus is on the company to demonstrate it has identified its hazards and is managing risks

Following the agreed industry approach, we should therefore be able to expect that sites in Tasmania be able to demonstrate that they have, in relation to the management of fatigue:

- Identified and understood the potential fatigue hazards that exist at their sites associated with their rosters
- Assessed their particular risks in a manner consistent with Australian Standards
- Put in place controls that are demonstrably effective.

It will be against these criteria that the Tasmanian sites will be assessed.

2.1.2 Current approaches to fatigue and shift work management in the mining industry

a) Risk management is accepted by the industry as the appropriate approach to managing rosters

Fatigue is now recognized as a potential hazard across the mining industry (WA DME, 1999, Qld DME, 2000). While numerical limits on working hours and rosters have not been specified, the association between work schedules and fatigue is now accepted, and risk management identified by the industry as the most appropriate approach to managing fatigue hazards (QMC, 2000, CCH, 2001).

Indeed, numerous employer associations have rejected a prescriptive approach that includes numerical regulatory limits. The QMC report specifically rejected any form of prescriptive regulation for working hours, advocating a risk management approach as the only appropriate response. In the recent AIRC Reasonable Hours Test Case, numerous employer submissions argued against the insertion of numerical limits on hours in the industrial relations legislation (AIRC transcripts 2001), arguing instead that risk management was the accepted and appropriate control by the industry itself. Indeed it was argued that excessive hours and extended shifts were health and safety issues, not industrial issues. Thus, setting aside arguments about the efficacy of the self-regulatory position, we can state unequivocally that at least for the last four years the mining industry in Australia has accepted the following:

- There is a relationship between work schedules and fatigue
- Fatigue is a hazard in the mining industry
- Risk management is currently the preferred approach advocated by both employers and some state governments.

b) Drivers for change

The risks associated with night work and shift work have long been recognised (e.g. Åkerstedt, Torsvall & Gillberg, 1989; Smith et al 1994, Nag et al 1998). However, what has changed is the realisation on the part of regulators to ensure that the associated hazards are being controlled.

Problems at a workplace level in mining have become so pressing, the evidence so overwhelming, response of the industry so patchy, that some regulators have decided that specific attention is warranted. The increased response to fatigue as a hazard in the mining industry has arisen as a result of a number of factors:

- Increased average working hours across the mining industry with the emergence of very long hours in some sectors, especially the metalliferous sector (ABS 1991 and 1996)

- Increase in compressed rosters involving 12 hour shifts with some states such as Queensland and Western Australia , where WA now has over 90% of its sites with some form of 12 hour shifts (Heiler, Pickersgill and Briggs, et al 2000)

- Emergence and spread of new extended and 'intensive rosters' (combining extended working days and extended weekly working hours), especially but not exclusively in isolated sites (QMC, 2000)

- Emergence of intensive schedules especially among some groups of employees (managerial and technical staff, casual and contact employees, labour hire employees)

- Acceptance of research evidence about fatigue as risk, and of fatigue being a cause of impaired performance (e.g. Dawson and Reid, 1997; Fletcher and Dawson, 2001)

- Increasing industry acceptance that a relationship exists between particular work schedules, especially 'intensive' ones, and increased risks of fatigue (e.g. QMC, 2000)

- Research evidence and industry experience of fatigue problems and incidents on the ground, especially in the open-cut mining industry

- Greater focus on fatigue as an accepted hazard by the inspectorate in jurisdictions such as NSW.

As a result of these factors, regulatory agencies in some jurisdictions accept that specific risks associated with fatigue and work schedules exist. There have been a range of initiatives.

c) Regulatory initiatives

Some of these initiatives are summarised below:

(i) Western Australia 1999

1999 Department of Minerals and Energy commence discussion on Guidelines on Fatigue Management for the Western Australian Mining Industry. Guidelines were released October 2000.

(ii) Queensland 2000, 2001:

Coal Mining Safety and Health Act (1999) Regulations Part 6 Division 1

- Prohibits persons working while under the influence of alcohol
- Safety and Health Management Systems (SHMS) for alcohol

- SHMS for personal fatigue, other physical and psychological impairment, and drugs.

The SHMS includes provision for:

- education
- employee assistance programs
- fatigue:
  - the maximum number of hours per shift,
  - the number and length of breaks during a shift and,
  - the maximum number of hours of work per work roster.
- drugs:
  - personnel on medication are required to notify the Site Senior Executive (SSE) if the medication could impair the individual's ability to work safely.
  - testing is not mandatory
- alcohol:
  - testing:
    - voluntary
    - random before work
    - on suspicion

Mining and Quarrying Safety and Health Act (1999) **Regulations Part 9**

- Prohibits persons under the influence of alcohol
- Limits to the consumption of alcohol on a mine site
- Fitness for work
  - No central scheme is required
  - Self assessment by worker for effects of heat strain and fatigue
  - SSE must ensure that each worker must be able to work at the mine safely
  - This assessment may include a medical and must be pre-employment, periodic, and on change of duties or capabilities
- Fatigue is required to be risk managed to ensure the worker does not work excessive hours and has sufficient breaks of adequate length.

(iii) New South Wales 2001

Mines Inspection Act 1901 **– General Rule 2000**

Part 3 Division 2 Fitness for work

31 Fitness for work procedure required

(1) The general manager of a mine must prepare a procedure that makes appropriate provision to deal with the fitness for work of persons working at the mine, including provision relating to persons at the mine who are affected by fatigue, alcohol or drugs.

The procedure must include:

c) strategies in regard to working arrangements to reduce the effect of fatigue of person working at the mine

(5) The general manger must:

a) communicate the procedure, or a summary of the procedure to the perspns working at the mine
b) regularly review the procedure through a process of consultation with those persons and
c) implement programs to give effect to the procedure

(iv) Tasmania 2001

Announcement of a review into the OHS impact of extended shifts in the mining industry

The fact that some State governments have elected to specifically highlight fatigue and work schedules in their legislation reflects the importance now given to these issues. At the same time, its absence in regulations or legislation in other jurisdictions – including Tasmania - does *not* imply that these States do not consider them to be serious hazards. Instead, the fact that they have been identified as specific hazards in other jurisdictions should have alerted the Tasmanian mining industry of their seriousness and indicated the need for an elevated response.

Before we assess the effectiveness of current fatigue assessment and control initiatives across the Tasmanian industry, we offer an approach for understanding the kinds of risks associated with extended shifts.

2.1.3 A framework for understanding risks associated with work schedules and fatigue

a) The causes of fatigue are multi-dimensional and multi-factorial

It is now accepted that long hours and poorly designed rosters are a major contributor to fatigue (Dawson et al 2001[2]; Parliamentary Inquiry into Fatigue, 2000).

While work hours and schedules are the major contributors, there are other causes that are derived from:

- work and non-work related sources
- individual and organisational sources

These sources can be multi-dimensional, multi-factorial and can have a compounding effect. There is not necessarily a linear relationship between the causes and effects of these hazards and the risks they generate; hazards can combine and converge to create new risks. For example, a singular set of hazards associated with one aspect of the roster (such as shift length which restricts daily recovery time) can combine with other factors, (such as driving at night), to increase overall risk. Similarly, an individual working a particular roster with a sleep disorder is at far more risk than an employee who obtains regular quality and quantity of sleep.

The **risk factors** associated with fatigue can be grouped in three broad clusters:

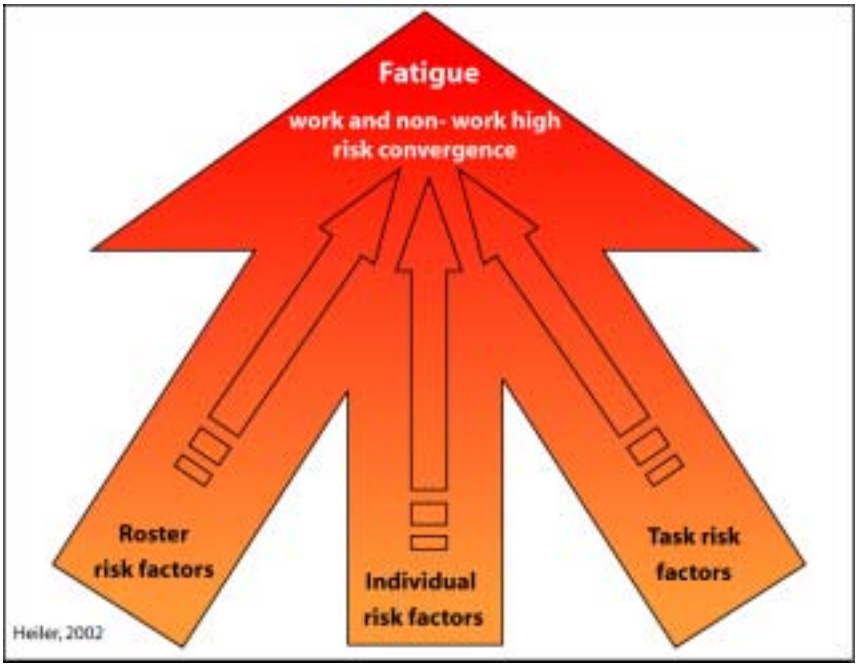
- Roster design and implementation
- Work tasks, work processes and workplace environment
- Individual health lifestyle and behavioural factors

These factors both alone *and* in combination can increase the risks of performance impairment and negative impacts on health, family and the psycho-social aspects of employees lives. While hazards associated with the design of the roster can constitute 'stand alone' risks, the risk must be also assessed in light of the nature of the task and other work process and environmental factors.

This way that these risks combine and converge is represented in diagram 2.1.3a and explained in more detail below.

[2] This report by Dawson et al 2001 was commissioned by the Queensland Department of Industrial Relations and represents one of the most up-to-date overviews of findings and literature about extended shifts and the effects of fatigue. The Review refers readers to this source for further information. The full report can be found at http://www.ir.qld.gov.au/publications/workinghours/report.pdf

Diagram 2.1.3a: Convergence of roster-related work and non-work risk factors for fatigue



b) Risk factors associated with the design of the work schedules

There are a range of factors associated with the design, structure and implementation of the roster. Alone or in combination, they may compromise quantity and quality of sleep, increase the risk of fatigue and lead to impaired performance. (See for example, Dawson et al 200; Fletcher and Dawson, 2001; Ahsberg et al 2000; Tucker et al 1999; Nag and Patel, 1998, Smiley 1998; Smith et al 1998; Kahleque, 1998, Akerstedt, 1995).

Dawson et al 2001 outlined the key risks associated with extended shifts:

- Reduced sleep
- Fatigue
- Impaired performance and productivity
- Increased accident risk
- Reduced safety
- Reduced social and family time
- Health and psychosocial consequences

(i) Roster risk factors

While there are arguments around the margins of the debate, there is also considerable agreement about the kinds of factors which are likely to increase risks associated with sleep impairment, leading to increased sleepiness and thus fatigue.

Essentially, the main risk factors associated with rosters are those that compromise the amount or quality of recovery time possible between shifts. These “roster risk factors” include and are not restricted to:

- Limited daily recovery time
- Limited cumulative recovery time
- Night work and early starts
- Inadequate recuperation time between blocks of shifts
- Being on call
- Excessive overtime
- Irregular or unpredictable working hours
- Appropriateness of rest breaks across the shift
- Commuting time and method from sites
- Proximity of residence or accommodation.

In particular, the convergence of the following factors can greatly increase risks of fatigue and impaired cognitive and physiological performance.

- **Time of day effect:**

We know that night work or work that commences in the early hours of the morning leads to profound circadian disruption and an deterioration in the quality and quantity of sleep (eg Smith et al, 1998). This is because awake at night, sleeping during the day, or regularly truncating sleep by waking prior to around 6.00am reduces both the quantity and quality of sleep. This also impacts on cognitive and physiological performance and there is evidence of increased accident risk during the peak circadian time 2am - 7am, and again in the afternoon between 1400 and 1600 (Smiley, 1998, Monk, 1987).

- **Shifts of long continuous duration**:

Concerns are raised about extended shifts (shift generally longer than 8 or 9 hours) because we know that performance appears to decline as work hours and task duration increase (eg Belenkey, et al 1998; Smith et al, 1998; Tucker, Barton and Folkard, 1996, Mitchell and Williamson, 2000

- **Pattern of work and rest across a roster cycle**

The history of work sequence, the rotation of the blocks of shifts, the number of consecutive shifts and the quality of the rest breaks between shifts all contribute to and may impact on an individual's daily and cumulative sleepiness and fatigue (eg Folkard and Akerstedt, 1987; Totterdell et al, 1995).

- **Adequacy of recovery periods between blocks of shifts**

The exact role of recovery days and the impact of inadequate recovery time across a roster cycle must be inferred from what we know about other aspects of the relationships between sleep/rest/performance (Fletcher, 2000; Totterdell et al, 1995). There will be individual differences involved with how long it takes to recover – especially where long sequences of shifts are worked – but we can infer that the cumulative effect of fatigue will be higher where recovery periods are reduced and when the rest period occurs after periods of likely sleep deprivation. This is the case especially after long stretches of day and particularly night shifts.

(ii) Special issues associated with 12 hour shifts

Twelve hour shifts are designed to be worked within a *compressed* work regime (i.e. where standard hours of around 38-42 per week are retained but worked over fewer days). The

logic behind the introduction of 12 hour shifts was that the additional recovery time required after working longer days or nights shifts is compensated for by working fewer shifts overall (Wallace, 1989).

The evidence of the impact of 12 hour shifts worked within an extended or intensive regime (as they are in Tasmania), especially over such a sustained period, is still developing. Research on the effects of 12 hours has predominantly been undertaken within a compressed shift regime because this is how they are typically worked. However, some inferences can be made from the knowledge researchers have gained about the impact of particular work/rest patterns, human recovery time and the impact of sleep deprivation on human performance. It is generally agreed that (Wallace, 2000; Tucker et al, 1996; Wedderburn, 1996; Rosa, 1995, Ong and Kogi, 1990) 12 hour shifts should only be introduced if:

- they are *not* extended by overtime
- that the number of consecutive night shifts is kept to ideally no more than two
- the nature of the work and the workload is suitable for extended working hours
- the shift system is well designed to minimise the accumulation of fatigue
- there are adequate arrangements for the cover of absences
- toxic exposure and exposure to other harmful agents is limited
- it is likely that complete recovery after work is possible for domestic or commuting reasons
- being on call is handled carefully.

c) Risk factors associated with the task, work processes and work environment

In addition to risk factors associated with the design of the rosters, we also noted that risks can increase depending on the nature and duration of the task and other workplace factors. The way that fatigue is known to impact on performance can give us a better idea of the kinds of tasks that are more 'fatigue susceptible' to impairment than others.

(i) Fatigue and performance

Research undertaken across a number of laboratory, workplace and industry settings suggests that fatigue can affect human performance in one or a number of the following ways:

- Hand-eye co-ordination, response times and accuracy, visual discrimination and tracking, similar to impairment caused by alcohol (Dawson and Reid, 1997)
- Vigilance(Frazier, 1968)
- Ability to sustain and maintain concentration (Hancock and Warm, 1989)
- Mental efficiency (Colquhoun, 1971)
- Logical reasoning (Gillooly et al 1990)
- Increased errors and evidence of increased accidents at these times of day (Gander et al, 1998)
- Failure to recognise the existence of a problem (Olsen and Ambrogetti, 1998)
- Reduced attention to subsidiary task requirement (Hockey et al, 1998)
- Shift to less demanding information processing (Hockey et al, 1998).

Dawson et al 2001, citing a comprehensive review undertaken by Harrison and Horne (2000) highlight the dimensions of workplace performance susceptible to the effects of fatigue including:

- Ability to comprehend complex situations without distraction
- Monitoring events and improving strategies
- Risk assessment and accurate prediction of consequences
- Thinking laterally and being innovative
- Controlling mood and behaviour
- Monitoring personal performance
- Recollection of timing and events
- Effective communication

(ii) Task and work environment risk factors

Research also suggests that there are particular tasks, and the way work is organised, that can lead to greater susceptibility to performance impairment:

- Task duration – the longer the task is performed continuously the more likely performance will deteriorate (Kahneman 1973; Desmond and Hayes, 1996)
- Sedentary tasks
- Repetitive, monotonous, boring, undifferentiated tasks (Gillberg and Akerstedt, 1998)
- Tasks requiring little discretion and judgment
- Task and jobs requiring a high level of vigilance and concentration (Hancock and Warm, 1989)
- Where employees feel complacent about safety or are unaware of the risks (Singh et al, 1993)
- Low control and high demand jobs
- Undifferentiated jobs interspersed with the need to respond to the 'unexpected' or 'out of the ordinary" event (Mitchell and Williamson, 2000)

(iii) Special 'high risk' tasks

These are tasks which are critical and where the consequences of impaired cognitive judgment or impaired physiological ability are high, or tasks/processes that have been identified as carrying a higher risk in themselves. These may include (but not be restricted to):

- Critical maintenance and electrical work
- Where critical judgment is required (such as assessing risks associated with a new or unplanned procedure that must be undertaken quickly)
- Work for which special permits or procedures are required (such as working alone; working at heights; working in confined spaces)
- There may be environmental factors that create stresses (for example hot, dark, poor visibility, cramped, confined) that can increase the effects of fatigue (dark, hot, poor visibility etc).

(iv) Exposure to harmful agents and work processes

Extended shifts can also increase the risk associated with exposure to a range of harmful agents, environments and work processes.

Exposure limits
Exposure limits may need to be reassessed and readjusted for longer shifts as most of them are based on 8 hour days. These include:

- Noise
- Dust and particulate (such as diesel)
- Vibration
- Heat
- Chemicals
- Repetitive work
- Physically arduous work.

Tasks and processes
In addition, there may be work processes and tasks where duration is of concern (such as driving) or physically arduous tasks where special attention needs to be given to reducing load or duration through strategies such as job rotation, mechanical lifting, additional breaks in work.

d) Lifestyle and individual health risk factors

There is a range of individual lifestyle and health factors that are known to be increased by shiftwork and in turn can increase risks associated with the rosters. These can interact with the design of the roster and nature of the task to increase the likelihood and consequences of negative outcomes (e.g. Costa 1996; Dawson et al 2001). These include factors such as:

- Increase in inappropriate coping strategies such as increased drug and alcohol use
- Lifestyle factors such as, weight gain, lack of exercise, poor nutrition
- Increased health problems such as cardiovascular problems and blood pressure
- Negative effects for pregnant women
- Gastrointestinal disorders
- Psychological disruption
- Circadian disruption (effects on eating and sleep).

In addition, lifestyle practices undertaken by employees may compromise the quality of recuperation time, such as

- Drug and alcohol use
- Non-work activities (sport, second jobs, leisure activities)
- Family commitments and pressures
- Any arrangements where access to adequate rest and diet is compromised
- Level of knowledge and understanding of risks.

e) Local factors
Finally, Reason (1997) has argued that when understanding casual trajectory of accidents and critical incidents, there are usually a range of 'local factors' that contribute to increased risk[3]. These local factors can include:

[3] See Reason (1997: 121) for an excellent discussion of the role of local conditions.

- poor workplace design
- clumsy or inappropriate automation
- inadequate tools and equipment
- unworkable procedures
- absence of effective supervision
- high workloads
- time pressures
- inadequate training and supervision
- poor job planning
- understaffing
- badly calibrated hazard perception
- inadequate personal protective equipment
- poor teamwork
- poor leadership

The above factors can all create the pre-conditions for unsafe acts and accidents. Fatigue acts to increase the probability that one or several of the above factors interact in the workplace to produce increased risk of injury and accident. The negative effect of fatigue on work performance, health and safety is the aggregate of its direct effects and its amplification of other 'local' factors.