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Research Director
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Natural Resources Committee
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Dear Committee

Submission from ASA and SHF to the Infrastructure, Planning and Natural Resources Committee into Fly-in, fly-out (FIFO) and other long distance commuting work practices in regional Queensland.

The following submission is presented by the **Australasian Sleep Association (ASA)** and the **Sleep Health Foundation** and was authored by the current and past Chairs of the Occupational Health, Safety and Productivity Special Interest Group of the ASA, Ian Dunican MSc, Prof Sally Ferguson and Dr Mark Howard.

The focus of this submission is on elements of FIFO, DIDO and other long distance commuting work practices which impact sleep and have downstream implications for health, safety and well-being of individuals and communities.

Yours sincerely

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To Infrastructure, Planning and Natural Resources Committee

Re Fly-in, fly-out (FIFO) and other long distance commuting work practices in regional Queensland

1 Introductory statement:

Operations that are either located a significant distance from major towns or cities and/or cannot be staffed by workers solely from the local area, often use long-distance commuting or fly in/fly-out work practices.

Given the cost in transporting workers to remote locations, operations routinely use long sequences of day and/or night shifts to limit the amount of travel required. Termed commutes or swings, each block of time on site varies between operations from as little as ten days to as much as thirteen weeks.

The rosters used during swings are characterized by 12-hour shifts, a rotation of days and nights, longer hours for supervisors, and depending on location, may involve early starts to day shifts.

Another characteristic of FIFO and DIDO working arrangements is pyjama days or the 24-hour period between the end of one block of shifts and the beginning of the next block.

The time away from site also varies, sometimes in proportion to the length of swings. Even-time rosters involve the same period of time on-site as off-site. Other rosters involve much shorter periods of time at home than at work. Generally, the time to travel to and from site occurs during the scheduled days off.

In relation to health, safety and well-being, both time at work and time away from work are important considerations.

FIFO is synonymous with shift work – rotating shifts, long hours and/or night work. Long hours and night shifts are associated with an elevated likelihood of fatigue and elevated risk of incident and accident [1-4]. In addition, there is an increasing body of evidence suggesting that shiftwork and long hours may be associated with adverse health outcomes [5-8].

While little research into health outcomes, or indeed safety outcomes, has been conducted in FIFO settings in Australia, work in other shiftworking settings is applicable as the impacts of shiftwork on sleep and the circadian system are universal.

1.1 Sleep

Sleep is an essential human function. Sleep provides recovery from the previous wake period and preparation for the next one. Inadequate sleep is associated with impaired performance on some tasks, negative mood, poorer health outcomes and increased risk of accident and injury [9, 10]. Both the quantity and quality of sleep are important for next day functioning.

1.2 The circadian system:

The human circadian system has evolved to drive activity during the daylight hours and sleep during the night hours. The innate functions of the body become desynchronized from the external environment in certain scenarios including shiftwork and international travel. Night work for example, requires individuals to work against the drive for sleep during the shift, and to fight the drive for wake during the day in order to get some sleep.

This means that various characteristics of shiftwork and FIFO/DIDO operations impact on sleep and the circadian system, and consequently health and well-being.

2 Work characteristics

The characteristics of work hours that impact on sleep either directly, or via disruptions to the circadian timing system are discussed briefly.

2.1 Long hours

Long hours of work reduce the time available for sleep. Twelve-hour shifts are used routinely in FIFO and other long-distance commuting operations. A number of research studies report that workers on 12-hour shifts obtain approximately six hours of sleep whether at home [11-13] or on-site [14-16]. Offshore workers on oilrigs in the north sea are reported to obtain up to seven hours [17-20]. Offshore workers do not have travel time from the work site to the accommodation block as is often required in FIFO operations.

There is also anecdotal information that supervisors, crew-leaders and team-leaders work extremely long hours. While rosters govern the start and end times of shifts for most personnel, supervisors and leaders are required to work extra hours to allow for handovers between shifts and to meet other operational goals. Each hour worked is one less hour available for sleep.

2.2 Night work

Night work is challenging for two key reasons: the first is that it requires workers to be alert and active when their biological clock is driving them to sleep, and it requires workers to sleep when their clock is driving them to be awake. The combination can mean impairments in alertness and performance during the shift and these impairments may be exacerbated by inadequate sleep in between shifts due to reduced sleep quality and quantity. Total sleep time has been reported to be less on night shift in some FIFO operations [14, 21] but not in others [15] and the specific roster schedule also plays a role [16]. Sleep needs to be protected on site (see section 5).

2.3 Early starts

Early start times on day shift can be problematic for sleep. The biological clock drives the body to be awake in the evening hours, indeed the peak of core body temperature is in the evening hours. It is therefore difficult to initiate sleep during these hours. Early start times require earlier wake times and the forbidden time for sleep in the evening hours [22] means we struggle to get to sleep early enough to compensate for the early start. Sleep is truncated and shorter than at later start times. This seems obvious but early starts truncate total sleep time in a disproportionate manner [11, 23]. If sleep is truncated then sleep debt can build across consecutive early starts.

2.4 FIFO and DID rosters

The characteristics described above are all present in FIFO and DIDO rosters but are these rosters any more of an issue for sleep than residential rosters with the same inherent characteristics? A recent review of sleep and sleeping location suggests that it is less about location or work operation and more about the roster [24]. Early starts, long hours, consecutive shifts and night work all challenge sleep and all impact on quality and quantity of sleep and recovery. The main difference between FIFO rosters and 'residential' rosters however, is the long blocks of consecutive shifts. FIFO and DIDO rosters can amplify sleep debt issues associated with long hours, night work and early starts to day shifts due to the number of days and/or nights worked consecutively. Sleep debt builds up over time and is as detrimental to waking performance as total sleep deprivation [25-27]. Thus, in addition to work hours, it is also important to consider rest breaks, or recovery opportunities.

2.5 Recommendation

Employers and employees are made aware of the accumulation of sleep debt across a block of shifts and strategies are put in place to protect both short- and long-term health and safety. Such strategies should include fatigue risk management systems, training and education programs to identify healthy choices, and infrastructure and support systems both on-site and off-site to facilitate rest and recovery.

3 Recovery opportunities:

3.1 Between shift:

As outlined above, the time between shifts is critical for sleep and sleep is critical for recovery and next day functioning. In remote operations that predominantly use 12-hour shifts, the actual break time is generally 10-11 hours due to the need to travel between the work site and the accommodation for each shift. In addition to sleep, the time between shifts is used for meals (dinner and breakfast), leisure (physical activity, socializing, contacting home/family) and personal activities (showering, laundry etc). As described above, actual sleep time averages approximately six hours.

3.2 Between blocks of shifts:

A challenge for remote work operations is to manage the recovery opportunities and maximize return on investment of transporting and accommodating personnel on site. This translates to short breaks between blocks of shifts during a commute. For example, between a block of day shifts and a block of night shifts, workers invariably have only 24 hours. Two things should happen in such a break – recovery from any accumulated sleep debt and preparation for the coming shifts.

Recovery from a period of sleep restriction is best facilitated by long sleeps. Research from the laboratory suggests that ad libitum sleeps, and often more than one, may be required for full recovery to normal levels of functioning [15, 28-30].

In preparation for a night shift, some workers choose to sleep during the day and this is a recommended strategy [31, 32].

The challenge however, is that a long recovery sleep and a prophylactic (anticipatory) nap do not fit well in a 24-hour break.

3.3 Between commutes:

In principle, time between commutes is time for recovery. Blocks of time away from site provide the rest, relaxation and family/social/domestic time that other workers get on weekends and between shifts (evenings for example). Time between commutes is also important for physical and mental recuperation. Recovery from periods of disrupted or restricted sleep, including consecutive sleeps of reduced quality or quantity, requires long sleeps [28, 33] making time away from site critical in recovery. We do not have data to inform our understanding of the role that time away from site plays in recovery more generally. We do know that workers sleep more at home than on site which suggests they are getting less than is needed, or ideal, on site [14, 15].

3.4 Recommendation

Breaks should be prioritised for rest and recovery to preserve health and safety. Sleep should be protected on site to facilitate recovery between shifts. Consideration could be given to breaks between blocks of shifts being longer than 24 hours. Support should be given to recovery away from site.

4 Protecting sleep on site

Sleep environments on remote sites or operations should address the following factors:

- Shift workers shall be accommodated in rooms which have at least the following:
- Signage notifying outside personnel of their rotating roster type and designated quiet zones for shift workers.
- Rooms with controlled temperature environment (air-conditioning and/or heating).
- Window tinting, curtains and or coverings. The window coverings must be capable of blocking out all light.
- Ensuite bathroom facilities within the sleeping environment (highly recommended for shift worker environments)

Maintenance activities in and around the camp facilities shall be scheduled to minimize the potential impact on employee sleep.

Employees should be able to communicate with their families while away from home.

Dry mess facilities (e.g., cafeterias) shall provide well-balanced meals and drinks, at times convenient for employee’s working day and night shifts.
Wet mess facilities (e.g., onsite bars) should operate reasonable hours to allow adequate sleep opportunity.

Table 1 Sleep environment rating

Sleep Environment Rating	Sleep Environment Conditions
Excellent	Home environment with bathroom, controlled environment e.g. temperature, heavy curtains/blackout, low noise/interruption
Good	FIFO/DIDO Camp, room 25m^2, ensuite, window light blackout, split A/C
Fair	FIFO/DIDO, <25m^2, no ensuite, box A/C
Poor	Exploration, no A/C, no ensuite

5 Health impacts – acute and chronic

There is little information in relation to FIFO/DIDO working practices and the impacts on health related to sleep and circadian disruption. However, shiftwork more generally is associated with negative health outcomes. Rajaratnam and colleagues reviewed the literature for a special issue of the Medical Journal of Australia in 2013 [5]. Sleep disorders are an obvious negative health outcome for shiftworkers and are covered in section 7. However, conditions including metabolic disorder, Type II Diabetes, some cancers, mental health disorders are also more prevalent in shiftworkers than dayworkers.

A paper published this year reports sleep and health issues as being stressors for FIFO workers, particularly obesity (a risk factor for metabolic disorder and Type II diabetes) [34].

5.1 Alcohol and other drugs

Alcohol and drugs are present within the mining and resource industry at varying levels. Over the past 20 years in Australia we observe more education and awareness amongst the mining community, coupled with a strong stance by companies on the abuse of such substances at work. In a review paper of health in mining, Donoghue states

"Drug and alcohol abuse has been a difficult issue to deal with in mining, but policies and procedures are now in place in most large mining operations. Debate continues about how to measure psychophysical impairment. Nevertheless, mining operations commonly require the measurement of urinary drug metabolites and breath or blood alcohol on pre-employment and following accidents." [35].

There have been many reports that FIFO mining projects are causing serious social problems. This is mainly due to a heavily dominated male workforce who is deemed to be causing social problems including alcohol, gambling and sexual assault. This may be a cause and effect argument in relation to sleep quality, quantity and the relationship with alcohol and drugs. This may lead to the emergence of bingeing on recreational drugs and or alcohol on ones scheduled time off. In particular FIFO and DIDO rosters that have longer scheduled periods of time off compared to residential workers may be at risk. Shift workers in other industries are more likely to be at risk through binge drinking behaviour [36]. Shift workers may also utilise alcohol as an aid to promote sleep onset completing a shift [37].

5.2 Recommendations

Understand the risk factors for adverse health outcomes and implement controls to manage the risks. In addition to strategies that manage work hours and protect sleep, infrastructure and support systems that facilitate healthy choices in regards diet and physical activity are also critical.

6 Commuting

Commuting to the workplace is an everyday occurrence. Commuting is defined as: "*The time it takes to depart ones residence until they reach their place of employment for that day/nights work".*

Commuting occurs in the following scenarios [38] and a combination of two or more may occur during a roster or work pattern period:

- **Fly In, Fly Out (FIFO),** in general occurs from capital cities or large regional towns.
- **Drive In, Drive Out (DIDO)**, in general occurs from capital cities or large regional towns.
- **Daily Fly In, Fly Out (FIFO)**, occurs in remote areas where residential and or temporary camps do not exist or availability of accommodation does not meet demand.
- **Daily commute** by bus /car from a permanent residence, permanent and or temporary camps.
- **Irregular commute** occurs when no set roster or work pattern exists. Roster and location changes to meet task demand

6.1 FIFO and DIDO commutes

On the first day of a roster or work pattern an individual will typically not achieve the recommended sleep duration of 7-9 hours [38] due to an early wake time. Wake time generally occurs at the low point in their circadian rhythm (03:00 -06:00) subsequently individuals experience sleep inertia (i.e. groggy, hung over and jet lag feeling). In conjunction with a reduction in sleep duration may come a reduction in certain sleep stages such as rapid eye movement (REM) sleep (dreaming sleep), which is required for alertness, psychological and physiological recovery. To counter this earlier sleep onset times are recommended. This can prove difficult due to the inhibition of sleep during the hours of 17:00 -21:00, known as the forbidden zone [22].

Driving to airports or bus pick up points during this period of circadian low is high risk [39]. The extended hours of wakefulness on the first day can be in excess of 17 hours. Performance at 17 hours awake is equivalent to a blood alcohol concentration (BAC) of 0.05 and at 24 hours awake equivalent to 0.1 BAC [40, 41]. Employees are therefore at increased risk of accident during these periods.

Similarly, the last day of a roster may also be associated with an extended period of wake. Employees may drive home from site drive or drive home after landing at an airport at an elevated level of fatigue-related risk. Not only are employees at increased risk of accident or injury themselves but they may also be placing other road users at increased risk.

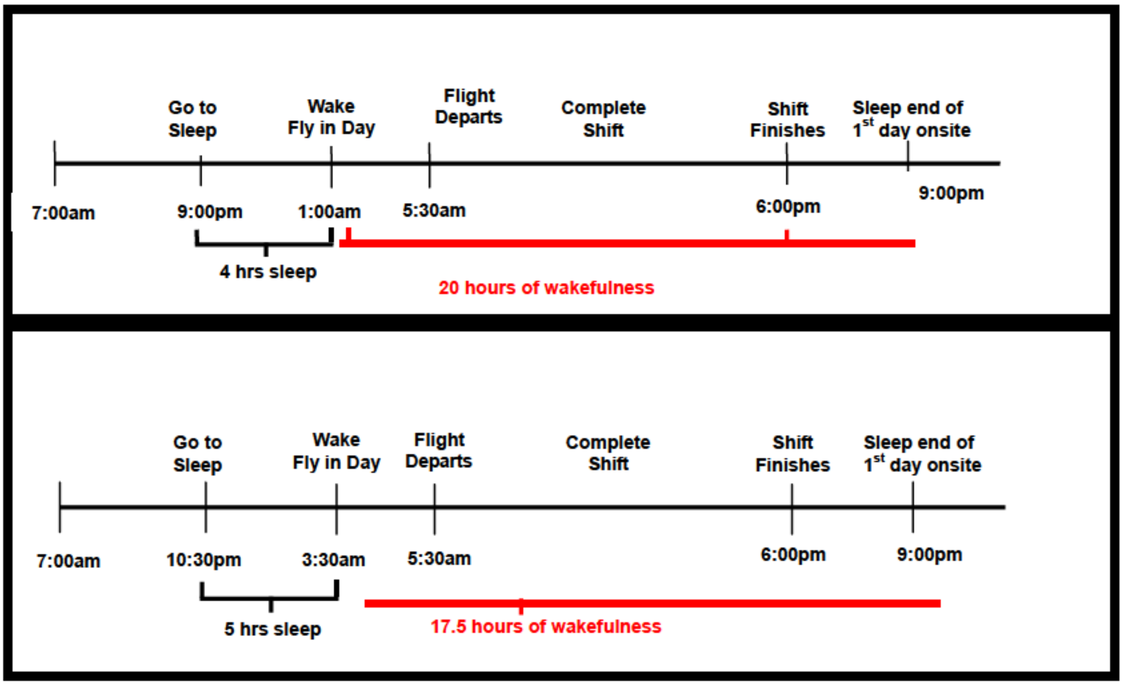

Figure 1: Example of a fly in day from a major city

6.2 Residential and irregular commute

Commuting between home, operations or places of work raises issues of fatigue. For residential workers who work greater than a 12 hour shift, commuting back and forth from the workplace everyday may increase the likelihood of fatigue [42]. Driving on remote roads has greater incidences of fatigue related accidents than on urban roads, which adds to the risks involved with the work place. It is critical that work hours and schedules, in addition to the time of day and length of commute are factored into risk management processes.

Long drives in hot conditions after long days increased fatigue-related risk, as do conditions such as uncomfortable or unfamiliar vehicles and unfamiliar roads.

Employees on an irregular commuting pattern have the same sleep disadvantages associated with FIFO employees, but can experience greater sleep disruption due to longer hours, unpredictable sleep opportunities and reduced time for rest.

6.3 Recommendation

It is recommended the first shift on-site be a maximum of 14hrs taken from when the employee first leaves their home. This will reduce exposure to fatigue on the first day and help to control fatigue over subsequent days. This reduces sleep debt on the second shift by providing an opportunity for quality sleep on the first night onsite. However this control does not have any effect on fatigue on the Fly In day and performing safety critical tasks. This solution could bring up issues of fairness and bias based on where an employee lives, as those with long commutes will be seen to have to work less having been given an earlier commute to the airport. It may also impact production rates, as the workday would be shortened.

7 Obstructive sleep apnoea

Sleep disorders, such as sleep apnoea, insomnia and restless legs syndrome, can impair the quality and amount of sleep and exacerbate the impacts of shift work on drowsiness. In obstructive sleep apnoea repeated brief episodes of obstruction in the upper airway disrupt sleep and result in dips in blood oxygen level. Formal assessment of the presence and severity of obstructive sleep apnoea is undertaken with polysomnography, which uses multiple physiological measures to assess sleep, breathing, blood oxygenation and heart rate. Sleep apnoea is more common in men, with 9% of women and 24% of men having at least mild sleep apnoea in the general community [43].

More than 50% of Australian commercial vehicle drivers have sleep apnoea, due to a high proportion of males and obesity, and this is considered clinically significant (associated excessive sleepiness) in 16% [44]. There is a lack of published prevalence data for sleep apnoea in most other industries, including the mining industry in Australia. However, industries with a male predominance are likely to have a prevalence of sleep apnoea amongst employees that is similar to the general male adult population. The related impaired cognitive function and excessive sleepiness from sleep apnoea results in an increase in road crash risk (2-7 fold increased risk) and occupational accidents that improves with treatment [45-49].

7.1 Screening for OSA

Obstructive sleep apnoea may remain unrecognized and untreated for many years, which has led to consideration of screening for it in high risk occupations and assessment for sleep apnoea in medical fitness assessment for transport drivers. Screening using formal polysomnography would be expensive and not practical. Consequently a range of screening tools have been developed including: questionnaires for symptoms of sleepiness [50] and snoring or gasping during sleep [51, 52]; individual characteristics, such as age, gender, body mass index (BMI) and neck circumference [51]; co-morbid illness, particularly hypertension; simplified and portable objective measures of breathing and/or oxygenation.

Many first line tools combine questions with physical measures (e.g. BMI) or the presence of hypertension. In clinical settings these combined tools are sensitive, detecting 80-90% of those with obstructive sleep apnoea (higher for those with severe disease) [53]. They also have a significant false positive rate (around 50%), so those that screen as high risk for sleep apnoea need to proceed to objective assessment [54]. The use of a two stage procedure of questionnaire screening followed by nocturnal oximetry in those found to be at risk, provides a high sensitivity and marked improvement in specificity to 95% (low false positive rate) [55].

One of the concerns of using a questionnaire approach to screening for sleep apnoea in occupational settings has been whether staff will accurately respond if they are concerned about impacts on work or licensing. Anecdotally, transport drivers rarely declare problems with sleepiness during formal medical assessments. During independent occupational screening and management for sleep disorders, drivers frequently declare symptoms of sleep apnoea and sleepiness, however the frequency is reduced when compared to anonymous responses [44, 56]. Given these features it is important to include objective indices of sleep apnoea risk in occupational screening programs, such as age, body mass index or the presence of hypertension [57, 58].

7.2 Programs in industry

Economic modelling of the costs of screening in comparison to savings from reduced accidents and injuries suggests that a two stage screening and treatment process for obstructive sleep apnoea is cost effective [59]. As described above, questionnaire assessment (including body mass index) was followed by objective measurement of sleep apnoea with polysomnography in those found to be at high risk. Those identified with sleep apnoea then undertake treatment and several screening models have been trialled in commercial operations.

> A Victorian program screened almost 4000 transport drivers using questionnaires and physical measures followed by medical follow up for objective diagnosis and treatment [60]. 25% of drivers were found to be at high risk of obstructive sleep apnoea and 14% had excessive sleepiness. There was a 17% reduction in new lost time injuries following participation in the program.
>
> Schneider National, a US trucking company with more than 15,000 drivers, was an early adopter of sleep apnoea screening. The program has resulted in reduced health costs, disability claims, absenteeism and driver turnover.
>
> The Australian rail industry has recently included sleep apnoea screening criteria within their driver medical examinations, relying mainly on individual characteristics for the initial screening process. Those at risk are required to undertake formal medical assessment including polysomnography. Elevated body mass index (> 35 kg/m^2) in combination with either diabetes, hypertension or self-reported sleep apnoea symptoms is used to identify those at risk. This process has proved to have a low false positive rate and has substantially increased the number of train drivers treated for sleep apnoea, however the sensitivity of this screening procedure is unclear.

7.3 Treatment for OSA

Continuous positive airways pressure (CPAP) applied at night via a mask remains the mainstay of treatment for those with severe obstructive sleep apnea. It improves cognitive function and reduces crash risk if used regularly [46]. Compliance is poor in some people, however, and hence use of a device that records hours of use is recommended for those who require treatment in safety critical industries. Average use of at least four hours per night is required to achieve reasonable symptom control, although further improvements in cognitive function are evident with longer use of six hours [58, 61].

Alternative treatments include position modification during sleep, weight loss and mandibular advancement splints. Weight loss of more than ten percent can improve obstructive sleep apnoea, with a follow up diagnostic study required to confirm adequate improvement. Mandibular advancement splints provide similar clinical efficacy for treating mild to moderate obstructive sleep apnoea and are a reasonable alternative to CPAP in this group [62]. Devices that measure usage are also available now to ensure adequate compliance for those in safety critical industries.

Recent evidence suggests that not all drivers who suffer from sleep apnoea are at risk of cognitive impairment and accidents [63, 64]. There are several targets for determining who is at risk with utilization of these measures in conjunction with screening offering the potential to better target sleep apnoea treatment to those drivers at increased risk while enabling those at low risk to continue work. This is an evolving area with further work required to determine the best methods and strategies for implementation.

7.4 Recommendation

The mining sector investigate systems to assess risk associated with sleep disorders, particularly obstructive sleep apnoea and implement screening and management programs to manage the risks to health and safety.

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