

# **LITERATURE REVIEW REPORT: 7 on / 7 off versus 14 on / 14 off ROSTERS WITH RESPECT TO FATIGUE AND RELATED FACTORS**

**September 2009**

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**Disclaimer: The results contained in this report are based on all of the relevant information that could reasonably have been identified given time and other constraints. Conclusions have been drawn using a combination of assessment methods. There may be other factors beyond the scope of this review that impact the conclusions. Information should be verified using organisational data (objective and/or subjective) wherever possible.**

## Contents

Summary of the aims and method of the literature review.....	3
Summary of the documents reviewed .....	4
Further assessment of 7 on / 7 off versus 14 on / 14 off in the offshore context .....	8
Discussion .....	9
Scope of the Review.....	9
Research / Industry Practice .....	9
Relevance to Offshore 7/7 and 14/14 Operations.....	9
Main Findings .....	9
Conclusion.....	11
References.....	12

## Summary of the aims and method of the literature review

The literature search aimed to find published scientific journal articles and Oil & Gas industry reports relating to 7 on / 7 off versus 14 on / 14 off roster schedules in an offshore work context. Where necessary other documents not directly relevant to this comparison have also been studied, if their content was assessed to be indirectly relevant. For example, additional documents included articles and reports concerning shift changes, and fatigue management in the offshore context.

The main search terms that provided valuable results included “offshore” and “schedule”. Other search terms used, with much less value, included: “14 day roster”, “7 day roster”, “offshore roster”, “oil roster”, “oil schedule”, “oil 7 day”. The primary source of material was the *Entrez PubMed* database, which is a service of the U.S. National Library of Medicine that includes over 17 million citations from MEDLINE and other life science journals for biomedical articles. Additional uses of the search terms were with the Google search engine. Specific unpublished articles and reports were also provided by the client.

For each of the documents studied, relevant questions included:

- 1) *Is it based on scientific research or simply reflecting what is industry practice?*
- 2) *What are the main findings/points?*
- 3) *What are the strengths, limitations, and assumptions of what is presented?*
- 4) *What are any unanswered questions, remaining concerns, or anything else related to this source document?*

There were many journal articles, Oil & Gas industry reports and other documents found that relate to the broader fatigue management project, and that were not included in this review. The main reason for their exclusion was the importance of keeping the review as focussed as possible on rosters, and to not widen discussions too significantly.

## Summary of the documents reviewed

Table 1 below reports on the contents and findings of each reviewed document from the literature review. The columns from left to right detail the authors and title of the document, its year of publication, the type of document (e.g. journal article or industry report), the strengths, limitations and assumptions of the document (and therefore how relevant it is directly or indirectly to the offshore environment), and finally the main findings of each.

DOCUMENT TITLE	DATE	SCIENCE / INDUSTRY?	STRENGTHS / LIMITATIONS / ASSUMPTIONS	MAIN FINDINGS/POINTS & REMAINING QUESTIONS
<b>Baulk, SD., Fletcher, A., Kandelaars, KJ., Dawson, D. &amp; Roach, GD.</b> A Field Study of Sleep and Fatigue in a Regular Rotating 12-hour Shift System. <i>Applied Ergonomics</i> , 40(4): 694-8.	2009	JOURNAL ARTICLE: Research Study	Mining/Smelting operational employees studies for 14 consecutive days.	Sleep data showed differences between day and night shifts. While sleep prior to night1 was increased relative to day shifts, a reduced sleep length carried into the period leading to night2. Total wakefulness at the end of shift, and subjective fatigue were increased for night shifts. Decrements in performance data supported these findings.
<b>Costa, G. &amp; Di Milia, L.</b> Aging and Shiftwork: A Complex problem to face. <i>Chronobiology International</i>	2008	JOURNAL ARTICLE: Review	Brief mention of scheduling trends, not related to 7 vs. 14.	Highlights some issues associated with Aging and Shiftwork, summarises future action to cater for aging workforce.
<b>Banks, S &amp; Dinges, DF.</b> Behavioral and Physiological Consequences of Sleep Restriction. <i>Journal of Clinical Sleep Medicine</i> , 3(5): 519-528	2007	JOURNAL ARTICLE: Review	Review of sleep restriction studies.	Partial sleep loss can cause effects to accumulate equal to those seen after 1-3 nights of TOTAL sleep loss. Sleep restriction to 6-hrs or less per night is sufficient to cause this. Negative effects seen on endocrine, metabolic and psychological functions – i.e. Health.
<b>Baulk, SD., Kandelaars, KJ., Lamond, N., Roach, GD., Dawson, D. &amp; Fletcher, A.</b> Does Variation in Workload Affect fatigue in a regular 12-hour shift system? <i>Sleep &amp; Biological Rhythms</i> , 5: 74-77.	2007	JOURNAL ARTICLE: Research Study	Mining/Smelting operation.	There is a complex relationship between workload, performance and subjective fatigue – more research is needed, particularly for specific contexts.
<b>Parkes, KR.</b> Working hours in the offshore petroleum industry: Current knowledge and research needs regarding extended work periods and shift work offshore. Conference Paper – Work time arrangements in the petroleum industry. Petroleum safety authority, Stavanger, Norway.	2007	INDUSTRY CONFERENCE PAPER: Review	Focuses on Norwegian installations with 1-2 men per cabin.	Good description of research in different schedules. Commentary on fixed vs. rollover shifts within 14 schedule.
<b>Energy Institute.</b> Improving Alertness through Effective Fatigue Management.	2006	INDUSTRY REPORT: Review	Scope includes offshore work. States 14-21 days as “typical”.	Education of workforce of critical importance.
<b>Kandelaars, KJ., Baulk, SD., Fletcher, A., Eitzen, GE., Roach, GD. &amp; Dawson, D.</b> Observations of Age-related differences in Neurobehavioural Performance in a 12-hour shift system. <i>Sleep &amp; Biological Rhythms</i> , 4(2): 171-174.	2006	JOURNAL ARTICLE: Research Study	Mining/Smelting operation.	Data showed effects of age on reaction time performance in a 12-hour shift environment.
<b>Hanssens, O.</b> About Rest and Restitution <a href="http://www.ptil.no/news/about-rest-and-restitution-article1799-79.html">http://www.ptil.no/news/about-rest-and-restitution-article1799-79.html</a>	2005	WEB ARTICLE	Norwegian Petroleum Safety Authority.	Survey from 8500 employees showed a definite link between cabin-sharing and sleep problems. 2002 regulations require that employees are ensured necessary restitution and rest – this means able to sleep without disturbance and normally alone. Older installations must adapt to convert cabins to single occupancy.
<b>Van Cauter, E., Knutson, K., Leproult, R. &amp; Spiegel, K.</b> The impact of sleep deprivation on Hormones and Metabolism. <i>Medscape Neurology &amp; Neurosurgery</i> .	2005	WEB COLUMN: Review	Indicates that a metabolic impact of sleep deprivation can now be demonstrated.	Summarises research findings on effects of sleep loss on metabolism etc.
<b>Menezes MC, Pires ML, Benedito-Silva AA, Tufik S.</b> Sleep parameters among offshore workers: an initial assessment in the Campos Basin, Rio De Janeiro, Brazil. <i>Chronobiol Int.</i> 21(6):889-97.	2004	JOURNAL ARTICLE: Survey Study	Brazilian Offshore Sector, compared shift but not schedule type.	Findings of this study show that subjective reports of sleep-related problems are quite common among Brazilian offshore shift workers. Reliance on self-reported sleep problems and a cross-sectional design are the main limitations.
<b>Parkes, KR.</b> Report on Material relating to the proposed change	2004	INDUSTRY REPORT:	Most research conducted in sectors with 1-2 man	14/14 schedules have a number of advantages over 7/7 and fewer

from a 7/7 roster to a 14/14 roster by construction Contractors, Bass Strait, Australia.		Consultation/Review	cabins.	disadvantages.
<b>Parkes, KR., Carnell, S., &amp; Farmer, E.</b> "Living two lives": Perceptions, attitudes, and experiences of spouses of UK offshore workers. <i>Community, Work and Family</i>	2004	JOURNAL ARTICLE: Survey Study	North Sea Sector.	Data suggest that families of offshore workers are more able to adapt to and be satisfied than previously thought.
<b>Belenky G., Wesensten NJ., Thorne DR., Thomas ML., Sing HC., Redmond DP., Russo MB., Balkin TJ.</b> Patterns of performance degradation and restoration during sleep restriction and subsequent recovery: a sleep dose-response study. <i>J Sleep Res</i> 12:1-12.	2003	JOURNAL ARTICLE: Research Study	Laboratory study involving 7 days of sleep restricted to 3-, 5-, 7-, or 9-hrs time in bed per night, followed by 3 days of 8hrs in bed recovery. Performance measured using PVT reaction time.	Clear relationship shown between sleep amount and performance decrement. Some evidence for adaptation to sleep restriction, i.e. performance decrement does not continue indefinitely.
<b>Costa, G.</b> Shift work and occupational Medicine: An overview. <i>Occupational Medicine</i> , 2003; 53: 83-88.	2003	JOURNAL ARTICLE: Review	Some discussion of shift length, but no schedule types.	Summarises medical issues and implications of shiftwork.
<b>Van Dongen HP., Maislin G., Mullington JM., Dinges DF.</b> The cumulative cost of additional wakefulness: dose-response effects on neurobehavioral functions and sleep physiology from chronic sleep restriction and total sleep deprivation. <i>Sleep</i> 26:117-126.	2003	JOURNAL ARTICLE: Research Study	Laboratory Study involving 14 days of sleep restricted to 4-, 6- or 8-hrs time in bed per night, compared to 3 nights with no sleep. Performance Measured using PVT reaction time.	Sleep restriction to 4hrs per night caused performance to deteriorate to a level equivalent to 2 nights without sleep. Restriction to 6hrs per night caused performance to deteriorate to a level equivalent to 1 night without sleep.
<b>Gardner, R.</b> Overview and characteristics of some occupational exposures and health risks on offshore oil and gas installations. <i>Ann Occup Hyg.</i>	2003	JOURNAL ARTICLE: Review	Focuses mainly on North Sea sector.	Summarises exposures and health risks as part of offshore work – does not address schedule options in detail.
<b>Gibbs M, Hampton S, Morgan L, Arendt J.</b> Adaptation of the circadian rhythm of 6-sulphatoxymelatonin to a shift schedule of seven nights followed by seven days in offshore oil installation workers. <i>Neurosci Lett.</i> 7; 325(2): 91-4.	2002	JOURNAL ARTICLE: Study	North Sea Sector. Studied adaptation to SWING SHIFT (7n7d).	As a group, the subjects adapted to the night shift but very large individual variations were seen during the day shift. These individual differences clearly require further study.
<b>Ohayon, MM., Lemoine, P., Arnaud-Briant, V., &amp; Dreyfus, M.</b> Prevalence and consequences of sleep disorders in a shift worker population. <i>Journal of Psychosomatic Research</i> , 53, 577-583.	2002	JOURNAL ARTICLE: Survey Study	Survey conducted at a psychiatric hospital during work hours.	Fixed daytime vs. rotating daytime vs. shift/nighttime work. Working on rotating daytime shifts causes significant sleep disturbances. These workers are more likely to feel sleepy at work and are more likely to have work-related accidents and sick leave.
<b>Parkes, KR.</b> Age, smoking, and negative affectivity as predictors of sleep patterns among shiftworkers in two environments. <i>Journal of Occupational Health Psychology</i> , 7, 156-173.	2002	JOURNAL ARTICLE: Study	Compared onshore vs. offshore.	Factors were linked to sleep onshore but offshore sleep was not predictable.
<b>Parkes, KR.</b> Shift work and age as interactive predictors of body mass index among offshore workers. <i>Scand J Work Environ Health.</i>	2002	JOURNAL ARTICLE: Survey	Focuses on North Sea sector.	Shows that day-night work is associated with body mass index increases greater than for day workers – does not address scheduling options although data collected from 14/14 patterns.
<b>Baker A, Heiler K, Ferguson SA.</b> The impact of roster changes on absenteeism and incident frequency in an Australian coal mine. <i>Occup Environ Med.</i> 60(1): 43-9. <b>Baker A, Heiler K, Ferguson SA.</b> The effects of a roster schedule change from 8- to 12-hour shifts on health and safety in a mining operation. <i>J Hum Ergol (Tokyo).</i> 30(1-2): 65-70.	2003 2001	JOURNAL ARTICLE: Longitudinal Study	Health & Safety effects of roster changes in Australian Coal mine operations.	Data on sick leave and incidents collected for 33 months for 8-hr, 12-hr and 12-hr + overtime systems. No significant negative effects of 12-hr pattern, but unregulated overtime caused absenteeism rates to increase. Important to strictly control overtime and to consult employee population in the roster change process.
<b>Shrimpton, M., &amp; Storey, K.</b> <i>The effects of offshore employment in the petroleum industry: A cross-national perspective</i> (MMS 2001-041). Herndon, Virginia: Minerals Management Service, U.S. Department of the Interior.	2001	INDUSTRY REPORT	Review of general practice.	14/14 or longer schedules are considered "the norm" for offshore work.
<b>Mauthner, NS., Maclean, C., &amp; McKee, L.</b> 'My dad hangs out of helicopter doors and takes pictures of oil platforms'; children's accounts of parental work in the oil and gas industry. <i>Community, Work &amp; Family</i> , 3, 133-162.	2000	JOURNAL ARTICLE: Focus group survey	Children's views of offshore work – Scottish population.	Suggests stress around parting and reunion times, as implied by children's accounts of their parents' work in relation to fly in / fly out offshore operations.

<b>Lardner, R.</b> <i>Safe communication at shift handover: Setting and implementing standards.</i> Edinburgh: Keil Centre Ltd.	1999	INDUSTRY PAPER	Examines current practice in an Oil Refinery.	Miscommunication of important information at handover caused by discontinuity of personnel and tasks.
<b>Parkes, KR.</b> Psychosocial aspects of stress, health and safety on North Sea installations. <i>Scandinavian Journal of Work, Environment &amp; Health</i> , 24, 321-333.	1998	JOURNAL ARTICLE: Review	Reviews literature on stress, health and safety.	Offshore workers experience greater anxiety, more sleep problems, and higher workload. Factors such as size, age, type of installation, work patterns, and occupational differences, subjective work perceptions, individual differences (age and personality), and health behaviour, all have significant impact on health and safety.
<b>Reyner, LA. &amp; Baulk, SD.</b> Fatigue in Ferry Crews: A Pilot Study Seafarers International Research Centre.	1998	INDUSTRY REPORT: Research Study	Focuses on 7/7 ferry crews in Irish Sea.	Data showed no causes for concern in relation to fatigue but demonstrated a "recovery" period after work ends of about 3 days.
<b>Smith, L., Folkard, S., Tucker, P., &amp; Macdonald, I.</b> Work shift duration: a review comparing eight hour and 12 hour shift systems. <i>Occupational and Environmental Medicine</i> , 55, 217-229.	1998	JOURNAL ARTICLE: Review	Assumes that findings should be generalisable across different industries.	Few differences between 8- and 12-hr shift effects. Some advantages to 12-hr shifts in terms of lower stress levels, better physical and psychological wellbeing, improved durations and quality of off-duty sleep as well as improvements in family relations. Main negative concerns were fatigue and safety - considerable extension of wakefulness. Effects of longer-term exposure to extended work days not well studied. Longitudinal studies are needed.
<b>Ulleberg, P., &amp; Rundmo, T.</b> Job stress, social support, job satisfaction and absenteeism among offshore personnel. <i>Work and Stress</i> , 11, 215-228	1997	JOURNAL ARTICLE: Survey Study	North Sea Sector, Norwegian sector.	Stress associated with job dissatisfaction, and strain. Social support from supervisors had a main effect on strain. Some evidence of the moderating effects of social support were found. Strain and absenteeism were associated. Improving organisational and social factors should be the focal area in the offshore oil industry.
<b>Parkes, KR., Clark, MJ., &amp; Payne-Cook, E.</b> <i>Psychosocial aspects of work and health in the North Sea oil and gas industry. Part III. Sleep, mood, and cognitive performance: A comparison of offshore shift patterns.</i> Sudbury, UK: HSE Books.	1997	INDUSTRY REPORT: Review	UK north sea sector.	No major differences between week 1 and week 2 for subjective alertness, subtle changes in alertness over shift length between week 1 and week 2.
<b>Parkes, KR. &amp; Clark, MJ.</b> Psychosocial aspects of work and health in the north sea oil and gas industry. Part V. Offshore work/leave schedules: Data Analyses and review. HSE	1997	INDUSTRY REPORT: Review	North Sea sector. Assumes facilities Standards are met (for sleep and other factors).	Attitudes favour 14/14 over 21/21 schedules. Few data on 21/21 schedules. More data needed on physiological variables.
<b>Proctor, SP., White, RF., Robins, TG., Echeverria, D., &amp; Rocskay, AZ.</b> Effect of overtime work on cognitive function in automotive workers. <i>Scandinavian Journal of Work, Environment &amp; Health</i> , 22, 124-132.	1996	JOURNAL ARTICLE: Study	Automotive workers, not related to offshore work.	Findings support the hypothesis that overtime work results in impaired psychological performance in the areas of attention and executive function and that both overtime hours and the number of consecutive days worked prior to a test day affect mood.
<b>Parkes, KR.</b> The effects of objective workload on cognitive performance in a field setting: A two-period cross-over trial. <i>Applied Cognitive Psychology</i> , 9, S153-S171.	1995	JOURNAL ARTICLE: Study	Study of Driving Test examiners to investigate the impact of workload in relation to 7 vs. 8 tests per day.	The reduction in workload demonstrated a slight increase in performance, as measured by Search-and-Memory tasks, however the findings are difficult to transfer to the offshore environment.
<b>Totterdell, P., Spelten, E., Smith, L., Barton, J., &amp; Folkard, S.</b> Recovery from work shifts: How long does it take? <i>Journal of Applied Psychology</i> , 80, 43-57.	1995	JOURNAL ARTICLE: Survey/Diary Study	61 shiftworking nurses completed self-ratings, sleep diaries and performance tasks over 28 days.	Showed that most measures were worse on rest days following night shifts, and worse on the first rest day compared to others. Psychosocial measures were worse on workdays following 1 rest day compared to 2.
<b>Parkes, KR.</b> Mental health in the oil industry: A comparative study of onshore and offshore employees. <i>Psychological Medicine</i> , 22, 997-1009.	1992	JOURNAL ARTICLE: Study	Study used questionnaire data in the North Sea Sector. Aimed to compare offshore vs. onshore workers for mental health measures. No comparison of schedule types.	No evidence for greater mental health problems in offshore workers, as measured by the general health questionnaire psychometric measures such as neuroticism and anxiety.
<b>Hyypa, MT., Kronholm, E., &amp; Mattlar, CE.</b> Mental well-being of good sleepers in a random population sample. <i>British Journal of Medical Psychology</i> , 64, 25-34.	1991	JOURNAL ARTICLE: Survey Study	Random Finnish population sample, not from offshore workers.	Average "good sleepers" fell asleep in 10 min and had 7.5 hrs of sleep, without depressive, anxious, neurotic, or (trait) aggressive emotions. Also no chronic illness and were empathic and assertive. Poor sleepers, however, expressed stressful traits and states in psychological rating scales.

<b>Gann, M., Corpe, U., &amp; Wilson, I.</b> The application of a short anxiety and depression questionnaire to oil industry staff. <i>Journal of the Society of Occupational Medicine, 40</i> , 138-142.	1990	JOURNAL ARTICLE: Survey Study	North Sea platforms only.	No statistically significant differences in anxiety or depression scores were identified between groups working onshore or offshore.
<b>Morrice, K., Taylor, RC., Clark, D., &amp; McCann, K.</b> Oil wives and intermittent husbands. <i>British Journal of Psychiatry, 147</i> , 479-483.	1985	JOURNAL ARTICLE: Survey Study	Scottish wives of on and offshore workers.	No differences found in measures of general health; 'off-shore wives' shown to experience mood and behavioural changes, linked to partings/reunions. 10% had pronounced reactions ("Intermittent Husband Syndrome"). Many others would benefit from more effective preventive and support services.
<b>Taylor, R., Morrice, K., Clark, D., &amp; McCann, K.</b> The psycho-social consequences of intermittent husband absence: An epidemiological study. <i>Social Science and Medicine, 20</i> , 877-885.	1985	JOURNAL ARTICLE: Survey Study	Scottish Sector, wives of offshore workers vs. onshore.	Suggests that psychosocial effects of intermittent husband absence have been exaggerated. No major difference in mental and physical health of wives of men working off-shore to on-shore. Low levels of experience (marriage/absence) cited as causes.

## Further assessment of 7 on / 7 off versus 14 on / 14 off in the offshore context

In addition to summarising the main points related to each relevant document identified, as reported in the above section, we have also aimed to summarise the pros and cons of 7 on / 7 off versus 14 on / 14 off in the offshore context. The answers relate to the research in some ways, but are also intended to simplify and summarise common perceptions. This section has also received contributions from operational employees/representatives with direct experience of the relevant schedules and workplaces.

- **What are the Pros and Cons for 7 on / 7 off and 14 on / 14 off in relation to offshore operations?**

**Table 2. 7 on / 7 off Roster Schedules**

PROS	CONS
<ul style="list-style-type: none"> <li>• Existing roster schedule in place (i.e. no change or disruption required)</li> <li>• People already know how to make the most of the skills/knowledge they have</li> <li>• More frequent recovery/relaxation time at home</li> <li>• Fewer consecutive work days in hitch</li> <li>• Less need for phone, internet/email, Skype, etc.</li> <li>• Less potential for cumulative sleep loss and other physical/psychological decrements</li> <li>• Less people are likely to be motivated to get a second job as the break between hitches is shorter</li> <li>• People may choose to live closer to work because the commute will happen twice as often</li> <li>• Frequent time spent with immediate family</li> <li>• Less potential for partner/family problems</li> <li>• Less importance of family communication and supervisor/organisation support</li> </ul>	<ul style="list-style-type: none"> <li>• Shorter blocks of time at home for recovery, relaxation and to be with partner/family/friends</li> <li>• More frequent partings/reunions with partner/family</li> <li>• More frequent travel and associated financial costs</li> <li>• More frequent crew changeovers with associated communication risks</li> <li>• Feeling of pressure at work - little time between settling in and handover</li> <li>• Frustration that many jobs/projects could not be completed in 1 week - time spent completing office tasks on days off</li> <li>• Inability to better plan and spread the work required during a hitch can cause potential for long (&gt;16-hr) days - making returning home tired inevitable</li> <li>• Family irritations and arguments often surface in the days leading up to returning to work</li> <li>• Less time to interact with crews, restricting mentoring processes</li> <li>• Difficult to travel during time off for holiday or visiting family</li> <li>• Less time to enjoy individual hobby activities without the associated 'guilt' of abandoning family</li> </ul>

**Table 3. 14/14 Roster Schedules**

PROS	CONS
<ul style="list-style-type: none"> <li>• Some research shows no difference in accident rates, performance or mood in week 2 (assumes 1 or 2 people per bedroom)</li> <li>• Fewer changeovers (reduced direct business costs)</li> <li>• Reduced personal travel and associated costs</li> <li>• Reduced frequency of crew changeovers and associated communication risks</li> <li>• More prolonged time at home for recovery relaxation and to spend with partner/family</li> <li>• Some evidence of adaptation of sleep/wake patterns during week 2 (assumes 1 or 2 people per bedroom) for some individuals</li> <li>• Less frequent parting/reunion with partner/family</li> <li>• Some individuals will welcome new system</li> <li>• Some individuals will be able to adjust their physical, social and other factors relatively easily</li> <li>• Ability to spread workload evenly</li> <li>• More time to interact with crews, enhancing mentoring processes</li> <li>• Reduction in jobs left for oncoming sup to complete</li> <li>• Reduction in time required on off days to complete office tasks</li> <li>• An additional full day of leisure time in each 28 day cycle</li> <li>• Quality of family time dramatically increased - more choice in activity available, and less pressure to share oneself around</li> <li>• Much easier to take a trip of a few days to catch up with family members living some distance away</li> <li>• More time to enjoy individual hobby activities without the associated 'guilt' of abandoning family</li> </ul>	<ul style="list-style-type: none"> <li>• More prolonged time away from partner/family</li> <li>• Increased potential for partner/family problems during long absence</li> <li>• Increased importance of family communication and supervisor/organisation support</li> <li>• More requirements for phone, internet/email, Skype, etc.</li> <li>• Increased potential for cumulative sleep loss and other physical/psychological decrements</li> <li>• Some/many individuals will be reluctant to change</li> <li>• New roster schedule (i.e. change/disruption is necessary)</li> <li>• Increased number of consecutive work days in hitch</li> <li>• More potential for a second jobs as the break between hitches is longer</li> <li>• Less Frequent time spent with immediate family</li> <li>• People may choose to live further from work because the commute will be half as frequent</li> </ul>

## Discussion

### Scope of the Review

The literature search and review aimed to find published scientific journal articles, and Oil & Gas industry reports relating to 7/7 versus 14/14 roster schedules in an offshore work context. For each of the documents studied, the main questions were: 1) *Is it based on scientific research or simply reflecting what is industry practice?*; 2) *What are the main findings/points?*; 3) *What are the strengths, limitations, and assumptions of what is presented?*; and 4) *What are any unanswered questions, remaining concerns, or anything else related to this source document?*

The aims and scope of this review did not include consideration of the long-term health impacts of different rosters. Studies investigating roster/schedule changes typically follow a before-and-after design, and a few studies collect 'follow-up' data after a 3-6 month period or longer. It is recommended that a longer-term plan is considered if rosters are to be changed for some or all staff at any time in the future. Such a plan would include a periodic review to better ensure issues that emerge over time, but were not foreseen before the implementation, are identified and addressed. Therefore, long-term health effects are an issue which is considered of high importance for future work, regardless of which roster system is in place.

### Research / Industry Practice

A total of 36 articles were selected for review, with 26 from scientific journals (11 surveys, 9 research studies, 6 reviews), 8 from industry reports or conference papers (7 reviews, 1 research study) and 2 from web articles. These are listed in the reference section below.

### Relevance to Offshore 7/7 and 14/14 Operations

Although there is substantial literature relating to work schedules and their effects on numerous physiological and psychosocial variables, much of this literature is limited in its *direct* relevance to offshore operations. Most of the studies which *are* directly relevant to offshore oil/gas operations have been conducted in the north sea sector, with the resulting limitation that they concern 14/14 schedules and sleeping conditions of single occupancy, or at most 2 per cabin, which is in contrast to the Australian operations. It is also important to note that 2 per cabin can relate to 2 beds with either 2 people working the same shift and sleeping at the same time, 2 people working different shifts and sleeping at different times, or to a single bed with 2 people working different shifts and 'hot-bedding.'

### Main Findings

The literature highlights many of the pros and cons of the 7/7 and 14/14 schedules (as shown in tables 2-3 above) such as potential for errors in communication, cumulative sleep loss and particularly the psychosocial effects related to family life away from work.

### Sleep & Sleeping Facilities

A major area of research, discussion and commentary surrounds the issues associated with sleep and sleeping facilities. These include not only the effects of different roster systems on sleep and the potential for cumulative partial sleep loss (i.e. reduction in sleep time for a number of consecutive nights), but also the potential contributors to sleep loss in terms of the physical environment in which sleep occurs.

Sleep debt can accumulate over time where conditions do not allow adequate sleep. This can be considered one of the main risks for offshore operations working on/off rosters where employees sleep away from home. Factors influencing this include (as well as sleeping during the day and other scheduling factors): external noise, vibration, factors associated with sharing cabins (such as snoring), and psychological factors associated with sleeping and working in the same environment. Research studies investigating sleep debt have typically manipulated sleep length by asking subjects to reduce their sleep to

a fixed amount (e.g. 5 hours per night) over a prolonged period (e.g. 1-2 weeks or more).

These studies (e.g., Van Dongen et al., 2003; Belenky et al., 2003) show that this chronic restriction of sleep to <7 hours per night results in cumulative performance deficits, and the greater the sleep loss, the greater the rate of deterioration. 14 days of sleep restriction to 4h and 6h per night has shown performance deficits reach levels equivalent to 2 nights without any sleep (i.e., >48h awake). While this has clear potential to increase accident risk, it is also shown that performance does not always continue to deteriorate but can reach a plateau level as individuals adapt to sleep restriction. Clearly there is greater potential for accumulated sleep debt in the 14/14 vs. the 7/7 roster schedule. Thus, if the schedule of 14/14 involves reduced sleep, research indicates that unsafe levels of performance deterioration will occur, particularly if additional factors such as night work/day sleep are involved.

There are numerous major (and distinct) factors involved in determining whether people get sufficient sleep on a day-to-day basis in the context of offshore operations:

- 1) Opportunity to sleep (do the work hours provide adequate access to opportunity?)
- 2) Ability to sleep (does the environment, biological time of day and other factors allow sleep to occur?)
- 3) Motivation to sleep (are there competing needs that reduce sleep obtained or does the experience of not being able to sleep (e.g. during the day) make choosing not to *try*, more likely?)
- 4) Individual need for sleep (what sleep do individuals *need*?) including the trend for an increasing intolerance to working shifts with increasing age (Costa, 2003).

While some of these issues can be directly addressed in conjunction with the issue of sleeping facilities (see below), it is important to note that other factors must be addressed as part of the development and implementation of a broader fatigue risk management system to include (for example) training for employees/supervisors on fatigue, sleep, health and appropriate rostering and changeovers.

From both the research literature and employee commentary, the suggested benefits of a 14/14 roster are mostly applicable within a context two people per bedroom offshore (this could be configured as one day shift person and one night shift person, or two of each shift working at the same times). As a general statement one major benefit of occupancy lower than 4 per room is improved sleeping (and recovery), which can obviously reduce fatigue. Therefore, more significant fatigue benefits are applicable if individuals get adequate quality and quantity recovery sleep, which would be most easily achieved by minimizing the number of occupants in a room as well as ensuring a good standard of the rooms themselves (in terms of noise attenuation, etc.).

Therefore it is considered that a one essential step in moving towards 14/14 rosters would be converting sleeping facilities from 4 to 2-man rooms for day shift workers (and possibly single occupancy rooms for night shift workers). In addition, where applicable, steps should be taken to significantly and measurably improve soundproofing in these facilities.

### **Limitations of Existing Research & Remaining Questions**

Although many research surveys/studies have examined important issues surrounding the schedules worked in the offshore environment, there is a lack of comprehensive and directly relevant work which addresses some important remaining questions. These include:

- Direct Comparison between 7/7, 14/14 and 21/21 schedules in offshore environments
- Direct Comparison between North Sea and other offshore environments
- Longitudinal studies of 7/7 or 14/14 offshore roster schedules
- Before/After studies relating to schedule *changes* in the offshore environment
- Comprehensive studies capturing data on employees, partners and other family members

## Conclusion

The completion of this review has required assessment of relevant literature in the form of journal articles, industry reports, commentaries and survey data, in addition to gathering comment from employees and other representatives with direct knowledge of the working conditions. No evidence was found to support the implementation of a 14/14 roster under the *current* living conditions. This is particularly related to the current use of 4-person rooms, which is out of alignment with international practices for the application of 14/14 rosters that allow for one- or two-person rooms as standard. If steps are taken to upgrade the current living conditions to include reducing sleeping cabins to a maximum of 2 persons for day shifts (and possibly single occupancy for night shift), upgrading for sound attenuation, and also addressing other issues surrounding fatigue-risk management, there may be considerable benefits for the company in terms of safety and cost savings related to the safety improvements achieved by a 14/14 roster.

Despite the extensive literature surrounding fatigue and shiftwork, there is a lack of scientific data based on studies to *directly* compare 7/7 and 14/14 schedules in offshore operations. Given current technologies and research methods however, there may be scope to conduct such a study and capture important psychological, psychosocial and even physiological data in the operating environment. Other important remaining questions which could be addressed in such a study are the psychosocial impacts on partners and family members of offshore workers, and the longer term effects of schedules/schedule changes.

The 14/14 schedule is commonly worked around the world in similar installations, and could be considered the standard for this industry. However, as noted above, 14/14 schedules are only considered appropriate where the facilities support sleep and recovery at a significantly higher level than a 4-per-bedroom maximum would allow.

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