CIRCADIAN® Report

The Myths & Realities of Fatigue:

Reducing the Costs, Risks, and Liabilities of Fatigue in 24-Hour Operations

CIRCADIAN®

24/7 WORKFORCE SOLUTIONS

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Introduction

On the surface of things, fatigue seems fairly straightforward. We all get tired, do what we need to do to get through it, and then catch up on our sleep when we can. We still harbor a cultural mentality of mind over matter, and of human failing if one allows themself to get tired to the point of being unfit for duty. After all "if our people spent more time in bed getting their proper rest (and less time watching TV, sitting in a bar, or allowing themselves to be compromised by family life and personal activities), then they wouldn't be tired on the job!"

In other words, from a management perspective, fatigue is often perceived to be a behavioral problem, caused more by personal irresponsibility than by other factors (and certainly not by our operating policies and procedures). Well, those of us who have lived and worked shiftwork know better. Just try sleeping in the daytime or rotating back and forth from days to nights for an extend-ed period and see how much "proper rest" YOU can get!

Similarly, we have this notion that, like our process equipment, employee work capacity is a lin-eal function, that 80 hours of work will yield 80 hours of productive output (actually, it nets 50-55 hours depending on the level of employee interaction with the process; Nevison, 2001, Dembe, et al. 2005).

In other words, one should be able to work as many days in a row as management (or we employees) would like without any significant problem or loss of performance, and the company is happy to let us do it! Overtime saves having to hire more people and paying all those costly bene-fits (actually the National Average is only 32%, as opposed to the 50% premium we pay for over-time), and it sure makes a supervisor's job a whole lot easier to fill absences, vacations and other benefit days off by dishing out the overtime to those who want it.

Plus, we rationalize, people are happy to have the extra money. I used to think this way too, when I worked and managed shifts, but after several close calls, I realized that I was kidding myself and putting myself and others at risk. Indeed, today's sophisticated equipment and machin-ery is quite lineal and actually designed to operate non-stop for long periods of time. We humans are not.

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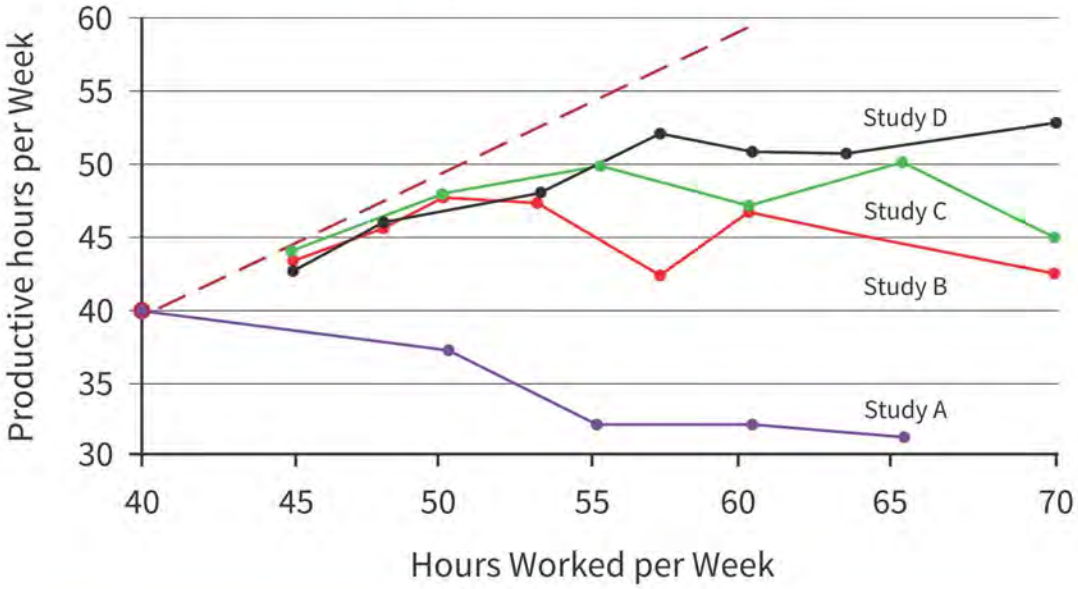
FIGURE 1. Overtime vs. Productivity



- Study A shows productive hours when a person is excessively fatigued (burnout). Study B is after working 4 weeks of long hours. Studies C and D are from just 1 week of long hours.
- Dotted line represents theoretical or expected productivity (i.e. hours of work = lineal work output) as acheivable with equipment or machinery.
- Solid lines represent human productivity, which is not lineal.

Over the past 25 years, extensive research has confirmed that fatigue, as related to shiftwork, is fundamentally a physiological problem, not a behavioral one. Certainly, one's behavior can induce or compound fatigue, but with most refinery operators this is the exception and not the rule. Rather, shiftworker fatigue is caused primarily by four operationally driven factors:

1. Circadian (Body Clock) Factors

a. Working when you would normally be asleep
b. Sleeping when you would normally be awake
c. Frequently having to change your sleep/wake cycles
d. Misalignment of daily alertness cycles with work requirements

2. Sleep Factors

a. Inability to get normal hours of sleep
b. Inability to get normal quality of sleep
c. Inability to get consistent bedtime routines
d. Having inadequate sleep environment

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3. Work and Environmental Factors

a. Having early shift start times
b. Having fast rotating schedules and/or long, irregular hours (i.e. overtime)
c. Having inadequate rest/recovery time between shifts and/or work blocks
d. Having boring/monotonous work environment
e. Having boring/monotonous jobs

4. Health Factors

a. Medical sleep disorder problems
b. Underlying health issues (e.g. hypertension, diabetes, epilepsy, etc.)
c. Improper timing and content of food (i.e. building cardiac risk factors, digestive disorders, etc.)
d. Use/abuse of coping substances (e.g. caffeine, sleeping pills, alcohol, etc.)
e. General lifestyle issues

The circadian (body clock) and sleep factors are inherent (Moore-Ede, 1982, Akerstedt, 1995). Human biology has been "hardwired" since the beginning of humankind. This did not become an issue until the development of electricity in the 1880's which ushered in the modern era of shift-work and compromised our physiological "design specifications". As a result, our shiftworkers have had to endure a dysfunctional state of being for the past 120 years… a state of being unknown to our primitive ancestors, and one which negatively impacts our performance and reliability.

Both the circadian and sleep factors are impacted by the operational necessity to keep the equipment running 24-hours per day (e.g. automation, continuous process, asset utilization, reduced unit costs, improved customer service, etc...). Work and environmental factors, on the other hand, are influenced by counter-productive management attitudes, policies, practices and operating procedures that often detract from human performance, rather than support it (e.g. by lack of human factors knowledge/understanding), by confusing human physiology with human behavior, by managing for the convenience of day managers to the inadvertent detriment of the shiftworkers, etc.).

Health factors are driven by all of the above, as well as by lack of employee knowledge and understanding on how to manage shiftwork, in general, and to manage fatigue and alertness levels, in particular (i.e. lack of shiftwork lifestyle training and education). The net results have been chronic ill health, inherent safety issues, broken families (i.e. higher divorce rates), and reduced performance (U.S. Office of Technology Assessment, 1991).

Having said all that, let's define what we mean by fatigue and look at some of its consequences and costs in the shiftworking industries, such as refining.

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What is Fatigue?

Fatigue is not just feeling physically tired, it's also a state of impaired alertness, attentiveness, mental and physical performance. Being fatigued also includes having reduced motor coordination, and slower reaction time. When we are fatigued, there is a loss of environmental awareness, impairment of cognitive/logical reasoning skills, poor judgment and diminished ability to communi-cate and/or process communications and information.

In fact, there is now scientific evidence that suggests when we're tired (or mentally fatigued) our ability to perform the simplest of tasks is impaired to the same level as if we were legally intoxicat-ed! (Dawson and Reid, 1997).

Consequences of Fatigue

Due to the reduced or impaired alertness caused by fatigue, the inevitable net result is increased human error, and reduced ability to work safely and productively. Numerous scientific studies, and extensive field experience, confirm that shiftworkers with higher relative fatigue index are more likely to experience sleepiness, nodding-off, and making mistakes while working, as well as nod-ding-off or fighting sleep while commuting to and from work. (Aguirre 2003).

Fatigue also affects mood. The National Sleep Foundation (2002) found that people who do not get enough sleep are more likely to get impatient or agitated, and they have difficulty getting along with others. Increased irritability and stress negatively influences personal, work, and family rela-tionships, resulting in inadequate/ineffective communications, and correlating with increased absenteeism and turnover as well as reduced morale and poorer labor relations. Industrial surveys reveal that absenteeism rates are nearly double in facilities with severe fatigue problems, as com-pared to facilities where fatigue is not a problem (Aguirre and Moore-Ede, 2008).

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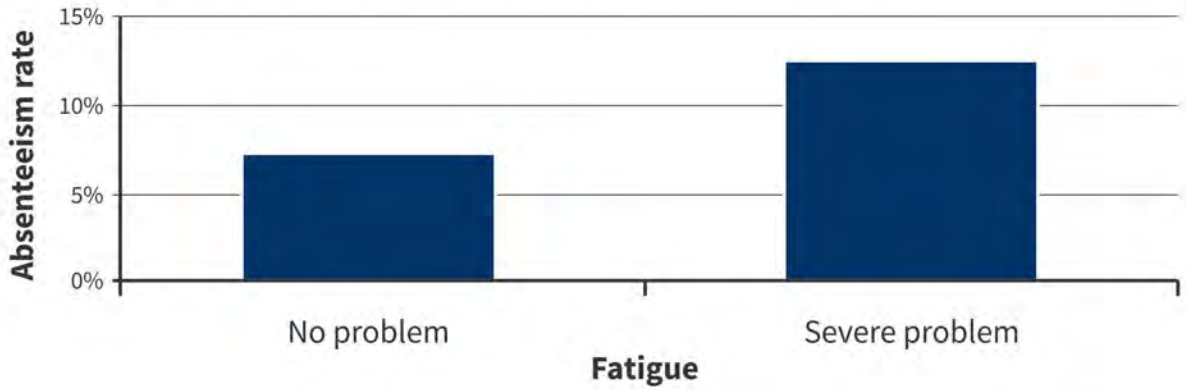
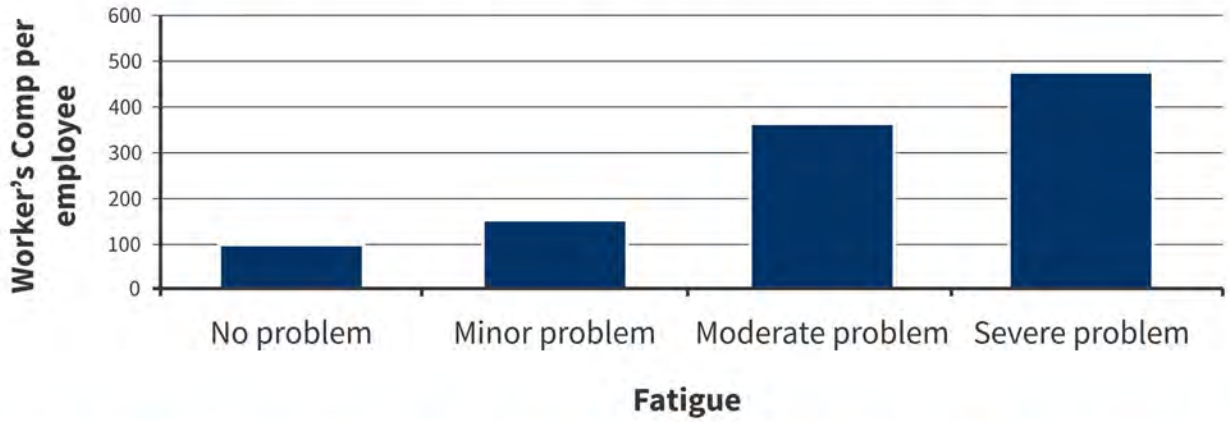
FIGURE 2. Fatigue Levels and Absenteeism in 24/7 Operations



The consequences of fatigue also impact a company's operating efficiency and costs. Fatigue results in reduced productivity and customer service quality, reduced operating reliability and decreased operating profit, increased health and wellness costs, and higher overall costs, risks, and liabilities. Industrial survey data further indicates that Workers' Compensation costs per employee per year were almost five times higher in facilities with severe fatigue problems, compared to facili-ties where fatigue was not a problem (Aguirre and Moore-Ede, 2008).

FIGURE 3. Fatigue and Annual Workers' Compensation Costs in 24/7 Operations



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Costs of Fatigue

Virtually every industry suggests that 80-90% of all their accidents and incidents are human error related. In no industry is this more true than in downstream operations, as confirmed by insurance claims adjusters and OSHA data. Equipment, maintenance, and human costs pose enor-mous risks, so safety is indeed a "condition of employment". Yet mental errors, personal injuries, and property and casualty damages are not infrequent occurrences.

While some of these incidents can certainly be attributable to inexperience or behavior, the vast majority are more typically physiological in nature. Adjustment to night work, shift rotations, and/or overtime create health, safety, and performance problems for operators. By every measure, performance decreases at the beginning of early morning shifts, during the post lunch hours, and during overnight shifts…particularly during the pre-dawn hours.

The number of fatigue-related accidents is considerably higher at night than during daytime (Mitler 1988). In fact, a study found that drivers are 50 times more likely to fall asleep at 2 am than at 10 am (Horne and Reyner, 1995). No matter how well trained, skilled, motivated, or experi-enced, operators are frequently compromised by fatigue. Behavior becomes erratic and deviant…not willfully, but because of our physiological nature. As a result, incidents are often misdiagnosed as being due to behavioral problems, when they are actually physiological in nature.

Thus, understanding human physiology is key to successfully identifying, and managing the inherent problems of shiftwork and fatigue-related human error.

The resultant costs of fatigue are far greater than just those of safety, although the $2 Billion already spent on cleaning up the Texas City Refinery mess should be enough justification to proac-tively address this issue. While there were certainly technical and equipment failures involved in this unfortunate incident, the US Chemical Safety Board (2007) also cited fatigue due to under-staffing and excessive overtime/consecutive shifts as a causal factor.

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Fatigue also correlates with higher maintenance costs, lost productivity, increased turnover, absenteeism, and presenteeism, higher health and wellness costs, reduced customer service quality, higher operating risks and lia-bilities, and, ultimately, reduction in overall operating profit.

In his book, ***THE TWENTY FOUR HOUR SOCIETY:*** Understanding Human Limits in a World That Never Stops, Dr. Martin Moore-Ede (1993) established the following conservative estimate of the global costs of fatigue:

FIGURE 4. Global Costs of Fatigue

Accidents/Incidents	$108 Billion
Lost Productivity*	$360 Billion
Health Care	$40 Billion
Security/Societal	????
TOTAL	**$508 Billion****

** Includes human error, turnover, absenteeism, etc.*
*** Adjusted for 3% annual inflation (1993-2007)*

We can certainly argue and debate over the magnitude of this cost estimate, but even if Dr. Moore-Ede is only partially right… the cost of fatigue is still enormous! The good news is that it clearly represents recoverable opportunity, and a whole new avenue for improving operator safety and performance that has been largely overlooked for the better part of the last century. Moreover, with today's ability to measure and quantify the costs of fatigue, it is now possible to build a com-pelling business case and ROI proposition to justify a proactive Fatigue Risk Management System (FRMS).

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Installing an Effective Fatigue Risk Management System (FRMS)

So how as a company, or as operating mangers, can we objectively, systematically, and measura-bly eliminate fatigue from our operations, thereby reducing our costs, risks and liabilities. And is it really possible to increase operational efficiency... while at the same time improving employee health, safety and quality of life to create a win-win proposition?

Perhaps this sounds far fetched, but it's already being done. With the current knowledge and experience base that exists today, dramatic improvements are being achieved in the way people live and work, to the betterment of both the employees and the business.

The first, and most important step, is to recognize the cause and the huge costs of fatigue, and make a corporate commitment to eliminate them. Too many companies are losing money and risk-ing the safety of their employees by not recognizing the importance and the urgency of fatigue management. This is evident by the fact that over 90% of shiftworkers receive no training on how to manage their schedules and shiftwork lifestyles (Aguirre and Moore-Ede, 2008).

We see many shiftworkers who are well trained and skilled at their jobs, but who have never been taught how to deal with fatigue, better manage their sleep or adapt to the inherent physical and social challenges of shiftwork. As a consequence, they develop bad habits and/or become vic-tims of common shiftwork pitfalls that compromise their ability to perform to their fullest capabili-ties. This is just one of the many reasons that shiftworking employees conservatively cost companies $8,600 per person per year in excess costs over and above their daytime counterparts (Kerin and Carbone, 2003).

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Once company management has made a corporate commitment to reduce fatigue and optimize the productivity and safety of their workforce, they need to develop a comprehensive, science based, fatigue risk management plan. To be successful this plan must at the very least:

- Educate the organizational infrastructure to achieve consensus and stakeholder support (e.g. managers and supervisors at all levels, union leaders, regulatory agencies, etc.)
- Provide training for employees to empower them to take more control over reducing their per-sonal levels of fatigue, as well as better coping with shiftwork, (especially with new hires)
- Reinforce the training and personal commitment to behavioral lifestyle change by providing educational support publications and practical shiftwork information to operators on a regular basis
- Educate/train supervisors on how to identify and intervene with tired shiftworkers
- Re-evaluate work schedules and overtime policies and practices to ensure they are not causing excessive fatigue
- Optimize staffing and crewing levels to maintain manageable overtime levels
- Evaluate the indoor and outdoor work environment for potential modifications that could reduce fatigue (e.g. more mentally stimulating control rooms, etc.)
- Evaluate work tasks and activities for opportunities to make them less boring and monotonous
- Re-evaluate operating policies and procedures that may no longer be valid, in light of our human physiology, and that may actually be counterproductive
- On a regular basis, screen and treat sleep disorders that are prevalent among shiftworkers, and provide education on managing sleep
- Incorporate fatigue analytics/human error analysis into reporting systems to monitor and track results by collecting and reporting fatigue-related data
- Incorporate fitness-for-duty impairment screening programs
- Keep abreast of new R&D initiatives to continually advance state-of-the-art
- Establish a continuous improvement process that is not merely today's priority, but rather a permanent core operating value of the company

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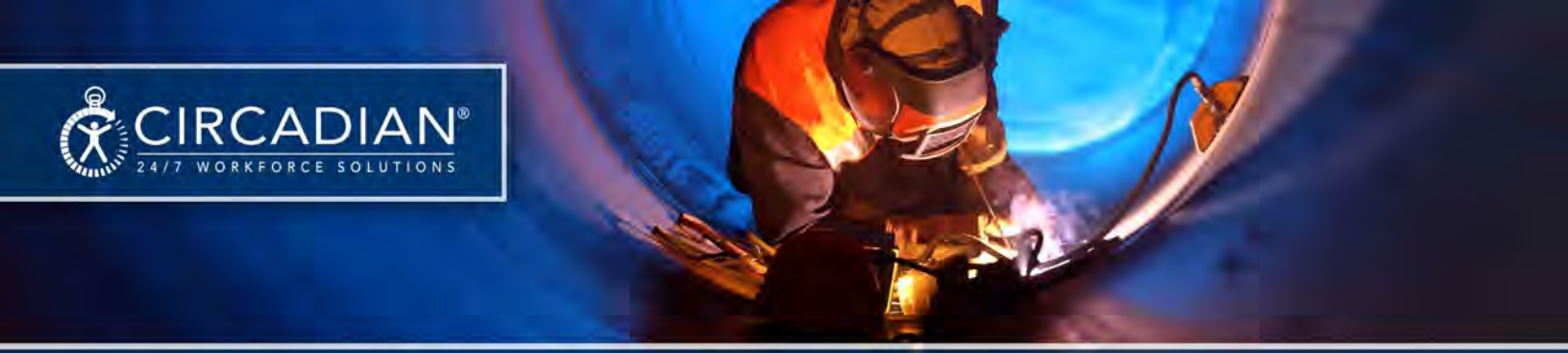

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Conclusion

As responsible managers and operators, we strive to keep our equipment well oiled and well maintained. We ensure that it is operated in full accordance with the manufacturers design specifi-cations, in terms of temperatures, pressures, flow rates, etc. To do otherwise would ensure prema-ture failure, costly downtime, high maintenance, and lost productivity/capacity. It would thus seem to make sense to keep what we all tout as our "most important asset" - our people - equally well maintained and operated.

Yet, ironically, our people are being asked to operate outside their design specs every day to sup-port our continuous production requirements. The net result, as you might surmise, has been pre-mature failure (in terms of sickness and injury), costly downtime (in terms of absenteeism and presenteeism), high maintenance (in terms of health and wellness costs), and lost productivity due to human error. Continuing to neglect our most important asset will perpetuate this cycle of high cost and catastrophic risk.

It is time to understand that these costs, risks and liabilities no longer have to be accepted and financed as part of doing business. With today's knowledge base, technology, and available fatigue/shiftwork interventions, they can be converted into a new source of operating profit and reliability that we never knew or believed existed. Moreover, they can be systematically addressed through a collaborative, human involvement process between labor and management to achieve substantial win-win benefits.

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References

Aguirre A. Health in extended hours operations: understanding the challenges, implementing the solutions. Circadian Technologies. Stoneham. 2003.

Aguirre A, Moore-Ede A. Shiftwork Practices 2007. Circadian Technologies, Stoneham. 2008.

Akerstedt T. Work hours, sleepiness and the underlying mechanisms. J Sleep Res 4, Suppl. 2:15-22.1995.

Dawson D, Reid K. Fatigue, alcohol and performance impairment. Nature 388 (6639): 235. 1997.

Dembe AE, Erickson JB, Delbos RG, Banks SM. The impact of overtime and long work hours on occupational injuries and illnesses; new evidence from the United States. Occup. Environ Med. 62(9):585.2005.

Horne JA, Reyner LA. Driver sleepiness. J. Sleep Res. 4 Suppl. 2:23-29.

Kerin A., Carbone J. Financial Opportunities in Extended Hours Operations. Circadian Technologies. Stoneham. 2003

Mitler MM, Carskadon MA, Czeisler CA et al. Catastrophes, sleep and public policy: consensus report. Sleep 11 (1):100-109. 1988.

Moore-Ede MC. The twenty-four hour society, Addison-Wesley, Reading. 1993.

Moore-Ede MC, Sulzman FM, Fuller CA. The clocks that time us. Harvard University Press, Cambridge, 1982.

National Sleep Foundation. 2002 Sleep in America Poll. www.sleepfoundation.org.

Nevison JM. Overtime Hours: The Rule of Fifty. Project Solutions Report. 2001.

U.S. Chemical Safety and Hazard Investigation Board. Final Investigation Report. Refinery Explosion and Fire. BP Texas City, TX. Report No 2005-04-I-TX. 2007.

U.S. Congress, Office of Technology Assessment, Biological Rhythms: Implications for the Worker, OTA-BA-463. Washington, DC: U.S. Government Printing Office. 1991.

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ABOUT CIRCADIAN™

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FOURTH EDITION
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