The science is indisputable. All three types of fatigue, whether physical (body), mental (mind), or neurocognitive (brain), impair human performance. The most insidious and dangerous form in workplaces is neurocognitive fatigue, which is caused by insufficient Delta-wave or deep, restorative sleep that the human brain requires every 24 hours. The particular parts of the brain that suffer from this type of fatigue are the four lobes of the cerebral cortex—the parts of our brain that control cognitive processes such as pattern recognition, auditory discrimination, visual processing, memory, speech, reasoning, planning ahead, problem solving and decision making. The primary root causes of this brain fatigue are insufficient amounts of and/or poor quality of sleep in either a given 24-hour period (acute fatigue) or across multiple days (cumulative fatigue). The likelihood of such sleep deprivation is also heightened by circadian rhythm disturbances, which are common among night-shift, early-morning shift, rotating-shift, and extended-daywork employees across all occupational classes, including salaried supervisors and engineers.
**Risks Created by Fatigue**

In turn, mild to severe sleep deprivation results in mild to severe levels of brain fatigue, with accumulating risks of performance errors on a wide range of cognitive tasks as sleep quantity and/or quality decline. For example, a 2009 study\(^1\) found that subjects who reported having 5.5-6.4 hours of good-quality sleep in the last 24 hours or as a cumulative average over the past seven days had a 2.3 times (230%) greater relative risk for errors than subjects with 6.5-8 hours of good-quality sleep. When the amount of good-quality sleep dropped below 5.5 hours, the relative risk for errors was almost 5 times greater than the control subjects. And, if the quality of sleep was reported as poor, the relative risk rate nearly tripled, independent of sleep duration.

Studies of cognitive fatigue risks also have demonstrated that impairment from sleep loss at mild to severe levels is comparable to alcohol intoxication levels ranging from 0.04 to 0.12% blood alcohol content (BAC), respectively.\(^2,3\) A BAC of .10% is legally drunk in most countries. No risk-conscious organization would allow a legally-drunk or even mildly-intoxicated worker to control a high-risk process, operate heavy machinery, utilize sharp instruments, or drive a company vehicle. Yet, sleep-linked cognitive fatigue has been rampant in all types of industries for years, including the medical profession. In fact, a robust study \(^4\) found that senior surgeons who performed operations under conditions of moderate to severe sleep deprivation (less than six hours of actual sleep opportunity in 24 hours) faced an 83% increased risk of complications. Similar research studies in aviation, oil & gas and medicine \(^5,6,7\) have found that cognitive fatigue is the primary root cause of human errors that cause personal injuries, near misses and fatal accidents in all types of work. That is why sleep deprivation and associated neurocognitive fatigue have been deemed Enemy #1 by the U.S. National Transportation Safety Board, and regulated for over a decade by the Nuclear Regulatory Commission in the U.S. That is also why companies striving to optimize their operational reliability and safety have embraced the need for effective fatigue risk mitigation.

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Critical FRMS Components

Because there are multiple root causes of the sleep deprivation that results in neurocognitive fatigue, including undiagnosed sleep disorders, high overtime levels, life status (e.g., parents of newborns), and some work schedules, companies committed to mitigating fatigue risks need a multi-component FRMS—Fatigue Risk Mitigation System. Like any management system, it is crucial for an FRMS to be:

• Strategically-aligned
• Scientifically-sound
• Data-informed
• Risk-focused
• Performance-based

For fatigue risk management, the system also must be fully integrated into the operating fabric and the culture of all departments that are subject to overtime work hours, whether hourly or salaried. Unless or until operating unit leaders embrace the fundamental value of an FRMS, the critical risk of human fatigue will continue to present a danger in today’s workplaces.

The fundamental purpose of this systemic solution must be the creation of sufficient opportunities for at least two unrestricted sleep and rest opportunities at every offtime period between work blocks. In addition, the following components are essential for managing the continuous risk created by sleep deprivation:

• **Robust Fatigue Education** – Many companies have provided their employees with “tips” on how to manage fatigue only to find that it has little to no sustained impact. Longitudinal studies have shown that in-depth, up-to-date education on sleep fundamentals are essential for improving employees sleep quantity and quality. Too often, sleep education is still focusing on the importance of REM sleep rather than the deep Delta-wave sleep that is now known to be necessary for daily brain restoration. Employees cannot be expected to actively prevent potential fatigue risks caused by their personal life choices, including their sleep hygiene and sleep patterns, if they are not fully educated on the impact of those choices.

• **Protected Rest Periods** – Since unrestricted sleep and rest time opportunities are fundamental to managing fatigue, no FRMS would be complete without provisions for ensuring that sufficient rest breaks occur on a daily and weekly basis to preserve high performance reliability on the job. At a minimum, daily time away from work needs to be 10 hours in length to allow for commute time, wind-down time, optimally a meal with family, and critically, at least 6.5 or 7 hours of sleep. On a weekly basis, the goal has to be prevention of cumulative cognitive fatigue due to long consecutive work periods. Achieving this end necessitates at least two uninterrupted sleep periods following every work block, with more rest and recovery time required after four or more consecutive night shifts.

• **Individual Fatigue Risk Assessments** – The last line of defense against the potential consequences of workplace fatigue is a real-time, objective, field-validated fatigue risk assessment tool administered by Qualified Fatigue Assessors. Importantly, neurocognitive fatigue can result in a loss of self-judgment. Thus, relying on a fatigued individual to accurately assess their fitness for error-free work, and especially their fitness for safety-critical tasks, is like relying on an intoxicated individual to assess their fitness to drive. No company wants to bet their reputation or their people’s safety solely on a fatigued person’s self-assessment.