FATIGUE and the NEW HOURS of SERVICE in TRANSPORTATION LITIGATION

Martin Moore-Ede, M.D., Ph.D.
Benjamin Schlesinger
Irene Fassler, J.D.

Circadian Technologies, Inc.
24 Hartwell Avenue
Lexington, MA. 02421

Presented at: Federation of Defense and Corporate Counsel Transportation Section Annual Meeting, Chesapeake Bay, Maryland, July 29, 2004
I. Introduction

With the rapid expansion of the global 24/7 economy, 24 million Americans now work night shifts or extended hours outside the daytime hours of 7am-7pm. Supply chain automation, telecommunications, the internet and logistical optimization have brought enormous efficiency, but also make the world move at faster more time- pressured non-stop pace. As a result the issue of human fatigue, a physiologic state of diminished capacity caused by acute or chronic sleep deprivation, has increasingly become a subject of public debate and litigation. See, Moore-Ede MC (2002) Fatigue in Transportation Operations. Clin Occup Environ Med 2, 11-27.

A substantial body of scientific research on sleep, alertness and circadian rhythms over the past 25 years has radically altered our understanding of the physiology of human fatigue. Yet the regulations that govern work and rest limits in the workplace, and on the highway, still follow the concepts and paradigms of a century ago when human fatigue was poorly understood, and assumed to be simply related to the number of consecutive hours of work or off-duty time.

After a prolonged and painful gestation and delivery, the FMCSA finally gave birth to new Hours of Service regulations (HoS) for truck drivers on January 4th 2004, which claim to improve safety, and be informed by the new science. They pose significant challenges and increased costs for some trucking operations. Yet in reality I will show that the HoS regulations remain a flawed solution to managing the problem of driver fatigue. Hence I suspect the controversy is far from over, and many unresolved issues will only stimulate further public debate and litigation.

The purpose of this paper is to provide a lay person’s background in sleep, circadian and alertness physiology that will allow the reader to understand the basic premise when fatigue is asserted or defended in a claim. The paper also reviews the new HoS Regulations, discusses whether they adequately address fatigue in the trucking industry and discusses the stakeholders’ responses. In addition this paper recommends some “good practice” discovery methods in fatigue related litigation.

II. The Physiology of Human Fatigue

Sleep deprivation caused by either extended periods of time awake (acute sleep deprivation), or the cumulative effect of reduced quantities of sleep over several days (chronic sleep deprivation) results in increased physiological sleepiness. However, physiological sleepiness may not always be apparent in the behavior of the subject. Other factors (such as motivation, stress, etc) may produce behavioral arousal that temporarily masks the underlying sleepiness. This observed level of sleepiness is called manifest sleepiness, and may lead an observer to conclude that fatigue was not the cause of an accident, just because the individual responsible does not appear drowsy in the immediate aftermath. On the other hand if a person is physiologically alert they will not experience sleepiness even in soporific situations. Heavy meals, warm rooms, boring lectures (hopefully not this one!), unmask the presence of physiological sleepiness but do not cause it.
A. Measuring Fatigue/Sleepiness

Unlike drug or alcohol abuse, excessive impairment by fatigue cannot be directly measured by a simple post-accident or post-mortem biochemical assay. In addition, an individual who is fatigued usually becomes aroused after an accident or near-miss incident – if they are not seriously injured - and this leads to substantial under-reporting of fatigue as an accident cause. Many states do not yet include fatigue in an accident report check-list, and people who fall asleep on the job are very unlikely to admit it and will concoct stories (I sneezed, a deer ran into the road, etc) to cover the reality.

Sleepiness can however be objectively measured. The laboratory gold-standard for measurement involves the use of EEG (electroencephalogram) which may be used to determine such measures as time to fall asleep when given an opportunity (Multiple Sleep Latency Test – MSLT), ability to remain awake (Maintenance of Wakefulness Test - MWT), differences in power of the EEG alpha band with eyes open and closed (Alpha-Attenuation Test - AAT) or continuous EEG recording which can provide the number of microsleep seconds per hour. The latter two can be measured in actual transportation operations taking advantage of portable EEG devices. See Moore-Ede MC, Mitchell RE, Heitmann A, et al: Canalert '95, Alertness Assurance in the Canadian Railways, Cambridge, Circadian Technologies, Inc., 1996; and, Torsvall L, Akerstedt T: Sleepiness on the job: Continuously measured EEG changes in train drivers. Electrencep Clin Neurophysiol 66: 502-511, 1987. However these are research tools and are not suited for day-to-day use.

Sleepiness can also be measured by a number of subjective tests or less direct fitness-for-duty tests. For example, a well-established test for chronic excessive daytime sleepiness is the Epworth Sleepiness Scale. See Johns MW: A new method for measuring daytime sleepiness: the Epworth sleepiness scale. Sleep 14(6): 549-545, 1991 and van Ert PM, Gapinski JP, Fuller MJ, et al: The Predictive Value of the Epworth Sleepiness Scale: Patient vs. Significant Other Assessment of Patient Sleepiness. Sleep 22 Suppl: S48, 1999. In addition, various fitness for duty tests using hand-eye coordination, pupillary and other ocular responses to light or cognitive performance measures show some promise. However, their use at the start of a shift is more reliable in screening employees for alcohol or drug impairment than for detecting fatigue, since fatigue impairment by its nature tends to increase over the course of a shift while the effects of alcohol and drugs will wear off.

Recently a number of various alertness/fatigue software simulation tools have been developed based on extensive quantitative scientific research on the factors that contribute to alertness at any moment in time, or chronic fatigue over a period of time. See Achermann P, Borbely AA: Simulation of daytime vigilance by the additive interaction of a homeostatic and a circadian process. Biol Cybern 71: 115-121, 1994; Dawson D, Fletcher A: A quantitative model of work-related fatigue: background definition. Ergonomics 44 (2): 144-163, 2001; Folkard S, Akerstedt T: A three process model of the regulation of alertness and sleepiness. In Ogilvie R, Broughton R, (eds): Sleep, arousal and performance: Problems and promises. Boston, B. Birkhauser, 1992, pp 11-26; and, Heitmann A, Trutschel U, Guttkuhn R, et al: In Hornberger S, Knauth P (eds): Computerized Sleep and Alertness Simulations for Work Schedule Evaluation. Shiftwork International Newsletter, 16 (2): 125, 1999. These models are designed to take into account information about recent work/rest and/or sleep/wake patterns (timing and duration of
sleep) and individual sleep characteristics in order to assess circadian and homeostatic sleep factors and determine the sleepiness or alertness level of the individual as a function of time. For example we have built a fatigue assessment tool ‘Circadian Alertness Simulator’ (CAS) which has been refined using 24-hour sleep-wake-work and alertness data from over 10,000 days of recordings from transportation employees living and working in real world occupations. See, Moore-Ede M, Heitmann A, Guttkuhn R, Trutschel U, Aguirre A, Croke D. Circadian Alertness Simulator for Fatigue Risk Assessment in Transportation: Application to Reduce Frequency and Severity of Truck Accidents. Aviat Space Environ Med 2004; 75(3, Suppl.): A107-118. It has been demonstrated to have predictive value in determining which employees are at excessive risk of having fatigue-related accidents.

B. Determinants of Physiological Fatigue

The level of fatigue, or physiological sleepiness of any individual at any moment in time is determined by a scientifically well-established combination of circadian (e.g. #1,2,6) and homeostatic (e.g. 3, 4, 5 & 6) factors. These include:

1. **Time of day according to the individual’s own circadian phase**

An individual’s level of alertness and sleepiness varies over the course of the 24–hour day in a predictable pattern with the greatest sleepiness in the early hours of the morning before dawn (typically 1AM-6AM), and a second lesser period of sleepiness in mid-afternoon (often referred to the “post-lunch dip” or the “siesta hour”). Numerous studies have shown that highway accidents caused by drivers who fall asleep at the wheel have a peak time of risk around 1-6 AM and secondary time of risk approximately from 1-4 PM. See Horne JA, Reyner LA: Driver Sleepiness. J Sleep Res 4 Suppl. 2: 23-29, 1995; and, Langlois PH, Smolensky MH, His BP, et al: Temporal patterns of reported single-vehicle car and truck accidents in Texas, USA, during 1980-1983. Chronobiol Int 2(2): 131-146, 1985.

It is not the clock time on the wall that determines these daily biologic cycles of sleepiness and alertness. The time of day according to a person’s biologic clock is called the “circadian phase.” Even in people who are not traveling across time zones, an habitual early bed time and early arising time on both work days and weekends/rest days is associated with an earlier (or “advanced”) circadian phase, and a pattern of maximum sleepiness and alertness that is shifted to earlier hours, as compared to someone who habitually stays up and sleeps in late, who will have a late (or “delayed”) circadian phase.

2. **Chronotype of the individual**

the morning hours. Evening types tend to rise late in the morning and they feel at their best late in the evening. It has recently been shown that these characteristics are genetic in nature, and independent of age, sex and ethnic heritage. See, Katzenberg D, Young T, Lin L, et al: Circadian Gene Polymorphisms are Associated with Morningness-Eveningness Tendencies. Sleep 22 Suppl: S122, 1999.

3. **Length of time since awakening from last sleep episode**

When a person first wakes up from sleep there is a period of grogginess or sleepiness that resolves typically in less than half an hour. This is referred to as “sleep inertia. Once a person has fully recovered from the residual sleep inertia from his last sleep period the drive for sleep builds with time until the next sleep period occurs. Eventually the extended time spent awake results in a strong sleep pressure. This is referred to as the homeostatic drive to sleep. However, sleep propensity, or the likelihood of falling asleep, is determined by a combination of the homeostatic drive and the other factors listed here. As a result sleep propensity does not simply relate the length of time awake which drove the original HoS regulations. In reality the circadian and homeostatic drives to sleep interact. This produces peaks in relative alertness in mid morning and early evening, separated by an early afternoon “post-lunch” dip in alertness or siesta hour. This circadian-homeostatic interaction also causes the precipitous drop in alertness after midnight when an employee begins his first night shift following several days of nighttime sleep and daytime wakefulness. Neither are predicted by the hour-glass HoS model.

4. **Duration and timing of the previous consolidated sleep period**

The sleepiness of an individual is quenched by sleep, just as water quenches thirst and food quenches hunger. The effectiveness of a sleep period in quenching the level of sleepiness that an individual has accumulated over the previous day(s) is determined by the sleep period’s duration, as well as by the quality of sleep obtained. The average adult needs 7-8 hours of sleep per day to maintain average levels of daytime alertness. However, there are considerable inter-individual differences, with some individuals needing as much as 9 or 10 hours per day, while others only need 5 or 6 hours.

In addition to the duration, the timing of the sleep episode is a key factor. Due to the influence of circadian rhythms, sleep is more effective and its quality better at some times of the day than at others. As noted above, it is also important to consider the time of day according to a person’s biological clock, (i.e. his “circadian phase”) not only in predicting or assessing his level of sleepiness, but also in judging the duration and quality of sleep that he obtains by sleeping at a particular time of day.

Significant increases in daytime sleepiness are found for most people when the nocturnal sleep length is reduced to 5 or less hours, or when reduced sleep duration occurs for two or more successive nights. Some scientists have suggested that humans have a “core” daily sleep requirement, in the same way that they have nutritional requirements. This “core” daily sleep has been estimated to be approximately 4-5 hours per day. See, Horne J: Why We Sleep. New York, Oxford University Press, 1987.
5. **Quality of sleep in the previous sleep period**

The quality of sleep at night also influences the sleepiness level on the subsequent day. When sleep is disturbed by deviations from typical sleep characteristics, this results in increased sleepiness the following day.

Many factors may influence these characteristics of sleep quality, including the time of day or night that sleep is attempted, the environmental conditions in which one is sleeping, and the existence of any clinical sleep disorders or other medical conditions.

To ensure adequate sleep, the sleeping environment should be both physically comfortable and psychologically conducive to sleep. People usually sleep better in their own bedroom than in an unfamiliar environment. One of the most important challenges many transportation employees face is the requirement to sleep away from home. In other words a transportation employee sleeping in their own bed on their regular nightly schedule and routine will have significantly higher sleep quality than the same person sleeping away from home in unfamiliar circumstances at an unusual time of day.

6. **Sleep Disorders**

The quality and duration of sleep is substantially affected by the clinical sleep disorders that range from the common to the obscure. There is no way to do them justice in the confines of this brief summary, so the reader who is interested should consult one of the texts of sleep disorders medicine. See, **Kryger MH, Roth T, Dement WC (eds.): Principles and Practice of Sleep Medicine, ed 2. Philadelphia, Saunders, 1994; and, Shneerson JM: Handbook of Sleep Medicine. Oxford, Blackwell, 2000.** In synopsis the most common include the following:

- **Breathing Disorders:** Obstructive Sleep Apnea (OSA) and Central Sleep Apnea. OSA in which the airways collapse during sleep resulting in loud snoring, cessation of breathing, multiple gasping arousals per hour and considerable fatigue impairment has an average prevalence of 9% in the adult male population and is especially prevalent in overweight individuals. See, **Agency for Healthcare Research and Quality, 2001. www.ahcpr.gov.** Untreated OSA cases are 6 times more likely to have a fatigue related accident which makes this disorder a key safety issue. It is effectively treated in most cases by CPAP (continuous positive airway pressure) devices.

- **Movement Disorders:** Restless Legs Syndrome and Periodic Limb Movement Disorder are very common disorders that involve movements that disturb sleep.

- **Arousal Disorders:** Parasomnias: Sleepwalking, Sleep Talking, Night Terrors and REM Behavior Disorder are disorders of arousal with associated mental confusion and disorientation.

- **Circadian Disorders:** Delayed Sleep Phase Insomnia, Advanced Sleep Phase Insomnia and the rarer circadian period disorders result from malfunctions of the circadian timing system, some of which may be genetic in origin.
Narcolepsy: A condition that affects 1 in 1000 people and results in severe unexpected sleepiness and cataplexy precipitated by emotion.

Psychiatric Disorders: Anxiety, depression and other psychiatric disorders are often accompanied by sleep disruption and insomnia.

7. **Cumulative effect of sleep duration and quality over the past week**

A person’s sleepiness level on a given day is most strongly influenced by the quality and duration of the last sleep episode. However, the sleep pattern during the preceding days will also affect sleepiness level. It is also well recognized that days-off, where there is no substantial restriction on the opportunity for unrestricted sleep, allow a person to recover fully from all accumulated sleep debt. The number of days required depends on the level of sleep deprivation, but in most circumstances two consecutive nights of sleep has been determined to be sufficient.

When a person follows a regular sleep-wake schedule, that is, going to bed and waking up at approximately the same hour every day, this helps to synchronize his sleep/wake and other circadian rhythms to that regular schedule.

Thus a regular daily pattern of bedtime and awake time, and a regular routine of exposure to light and dark will cause a person’s circadian sleep-wake rhythm to become optimally synchronized to the time of day that they are going to bed – even if that time of day is not a typical or traditional time. This synchronization will promote optimal sleep quality and consequently minimize daytime sleepiness.

C. **Manifest Influences on Fatigue/Sleepiness**

A number of additional factors have an immediate impact on whether any given level of physiological sleepiness (as determined above) will result in the manifestations of sleepiness that could result in any transportation operator performance impairment which could lead to an accident. Examples of these additional factors include:

8. **Timing and dosage of caffeine ingestion over the previous 12 hours**

The stimulating properties of caffeine are well known, and coffee may be the most commonly used sleepiness countermeasure. Caffeine is a stimulant of the nervous system. Persons ingesting caffeine or caffeine-containing beverages usually experience less drowsiness, less fatigue and a more rapid and clearer flow of thought. Caffeine has been shown to restore degraded function under conditions in which there is increased physiological sleepiness because of prior sleep loss. The effects of caffeine depend on a number of factors, including caffeine dose, habitual usage, body mass, and previous food intake, baseline alertness level, body steroid levels.

9. **Level of social interaction with other people**

Another key determinant of the ability to stay awake at a given level of physiological sleepiness is social interaction with other people who are awake. The presence of a sleeping co-worker or passenger, if anything, has the reverse effect.
10. **Perceived danger/interest of the task being performed**

Nothing pulls us faster from a drowsy state than the imminent threat of danger, or just surviving a near miss. Although less extreme than the response to danger, a stimulating job or task with safety hazards triggers a similar response. The manifest sleepiness level can also be reduced by an interesting challenge at work or anything that it is new and different. On the other hand, when the job is boring or monotonous, the underlying physiological sleepiness is unmasked.

11. **Environmental factors including light intensity, temperature and sound levels to which the individual is exposed.**

Various environmental factors can also influence manifest sleepiness. For example it is harder to stay awake in a dark, warm environment with monotonous sound. Environmental light intensity influences manifest sleepiness levels. Once light intensities approach daytime levels (above 1000 lux) there is an arousing effect of light, which will reduce manifest sleepiness.

**D. Consequences of Excessive Fatigue**

Fatigue has been identified by the U.S. Department of Transportation as the number one safety problem in transportation operations. Costs of fatigue in transportation operations have been cited to exceed $12 billion a year. See, Downey ML. U.S. Deputy Secretary of Transportation Speech. US DOT Conference. Tyson’s Corner, VA. August 29, 2000.. Most of these costs stem from the sleep deprivation and fatigue that occurs when work intrudes into normal nocturnal sleeping hours, although in some cases fatigue may be exacerbated by underlying sleep disorders.

Fatigue in safety-critical transportation employees impairs their judgement and cognitive reasoning, and can significantly increase the likelihood of automatic behavior (performance of tasks without cognitive awareness) and “microsleep” lapses of attention. A microsleep is a brief involuntary 2-30 second lapse into sleep of which the subject may have no memory, and during which the normal corrective maneuvers are not made of the speed or direction of the vehicle. As a result the vehicle may a) drift out of the lane or course in which it was traveling without the operator making the normal correction, b) continue to move on a continuing trajectory at the same speed even when faced by an obstacle (e.g. a stalled vehicle on a highway, or a rock in the sea) or when the route goes round a curve. The vehicle as a consequence will collide with the obstacle or leave the road as the vehicle reaches a curve without the driver making the correction in steering or braking that he would normally undertake. In a transportation operator who is drowsy one commonly observes early signs of degraded performance prior to the event, such as gradual drifting out of the traffic lane. Divided attention tasks requiring anticipation and proactive planning, such as use of turn signals, are typically the first to degrade, and are the typical early signs of progressively deteriorating performance because of sleepiness.

The risk is proportionate to the degree of vigilance required to safely perform the task, so that a truck driver on a narrow two lane highway is only 1-2 seconds away from drifting over the midline or off the road and endangering himself and other road users, whereas a helmsman at sea or a pilot at altitude has a larger margin of error. Railroad operators are confined to tracks but
may fail to slow around a bend, or brake at the beginning of a downward incline, or fail to observe and respond appropriately to signals.

However the probability and duration of microsleeps is also influenced by the transportation operator’s perception of risk. Microsleeps in truck or bus drivers are rarely longer than 4-5 seconds, whereas in railroad engineers 20-30 second microsleeps are common. Studies of train crews continuously monitored by brain electro-encephalographic recording (EEG) while operating trains show the risk of microsleeps can be as high as 100 microsleep seconds per train hour in sleep deprived train crews at night. See, Moore-Edé MC, Mitchell RE, Heitmann A, et al: Canalert ’95, Alertness Assurance in the Canadian Railways. Cambridge, Circadian Technologies, Inc., 1996.

The direct consequences are accidents and injuries caused by lack of operator attention. Because a person in the middle of a microsleep will not take evasive action the probability of catastrophic damage and likelihood of fatal injury are significantly increased in fatigue-related accidents. With the escalating cost of insurance in the post September 11th 2001 era, and court judgments reflecting the increasing public awareness of employee fatigue as a corporate responsibility there is an increasingly significant impact on the bottom line.

But fatigue has much wider consequences for business than just the safety impact. Morale, productivity, creativity, absenteeism, sick leave, turnover are all negatively impacted by employee fatigue. Each impact the competitiveness and productivity of the business especially when operations are 24/7 or include significant night time work.

III. The New Hours of Service regulations

The issue of fatigue in transportation operations led in the early 1900’s to the development of Hours of Service (HoS) regulations, which simply regulated the number of consecutive hours of work based on a simple but flawed theory. Over the past 30 years the science of human fatigue (sleep-wake, alertness & circadian physiology) has moved ahead rapidly, but regulatory reform has lagged behind. See, Moore-Edé MC: The Twenty-Four Hour Society: Understanding Human Limits in a World That Never Stops. Reading, Addison-Wesley Publishing Co, 1993; and, Moore-Edé MC, Sulzman F: The Clocks That Time Us: Physiology of the Circadian Timing System. Cambridge, Harvard University Press, 1982. Finally, after more than ten years of debate and a failed previous attempt to revise the trucking Hours-of-Service regulations, the new federal safety rules regarding truck driver work hours went into effect January 4, 2004.

It is now broadly accepted that, even with the new HoS regulations, while they can prevent some extreme abuses, under these HoS an employee can be perfectly legal but unsafe, or illegal and perfectly safe. It is not enough to point to HoS compliance and claim that fatigue has been successfully managed.

The basics of the new HoS rules are as follows:

- Driving time is extended from 10 hours at a time to 11 hours at a time.
- On-duty time is reduced from 15 hours at a time to 14 hours at a time.
- On-duty time is no longer a cumulative count of hours worked over the course of a day, but is now a “running clock” concept—a driver has 14 hours from the minute he starts his work day, regardless of any breaks taken during that time (see split sleep exception below).
- Mandatory rest times are extended from 8 hours to 10 hours.
- The maximum hours rules of 60 hours in 7 days and 70 hours in 8 days remain intact, however a driver can now “reset the clock” on a week by taking a 34 hour rest.
- If a driver takes a nap of two hours or longer in the middle of a work shift, the shift can extend beyond 14 hours by the length of time that the driver was napping. The driver can also add the nap length to a sleep period immediately following completion of the shift to total 10 hours, rather than having to take the full 10 hours off duty after the shift.

A. Do the Hours of Service regulations prevent fatigue?

The new formula for duty and rest hours will raise costs substantially for certain types of trucking operations, without necessarily improving safety across the board. With the new rules, drivers can comply perfectly with the new regulations but still be unsafe, or they can be perfectly safe even though not in compliance with the regulations. As is already the case, logbook violations will not necessarily mean unsafe or fatigued driving.

Two examples illustrate the flawed nature of the regulations:

1) A trucker who works lawyers hours say 7 AM to 8 PM from Monday through Saturday would be in violation of the 60-hour rule by Friday night and in violation of the 60 and 70-hour rules all day Saturday. But this same trucker could very well be physiologically alert and well rested if he or she had slept adequately at a consistent time every night throughout the week. This schedule might not be ideal (for obvious reasons) for the trucking business, but working such a schedule would not necessarily render the trucker impaired by physiological fatigue on Friday and Saturday, even though he would be in violation of the HOS regulations.

2) A trucker who drives from 8 AM Monday to 7 PM, rests until 5 AM Tuesday, drives until 4 PM, rests until 2 AM Wednesday, drives until 1 PM, rests until 11 PM, and then begins driving again, will quite likely be significantly fatigued over the course of this Wednesday-Thursday journey, yet be fully compliant with the HoS regulations. Even assuming the trucker maximized his or her sleep within the rest periods, the sleep would have been at a different time every day first during the day, then from early morning until midday, then from late night until late morning. This type of backward-rotating schedule can be problematic for the human physiological design, but this pattern would be well within the limits of the HoS regulations. A Circadian Alertness Simulator analysis shows the trucker’s alertness levels (on the scale of 0-100, 100 being maximum alertness) dipping as low as 10 during driving shifts well below the threshold of severe fatigue impairment. This fatigue would only become more dangerous if the trucker continued this pattern for another couple of days before reaching the 60-hour limit.
In the first case, the driver is in violation of the HoS rules, but would likely be an alert and safe driver. In the second case, a driver complying with the rules would, at varying times, be severely impaired by fatigue and represent a risk to himself and others on the road.

We see two trends emerging in the legal world from the new HoS regulations:

- First, trucking companies unfairly burdened by the new regulations will seek exemptions or waivers, or challenge the regulations in the courts. There is substantial data to support claims that the new duty-rest hours do not always correlate well with the actual physiology of sleep deprivation and fatigue, and exemptions for specific types of trucking operations can be supported by sound physiological research.

- Second, there is a rising tide of litigation claiming that truck accidents were caused by driver fatigue, with eight-figure jury awards becoming more common. With insurance studies showing that driver fatigue may only account for 10% of the claims but more than 60% of the costs, there will be an increasing need to educate juries on how to distinguish between legitimate and spurious claims of driver fatigue. Jurors must understand that log violations alone do not prove fatigue.

B. The Stakeholders’ Response

While the trucking industry prepares for inspection crackdowns following a 60 day grace period, the interest groups Parents Against Tired Truckers (PATT), Citizens for Reliable and Safe Highways (CRASH) and Public Citizen, Inc. have sued the FMCSA to amend the regulations to enforce harsher restrictions on the trucking industry. The petitioners argue for reducing the number of hours truckers are allowed to work, for lengthening the ‘weekend’ break required to reset a driver’s clock, and for minimizing the number of hours driven overnight. The American Trucking Associations, Inc. (ATA) countered the petition by filing an amicus brief as intervenors in support of the FMCSA, while at the same time filing their own petition against the FMCSA to amend a specific section of the new HoS regulations. See generally, Initial Brief for the Intervenors in Support of Respondent (1/23/04), Public Citizen, Inc., Citizens for Reliable and Safe Highways, and Parents Against Tired Truckers v. Federal Motor Carrier Safety Administration, TRAN-68FR22456.

Perhaps the most intriguing dynamic of this legal triangle has been the ATA’s support of the HoS regulations. When contrasted with the alternatives proposed by PATT, CRASH, and Public Citizen, it was only natural for the ATA to fall on the side of the FMCSA. Nonetheless, the pairing makes for an unnatural marriage, complicated by the ATA’s own petition against the regulations. Here are the main reasons for the ATA’s support of the new regulations, as stated in their amicus brief:

1. **There are factors affecting safety that extend beyond fatigue.**

   The ATA’s first line of defense is to downplay the importance of fatigue as one of numerous variables that contribute to highway safety. The most compelling arguments in favor of this position are that inexperienced drivers are at a higher risk of being involved in accidents than experienced drivers, and night driving allows trucks to be on the road when there is relatively little other traffic. The changes proposed by the PATT/CRASH/Public Citizen petition
would require the hiring of more truck drivers, leading to more inexperienced drivers on the road. These proposed rules would also restrict the amount of driving that truck drivers could perform at night, forcing them onto the roads in the daytime and contend with commuter rushes. The ATA opposes these changes and cites studies that claim the accident rate per mile driven by truck drivers between midnight and 6 A.M. is lower than the corresponding rates between 6 A.M. and noon, and between noon and 6 P.M. The ATA argues that the changes proposed by PATT, CRASH, and Public Citizen would not only put more inexperienced drivers on the road, it would put all drivers on the road at times of greater risk.

2. **The new regulations properly consider costs.**

   The ATA notes that the FMCSA is statutorily obligated to consider the “costs and benefits” of HoS regulations (citing 49 U.S.C. § 31136(c)(2)(A)). The ATA is concerned with the operational flexibility required in the trucking industry. Various studies have been cited which estimate the costs of alternative regulatory schemes at anywhere from $3-110 billion. The bottom line is that in an industry with minute profit margins that generally fall in the 1-3% range, overly restrictive HoS regulations could have catastrophic economic consequences. There is a safety cost to be considered as well, as overly restrictive HoS regulations would create serious lifestyle inconveniences for truckers that would likely lead to increased turnover in the industry. Turnover, of course, comes with a high financial price but it also means more inexperienced drivers on the road, which in turn leads to greater accident risk.

3. **The new regulations are properly grounded in scientific principles.**

   In this argument, the ATA focuses more on comparing the new HOS rule to the old rule than to the petitioners’ proposed rule, which is essentially dismissed as impractical.

   • The first argument supported by the ATA is that the daily 10-hour break required by the new rule is a major step in promoting alert driving. Citing an FMCSA study that found significant differences in performance between truck drivers sleeping five hours and those sleeping seven, the ATA notes that a ten hour break gives drivers ample time to eat meals on both ends of their sleep period, shower, and essentially follow a normal morning routine, while still sleeping at least seven hours. Under the old rule, only eight hours were required off duty before a driver could resume driving. If a driver was trying to maximize income, those hours would be used for meals and showering and no more than 6 hours would be left for sleeping.

   • The ATA’s second argument is that the 34 hour “weekend break” required in order to restart the weekly hours count is a sufficient period of time for a driver to obtain two full length sleep periods as well as the intermediate day off. In an age of six-day workweeks, 34 hours is comparable to a day worker who leaves work at 8 P.M. on Friday and returns at 6 A.M. Sunday. It may not be a long weekend, but it is an adequate period of rest to offer some refreshment.

   • The ATA also notes that the minimum cycle a driver can work (assuming he or she is using every available driving hour) is 21 hours, comprised of 11 driving hours and 10 off-duty hours; whereas in the old rules a driver could work an 18-hour cycle of 10-hour driving shifts and 8-hour breaks. Either of these cycles would result in a physiologically difficult
backward rotation, but the closer the number is to 24 hours, the safer it is from a physiological standpoint.

- Finally, the ATA notes that time awake is more important than time on duty. Under the old rules, a driver who began work at 6 A.M. and worked with intermittent breaks over the course of the day would still be allowed to work 20 hours (or more) later, as long as the time driven had not totaled 10 hours. The new rules acknowledge that what is important is not the number of hours worked, but the length of time awake. If the same worker started work at 6 A.M. under the new rules, he or she would not be able to work past 8 P.M. (14 hours after the shift start) unless there had been an intervening sleep period of at least two hours and the shift was followed by a second sleep period that combined with the first to total at least eight hours (see below). This adjustment is designed to end the opportunity for truckers to be legally driving after extended periods awake. The flaw, of course, is that truckers could be awake and off-duty for as many hours as they want before beginning a shift. At that point, though, training and responsible behavior must take over for the regulations to assure safe driving.

C. ATA Requests Amendment to Split Sleep Provision

In addition to an amicus brief filed in support of FMCSA’s defense of the new HOS regulations against the claims of PATT, CRASH, and Public Citizen, ATA has filed a petition to amend specific sections. The core of the ATA’s complaint revolves around a peculiar provision of the HOS rules that encourages drivers to sleep in their truck rather than more comfortably sleeping in their own bed, or in a motel room. Consider the following situation as an example:

A driver is on duty loading his truck for 3 hours, then drives for 6 hours (total = 9 hours), and then chooses to take a nap for 2 hours (total = 11). If he then drives for 5 hours (total = 16 hours), he is in violation of the HOS rules if he does anything other than get into the sleeper berth for 8 hours following the shift. This is because the rules do not permit a driver to be on duty more than 14 hours after the start of the shift. If, however, the driver completes the 16-hour cycle and goes to the sleeper berth for 8 hours, then under the “split sleep” exemption, the driver’s schedule was legal all day.

1. The ATA argues the following points:

- The rule discourages naps because drivers who are not in a position to utilize the split sleep rule would view naps as wasted work hours, even if their alertness while driving would benefit from a nap. Inability to use the split sleep rule could occur if a driver a) did not have a full two hours to nap; b) is not able to go directly from work to bed; c) chooses to sleep at home instead of in the sleeper berth, thereby logging his or her time as off-duty rather than sleeper berth. Every time a driver begins a workday, he or she is starting a 14-hour clock that can only be extended by properly utilizing the split sleep exemption.

- The split sleep exemption, as designed, discourages full 10-hour off-duty periods because drivers are allowed to total the two sleeps to account for their 10 hours of rest; therefore, if a driver takes a three-hour nap during the day and a seven-hour sleep following the shift, the driver would be allowed to resume driving the next morning after only seven hours off.
Since naps and mid-drive off-duty time would be considered wastes of time, drivers are motivated to work for 14 straight hours without breaks, which could often include driving for 11 straight hours.

At the end of multi-day trips, drivers would have to be sure the trip ends with an even number of trips to the sleeper berth to properly account for every split sleep period. Otherwise, a driver could end up sleeping in his truck’s sleeper berth parked in his own driveway after a trip is completed just in order to comply with the HoS rules, even if his own bedroom is next door!

Logbook inspectors and accident investigators would be placed in the impossible position of having to determine the driver’s intent to decide if a driver is in violation of the HoS rules. If the example driver cited above had his or her book inspected in the last two hours of the driving day, the legality of the trip would depend on whether or not the driver intended to sleep for eight hours in his truck sleeper berth immediately after the trip. If that sleep was intended, then the first two hours of sleep were part of a split sleep that could lawfully extend the driver’s work day by two hours; otherwise, the driver would be in excess of 14 hours since the start of duty, and therefore driving in violation of the HoS rules.

The ATA proposes amending the rule to allow for the back end of the split sleep to be achieved by a full 10 hours of off-duty time of any categorization. According to the ATA, this amendment would address concerns about the current rule in the following ways:

The proposed rule would encourage naps because no naps of two hours or longer would count toward the 14-hour rule, as long as the driver either sleeps in the sleeper immediately after the shift or goes off duty for at least 10 hours after the shift.

The proposed rule would encourage longer “anchor sleep” because instead of forcing drivers to obtain x hours in the sleeper berth after a shift (where x = 10 – [nap length]), drivers would have the option of taking a full 10 hours off-duty, which would allow for longer sleep because, clearly, 10 is greater than x. This would also encourage better quality sleep because drivers would be able to sleep at home or in a motel, where accommodations would usually be more comfortable than in the sleeper berth. Sleep quality is often overlooked as a contributor to fatigue, but in fact it is a very real and well-studied phenomenon that has significant impact on the extent to which sleep is restorative.

The proposed rule would encourage shorter driving periods because there would be no disincentive to using naps to break up a driving period.

The proposed rule would be “circadian friendly” because most drivers would take advantage of the naps in the afternoon post-lunch dip hours. While the increased accident rates in these hours are definitely of concern, it seems the ATA was slightly presumptive in asserting that these changes would address the circadian dips. What seems more likely is that drivers will drive through the early morning and mid-afternoon dips in order to take naps during the morning and evening rush hours when traffic is slow and driving efficiency is down.

The proposed rule would resolve the issue of drivers having to conclude trips by spending time in the sleeper berth after the route has been completed.
• The proposed rule would be easily enforceable because it would eliminate the aspect of interpreting a driver’s intent.

One of the FMCSA’s primary goals in enacting the new HoS rules was to properly consider 24-hour circadian rhythms by creating a schedule that forced drivers into a 24-hour daily routine—14 hours on duty and 10 hours off. The ATA acknowledges that its proposal would also allow for deviation from a 24-hour schedule when drivers take naps to extend shifts and then take 10 hour rests after the shift. But, citing works by this author, the ATA notes that forward rotations are less physiologically disruptive than backward rotations.

However, the rules already leave enough room for drivers to fall off of this intended schedule by either working fewer than 14 hours in a day or taking more than 10 hours off at a time. The former circumstance would lead to a backwards rotating schedule while the latter would lead to a forward rotating schedule.

This all ultimately leads to the conclusion that HoS regulations are at heart a flawed solution to a complex problem. The take-home lesson – certain violations of HoS, within limits, which allow drivers to get better quality rest may be justified physiologically if the ultimate goal is to achieve rested safe drivers on the roads.

IV. Discovery

When human fatigue is claimed in litigation, it is vital to establish the sleep-wake pattern of the individual over the hours, days, and even weeks leading up to the moment in question. Many people mistakenly believe that the number of hours slept in the previous night is the only variable that affects fatigue. While this factor is undoubtedly critical, the individual’s habitual pattern can be just as important.

Other variables, including time of day of the accident, the individual’s behavior prior to the accident, and environmental conditions, among others, can act in concert to strongly support the conclusion that fatigue either was or was not the likely cause of an accident. But the sleep-wake pattern on its own is able to reveal a great deal about the individual’s level of sleep deprivation, the timing of his or her biological clock, and ultimately the likelihood that he or she would have been suffering from fatigue impairment.

What information can attorneys solicit through the discovery process that would help their expert consultant to examine fatigue? Litigators who work extensively in transportation can attest to the dangers of relying on operator logs, which all too frequently prove to be poorly maintained or even deliberately falsified. This fact alone, however, does not necessarily mean victory for every plaintiff that sues a trucker, or doom for every company whose operator has filed a false logbook.

Through a comprehensive discovery effort, information can often be collected that helps to reconstruct a driver’s activities. From this reconstruction, best-case, worst-case, and most likely sleep-wake patterns can be established, and from there estimates can be made as to the most probable fatigue range.
In a nutshell, if you can prove the person was doing something else, then they could not be sleeping, and if they weren’t sleeping they were becoming increasingly sleep deprived. Common evidence that can establish a person’s place, time and activities as a data point for this sleep-wake history reconstruction includes:

- Cell phone records—presumably phone activity indicates wakefulness at a given time; even better, many records indicate the location of the tower the phone was utilizing, thus placing the driver within a radius of a few miles;
- Credit card and toll receipts—receipts always show a date stamp and many identify location as well as time, putting a pinpoint on where someone was when a purchase was made;
- Fuel receipts—like credit card receipts, fuel receipts often give a precise time and location; in addition, if two or more fuel receipts are discovered, calculations of the time between fuelings, the size of the fuel tank, and a vehicle’s gas mileage can indicate mileage traveled in a given time interval;
- Weight station receipts—again act as a data point for a place and time, as well as providing load weights that can be used to better define a vehicle’s gas mileage at a given point in time;
- Rest stop records—some rest areas keep records of vehicles that stop; these records can help establish periods when a driver was likely resting;
- Loading/Unloading records—many facilities keep detailed records of when trucks arrive to load or unload and when they leave; these records can often serve as key endpoints in reconstructing a trip by detailing the precise time that a driver arrived at a destination;
- Punch cards—these are generally used for short-haul jobs where drivers start and end days at a distribution center; they can put finite start and stop points to shifts.

By discovering the evidence to use as data points, a sleep-wake pattern can be derived, even for a driver whose logbooks have been discredited. Establishing a sleep-wake pattern allows for a more complete analysis of an individual’s fatigue and alertness over time or at a given point in time, by building a “bottom up” case for or against a theory of fatigue.

V. Conclusion

This review can only give a brief introduction into a complex area of science and regulatory debate on human fatigue. Yet it reflects one of the more important issues in our society as businesses and individuals learn to cope with the radical changes brought about by 24/7 globalization. Human fatigue has broad consequences for businesses, ranging from safety
and risk management, to productivity, creativity and competitiveness, and is a major determinant of absenteeism and turnover. In our highly litigious society, human fatigue is being asserted with increasing frequency. It is imperative that these claims now, more than ever, take advantage of the extensive scientific research and modeling tools which can convert a previously soft issue into objective science.

Circadian Technologies, Inc. is an international research and consulting firm providing programs to reduce the costs, risks, and liabilities of human factors in the extended hours workplace. For more information, please visit www.circadian.com.
© Circadian Technologies, Inc. 2004
Martin Moore-Ede, M.D., PhD. is a leading international expert on the role of human
fatigue in transportation accidents, including commercial motor vehicles (truck, bus and
motorcoach), automobiles, marine vessels (ship, tugboat), rail locomotives (freight and
passenger), public transit vehicles (bus, light rail, commuter rail) and aviation equipment
(commercial, cargo and private aircraft).

As a Harvard professor for 25 years, Dr. Moore-Ede conducted the pioneering research
investigating the role of fatigue as a leading cause of fatal and high cost accidents on highways
(including single vehicle, hit-rear and driver inattention accidents), and of train derailments,
collisions at sea, and human errors in aviation. He has published 10 books, and 125 scientific
papers on human fatigue, errors and accidents and the physiology of sleep deprivation and
circadian rhythms. He has served on multiple national and international committees, and has
received numerous awards. He is a frequent guest on television, & radio (CNN, Today Show,
Good Morning America, 20:20, Dateline, Oprah Winfree, Nova, BBC), radio (NPR Fresh Air,
Connection), and print media (Wall Street Journal, New York Times, Washington Post, Time
and Newsweek). He has testified before Congressional committees on multiple occasions, and
advised government agencies in the US, Canada and the U.K.

As the CEO of the consulting firm, Circadian Technologies, Inc., he currently advises
and supervises teams which work with over half of the Fortune 1000 companies on strategies to
minimize fatigue risk, and reduce accidents caused by fatigue. In addition, Dr. Moore-Ede
undertakes expert consultation work in selected cases, and provides confidential advice to
attorneys and their clients on how to minimize litigation risk, and distinguish readily defensible
from hard to defend claims, and on strategies to cross-examine opposing counsel’s witnesses.
He has extensive experience of providing expert testimony in the courtroom, where he has an
outstanding record of educating and engaging juries so they reach informed conclusions, and of
using scientifically validated computer models to reconstruct accidents scenarios in the
courtroom.