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Fatigue in the Railroad Industry

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Good Afternoon Congresswoman Brown, Representative Oberstar, and other committee members. It is my pleasure to have the privilege of testingfying before the committee once again on this important topic. As you may recall I testified before the committee in August on the topic of intermodal transportation. The two topics are actually related. The U.S. railroad system and its intermodal operations are the envy of every major economy in the world because of its capacity, efficiency, and profitability. One of the reasons for its competitiveness and efficiency is the fact it is operated in a very flexible manner allocating resources and equipment in a very effective fashion. Ensuring the safe and efficient movement of goods is key to our nations' economic security and viability.

It is my pleasure to testify on this topic because I believe that fatigue is a complex issue affecting thousands of railroad employees everyday. This issue is complicated by the fact that it is the result of complex biology and physiology of the circadian rhythms, as well as compounded by the operational and economic issues affecting railroads. The Human Factors Coordinating Committee of the U. S. Department of Transportation (USDOT, 1999) defined fatigue as "a complex state characterized by a lack of alertness and reduced mental and physical performance, often accompanied by drowsiness". Generally, fatigue in the railroad industry indicates that an individual suffers a loss of alertness, a loss of mental or cognitive capacity, and self-reports sleepiness. For the railroad workers, these issues also include the more practical concerns of pay, time away from home, and other quality of life issues.

In the few minutes I have I want to impress upon the committee three crucial points:

1. First, simply changing the hours of service law, such as decreasing on-duty hours or lengthening time off, will not necessarily reduce fatigue and may make it worse in some cases.
2. Second, in order to fully address the fatigue issue railroads should be required to established fatigue countermeasures plans evaluated by an independent scientific panel that include an accountability mechanism.
3. Third, making available additional research dollars to a consortium of research universities for the continued study of fatigue countermeasures and measurement tools calibrated to everyday operational criteria will expedite the successful management of fatigue in the railroad industry.

Variability in Operations and Conditions

Beginning in the mid- 1990s I engaged in a number of studies for the railroads, the FRA, and the labor organizations to examine fatigue and to identify effective countermeasures that can be used to manage it. Over the past 12 years we have conducted over a dozen studies in which over 3,500 railroad employees have completed fatigue surveys. In addition to survey completion, many of these same employees have also kept sleep logs, worn actigraphs, and participated in interviews and focus groups. We have looked at a number of different scheduling programs such as time windows, 8 hours on and 3 hours off, 7 hours on and 3 hours off, 10 hours on and 5 hours off, etc. In a number of these instances (described in greater detail in my book Managing Fatigue in the Railroad Industry - a pre-publication draft is available for the committee's review) fatigue was reduced or mitigated and in many cases satisfaction with quality of life was improved. I want to publicly thank the many engineers, conductors, brakemen and dispatchers and their managers who took the time to help us understand the complexities of this important issue. Their support helped us determine that there is no one single approach that is going to solve the problem and eliminate the risk of fatigue.

Many of these pilot programs are no longer in existence due to the fact that they were single problem solutions. They addressed scheduling, quality of life, or line-up concerns but failed to fully address fatigue, operational, compensation, or other issues. Nevertheless, some of the lessons learned from the pilots have made it into existing

practice. For example, the BNSF has developed the 7-3 overlay, the NS has greatly increased the number of scheduled work assignments, the CSX has a very large number of assigned days off, and the CN/IC has developed the meet- and return or mid-route crew change approach. But, none of these programs fully or completely manages the fatigue issues faced in the railroad operating environment. In some cases these approaches are too voluntary and can be circumvented by clauses in the contracts and in others the problem is simply transferred to the extraboard. The lessons learned are that in order to fully manage fatigue a comprehensive plan must be developed that includes all aspects of the operation and all members of the work group.

There are many reasons why it is difficult to identify a simple single solution to the problem of fatigue in the railroad industry. First, fatigue is caused both by a lack of sleep and by the circadian rhythm. The longer one is awake, the less alert one becomes thereby decreasing cognitive effectiveness. The chart below (Figure 1) visually depicts this as it shows an increasingly steady decline in alertness that gradually increases in the daylight hours and then begins to decline again in the evening.

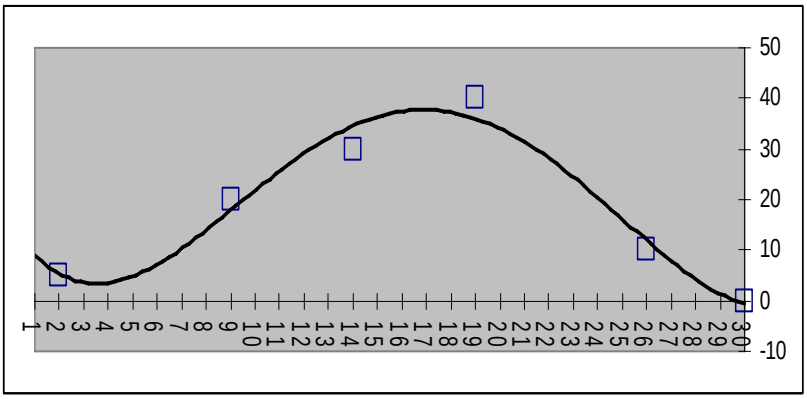

Figure 1. Alertness over time.

So, if the hours of service law were to change and give people 10 hours off between shifts, individuals would still experience lowered levels of alertness between 4 and 5 in the morning. Thus, fatigue would still need to be managed with additional countermeasures suggesting the need for a more comprehensive plan.

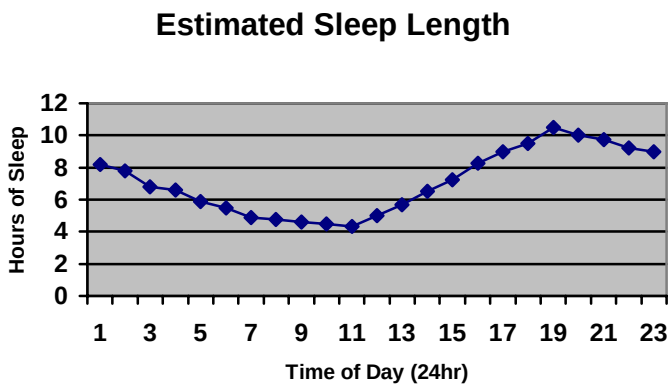

Figure 2. Estimated Sleep Lengths.

Similarly, sleep length varies according to the time of day. Again, looking at the graph in Figure 2, if one works a midnight shift and tries to go to sleep at 7am or 8am there is a strong likelihood that this individual will only obtain 4 1/2 hours of sleep. This too is due to circadian rhythms. So, simply giving a railroader more time off does not necessarily translate into more sleep nor reduce the employees' risk of working while fatigued. Fatigue is a function of the combination of hours of sleep, hours awake, and time of day relative to the circadian rhythms.

Another challenge is the fact that fatigue issues and problems occur in different locations and it has been is difficult to identify a single metric that clearly delineates and quantifies the problem. For example, last year, I conducted a small study investigating the impact of work schedules on operating procedures. As you can see from the graph below based on the work schedules of over 150 employees, with over 22,000 trip starts, the average number of hours on duty was 9.6 and the average number of hours off between trips was slightly over 25 hours. This location appears to have adequate time off. Incidentally, changing the hours of service in this instance would likely do little to reduce fatigue.

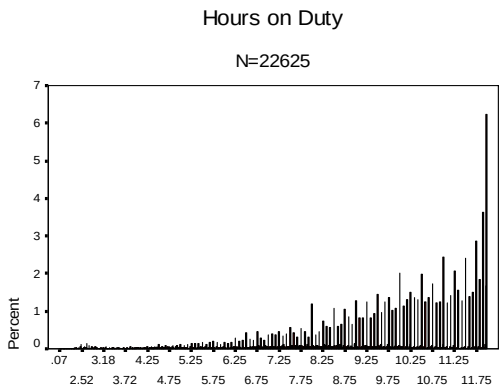

Figure 3. Hours on Duty.

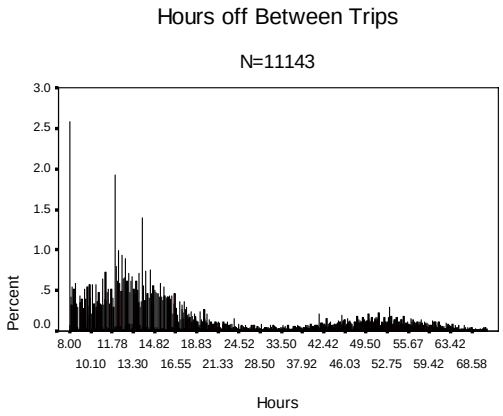

Figure 4. Hours off-duty between trips.

In another study, at a different location, funded by the FRA, 30 railroad employees (engineers and conductors) wore actigraphs for one month. As can be seen from the graph, the engineers slept an average of approximately 7.1 hours per 24-hour period while the conductors obtained an average of 5.8 hours of sleep. The average for the total group was 6.4 hours per 24-hour period. As you know most experts recommend 7 to 8 hours of sleep per sleep episode but most shift workers in the US report getting about 6.5 hours of sleep on the average.

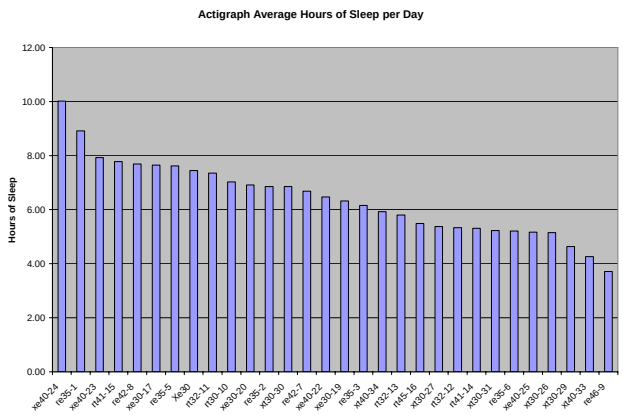

Figure 5. Average Hours of Sleep Obtained in a Sample of Engineers and Conductors.

Looking more carefully (see Figure 5) at the actual individuals in the study you can see that some averaged close to 10 hours of sleep and one obtained as few as 4 four of sleep. Most experts agree that 5-6 hours of sleep in a 24 hour period is the lower limit on what an individual needs in order to be able to function effectively. Put another way, being awake for over 18 consecutive hours following a sleep period has been shown to be associated with demonstrable decreases in cognitive performance. Clearly, there are wide individual differences in amounts of sleep obtained and huge variability in individual sleep habits. Interestingly, none of the participants reported an accident or an injury during the study period. Some people were getting very little sleep and one person may have had a sleep disorder.

Qualitative data obtained from study participants in focus groups indicated that the situation varied from pool to pool and individual to individual. The engineers in this study reported that they were able to book 10 hours rest off undisturbed if they needed it as part of their contract. But, they also indicated that even with that amount of time off they were only able to sleep for 3 or 4 hours, which is most likely due to time of day effects and reported anxiety over anticipated calls. Clearly, more time off between trips is desirable but additional countermeasures would be needed to address the fact that they were unable to sleep during their off time.

Looking more deeply into the data we found that a typical pool engineer had a schedule that demonstrated an acceptable overall average amount of sleep but masked the fact that individual sleep episodes were very low on particular days. The point is that, under the current hours of service this individual had an opportunity to obtain adequate

rest but that even with the opportunity to book up to 10 hours undisturbed rest there were still occasions when the individual did not obtain an adequate amount of sleep.

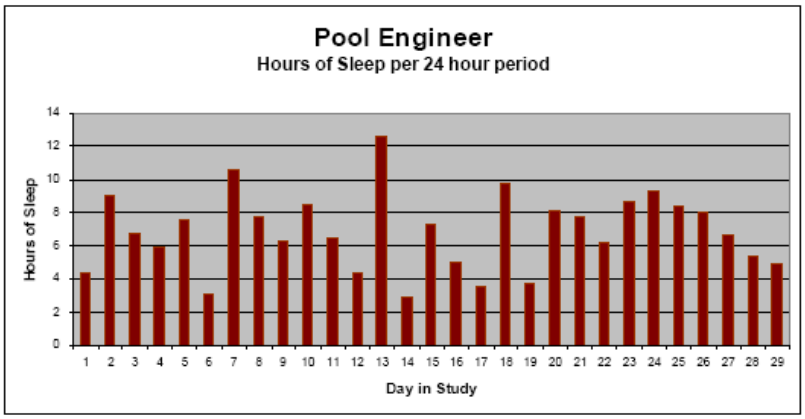

Figure 6. Daily Hours of Sleep for Pool Engineer.

Again, this is likely due to the time of day that the person tried to sleep and the influence of the circadian rhythms.

This pattern of results also points up the phenomenon of sleep debt which occurs when an individual obtains less than 7-8 hours of sleep per night over consecutive nights. The best research available suggests that a person's reaction time decreases as the sleep debt builds. Persons in this study appeared to have accumulated a sleep debt due to working on less than 5 hours of sleep more than 50% of the time. Therefore, efforts to reduce sleep debt through the use of fatigue countermeasures plans would be the most desirable approach.

Fatigue Management Plans

Most fatigue experts agree that a non-prescriptive approach is the most desirable because it is too difficult and impractical to identify a rule that takes into account all of the scenarios in a practical fashion. This is my second major point. Given the great variability in conditions and circumstances it is recommended that railroads be required to develop and be held accountable for comprehensive **fatigue management plans**. This non-prescriptive approach is currently being used in Canada and Australia and would provide for the most comprehensive and most flexible application of scientific principles to the management of fatigue in the railroad industry.

Due to the complex array of variables that influence a person's ability to function at an optimal level it is extremely unrealistic to develop a rule that will cover all the contingencies and still be practical. Moreover, fatigue is a condition of the workplace that should be managed like any other hazard or risk to working safely. Fatigue should not be considered as a category in and of itself, but rather integrated into the array of risks that are regularly managed by transportation professionals in the workplace. It should be noted that U.S. based railroads with Canadian operations have already complied with this approach and have filed FMPs with Transport Canada.

Lastly, the UPRR has already begun to use this approach. A short time ago I served as a member of an *independent scientific panel* commissioned to review the UPRR Fatigue Management Plan. The independent panel was able to review the plan, and make recommendations to the company to improve its plan. Representatives from the FRA, the NTSB, as well as labor and management, observed the process. The use of a scientific panel was extremely beneficial because the opportunity for collaboration and development of additional countermeasures based on the review. Improved collaboration is more likely if independent experts with no regulatory responsibility are involved. A finalized plan could be submitted to a regulatory body for evaluation and accountability. Interestingly, one component of the UPRR approach is the utilization of a model of fatigue and alertness to assess the fatigue risk associated with various schedules. This approach is a good one, but needs further research to operationalize the metrics used. Other railroads are currently in discussions about adopting this approach.

Given that it is nearly impossible to come up with a rule that covers all possible scenarios that occur, FMPs should be implemented that utilize the following principles to address fatigue problems:

- Individuals require approximately seven to eight hours of sleep in twenty-four hour periods to be at optimum levels of performance.
- In order to recover from regular work shifts, there should be sufficient time off between shifts in order to ensure eight hours of time in bed.
- In determining time off between starts, consideration should be given to the practicality and likelihood of actually obtaining sleep, based on considerations of the circadian rhythms of the human body, during the time available.

- The overriding principle that should guide decisions in this area is the need to address, not just the number of hours worked, but the number of hours off between duty periods. Such rest hours will facilitate adequate rest for recovery.
- Efforts should be made to reduce consecutive days with less than six hours of sleep obtained may result in a sleep-debt which can affect cognitive performance and reaction time
- There should be a limit to the number of consecutive long work periods allowed.
- When chances for sleeping an adequate amount decrease, there is greater need for mandatory time off.
- When opportunities for sleep during the midnight hours are limited, individuals may need more time to recover from extended work periods.

Research Funding

My final point is to call for the allocation of more research funding to speed up the process of developing tools to address fatigue. The FRA and the AAR have made a good initial effort at developing fatigue countermeasures, validating scientific models, and additional measurement tools for training and education efforts. However, just as we rely on more than one research university to search for the cure for cancer, this process could be faster if more scientists and researchers were involved. Furthermore, the development of an independent consortium of universities would likely lead to increased progress, more collaboration and cooperation of interested parties if the fear of regulation or punitive fines were removed. In my opinion, progress to this point has been slow due to the fear of regulation or possible fines. It is much easier to collaborate if you don't have to have your attorney at the table. There are many existing outlets for these funds such as NIOSH or the UTC program.

In summary, in my opinion, the development of FMPS is the most viable way to ensure that the complex problem of fatigue is addressed using the best available scientific

knowledge. While some changes or alterations to the existing hours of service would make some specific improvements a mechanism for addressing the overall risk of working fatigued would not have been addressed.

I would like to thank the committee for inviting me to testify on this very important topic.