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FATIGUE IN THE RAIL INDUSTRY

(110–8)

HEARINGS

BEFORE THE

SUBCOMMITTEE ON

RAILROADS, PIPELINES, AND HAZARDOUS MATERIALS

OF THE

COMMITTEE ON TRANSPORTATION AND INFRASTRUCTURE
HOUSE OF REPRESENTATIVES

ONE HUNDRED TENTH CONGRESS

FIRST SESSION

FEBRUARY 13, 2007

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Washington, DC 20515

February 8, 2007

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Ranking Republican Member

James W. Coon II, Republican Chief of Staff

SUMMARY OF SUBJECT MATTER

TO: Members of the Subcommittee on Railroads, Pipelines, and Hazardous Materials

FROM: Subcommittee on Railroads, Pipelines, and Hazardous Materials Staff

RE: Hearing on Fatigue in the Rail Industry

PURPOSE OF HEARING

The Subcommittee on Railroads, Pipelines, and Hazardous Materials is scheduled to meet on Tuesday, February 13, 2007 at 2:00 p.m. to receive testimony on fatigue in the rail industry.

BACKGROUND

According to the Federal Railroad Administration (FRA), the total number of train accidents, including collisions and derailments, has increased from 2,504 in 1994 (when the FRA was last reauthorized) to 3,325 in 2005. The accident rate – which takes into account the corresponding increase in train miles traveled from about 655 million miles in 1994 to about 790 million miles in 2005 – has also increased since 1994. Meanwhile, fatalities and injuries have increased from 12 fatalities and 262 injuries in 1994 to 33 fatalities and 734 injuries in 2005.

Although generally accepted as a factor in train accidents, the exact number of accidents due to fatigue is difficult to determine and likely to be underestimated, according to the National Transportation Safety Board (NTSB). The difficulty in determining the incidence of fatigue-related accidents is due, at least in part, to the difficulty in identifying fatigue as a causal or contributing factor in accidents. There is no comparable chemical test for identifying the presence of fatigue as there is for identifying the presence of drugs or alcohol; hence, it is often difficult to conclude unequivocally that fatigue was a causal or contributing factor in an accident. In most instances, one or more indirect or circumstantial pieces of evidence are used to make the case that fatigue was a factor in the accidents. This evidence includes witness statements, hours worked and slept in the days prior to the accident, the time at which the accident occurred, the regularity or irregularity of the operator's schedule, or the operator's admission that he fell asleep or was impaired by fatigue.

Despite the difficulty in identifying fatigue as a causal factor, estimates of the number of accidents involving fatigue have been made for the different modes of transportation. With respect to railroads, the FRA reports that human factors are responsible for nearly 40 percent of all train accidents, and that fatigue plays a role in approximately one out of four of those accidents.

The NTSB's in-depth investigations have also demonstrated that fatigue is a major factor in transportation accidents. In fact, fatigue has been on the NTSB's Most Wanted list of safety improvements since its inception in 1990. In the late 1980s, following a series of fatigue-related accidents, the NTSB issued three recommendations to the U.S. Department of Transportation (DOT) addressing needed research, education, and revisions to hours-of-service regulations. Between 1989 and 1999, the NTSB issued more than 70 additional recommendations to the DOT, States, industry, and industry associations to reduce the incidence of fatigue-related accidents.

In 1999, the NTSB published a report evaluating the efforts of the DOT to address operator fatigue. According to the NTSB, in response to the three recommendations issued in 1989, the DOT and the modal administrations "acted and responded positively to those addressing research and education; little action, however, has occurred with respect to revising the hours-of-service regulations."

Hours-of-service regulations specify the length of on-duty and off-duty time for operators in transportation. The current hours-of-service regulations vary from mode to mode. The NTSB reports that the maximum number of hours an employee of each mode is permitted to work in the course of a 30-day period is 100 hours for commercial pilots, 260 hours for truck drivers, and 360 hours for licensed individuals on an oceangoing vessel or coastwise vessel (when at sea). Meanwhile, locomotive engineers may operate a train up to 432 hours per month.

The NTSB recommended that the FRA establish within two years scientifically based hours-of-service regulations that set limits on hours-of-service, provide predictable work and rest schedules, and consider circadian rhythms and human sleep and rest requirements. However, the FRA is the only modal administration within the DOT whose hours-of-service standards are mandated by Congressional statute and, therefore, may not be adjusted or modified by administrative procedures.

HOURS-OF-SERVICE

The Hours of Service Act was first enacted in 1907; it was substantially revised in 1969, and amended again in 1976 and 1988. The Act governs maximum time on-duty for all persons engaged in or connected with the movement of a train, including locomotive engineers, conductors, signalmen, and dispatchers. Maintenance-of-way workers (who maintain and repair tracks and other structures), carmen (who repair and inspect railroad cars), other shop crafts, and contractors who perform signal duties are not covered by the Act and thus have no limits on hours-of-service.

Under current law, train operating crews and railroad signalmen can work 12 consecutive hours with 10 hours of rest. However, if they work less than 12 hours by even one minute, then they are only required to get 8 hours of rest. Duty tours may be extended by interim periods of release, 4 or more hours for train service and 1 or more hours for signal service.

This means that an individual can begin a shift on Monday at 8:00 a.m., and be called for a shift on Tuesday at 4:00 a.m. and a shift on Wednesday at midnight. According to the FRA, this kind of "backward-rotating shift" may continue for weeks, and can wreak havoc on an employee's circadian rhythm, the biological cycle that governs sleeping patterns.

Train dispatchers are under a different hours-of-service regime. Under current law, dispatchers can work a total of nine hours in a 24-hour period in a tower, office, or station that has two or more shifts in a 24-hour period, or a total of 12 hours in a 24-hour period where employed in a one-shift office.

There are two exceptions to these work periods. During emergencies, all of these employees may be required to work up to an additional four hours, for a total of 16 hours for train operating crews and railroads signalmen, and a total of 13 to 16 hours for train dispatchers (limited to three days per week for dispatchers). In addition, signalmen may be called for one or more "trouble calls" to deal with wayside signal problems or malfunctioning warning devices at grade crossings. Trouble calls can add up to four hours on top of the 12-hour on-duty limit.

Then there is "limbo time," a term used to describe the period of time when a train operating crew's hours-of-service has expired, but the crew has not yet arrived at their point of final release; meaning, the off-duty location or terminal point where they can go home or obtain food and lodging at an away from home terminal. Limbo time also accrues for train operating crews whose trains are stopped on a line of track, frequently due to the expiration of their 12-hour on-duty time limit, before they reach their destination terminal (point of final release). Limbo time accrues from the time the train is stopped until the crew arrives at the final release point, and includes time spent in transportation to their final release point, as well as time spent waiting for transportation to pick them up from their train.

During limbo time, crewmembers are required to stay awake, alert, and able to respond to any situation and follow the railroad's operating rules. Although time spent in limbo is classified under current law as neither on-duty nor off-duty time, it may be paid time for the crew, and any required minimum rest period does not begin until the limbo period ends, limbo time can and has kept railroad operating crews effectively on-duty for well over 12 hours and, in the case of the Union Pacific engineer involved in the 2004 Macdona, Texas accident, 22 hours (12 hours on-duty and 10 hours of limbo time).

When it comes to time available for rest, train crewmembers are generally called for service approximately two to three hours before their report for duty time. So, if a train crewmember is called to return to duty at the completion of his or her statutory off-duty period, then the duration of uninterrupted off-duty time available for sleep could be as little as five or six hours. However, since the required eight or 10 hours of off-duty time includes commuting, leisure, and personal time, the duration of any period available for sleep could be even less than that.

THE MACDONA ACCIDENT

On June 28, 2004, a westbound Union Pacific (UP) freight train traveling on the same main line track as an eastbound BNSF freight train struck the midpoint of the 123-car BNSF train as it was leaving the main line to enter a parallel siding. The accident occurred at the west end of the rail

siding at Macdona, Texas, on the UP's San Antonio Service Unit. The collision derailed the four locomotive units and the first 19 cars of the UP train as well as 17 cars of the BNSF train. As a result of the derailment, the 16th car of the UP train, a pressure tank car loaded with liquefied chlorine, was ruptured. Chlorine escaping from the punctured car immediately vaporized into a cloud of chlorine gas that engulfed the accident area to a radius of at least 700 feet. Three persons, including the conductor of the UP train and two local residents, died as a result of chlorine gas inhalation. The UP train engineer, 23 civilians, and six emergency responders were treated for respiratory distress and other injuries. Damages to the rolling stock, track, and signal equipment were estimated at $5.7 million, with environmental cleanup costs estimated at $150,000.

The NTSB determined that the probable cause of the collision was UP train crew fatigue that resulted in the failure of the engineer and conductor to appropriately respond to wayside signals governing the movement of their train. An NTSB review of the UP engineer's work schedule revealed that his time on-duty in the days leading up to the accident ranged from nine hours to more than 18 hours. Eleven of his work days were longer than 14 hours, with one day totaling 16 hours and eight minutes on-duty, another day totaling 18 hours and 34 minutes on-duty, and another day totaling 22 hours on-duty (12 hours on-duty and 10 hours of limbo time).

Contributing to the crewmembers' fatigue was their failure to obtain sufficient restorative rest prior to reporting for duty because of their ineffective use of off-duty time and UP's train crew scheduling practices, which inverted the crewmembers' work/rest periods. A review of the UP conductor's work schedule showed that in the 10 days prior to the accident he had four days off followed by six consecutive work days leading up to the day of the accident. His duty times for the six work days would have allowed him to continue the nighttime sleep pattern that he had adhered to during the preceding four days off, but the conductor's call for the accident trip shortly after midnight inverted the work/sleep cycle he had developed over the previous 10 days. According to the NTSB, "such a disruption would be expected to produce severe effects for sleepiness and performance."

The NTSB concluded, "The minimum rest periods prescribed by Federal regulations do not take into account either rotating work schedules or the accumulated hours spent working and in limbo time, both of which can affect the ability of an employee to obtain full rest and recuperation between job assignments." The NTSB recommended, among other things, that the FRA require railroads to use scientifically based principles when assigning work schedules for train crewmembers, which consider factors that impact sleep needs, to reduce the effects of fatigue and establish requirements that limit train crewmember limbo time to address fatigue.

In response to the recommendation, FRA Administrator Joseph Boardman stated in an October 24, 2006 letter that the FRA currently lacks rulemaking authority over duty hours, which precludes the FRA from making use of almost a century of scientific learning on the issue of sleep-wake cycles and fatigue-induced performance failures. Administrator Boardman also stated that the FRA lacks the statutory authority to deal with limbo time because the hours-of-service law specifically states that time spent in deadhead transportation from a duty assignment to the place of final release is neither time on duty nor time off duty. In addition, because the United States Supreme Court has held that time spent awaiting deadhead transportation to the place of final release is of the same character as the time spent in the deadhead transportation itself, and is therefore neither time on duty nor time off duty, the FRA lacks authority to adopt regulatory

requirements related to these periods. *See Brotherhood of Locomotive Engineers v. Atchison, Topeka and Santa Fe R.R. Co., 516 U.S. 152, 116 S. Ct. 595 (1996).*

"The FRA supports efforts to address the fatigue experienced by railroad operating employees, and acknowledges that the existing hours-of-service law is not designed to address the causes of fatigue. Also, any requirements that FRA might implement to address fatigue would result in conflict with the provisions of the hours-of-service law, therefore exceeding FRA's existing statutory authority," said Boardman.

The DOT has on four occasions formally submitted legislation to Congress to reform the hours-of-service law, supplement it with fatigue management requirements, or authorize the FRA to prescribe regulations on fatigue in light of current scientific knowledge. To date, however, no action has been taken.

THE SCIENCE OF FATIGUE

Several FRA data collection and research activities provide a quantitative picture of the role of fatigue in railroad accidents. In 1996, the FRA commissioned a work/rest survey of 200 locomotive engineers, which found that while the average locomotive engineer obtained only 20 minutes less sleep than the average person, locomotive engineers who started work between 10:00 p.m. and 3:00 a.m. averaged only about five hours of sleep. Researchers determined that there is considerable variation in the amount of sleep that locomotive engineers obtain, depending on the time of day when work starts, because human physiology enables sleep at night but makes sleeping during the day difficult.

In 1997, the FRA commissioned a simulator study, which found that locomotive engineers working strictly within the hours-of-service standards accumulated a progressive sleep debt over a period of days. Engineers working a 10-hour shift with 12 hours off-duty averaged 6.1 hours of sleep, while engineers with 9.3 hours off-duty averaged only 4.6 hours of sleep. The engineers reported a progressive decrease in subjective alertness across the duration of the study, and performance of safety-sensitive tasks degraded during the same time period. Researchers concluded that the hours-of-service law allows work schedules that degrade job performance and reduce the safety of railroad operations.

Most recently, the FRA released its Fatigue Avoidance Scheduling Tool, a biomathematical model that can be used to reduce the risk of fatigue in work schedules. FRA researchers used two and one-half years of accident data from five Class I freight railroads and the 30-day work schedule histories of locomotive crews preceding about 1,400 train accidents to determine the relationship between accident risk and crew effectiveness. Data from the research showed a strong statistical correlation between the crew's estimated level of alertness and the likelihood that they would be involved in an accident caused by human factors. The level of fatigue associated with some work schedules was found to be equivalent to a 0.08 blood alcohol level or being awake for 21 hours following an 8-hour sleep period the previous night. At this level, train accidents consistent with fatigue, such as failing to stop for red signals, are more likely to occur.

Other FRA analyses of accidents agree substantially with the results of the Fatigue Avoidance Scheduling Tool project. For example, the FRA's Switch Operations Fatality Analysis

(SOFA) working group indicated that fatigue was responsible for more than 22 percent of the risk of SOFA severe incidents from 1997 through 2003. Additionally, the FRA's Collision Avoidance Working Group (CAWG) examined 65 main-track train collisions from 1997 through 2002 in which human factors contributed to trains exceeding their authority by passing a stop signal, failing to comply with a restricted speed signal, or entering territory without authority. The CAWG found that 19 of the 65 accidents involved impaired alertness; nearly all of the 19 collisions occurred between midnight and 8:00 a.m., which indicates a strong circadian effect.

In addition to research focused on fatigue, the FRA has also conducted research and development of new technologies that can help prevent human factors-caused accidents. Positive Train Control (PTC), for example, is an advanced train control technology that can prevent collisions with automatic brake applications. It also provides capabilities such as automatic compliance with speed restrictions and enhanced protection of maintenance-of-way workers. PTC could have prevented the accident in Macdona, Texas, and remains on the NTSB's Most Wanted list of safety improvements.

EXPECTED WITNESSES

The Honorable Joseph H. Boardman
Administrator
Federal Railroad Administration

The Honorable Mark V. Rosenker
Chairman
National Transportation Safety Board

Mr. Edward R. Hamberger
President
The Association of American Railroads

Mr. David Dealy
Vice President, Transportation
BNSF Railway

Mr. Thomas A. Pontolillo
Director of Regulatory Affairs
Brotherhood of Locomotive Engineers and Trainmen
On behalf of the Rail Conference Division, International Brotherhood of Teamsters

Mr. James Brunkenhoefer
National Legislative Director
United Transportation Union

Mr. Leonard Parker
Legislative Director
Brotherhood of Railroad Signalmen

Dr. Steven R. Hursh
President
Institutes for Behavior Resources

Mr. Pat Sherry
Professor
University of Denver

FATIGUE IN THE RAIL INDUSTRY

Tuesday, February 13, 2007

HOUSE OF REPRESENTATIVES,
COMMITTEE ON TRANSPORTATION AND INFRASTRUCTURE,
SUBCOMMITTEE ON RAILROADS, PIPELINES AND HAZARDOUS MATERIALS,
Washington, DC.

The subcommittee met, pursuant to call, at 2:00 p.m., in room 2167, Rayburn House Office Building, the Honorable Corrine Brown [chairwoman of the subcommittee] presiding.

Ms. BROWN. Will the Subcommittee come to order?

The Subcommittee is meeting today to hear testimony on fatigue in the rail industry.

Let me just say from the onset because the Federal Government is shutting down at 2:00, we are going to try to conduct this hearing within an hour. There is going to be restraint on my part, the Ranking Member's part and the members, and also we are going to hold to the five minute rule.

According to the FRA, human factors are responsible for nearly 40 percent of all train accidents, and a new study confirms that fatigue plays a role in approximately one out of four of these accidents. Research analysis of the 30 day work schedule of locomotive crews represent 1.40 train accidents and not surprisingly found a strong correlation between the crew levels of alertness and the likelihood that they would be involved in an accident. The NTSB investigators have reached similar conclusions.

The Hours of Service Law which was originally enacted in 1907, amended in 1969, is outdated. It deals only with acute fatigue, not cumulative fatigue. Since the rail industry is remarkably different today compared to 40 or 100 years, there are some significant shortcomings in the law.

For example, the law does not properly address limbo time which is a time when crew workers' assignment is finished and they are waiting for transportation back to their homes. During limbo time, crew members are required to stay awake, alert and able to respond to any situation which means the crew can be on the job for as long as 15 to 20 hours at a time.

In the case of the Texas accident which the NTSB will mention this afternoon, the engineer worked longer than 14 hours on 11 days prior to the accident. On one of those days, he worked a total of 22 hours, 12 hours and 10 hours in limbo time. The Texas accident raised some longstanding concerns with the Hours of Service Law and railroad operation procedures.

Although the NTSB has repeatedly asked the FRA to make improvements to Hours of Service and address fatigue, the FRA singly does not have the regulatory authority to do so. So it is up to Congress to take action. I understand the railroads are busier than ever and need all of the manpower they can get, and I understand that the railroad workers are happy to work long and hard just to make ends meet, but these hearings are about safety, and we have an opportunity to stop a large percentage of accidents if we use sound science to determine a safe and productive work schedule.

I want to welcome our distinguished panelists today, and I am looking forward to working with you in the hearing and to hearing your ideas on reducing fatigue in the railroad industry and strengthening the overall safety environment.

Before I recognize Mr. Shuster for his opening remarks, I ask unanimous consent to allow 30 days for all members to revise and extend their remarks and to permit the submission of additional statements and material by members and witnesses, without objection.

Mr. Shuster?

Mr. SHUSTER. Thank you, Madam Chairwoman. I want to thank you for putting together this hearing today on fatigue in the railroad industry.

As we have heard over the last two weeks from several people, fatigue has been identified as a contributing factor in several serious accidents. If reducing worker fatigue equals reducing accidents, then I am all for it.

However, when examining this issue, we must also keep in mind that our existing rail safety laws have been a remarkable success. The Bureau of Labor Statistics reports that the rail industry is rated safer than manufacturing, aviation and trucking and from the figures I have seen, statistically, working on the rails is safer than working in a grocery store. According to testimony delivered at our last hearing, there have been a 71 percent decline in train accidents since 1978. Total rail-related fatalities declined 46 percent while total employee deaths have dropped 80 percent.

Worker fatigue is certainly an important issue, and we need to ensure that railroad workers receive adequate rest. When addressing these issues, we must also remember that even well rested humans sometimes make mistakes. One of the best ways to combat human error is through advanced technology. Positive train control can stop a train if an engineer mistakenly runs a red light, new tank car designs can prevent the accidental hazmat releases, and advanced track inspection cars can detect track flaws invisible to the human eye. We must continue to look forward and explore new technologies to keep our railroads safe.

In closing, Madam Chairwoman, I would like to thank you again for holding these hearings on fatigue and thank all of the witnesses that are here today to testify before us. I am looking forward to a most informative hearing today.

Thank you and I yield back.

Ms. BROWN. Thank you.

The other members will have an opportunity to submit their opening remarks and questions.

Now I want to welcome the Honorable Joseph Boardman who is the Administrator for the Federal Railroad Administration. Mr. Cothen, who is the Deputy Assistant Administrator of Safety Standards and Program Development at the FRA, is joining him today.

TESTIMONY OF THE HONORABLE JOSEPH H. BOARDMAN, ADMINISTRATOR, FEDERAL RAILROAD ADMINISTRATION, ACCOMPANIED BY GRADY C. COTHEN, JR., DEPUTY ASSOCIATE ADMINISTRATOR FOR SAFETY STANDARDS AND PROGRAM DEVELOPMENT, FEDERAL RAILROAD ADMINISTRATION; THE HONORABLE MARK V. ROSENKER, CHAIRMAN, NATIONAL TRANSPORTATION SAFETY BOARD

Mr. BOARDMAN. Thank you, Madam Chairwoman and Mr. Shuster.

In an effort to get underway quickly, I am very pleased to be here today for Secretary Peters to testify regarding the issue of fatigue and its relationship to the safety of railroad operations.

In any given year, approximately 35 to 40 percent of train accidents, and very likely the majority of railroad employee fatalities and personal injuries, involve what the safety community refers to as human factors. As I testified before this Subcommittee last July, we are here to maximize safety. We need to make sure that we have good rules and procedures, effective training, system accountability, and positive safety culture.

I also called attention to the need for employees to be fit for duty, well rested, free of alcohol and other impairing drugs, and free of medical conditions that could compromise performance. In the 1980's, the FRA led the way in targeting alcohol and drug use, and the Railroad Safety Advisory Committee is currently exploring the establishment of medical standards for safety-critical railroad employees. This effort includes a sharp focus on sleep disorders which can contribute to fatigue.

My written testimony addresses the broad range of fatigue initiatives we have underway; but, in the few minutes that I have here today, I would like to focus particularly on the providing of employees with the opportunity to get needed rest.

As you stated, we are approaching the 100th anniversary of the Hours of Service Act on March 4th of this year, and its substance as applied to train crews has not been amended for over 37 years. For the last 25 years the National Transportation Safety Board has been calling attention to the apparent role of fatigue in major train accidents. For much of that time, FRA, labor, and management have worked together to get a better understanding of this problem and to develop effective responses.

This past November, I had the pleasure of releasing a study that reported the largest body of fatigue-related data from the railroad industry ever made public. The study documented successful validation and calibration of a fatigue model that may be used to evaluate the scheduling of railroad operating personnel. The underlying data also confirmed what we inferred in other studies, that is, that a significant number of the most serious accidents involve employees whose performance is adversely affected by fatigue.

Today I am here asking for your support for legislation that will permit us to put into action what we have learned. We propose to sunset the hours of service laws but retain its protections as interim regulations. Then we would convene the Railroad Safety Advisory Committee to develop new science-based requirements that can help to reduce human factor accidents and casualties.

We will need revised benchmark limits on work hours and requirements for rest periods to provide simple guidance for fixed schedules where that will suffice, but with the tools now available, we will be also able to recognize fatigue management approaches that include careful evaluation of a wide variety of more flexible work schedules by validated techniques.

Madam Chairwoman, some will tell you that statutory hours of service should live on because, although that Boardman fellow can be trusted for now, who knows who will follow him? I understand the concern that hard-won gains might be lost, but one thing I have learned at the FRA is that we are subject to an incredible amount of oversight and public scrutiny, and we wouldn't and couldn't go far wrong even if we wanted. We are a part of the U.S. Department of Transportation, and FRA as an institution can be trusted to take this on just like the FAA or the FMCSA, and we have prepared ourselves to do it.

Others will tell you that the days of excessively long hours are over. They will say that a variety of improved practices are in place. The situation is under control. In fact, we are gratified that many employees are better off from the point of view of adequate rest than they were in 2004 and 2005. But history teaches us that unexpected forces can sweep rapidly through this industry and that when the spotlight is not on, safety can suffer.

As I pointed out in my prepared remarks, the solution to this problem should not break the bank. Even during the worst of times, employees have received adequate opportunity for rest most of the time, and most employees take advantage of those opportunities. Let us close this remaining gap, and let us ensure the solution holds. I believe that is done by giving the FRA the ability to apply scientifically-based fatigue management through RSAC, advised by RSAC, and with regulation-based hours of service.

Madam Chairwoman, thanks for the opportunity to talk about the problem of fatigue, which affects all of us in every walk of life but which looms largest when life is itself at stake. FRA looks forward to working with this Subcommittee as you move forward with rail safety reauthorization, and our bill will be delivered to Congress tonight.

Ms. BROWN. I ask unanimous consent to permit the gentleman from New York, Mr. Kuhl, to sit with the Subcommittee and ask questions throughout the course of the hearing. Without objection, so ordered.

I welcome the Honorable Mark Rosenker who is Chairman of the National Transportation Safety Board.

Let me remind the witnesses to try to limit their oral statements to five minutes. Your entire statement will appear in the record.

Mr. ROSENKER. Thank you, Chairwoman Brown, Ranking Member Shuster and distinguished members of the Subcommittee. I have submitted my written testimony for the record, and I wish to

thank you for the opportunity to testify on this important safety issue: fatigue in the rail industry.

I plan to discuss three areas of concern today: first, the decades long history of fatigue-caused railroad accidents that the Safety Board has investigated; secondly, the equally long history of safety recommendations that we have made to address the problem; and finally, the frustration we share with the Federal Railroad Administration regarding its lack of legislative authority to address the root causes of fatigue through scientifically-based principles of work load and fatigue management.

Since 1984, fatigue-related train accidents have continued until the most recent collision between two freight trains at Macdona, Texas in June of 2004. Both crew members failed to obtain sufficient restorative rest before reporting for duty because of their ineffective use of off duty time and the railroad's train crew scheduling practices. Work as a train crew member often entails an unpredictable work schedule. That unpredictability may have encouraged this crew to delay obtaining rest.

The work schedules of rail crew members permit repetitive 12 hour duty days that we know lead to cumulative fatigue. When the workers commute, limbo time and family responsibilities are added to those 12 hour daily schedules. The conditions for exceedingly long delays that lead to acute fatigue are quite evident. Further, the relatively short mandatory periods of time off may not afford the opportunity for fully restorative sleep.

In the past two decades, the Safety Board has issued 33 recommendations specific to railroad employee fatigue. The FRA received eight, and others have gone to rail carriers and operating unions. Just as our accident history traces the problem of fatigue in railroad accidents, the Safety Board's recommendation history defines the actions that we think could address the problem including enhanced nighttime supervision, crew alerters, actions to reduce the irregularity and unpredictability of crew members' work-rest schedules, education and counseling to help crew members avoid sleep deprivation and finally the establishment of rail carrier policies that would allow an employee to report off duty when they are impaired by lack of sleep.

Recommendations to address the issue of operator fatigue were placed on the Board's most wanted list in 1990. One recommendation in 1999 asked the FRA to establish scientifically based Hours of Service regulations that set limits on hours of service, provide predictable work and rest schedules and consider circadian rhythms in human sleep and rest requirements. The FRA acknowledged the seriousness of the effects of fatigue on safety, but it stated it did not possess the authority to change Federal Hours of Service. The FRA also stated that the DOT had attempted to seek Congressional authority in 1991 to bring about modernization of Federal Hours of Service laws in a bill submitted to Congress. However, according to the FRA, the bill was not supported by rail labor and rail management, and unfortunately it was not enacted in the 102nd Congress. Therefore, our 1999 safety recommendation was classified ″closed, reconsidered″ in recognition of the FRA's lack of authority to be responsive to the recommendation.

However, after more railroad accidents were attributed to fatigue including the accident in Macdona, Texas, the Safety Board last year recommended that the FRA require railroads to use scientifically based principles when assigning work schedules and establish requirements that limit train crew members' limbo time. The FRA in October, 2006 again responded by saying that the FRA lacked rulemaking authority over duty hours which the FRA says precludes it from making use of almost a century of scientific learning on the issue of sleep-wake cycles and fatigue-induced performance failures.

We believe the FRA needs the authority to regulate crew member work schedule practices and work limits and continue to support changes that would provide the FRA that authority.

Madam Chairwoman, that completes my statement, and I will be happy to respond to your questions.

Ms. BROWN. Thank you.

Mr. Boardman, my questions mainly go to you. You are working on a bill, and you mentioned a need for legislation to address fatigue. Why not leave this up to labor and management to negotiate this?

Mr. BOARDMAN. Yes, Madam Chairwoman, you will have the bill this evening.

Basically, because the public is really not represented in labor and management negotiations and at the collective bargaining table, yet the public is the one that is at risk along the tracks when the workers are not rested and an accident occurs. Companies and labor organizations have their own agendas to deal with, and to place this additional agenda on them at the collective bargaining table, we don't think is the right approach.

Ms. BROWN. Can you give us the five main points of the bill that you all are going to be bringing forth?

Mr. BOARDMAN. Certainly, one of them is the hours of service regulation, in and of itself. In addressing limbo time, for example, we may be asking for a performance-based approach that will take into consideration any prior sleep deficit, the ability to plan rest, the duration of the covered service period, time spent awaiting transportation, time, in transportation, of the day with the circadian rhythms, as the Chairman talked about, and any other factors that may be important.

In terms of saving you time on this particular Committee, I can list each of the elements and get back to you on the major parts of the safety bill itself, but it includes grade crossings, and it includes some clarifications, several areas that I would rather not go into now to save you time.

Ms. BROWN. Thank you.

Did you want to respond?

Mr. ROSENKER. I am in support of what the Administrator is trying to do. We are quite supportive of the action of trying to get the Congress to change the way the legislation is written. It is the only mode of transportation that the Hours of Service are dictated by statute rather than regulatory action.

Ms. BROWN. Mr. Shuster?

Mr. SHUSTER. Thank you.

Mr. Boardman, I think you just mentioned you did not have management or labor consulting when you were drafting what you are going to propose here, is that correct?

Ms. BROWN. In terms of the bill itself. For the regulations, though, the way that will be handled is we will go into the RSAC Committee which is the Rail Safety Advisory Committee where both labor and management are represented.

Mr. SHUSTER. But on the legislation, though, you have put something forward. Did you consult with management and labor?

Mr. BOARDMAN. We have consulted on a regular basis and understand what labor and management believe or think about many of these things, but in the clearance process of the Federal Government, they are not in that clearance process.

Mr. SHUSTER. But you feel confident of their views because obviously if we start to draft legislation, before we put something through, management and labor are certainly going to want to weight in and make sure that they are heard.

Mr. BOARDMAN. We believe it is absolutely critical that management and labor are heard in whatever it is that we develop in terms of a performance approach on the regulations, yes.

Mr. SHUSTER. You testified about FRA's development of a new mathematical model that is going to be helpful in putting forth guidelines in rail's future fatigue management. Have you put that out into the scientific community? Have they reviewed it and what were their findings on that new mathematical model?

Mr. BOARDMAN. I think one of the reasons I brought Mr. Cothen with me today is the history and the amount of detail that have been involved in this whole scientific analysis. So, if it is OK with you, I would ask him to answer that.

Mr. SHUSTER. Sure, absolutely.

Mr. COTHEN. The underlying model, the scientific model———

Mr. SHUSTER. Can you pull the microphone closer?

Mr. COTHEN. Yes, sir.

Mr. SHUSTER. Thank you.

Mr. COTHEN. The scientific model which is embodied in the tool which we are using at the Federal Railroad Administration has been developed by the U.S. Department of Defense and has been peer-reviewed in a major conference in which sleep models were reviewed by established experts in the field. In that review, it was concluded to be the most nearly accurate model available currently.

What we have then done is we have taken the model, and we have applied it to real life railroad data, 400 human-factor train accidents and 1,000 non-human-factor accidents, and we have looked for correspondence to see if what one would think it would predict is in fact predicted. It satisfied that test with a high degree of statistical significance. I am sure that there will be additional peer review of the model as time goes forward.

Mr. SHUSTER. Thank you.

As we move forward on this issue, I know Mr. Boardman has already said that he doesn't have the statutory ability to change the law, but from what I have seen and what I have read is that the average worker in the rail industry is working about 250 hours as opposed to a trucker who works about 240 hours and then down from there, an airline pilot, around 100 hours a month. As we start

to look at this and if we are going to pass laws and enforce the time standards onto railroad companies and into labor, how are we going to enforce that with the individual?

I know myself, I go home with good intentions of going home and having eight hours of sleep, but then my son has homework, a project and I stay up later than I want to. How are we going to make certain that the worker, that the engineer, that the conductor is going to abide by those laws when those things come up in life? That is of great concern, and I would certainly be opposed to forcing an engineer or anybody to say you have to have eight hours of sleep, and in fact how do we enforce that?

What are your thoughts on those types of situations?

Mr. BOARDMAN. I think, first of all, 250 hours, when you think about it, is 3,000 hours a year. That is 60 hours a week. So that is six ten-hour days a week on average, and that really is only an average. It is not clear, when that is talked about, as to whether or not that includes or doesn't include limbo time, and limbo time is neither time worked nor time off, and you are going to hear more about that as we go forward. So it could be a lot more than the 250 hours, or perhaps it is less.

We are not actually saying that, and we know in the industry they want rested workers, and certainly workers want to be rested.

I think one of the things that the model really shows and the scientific work shows is that if you have more time to rest, you will rest more. In some cases, because of the push that is out there today or has been out there in the past, there has been an inability to provide that kind of rest.

But, again, our intent is to have a fatigue management mode or model, or part of what it is that we want to do in terms of regulation, doing something very different than FMCSA or FAA or others have done in the past. With the history that we have here, with over 100 years, with the scientific knowledge that we have today, and with the ability for us hopefully to come to an agreement where we know many progressive issues with railroads and unions have looked at how they might solve this, we can come together with a performance-based fatigue management plan.

Mr. SHUSTER. I know if my time has expired, but I wonder if Mr. Rosenker could just respond to that.

Mr. ROSENKER. There has to be a bit of personal accountability in this too. No one is in your home, making sure that if you have the appropriate 10 hours or 8 hours of rest that has been guaranteed to you by the Hours of Service rules and that you are going to take advantage of that. But for the most part what you must be able to do is create at least that environment. The way the rules are right now in the railroad industry, that may not be accomplished. That may not be possible with this use of the limbo time.

But I would like, if you will give me the opportunity, to compliment you, Mr. Shuster, and also my colleague at the FRA, the Administrator, on the recognition of the importance of a tool that we believe is the beginning of prevention of accidents in the railroad industry, and that is positive train control. We have seen some tremendous progress being made by the FRA and by the industry itself which will be a device ultimately in the event an engineer does, by accident, miss a signal or perhaps does something

that may well be wrong in his locomotive. This device will help bring that locomotive to a stop and prevent a collision or an accident. So we are very, very pleased that we have seen this recognition and seen the progress by the Administrator.

Mr. SHUSTER. Thank you.

I have a number of questions. I will submit them for the record because I know the time constraints. Thank you.

Ms. BROWN. Thank you.

I just have one follow-up question. Mr. Boardman, how will the Administration be able to deal with limbo time? I guess the follow-up question is: Is limbo time paid for by all of the railroads or how is it handled?

Mr. BOARDMAN. Limbo time is right now handled in that anybody who has limbo time is paid, but the interesting part of it is it is neither on-duty time nor is it off-duty time. It comes at the end of the hours of work schedule for the train crew, and it exists until their final relief point.

What we are really looking for is really to have a performance-based approach, as I said, that can take into consideration any prior sleep deficit, the ability to plan rest, and the duration of the covered service period itself, and try to really work limbo time into an integral part of that analysis.

Ms. BROWN. Thank you.

Mrs. Napolitano?

Mrs. NAPOLITANO. Thank you. I will submit something for the record, but I will keep mine to a minimum.

One of the things that, Mr. Rosenker, you indicated that the FRA does not have the authority to do certain things. If they don't, who does?

Mr. ROSENKER. In Hours of Service, Congress. In the 1907 legislation, it was created at 16 hours in the Hours of Service and changed later to 12 hours back in 1969. Although the FRA is in agreement with us philosophically, they don't have the statutory responsibility or capability to make those amendments. That is what I believe they are asking for in their reauthorization.

Mrs. NAPOLITANO. Can you tell me if any of those long hours, what portion of that might be attributed to the lack of trained personnel to be able to step in and take over some of those jobs?

Mr. ROSENKER. As far as the Hours of Service, I think both the operators and the companies wish to take advantage of as much operating time as they possibly can. I think that is the issue rather than lack of trained personnel at this time.

Mrs. NAPOLITANO. Then there is another one, that there have been fatigue training programs. Mr. Boardman, you have written in your testimony that railroads and labor organizations make significant efforts to deliver fatigue training programs and ensure ongoing awareness. Could you elaborate how effective these have been to reduce fatigue and improve safety?

Mr. BOARDMAN. Congresswoman, education and training of the railroad employees themselves is really an important factor in fatigue countermeasures that the FRA would continue to evaluate. Fatigue is a complex issue, as you well know.

Mrs. NAPOLITANO. Sir, may I interrupt?

Mr. BOARDMAN. Certainly.

Mrs. NAPOLITANO. There is an issue here that is not answered and that is under the training programs, somebody gets a slide presentation and that is it or a pamphlet to read and that is supposed to be training. Am I correct?

Mr. BOARDMAN. No. Actually, I think the industry has some Web sites now that people can go to, to talk about sleep hygiene. There has been a lot of study and work done to try to educate and train employees on what fatigue means.

Mrs. NAPOLITANO. Well, yes, true, but if they don't have a computer, then whose time is it on that they have to go on a computer, say, in a board room?

Mr. BOARDMAN. I don't know the answer to that.

Mrs. NAPOLITANO. Well, that would go to the core of my question which is: How do you get these individuals educated on the programs that you have and could we have possibly a copy so that we can see what programs you have in effect?

Mr. BOARDMAN. I think that with some of the work that Grady has done on the RSAC Committee, he can probably give you some real facts on that.

Mr. COTHEN. Congresswoman, the National Rail Alertness Partnership and the Work-Rest Taskforce, which is a labor-management group, have talked about this and worked on this issue for a considerable amount of time, and I think that you will find that, in union publications which come to the homes of most of the employees and in railroad training programs, there is significant emphasis on the issue of fatigue and the importance of taking advantage of rest.

Mrs. NAPOLITANO. We are talking about training programs, sir, not the significance of getting rest. I am talking about training programs themselves, the actual training of the signalmen, of the locomotive engineers, of all the people that are involved. What training? To what extent do they have access to it? How many hours are required? When are they given the training?

I have heard from a couple, and they say they do a slide presentation, and that is it. That is your training, kids.

Mr. COTHEN. I think awareness and education in this area are something we need to continue to work on.

Mrs. NAPOLITANO. You are not answering my question, sir. What programs are there?

Mr. BOARDMAN. Congresswoman, if you would like, I think it is best if what we did was give you a written response to your question.

Mrs. NAPOLITANO. If you would please with a copy of those programs for the record.

Mr. BOARDMAN. Certainly, I will do that.

Mrs. NAPOLITANO. Thank you, Madam Chair. I yield back.

[The information received may be found on page :]

Ms. BROWN. Mr. Space?

Mr. SPACE. Thank you, Madam Chair. I have no questions at this time.

Ms. BROWN. Mr. Lipinski?

Mr. LIPINSKI. Thank you for your testimony. Right now, I just want to say I look forward to seeing tonight your recommendations,

and I am sure that in the future we will have more to talk about on this issue.

Thank you.

Ms. BROWN. Mr. Walz?

Mr. WALZ. No questions.

Ms. BROWN. No questions, OK.

I guess the last question. Do you have additional questions?

Mr. Boardman, you mentioned that signal maintenance could be adversely affected by unscheduled trouble calls on top of the normal eight hour day. What does that mean and how would the Administration bill address this issue?

Mr. BOARDMAN. Congresswoman, Madam Chairwoman, the signal employees can work up to 12 hours, but that can be increased by an additional 4 hours in case of an emergency. It was generally understood at the time the statute was passed that this could include one or more trouble calls due to a signal stuck on a red or a grade crossing warning system that either is continuously operating or failed to operate. This happens somewhat often, and if it is not followed by adequate rest, that can become a problem for the signal maintainer.

Our bill would permit us to look at the whole picture and give them an opportunity for rest, give them an opportunity for rest prior to their tour of duty and the duration of their regular tour. We don't want to set up restrictions that keep signal employees from responding to emergencies, but we do want to make sure that they are rested and able to handle them well.

Ms. BROWN. Thank you.

I want to thank the witnesses for their valuable testimony and members for their questions.

The members of this Subcommittee may have some additional questions for the witnesses, and we will ask you to respond to them in writing. The hearing record will be held open for additional response.

Thank you very much.

Mr. BOARDMAN. Thank you, Madam Chair.

Ms. BROWN. The second panel, please.

The second panel is Dr. Hursh and Dr. Sherry. Is that correct?

I want to welcome the second panel of witnesses, and I want to thank Dr. Hursh who serves as President of the Institutes for Behavior Resources in Baltimore, Maryland. He also serves as a professor at the Johns Hopkins University School of Medicine.

Next we have with us, Dr. Sherry who is a professor at the University of Denver's Intermodal Transportation Institute.

We are please to have you here with us this afternoon. Your full statement will be placed in the record. We would ask you to limit your testimony to five oral minutes and summarize it and then we will have some questions. I want to thank you and welcome you for coming out today.

TESTIMONY OF STEVEN R. HURSH, Ph.D., PRESIDENT, INSTITUTES FOR BEHAVIOR RESOURCES; PATRICK SHERRY, PH.D., PROFESSOR, UNIVERSITY OF DENVER

Dr. HURSH. Good afternoon, Madam Chairwoman and Ranking Member Shuster and other members of the Subcommittee. Thank

you for inviting me to testify before you on the important subject of fatigue in the rail industry.

The work I support was supported by the Federal Railroad Administration, but the remarks are my own perspective.

By way of background, I am the former Director of Neuro Psychiatry of the Walter Reed Army Institute of Research, home of the largest DOD sleep laboratory and the technology I report is the result of over 12 years of research to develop a fatigue model for the Defense Department and six years of investment by the FRA to adapt it for use by the railroads. The model has been independently reviewed by the scientific community and has been adopted as the Defense Department war fighter fatigue model.

Today I report that this model has now been validated as a measure of fatigue in the rail industry that can predict accident risk in rail operations. The development opens the way for the rail industry to use fatigue models as part of effective fatigue risk management programs. I will suggest some actions that can be taken now as a result of this new development.

Fatigue is a complex physiological state characterized by lack of alertness and reduced mental performance often accompanied by drowsiness. Fatigue is clearly more than falling asleep at the switch. Fatigue causes a range of performance changes, often without self-awareness. The factors that cause fatigue, inadequate sleep and the body clock, have been extensively studied and are well understood, but there is no biological marker like a breathalyzer for alcohol. In the absence of a biological marker, a predictive mathematical model of fatigue based on work schedule information can give the organization an objective fatigue risk measure.

To test the validity of this technology, an FRA-sponsored study was just completed, conducted with the cooperation of five railroads and the labor unions which examined 1,400 accidents over 2 and a half years. The results I report today show the ability of a fatigue model to predict accidents caused by fatigue-induced human error.

Chart 1 indicates that as predicted performance effectiveness scores decreased and fatigue increased, the risk of having a human factors accident increased, the blue dots. The results indicated a maximum increase risk of 65 percent at the highest level of fatigue and lowest effectiveness and a meaningful increase in risk when effectiveness scores were below 70. The fatigue model study that fatigue as measured by a fatigue model increases the risk of rail accidents.

The question is how to respond to this information, and I shall offer several concepts for your consideration. First, fatigue cannot be totally eliminated. Approximately 22 percent of over the road rail operations occur between midnight and 6:00 a.m. when people are naturally less alert and risk is elevated by 10 to 20 percent. So the goal of fatigue management cannot be to eliminate risk but rather to minimize unnecessary fatigue and manage the consequences of fatigue.

Within the necessary boundaries of Hours of Service rules, whatever they may be, effective evidence-based or performance-based fatigue risk management can effectively limit fatigue. Evidence of excessive fatigue shapes operating practices and individual lifestyle decisions towards reduced fatigue and better performance.

The approach is based on four Ms: measurement, modeling, modification of practices and monitoring of results. At the center of the process, all the constituents—labor management, government—supported by the scientific community are at the table to formulate solutions. The process is driven by evidence of success and provides for continuous performance improvement.

I would encourage the adoption of such programs as a complement to Hours of Service regulations. There are a number of enabling practices that can facilitate the processes assessed in my testimony.

Beyond the current initiatives, the FRA could play a key role in advancing the development of fatigue risk management programs under Hours of Service regulatory authority comparable to the other modes of transportation. The FRA could set standards for acceptable programs and, more importantly, exercise regulatory function to examine the objective evidence of program effectiveness. As a scientist, I endorse that approach as the best prospect to minimize fatigue and improve rail safety.

I would be glad to accept any questions. Thank you very much.

Ms. BROWN. How much additional time did you need, a couple more minutes?

Dr. HURSH. No. I am fine, ma'am.

Ms. BROWN. OK.

All right, Dr. Sherry?

Mr. SHERRY. Good afternoon, Chairwoman Brown and Ranking Member Shuster and other distinguished guests. It is my pleasure to testify before the Committee on this very important topic.

Ensuring the safe and efficient movement of goods is key to our Nation's economic security and continued economic viability.

Today I hope to make three main points. First, simply changing the Hours of Service laws such as decreasing hours on duty or lengthening time off will not necessarily reduce fatigue. Second, railroads should be required to establish fatigue countermeasure plans, evaluated by independent scientific panels and then be held accountable for those plans. Third, providing funding to a consortium of research universities for the continued study of fatigue countermeasures and measurement tools would expedite the identification of successful fatigue management programs.

Over the past 12 years at the Intermodal Transportation Institute and the National Center for Intermodal Transportation, we have in over a dozen studies of over 3,500 railroad employees who have completed fatigue surveys or worn actigraphs or other research measures. Their support has helped us to determine that there is no one single approach that is going to solve the problem and eliminate the risk of fatigue. I should point out that if it was that simple, labor and management would have agreed on it by now and we wouldn't be here.

Fatigue is caused both by a lack of sleep and by the circadian rhythms of the human body. The longer one is awake, the less alert one becomes, thereby decreasing cognitive effectiveness. So if the Hours of Service law were changed to give people 10 hours off between shifts, this would be helpful, but individuals would still experience lowered levels of alertness when working between 4:00 and 5:00 in the morning. Plus, fatigue would still need to be man-

aged with additional with additional countermeasures suggesting the need then for a more comprehensive plan. Let us see here.

Sleep length varies according to the time of day. Looking at this graph, we see that if an employee works a midnight shift and tries to go to sleep at 7:00 a.m. or 8:00 a.m., there is a strong likelihood that this individual will obtain only four and a half hours of sleep. Fatigue is a function of the combination of hours asleep, hours awake and time of day relative to the circadian rhythms, and this needs to be taken into consideration when managing fatigue.

In a recent study, 30 railroad employees wore actigraphs for one month. The average amount of sleep for the total group was six and a half hours of sleep for each 24 hour period which is equivalent to the National average for shift workers as reported by the National Sleep Foundation.

Inspecting the individual data, we found that a typical pool engineer had a schedule that demonstrated an acceptable overall average of sleep but masked the fact that individual sleep episodes were very low on particular days as evidenced by this graph, the little short bars.

Notice the spikes in the profile where the individual slept long periods following shorter sleep periods. This is likely the result of an accumulated sleep debt which occurs when an individual obtains less than seven or eight hours of sleep per night over consecutive nights.

The best research available suggest that a person's reaction time decreases as cumulative sleep debt builds. Reaction times are thought to be related to unsafe acts. Thus, persons in this study appear to have developed sleep debt. In our sample, we found that people were working after having obtained less than five hours or more of sleep almost 50 percent of the time.

This leads to my second point which is that due to the great variability in conditions and circumstances involved, 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. U.S.-based railroads with Canadian operations have already complied with this approach and have filed FMPs, fatigue management plans, with Transport Canada.

The Union Pacific has begun to use this approach. A short time ago, I served as a member of an independent scientific panel commissioned to review the UP fatigue management plan. The independent panel, without the involvement of the regulators, was able to review the plan and make recommendations to improve it.

Given that it is nearly impossible to come up with a rule that covers all possible scenarios, FMPs should be implemented that utilize the principles that I have outlined in my submitted written testimony along with the supporting documents to address fatigue problems.

My final point is to call for the allocation of more research funding. Just as we rely on more than one research university to search for the cure for cancer, this process could be faster and more expeditious if more scientists and researchers were involved. Currently,

the FRA is funding the research and regulating as well. Collaboration and cooperation from railroad and labor would increase if the fear of regulation or punitive fines as a result of participation in research were removed. While the one study that the FRA had cited is significant and Dr. Hursh should be congratulated for his efforts, additional work is needed to prepare the model for utilization in the operational environment.

In summary, in my opinion, the development of the FMP is the most viable way to ensure that the complex problem of fatigue is addressed, using the best scientific available knowledge. While changes or alterations to the existing Hours of Service would make some specific improvements, a mechanism for addressing the overall risk of working fatigue would not have been addressed.

I would like to thank the Committee for inviting me to testify on this topic. I look forward to hearing and answering your questions. Thank you very much.

Ms. BROWN. Thank you.

I am pleased that our distinguished full Committee Chair has joined us today, and I recognize him for any remarks he may care to make.

Mr. Chairman?

Mr. OBERSTAR. Thank you, Madam Chair. I thank you for holding this hearing and Mr. Shuster for his participation. He has a very keen interest in railroading with a major rail facility in his district. I know of your very keen attention to these issues, and I thank you, Madam Chair, for the splendid work you have put in over a period of several years.

I have a statement of general observation about safety and fatigue that I will include in the record.

I do want to ask, though, the panelists. You are measuring sleep. You are not measuring quality time between shifts. Could you address the broader question?

I have done shift work when I was in high school and college, high school during summer months, working in college during the summer months. I watched my father in the underground mine, work 7:00 to 3:00, 3:00 to 11:00, 11:00 to 7 and on the changeover shift which was always so difficult.

It is not just how much time you are spending in bed, but it is how much quality time off that the worker has between shift. Rehabilitation is not just one aspect, not sleep alone. It is the entire rest time. You also have to have good quality of sleep.

I have read much of the literature in the field on sleep, adequate rest. I understand that the issue is not only in railroading but for air traffic controllers, for pilots with whom I was just meeting—incidently, Madam Chair and Mr. Shuster, on Age 60 Rule which is something we will be visiting in another subcommittee—pilots on tugboats, on maritime vessels, and the Great lakes fleet.

The commonality, as you described it well, the circadian rhythm, interrupted, does not recover quickly. So could you address the total cycle of time between shifts and the effect on the body and responsiveness and clarity of action and reaction time?

Dr. HURSH. Mr. Chairman, I would be glad to try and address your question. You are right on the mark.

Fatigue models, as they have been developed, take into consideration a number of factors other than the total amount of time available to sleep. Ten hours of rest time or available time to sleep during the day time hours is not equivalent to ten hours opportunity to sleep at night, and the model takes that into consideration. It is not given the same amount of weight because your sleep during the day simply isn't as restorative.

The model also considers disruptions in your circadian rhythm as you switch from working days to working nights and back and forth, your circadian clock becomes out of sync with your work demands, and the model takes that into account as well.

There are issues that no model can take into account—the quality of the time that you have and some of the activities that you engage in, your quality of your health and so forth—but to the extent possible, the models that we have take into account most of the documented factors that determine the ability of sleep to restore your functioning. I think it is a great step ahead to be able to use those to evaluate opportunity to sleep and determine how well they contribute to restoring performance.

Dr. SHERRY. Let me just add a couple of points. I think you are absolutely right. The issue of time in bed is one of the many factors, and I understand that Dr. Hursh's model does take that into account.

I think the overriding concern is making sure that people have adequate time so that they are not put in the position of making choices between spending time with their family, going to the doctor, engaging in leisure activities that would contribute to quality of life. I think what happens if you address just the hours on duty or off duty is that that narrows the options that people have. So in terms of improving quality of life and reducing job stress and most likely the other associated health concerns related to shift work, I think a more comprehensive approach needs to take place. That is why I recommend that the use of fatigue management plans be developed as opposed to a simple number of hours type of solution that might be thought of.

Thank you.

Mr. OBERSTAR. Thank you both for your response. Thank you very much.

Does better scheduling or a different kind of scheduling make a difference in the responsiveness of workers?

I have in mind testimony or at least conversations that we had with over the road bus drivers. Some of the Greyhound Fleet have drivers who work only, as I call it, we call it in the mines, the graveyard shift, 11:00 to 7:00. They do it every day, though, every week. They have their time off, but that is their shift. They know it. Their body, they say, drivers say, adapts to it. Others will work just 7:00 to 3:00. Others will work just the 3:00 to 11:00 shift.

There is a railroad that described for me a process where their outbound train, for want of a better term, the locomotive engineer operates for half of the shift, stops, gets on an inbound train and works the other half of the shift going home and is able to be at home for the rest period that he needs. Do those changes in shifts and more predictability in shift work make a difference?

Dr. SHERRY. Yes, I think you are describing the Illinois Central CN approach. They call it the mid-trip switching where the crews operate the equipment halfway and then turn around, switch trains and come back to their home terminal. That is a very desirable scheduling plan, and many people are very satisfied with it. I think it does improve a person's restiveness, their feelings of restiveness, and in addition it also improves their overall feeling of positive control over their life that they are able to return to their home terminal, sleep in their bed and become better rested.

I think the other piece of that, however, is that you shouldn't lose sight of the fact in this that it is still important to have an adequate numbers of hours of sleep and that a schedule that is devised in that way could in fact provide that.

Having said that, that might not work in some other locations. The Illinois Central CN region, as I understand it, is nicely suited to that kind of an operation, whereas for example in Northern Canada, for example, the Northern Manitoba line, it is difficult to get more than one train over a certain segment of territory in under 13 hours.

So there needs to be flexibility. There needs to be the opportunity to create many different types of solutions. No one schedule is going to solve the problem.

Mr. OBERSTAR. Dr. Hursh?

Dr. HURSH. Mr. Chairman, I agree with Dr. Sherry's analysis that it would be dangerous to think that there is one single solution that is going to fit every railroad's operating demands, and that is why I think the consensus is that a flexible fatigue risk management program is the best approach, taking advantage of opportunities to apply wisdom from different railroads that might work in one particular situation.

But the most important thing is that we build into that kind of a system, the ability to monitor the outcome and make sure that what happens, that the result of that process, whatever it is, creates an improvement in performance and a reduction in fatigue. Without that kind of monitoring to ensure success, this kind of a program will lack accountability. I think that if given the appropriate authority, the FRA can invest in having these sorts of programs and exercise authority to ensure that performance is measured that evidences success.

Mr. OBERSTAR. Thank you very much for your contribution, very substantial.

Thank you, Madam Chair.

Ms. BROWN. Thank you, Mr. Chairman.

Mr. Shuster?

Mr. SHUSTER. Thank you.

I am having technical difficulties.

Ms. BROWN. OK.

Mr. SHUSTER. Sorry about that.

The question that I have is, first of all, I believe it was Professor Sherry, you mentioned that it was the Canadian and Australian rail companies already have instituted a fatigue management plan?

Dr. SHERRY. That is my understanding, yes. In fact, I was invited to review the Canadian program.

Mr. SHUSTER. Do you have any statistics since it has been in place? Have the accident rates gone up, gone down, stayed the same, injury rates?

Dr. SHERRY. I am sorry. I don't have that information.

Mr. SHUSTER. You don't have that. Do you have any idea how long it has been in place?

Dr. SHERRY. It has been in place a couple of years.

Mr. SHUSTER. A couple of years, OK.

Dr. SHERRY. I have it somewhere, but I don't have it right with me.

Mr. SHUSTER. I will come back to a question that I asked the first panel, and I am going to continue to ask this, and I am not advocating forcing people who work on the rail to have eight hours of sleep because I don't think that is possible for us to enforce. I think it was Mr. Rosenker who mentioned that when people have more time off, they tend to have more rest. Is that your feeling?

My concern is—I don't know if you were in the room when I asked the question before—if we mandate that people can only work certain hours and have to have a certain amount of time off, there is no guarantee that you are going to go home and go to sleep for eight hours. You are going to go home, more than likely like most Americans, and it is snowing out today, I am going to shovel the walk. The first thing in the morning I am going to get up to help my child with homework. Can you comment on that, especially the comment that was made that the more time off people have, generally the more rest they get?

Dr. HURSH. I think you are quite right. There is no way we can legislate responsibility on the part of the employee. All we can do is provide an opportunity for them to get the adequate sleep that they need. Training is certainly an important element of this to inform them of the importance of getting rest, so that they can be competent and fit for duty when their time is called.

What is important here is that we recognize that when they have that opportunity to sleep, they also have predictability of the schedule so that they can use that opportunity effectively to get naps prior to work so that they are well rested when they are called. I think the only responsibility, the only power that we have here is to ensure that those opportunities are available.

But I do think it is a shared responsibility. This is not just a problem of the railroads providing opportunities. It is also a responsibility of the employees to take that opportunity and use it effectively to get adequate sleep. I don't think anyone is suggested that this responsibility falls on the shoulders of any one constituent.

Dr. SHERRY. January, 2005, that is when I think the Canadian law went into effect.

Mr. SHUSTER. Thank you.

Dr. SHERRY. You are welcome.

My comment about that is I think there is some truth to the idea that more time off, the more likely you are to get rest.

But the other side of the problem is that, as I mentioned in my remarks just a couple of moments ago, that doesn't prevent a person who has been "well rested," showing up and having to go to work at 3:00 in the morning, and if they have been sleeping at that

time normally, they are still going to be tired. Now they can learn to kind of cope with it. As one of the Congress persons earlier mentioned, they can learn to deal with that and to learn to apply specific countermeasures, but that is why a more comprehensive, holistic approach needs to be applied.

Mr. SHUSTER. Then the next question I have to follow that up is I understand that fatigue-related accidents are more common after an employee comes back after vacation. So how does that square up if you have taken a week off?

I know when I come back to work, I am generally more rested. How does that square with if you are given a week off or you are taking a week off or a couple days off?

Dr. HURSH. Obviously, the conditions that would occur would have to be looked at on an individual basis. One of the conditions that often occurs that can conspire against you, even after you have been on a vacation, is that you come back. You are available for duty at 8:00 in the morning. You have gotten up at 7:00 and you are ready to go. You are well rested. But you don't know when you are going to be called. Then what happens is 10:00 that night, you get called to come work, and you may have been up all day because you have been on the rhythm of sleeping all night and being up all day. That is what you do when you are on vacation.

You report to work at 10:00 at night, and you have been awake since 7:00 that morning. So you go to work fatigued, and that kind of a pattern can conspire against you even under the best of circumstances.

Mr. SHUSTER. So, disrupting sleep patterns?

Dr. HURSH. Well, you are disrupting sleep patterns and having lack of forewarning that you are going to have to take an afternoon nap to be prepared to go to work.

Dr. SHERRY. May I comment on that?

Mr. SHUSTER. Sure.

Dr. SHERRY. The other piece of that, and this is I think why the railroads, a lot of them, went to what is called the 8:00 a.m. markup. It used to be you would mark up at 12:01 after vacation, so you would be eligible to be called immediately after midnight.

You have been off for a week, and you have been going to bed at, let us say, 11:00 at night and getting up at 7:00 in the morning. If you are called at 2:00 in the morning or if you are called at 1:00 in the morning and you need to go to work at 3:00 in the morning, once again you are going to be working against your circadian rhythm. The having a week of rest is no guarantee that you are going to show up and be absolutely rested if you are called for an early start time, for example.

Mr. SHUSTER. Thank you.

Ms. BROWN. There have been significant changes in the rail industry since the Hours of Service Act was enacted in 1907 which was 99 years ago. I know that because that is the year my grandmother was born.

Do you believe that an increased growth in the rail industry and the decreased number of train crews have an impact on fatigue and fatigue-related accidents? That is to both of you.

Dr. HURSH. Madam Chairwoman, shortages of personnel are certainly one of the drivers of fatigue in the rail industry as in any

industry. If the industry does not begin to manage fatigue more proactively, the problem promises to get worse. Over the next five years, the industry will experience the exodus of the baby boomers, and I am included in that group. They will be retiring. The railroading industry is going to have to make jobs on the railroads more palatable for the current generation if they are going to fill those openings. If they don't adopt fatigue management plans to manage the stresses that create fatigue, it is going to be hard to fill all those vacancies, and that is simply going to put additional stress and increased fatigue on those that remain.

So I believe that the adoption of fatigue risk management plans will ultimately help to improve the retention of employees, improve their morale, improve the recruiting of new employees and, in short, will serve to pay back dividends for the investment in those plans.

Dr. SHERRY. That is a very complex question that you have asked, Madam Chairwoman, about the relationship between the number of employees and changes in the work practices. Certainly, we have seen a number of improvements in technology which have contributed to the overall productivity of the railroads. In my work with other countries, I know that the U.S. railroad industry, the freight industry in particular, is the envy of the rest of the world.

I am not sure if this particular change that you have identified is statistically related to an increase in fatigue-related accidents. I think it is important to recognize that fatigue-related accidents are the result of individual actions and the capacity of the individual to safely perform the act is related to the amount of sleep and the amount of time off. So I am not sure what the exact statistics are in terms of the changes. The other thing is it is only recently that we began to consider looking at the contribution of fatigue as a factor.

It is a complex question. I think there may be some additional research that needs to look into that, but it is certainly something that can be significantly addressed by fatigue management plans.

Ms. BROWN. Mrs. Napolitano, do you have a question?

Mrs. NAPOLITANO. Thank you, Madam Chair.

To that same question, Professor, one of the questions I had asked previously in regard to the lack of trained employees because right after 9/11 my area was suffering from lack of personnel to carry some of the freight increase in the two ports of Los Angeles and Long Beach, very well documented. To me, that would have caused fatigue because you are calling in employees to come in and fill in or work longer hours which then leads me to the question of overtime.

If you ask an employee, can you work overtime, they are going to jump on it if they are the kind of employee who I would assume would want to work the overtime. Did you take into consideration any of those factors?

Dr. HURSH. Well, the study that I reported on today really was an investigation of five railroads and samples of work histories from those five railroads, and we didn't drill down to see specifically what kind of manpower decisions resulted in the schedules that we analyzed. I am not an expert on the manpower decisions that have been made that might have created the schedules that

I evaluated nor am I an expert on the training programs that are utilized by the railroad industry.

I do know that one of the factors that can be used to manipulate fatigue in any industry, but in particular in the railroad industry, is how many people you put on the system to drive the trains. The fewer the individuals available, the more work is going to have to be performed by the ones that are available. Obviously, they need to be well trained if they are going to fulfill their function. A fatigued employee that is, in addition, poorly trained is not a very safe employee.

Mrs. NAPOLITANO. Thank you, sir. That is one of the things that was a question in the derailments in my area. There were five derailments in less than a year that were questionable. Thankfully, none of them resulted in personal injury. We were never able to get information specific to the causes other than failure of a rail tie, a joint bar, if you will.

It is very, very critical because there is going to be increased traffic in our area specifically and I am sure in other parts of the Nation, that if we don't work and continue to provide the training, be able to have the work hours, the rest in between to be able to ensure that they are not as fatigued because they will be fatigued, working. Everybody gets fatigued. We will be putting people at jeopardy, and that is something I think that people don't want us to go over lightly, if you will, but address it to the greatest extent that we can.

Professor, the findings in the 3,500 employee survey, have you reported on those?

Dr. SHERRY. Those are described in my book entitled Managing Fatigue in the Transportation Industry. I have a copy that I can make available. Many of the studies involving training and with the over 3,500 employees are summarized in that. There is also a summary report of those in the monograph that I provided to the Committee as well.

Mrs. NAPOLITANO. Dr. Hursh, I am very interested in the fact that you are a psychologist because I have a very great interest in mental health issues. When you do fatigue research, and I know you stated something to the effect that you have other issues, drug and alcohol use as regards the impact it might have on the ability to react or be able to carry forth.

Fourteen hundred accidents, was that the quote, the figure you gave?

Dr. HURSH. Yes, ma'am, 1,400 accidents were submitted for analysis in that study.

Mrs. NAPOLITANO. What were the minor accidents? In other words, what were the major accidents and the minor accidents actually reported on? Were they the kinds where somebody forgot to put a lock on and their locomotive went on its own because some of those are not reportable? In other words, the railroad does not report them to the FRA.

Dr. HURSH. Congresswoman, these were 1,400 reportable accidents, so they were the kinds of accidents which would have reached the threshold of sufficient damage or loss of life or injury that would have required it to be reported to the FRA.

Mrs. NAPOLITANO. Do we or does the FRA or does anybody record any of the accidents that do not result in major damage but again are accidents that could contribute to serious accidents?

Dr. HURSH. I don't know. Neither of us know the answer to that, ma'am. The one initiative that I know the FRA has undertaken is a close call study to look at changes in performance or close calls that would be short of a serious accident. This is a confidential non-punitive way to collect information on close calls. I think it is an extraordinarily important study or initiative. I am not intimately involved with it, but it certainly would contribute information that could help us understand better some of the factors that contribute to close calls that are forewarnings of the potential for an accident if the factors aren't addressed.

Mrs. NAPOLITANO. But you have no access to those?

Dr. HURSH. Well, that whole process is confidential, and I have no access to it.

Mrs. NAPOLITANO. Madam Chair, may I request that this Committee specifically ask for some kind of report on that because that should be part of the investigation that we should be looking at to determine whether or not, as he states, it could contribute to a major accident in the future.

Ms. BROWN. Without objection.

Mr. Lipinski?

Mr. LIPINSKI. Thank you, Madam Chairman.

As a trained engineer although not a train engineer and as a social scientist, I appreciate the research you have done. It certainly will be helpful as we work on legislation on this issue on fatigue, certainly a very critical issue when we are dealing with safety on the rails. I just hope maybe also you could do some research on fatigue among public officials and figure out any tricks that we can use so we can suffer from less fatigue.

Thank you very much for your testimony and for your work.

That is all, Madam Chairwoman.

Ms. BROWN. Thank you.

Dr. Sherry, in an article entitled Hours of Service Regulation in the U.S. Railroad Industry: Time for a Change, you made a number of suggested improvements for hours on duty. Can you talk about those suggestions a little more, and in your answers, can you tell us whether you believe something should be done to address limbo time? It seems to be a significant contributor to fatigue.

Dr. SHERRY. Yes, I would be happy to discuss that. In the article, I made a number of, I discussed a number of different scenarios that might be considered and talked about the importance of the need for anchor sleep especially after long duty periods. I talked about the needs for the use of napping as an appropriate countermeasure. I talked about the importance of understanding that the cumulative effects of sleep debt can in fact be related to the occurrence of delayed reaction time. All of those factors are detailed in the article, and I would urge the Committee to look at those more carefully.

However, I wanted to be cautious in simply coming up with a list of do this, do this, do this because I don't think that is the way to go. I think it is important to create a mechanism, to create a process that everyone is able to utilize these particular principles.

Having said that, the comment about a limbo time is a significant one. I read over the testimony of the gentleman from the BLET, and I share people's concern about the length of limbo time and the away time that a person spend on duty in that way. However, I think the important thing to keep in mind is the cumulative number of hours is the factor, is one side of the equation. The other side of it is the amount of recovery time that a person has after that lengthy work period.

I am not sure I would create a rule—I will leave that to you, where to draw the line, but I would put both together. If there is going to be long work hours, there needs to be sufficient recovery time.

Thank you.

Ms. BROWN. Mr. Shuster?

Mr. SHUSTER. Nothing further.

Ms. BROWN. Mr. Oberstar?

Mr. OBERSTAR. I would like to have the panel's view about backward rotating shifts. It is a matter that was of some extensive discussion in the course of our consideration of the Hours of Service rule about six years ago or so when we went through that process in the Committee and became quite a point of dispute in the trucking sector of power companies who have their crews working out on outages due to storms. We had quite an extensive discussion about backward rotating shifts and the effect on alertness and response readiness of crews. Give me your thoughts about those matters.

Dr. HURSH. Mr. Chairman, the scientific consensus, I believe, on this process is that you really need to look at the details of how the backward rotating shift is implemented and how much time for recovery sleep there is between shifts and so forth. If you analyze backward rotating shifts with a fatigue model, sometimes they can be detrimental to performance, sometimes they can be fine. It depends on how they are implemented, how many off duty days there are between on duty days and so forth.

The reason that it is controversial, I think is there is no single rule of thumb that can determine whether a particular backward rotating shift is good or bad. You need to submit it to analysis by a fatigue model or some other kind of sophisticated approach.

Dr. SHERRY. I agree. I have run backward rotating shifts through Steve's model, and they come out looking very, very good, some of them. It is really a very popular solution, though, I think from a quality of life standpoint, and so I think that needs to be taken into consideration.

Going back to the Congresswoman's point about training, how people use appropriate fatigue countermeasures, how people prepare themselves for those types of work and duty periods. I have looked at very compressed and extended schedules and people, if they are prepared, can work them very effectively, but they have to kind of really focus. They have to give up a lot of social activities and focus primarily on that kind of an operation. I think it is a controversial topic because people like it, but it may or may not be the most advantageous.

Mr. OBERSTAR. Dr. Hursh?

Dr. HURSH. Mr. Chairman, at the risk of sounding like a broken record, I think that this speaks, though, to the need for a flexible approach where we submit the practices of any particular railroad or practices of any particular location to a fatigue risk analysis that would include understanding the particular schedules that are in force, modeling the effects of those schedules and modeling the impact on fatigue. Only in that way where we have a performance-based, evidence-based approach are we going to be able to get to solutions which are truly effective.

Trying to make rule of thumbs judgments about whether this is a golden schedule or that is a terrible schedule is probably not the way to solve the problem.

Mr. OBERSTAR. There is a practice in railroading called limbo time, the time when trains' hours of service are expired but they are not yet at their final destination, final relief point. The crew is expected to be awake and alert and able to respond to situations, follow the operating rules. What experience do you have with limbo time?

Dr. HURSH. The current Hours of Service rules, as you know, at minimum require eight hours of rest between shifts, but we know that eight hours rest does not really afford the employee eight hours of sleep opportunity when you factor in things like commute time, limbo time which doesn't count as on duty time and call time, the time between when they are called and when they report for work. So as a practice, the eight hour rest rule does not really provide an eight hour sleep opportunity.

But before we jump to some single solution, I really would still prefer to see any change in the regulations, whatever they might be, to be enacted as part of an overall regulatory authority conferred on the FRA similar to all the other modes of transportation and that those rules, whatever they may be, be designed within that kind of framework. Ultimately, though, I think new rules, whether they be to compensate for limbo time or to give defined days off or whatever the solution might be, that they be tried and enacted at the grassroots level within evidence-based programs similar to the 4 Ms that I was describing earlier. It is only in that kind of a framework that we can assure that the solution will fit the problem and will be compatible with the work demands and the operating demands that are placed both on the employee and on the operator.

Mr. OBERSTAR. Not all modes are comparable. You can't just say compare practice in one mode of transportation to another. In aviation, there is duty time and flight time, and they are two different items. When I chaired the Aviation Subcommittee, it took a very long time and many hours of hearings and meetings in camera—as we say in Latin in my office when we hammer out a few items—to get a definition of what is flight time, and it finally came down to when the brake is released at the gate and the aircraft backs away. When does it end? When the brake is applied at the gate of the destination flight.

Then you have duty. You may be on duty for a much longer time than you are actually flying. All of that factors into fatigue, and the same with flight attendants. The 14 hour rule, it took the FAA 15

years with a lot of prodding from the Committee and finally legislation to implement a rule.

Now you say you want flexibility but the Hours of Service rules were first established in 1907. There are a couple of amendments to it, and yet we still have problems serious enough for the NTSB to have repeatedly chided this industry and the FRA and asked them to take more vigorous action on Hours of Service for railroad employees.

Dr. SHERRY. If I might respond to this point here about limbo time, I think it is complicated. You are talking about when you say the gate. We have done a study with flight attendants, the amount of time that they are working versus when they are not working. Frankly, the bottom line is if you are awake and you are not sleeping, in terms of fatigue, that is what we should be talking about. That is why I keep saying it is about the amount of time you are awake and the amount of recovery time available.

My understanding of the FRA rules is that when people are "in limbo time" they are not technically responsible for any operating or safe practices. So that is great in terms of protecting the public and the operation of the equipment, but from the point of the individual, they are still awake and not in their bed. So the question is: How do you take that into account? What do you do with it?

I would argue that you need to look at it from a recovery time point of view to make sure that you have protected the individual and in their next duty period in order to be able to operate safely.

Mr. OBERSTAR. Dr. Hursh, we need to get on to the next panel, but please I want your contribution.

Dr. HURSH. I simply wanted to add, though, that I don't want this comment about flexible fatigue management plans to be interpreted as there would be a total elimination of Hours of Service rules. I am not sure that that is the approach that we are suggesting.

What we are saying is that within the boundaries of Hours of Service rules, there needs to be additional barriers to fatigue, and it is only with those additional barriers that themselves would be flexible, that we are going to reach a solution.

Mr. OBERSTAR. Thank you very much for your very valuable contribution and for your writings on the subject matter. You make a great contribution to safety.

Dr. SHERRY. Thank you.

Dr. HURSH. Thank you, sir.

Ms. BROWN. I personally want to thank you all for your valuable testimony and the members for their questions. I want to thank you again. We will be submitting additional questions in writing.

Thank you.

Dr. HURSH. Thank you, Madam Chairwoman.

Dr. SHERRY. Thank you.

Ms. BROWN. And for the last panel, I know that we have expedited this afternoon, and I want to thank you all for that also.

I want to welcome the final panel of witnesses. I know this is a very difficult afternoon, but we have already scheduled this meeting, and this is such an important issue. I want to say right up front that I appreciate you all for being here today.

Mr. Hamberger who serves as the President of the Association of American Railroads, welcome.

Next, Mr. Dealy who is Vice President of Transportation for the BNSF Railroad, thank you for being here, sir.

Mr. Pontolillo, who is the Director of the Regulatory Affairs for the Brotherhood of Locomotive Engineers and Trainsmen, he is representing the entire Rail Conference Division of the International Brotherhood of Teamsters, thank you, sir, for being here.

Mr. Brunkenhoefer, who is the National Legislative Director for the United Transportation Union and Mr. Mann who is joining him today and Mr. Parker who is the Legislative Director of the Brotherhood of Railroad Signalmen, we are please to have all of you here with us this afternoon.

I appreciate your patience in waiting to hear the other panel, but I think it is very important that you hear what the other panel had to say and their conclusions. Your full statements will be placed in the record. We ask that all witnesses try to limit their testimony to five minutes or a summary of their written statement as a courtesy to the other witnesses and, of course, what is going on in the community.

We will begin with Mr. Hamberger. Please proceed.

TESTIMONY OF EDWARD R. HAMBERGER, PRESIDENT, ASSOCIATION OF AMERICAN RAILROADS; DAVID DEALY, VICE PRESIDENT, TRANSPORTATION, BNSF RAILWAY; THOMAS A. PONTOLILLO, DIRECTOR OF REGULATORY AFFAIRS, BROTHERHOOD OF LOCOMOTIVE ENGINEERS AND TRAINMEN; JAMES BRUNKENHOEFER, NATIONAL LEGISLATIVE DIRECTOR, UNITED TRANSPORTATION UNION; LEONARD PARKER, LEGISLATIVE DIRECTOR, BROTHERHOOD OF RAILROAD SIGNALMEN

Mr. HAMBERGER. Thank you, Madam Chairwoman. I appreciate the opportunity to be here on behalf of the Association of American Railroads to discuss issues surrounding the Hours of Service Act and fatigue management. I share your view that this is an incredibly important topic.

Before I begin, I would like to, on the record, congratulate Mr. Oberstar for his ascendancy to the chairmanship of the full Committee. He was not here when I testified last week. Congratulations and I look forward to working with you, Mr. Chairman.

I would also like to take this opportunity to pay my respects to former FRA Administrator Jolene Molitoris who is with us in the audience here today of her own volition. She began the Rail Safety Advisory Committee which is a cooperative effort of management, labor and the FRA which has made some major contributions to improving safety in the industry, and I want to thank her for that and all the other efforts that she initiatedd.

Railroads want properly rested crews. It is not in a railroad's best interest to have employees who are too tired to perform their duties properly. That is why railroads have long been working diligently to gain a better understanding of fatigue-related issues and finding innovative, effective solutions to fatigue-related problems. Properly rested crews are critical to safe, efficient operations.

I want to reiterate my testimony from last week. Overall, our industry safety record is excellent. Between 1980 and 2005, the overall train accident rate dropped by 64 percent, and the employee casualty rate fell 79 percent. What is more, data through the end of November indicates that 2006 will be the safest year on record in terms of the train accident rate, the employee casualty rate and the grade crossing incident rate. When using the 2006 data, the 1994 to 2006 timeframe will actually reflect a 9.2 percent reduction in the accident rate.

Having said that, fatigue issues concern us, and we continually search for methods to reduce fatigue in the industry. In the interest of managing fatigue-related issues, the industry has adopted a set of principles to guide such efforts. Now let me briefly numerate those.

Principle number one, railroads want fully rested crews.

Number two, after 12 hours of service, crews in limbo time should receive additional rest after that limbo time, and that is consistent with what you heard from Dr. Sherry on the previous panels that it is the combination of the time on duty and the time in limbo time and then the opportunity to rest afterward.

To the extent practical, fatigue management policy should be based upon scientific research.

Four, railroads are willing to provide more than the statutorily required rest time at both home and away terminals to assure that crews are fully rested.

Five, railroads are willing to require employees to take time off for rest opportunities.

Six, fatigue management issues are a joint responsibility of the railroad and the individual employees.

We have already made substantial progress in addressing fatigue issues. As my testimony illustrates, 83 percent of employees work less than 200 hours a month, and 95 percent work less than 250 hours a month.

A variety of fatigue countermeasures have been employed. They include increasing the minimum number of hours of rest at both home and away terminals, implementing a return to work in the morning if time off work is 72 hours or more, evaluation and adoption of a sophisticated fatigue modeling computer program, permitting napping by train crew members under limited circumstances, sleep disorder screening and improved standards for lodging in away from home facilities that provide blackout curtains, white noise and increased soundproofing.

The importance of education in combating fatigue cannot be overstated. Since the value of fatigue-related initiatives is highly dependent upon the actions of employees while off duty, employees must make the proper choices regarding how they utilize their off duty time as Mr. Shuster has indicated. Consequently, an educational web site designed solely for railroads and rail employees is under development by the railroads and the American Public Transit Association to provide general information to employees about alertness and to identify possible sleep disorders. The site will include a self-assessment tool and an explanatory letter about sleep disorders that employees can take to their physicians.

Railroads' commitment to safety is absolute. Combating fatigue, however, is a shared responsibility. Railroads recognize that they must ensure employees have sufficient opportunity to rest, and they are open to reasonable changes to the Hours of Service Act to help assure this outcome. For their part, employees are responsible for using a sufficient amount of the time made available for them to actually rest.

The railroad industry looks forward to working with the Committee, the FRA and our employees in developing further approaches to fatigue-related issues.

Thank you for the opportunity to be here today.

Mr. DEALY. Good afternoon, Chairwoman Brown, Ranking Member Shuster and members of the Subcommittee.

In my position as Vice President of Transportation for BNSF Railway, I am responsible for the overall transportation operation of BNSF's 34,000 mile rail network and just over 20,000 rail employees. I oversee field operations, train dispatching, crew management and locomotive distribution.

I am responsible for the safety of these 20,000 plus employees which is a responsibility that we at BNSF take very seriously, and we believe our track record shows this. Since the year 2000, we have reduced our injury rate by 48 percent, meaning 182 fewer injuries in 2006 than in the year 2000. On top of the fact that we have had 24 percent more employees. Derailments over that same period are down 21 percent on an incident per train mile basis.

We believe that fatigue can be a serious issue and have addressed it in a combination of improved policies and processes as well as changes in labor agreements. In my testimony this afternoon, I would like to outline for you the scope of the problem which is knowable and well understood by the railroad industry, detail for you some of the steps that BNSF has taken in partnership with our employees and unions to manage the fatigue issue down to a very narrow set of employees and suggest to you some solutions that are achievable.

I will point to page number one in my handout. Thirty years ago, railroads were largely made up of traditional box car type trains moving in balanced train flows over relatively short crew distances. The normal distance a train crew would operate was between 100 and 125 miles, and most of our employees would have to work every day. A high density corridor at that time would be about 20 trains each way a day.

Our business today, however, is driven by a large network of long distance trains loaded with double stacked international shipping containers, unit coal and grain trains all moving distance of over 2,000 miles. It is considerably more varied and complex. A great majority of our through freight crews now operate over assigned crew districts greater than 260 miles with some over 300 miles. We pay our train crews by the mile, so compared with the shorter runs 30 years ago, many of our employees can make the equivalent of six days pay in one round trip, allowing them to be at home two to three days between trips. Yes, two to three days between trips. On these territories, we now run 100 trains a day, quite a change from 30 years ago.

On slide four, on our railroad, there are two distinct types of work assignments for train service employees, and you can see it on the slide in the room. Over 20 percent of our active employees work in yards, terminals or perform pick-up and delivery services in our industries. They have set on duty times and set days off, and many of these employees work a 40 hour work week.

The other 80 percent of our employees work in over the road train service where two person train crews, a conductor and engineer, perform round trip service from their home terminal, traveling to an away from home terminal, getting rest and returning home. Because of the long distances our train crews operate, the vast majority or 60 percent of these crews, spend over 24 hours off at their home terminal. A third of these employees actually get more than 48 hours off at their home terminal.

Employees in this service regularly make between $80,000 and $100,000 a year, and for obvious reasons regarding earnings potential and quality of life, these long runs are preferred jobs that attract employees with the highest seniority. You may hear these employees referred to as mileage hogs, but just remember that they are still getting a lot of time at home. As FRA Administrator Boardman said earlier this afternoon, if you have more time off, you will get more rest.

The remainder of our through freight employees work in assignments where they do not get at least 24 hours off at their home terminal, and we have, for all but a small percentage of these employees, implemented through innovative work agreements with the UTU and BLET work schedules that prescribe working seven days and then having three days off. These off days are not mandatory for the employee to take, but they are mandatory and irrevocable on behalf of management to allow them.

Taking all this into account, it is important for the Committee to understand that only fewer than 500 of our employees out of our entire population of over 17,000 work these short crew districts with no scheduled days off. While they have all been offered these same scheduled rest days as the other crews, they have opted not to accept them.

Since our merger in 1995, BNSF in working with the UTU and BLET, has had a proven track record of innovative and aggressive labor agreements to address these work-rest issues and fatigue countermeasures, and you can see these on page six of our deck.

We also tried some things that didn't work, and one of them was to actually schedule our train crews 30 in advance with set days they would work and set starting times. Some of these pilot projects actually allowed employees to schedule their trips 90 days in advance. However, none of these pilot programs were ever ratified because they were actually not popular with the employees. They liked the predictability, but they still wanted the flexibility that the status quo offered.

In summary, our operations are complex and to meet customer expectations, we have to be able to handle the variability for some of which we have no control. What works well in some areas doesn't work in others. We look forward to continued success of working with UTU and BLET.

Thank you.

Mr. PONTOLILLO. Good afternoon, Chairwoman Brown, Ranking Member Shuster and members of the Subcommittee. On behalf of the more than 70,000 men and women that comprise the Teamsters Rail Conference, I want to thank you for holding today's hearing and for the opportunity to present you with our views concerning fatigue in the industry.

A couple of preliminary things, I also want to thank Brother Broken Rail. The BLET and the UTU we worked together on our written testimonies extensively, so we didn't cover too much of the same ground, and we will be splitting up the oral presentation as well. We also support and endorse the testimony of the Brotherhood of Railroad Signalman and Brother Parker today.

In the brief time available to me, I would like to address limbo time which arose earlier today and touch on a couple of other factors which impact our BLET members. I also briefly want to comment on fatigue for our BMWED members. Maintenance of Way workers are not governed by Hours of Service requirements. Nonetheless their working conditions do create a certain amount of fatigue of which the Subcommittee should be aware, given the safety sensitive nature of their work in maintaining and repairing the Nation's rail infrastructure.

I do want to start with giving you some data on limbo time because some of what we have collected in the past 18 months is absolutely shocking. One class one railroad which I will call Railroad A had nearly 335,000 crews that worked over 14 hours counting limbo time between 2001 and 2006. For the last three years, this railroad has averaged 205 crews a day over 14 hours every day. Ninety-four of those crews worked longer than 15 hours and almost a crew a day worked over 20 hours.

We also have over two full years worth of data covering a single terminal on another Class 1 railroad which I will call Railroad B. This is one terminal. It has two pools and one extra board and about 110 to 115 engineers. In the two year period at this one terminal, there were over 3,100 work tours in excess of 13 hours and over 900 in excess of 14 hours.

We also had, for Railroad B system, two days worth of data from consecutive days in mid-September of last year. In those two days in late summer, there were over 1,000 crews that worked more than 14 hours and over 125 more than 15 hours. In that two day period, there were three shifts that were 32 hours long.

Now many crews do not receive additional pay for these work tours. Under our National agreement, a crew in a 250 mile pool must accrue almost three and a half hours of limbo time before they are entitled to overtime. In a 325 mile pool, it must accrue more than eight hours of limbo time before they are entitled to overtime. As was previously mentioned, even while in limbo time, the crew is responsible for obeying operating rules requiring that they remain alert and observant and that they take any action necessary to protect the train against an unanticipated mechanical problem or vandalism.

We believe that the only solution to limbo time is legislative.

Railroad-imposed attendance policies also contribute to fatigue. Typically, these policies require an operating employee to work or be available for work 85 percent of the time or face discipline up

to dismissal for a failure to do so. An eighty-five percent standard makes sense in a five day, 40 hour work week, but it is absurd in a 24/7 setting like the railroad industry where, for example, our divorced members regularly must choose between visiting their children within limits imposed by divorce custody orders or facing discipline for poor attendance records.

Another contributor is cultural change over the past 30 years, and actually that is something that the carriers are victimized as much as we have been. Dual income families are the norm in 21st Century America, and today's railroad workers have far more direct domestic responsibility than their predecessors. But the railroad hasn't met us halfway in responding to these cultural changes and indeed demands more work from today's workforce than the past because of these availability policies.

That said, both AAR and BNSF have testified concerning ongoing fatigue mitigation efforts, and we have all worked together very hard for a number of years, and they should be congratulated for their efforts because they have worked as hard as we have.

But progress has not been consistent and has not been even across the industry. Railroad A, for example, that I referred to before is currently attempting to reduce our members' ability to combat fatigue. This railroad is attempting to eliminate freight pools and replace them with identical pools operating between the same terminals, but the railroad says that these pools are new and as a result of that, 25 year old agreements that permit engineers to take 24 or 36 hours rest when they get back to their home terminal no longer apply.

Like the operating crafts, maintenance of way forces also are affected by fatigue. Causes of MW fatigue and solutions are very different than for operating crafts. In the MW craft, fatigue is most often caused by long commutes, inadequate overnight lodging and a lack of manpower. Over half of maintenance of way employees today have to travel significant distances just to get to work. Twenty-five to 30 percent of them are responsible for covering production gangs that cover an entire railroad system, in BNSF's case, 34,000 miles. Some of these people have to travel several hundred miles or a thousand miles just to be able to report to work.

We believe a solution to excessive fatigue-inducing conditions for MW workers is to reinstate reasonable limits on territorial sizes that they have to cover. But those long commutes for maintenance of way workers combined with double occupancy lodging or eight to ten person camp cars which are decrepit and unclean also contribute to MW fatigue.

At this time with the permission of the Chair, I would like to have a video played that shows the conditions facing our BMWED members in camp cars.

Ms. BROWN. Without objection.

[Video played.]

Mr. PONTOLILLO. I don't believe that noise is very conducive to restorative sleep.

Madam Chair, the Rail Conference believes the evidence establishes that fatigue seriously degrades safety in the rail industry among all crafts. Real solutions to the problem need to be formulated and implemented in some cases by legislation, and we im-

plore you to pass common sense legislation enabling the FRA to affirmatively and aggressively regulate fatigue in our industry.

Thanks for hearing us, and I will be happy to answer questions when the time comes.

Mr. BRUNKENHOEFER. James Brunkenhoefer, United Transportation Union. First, I would like to thank the Committee for the opportunity to be here today, and I also support the testimony of the Brotherhood of Railroad Signalmen and the Rail Conference of the Teamsters.

The Hours of Service Act that was passed during your grandmother's day, I worked under some of the agreements. You had to live within a mile of the round house. The people would get on a bicycle, pedal to your house and wake you up. Then you could walk. You had to be less than a mile.

Today in the Los Angeles basin, people who work for the railroads have to commute two to two and a half hours. Now they are not fatigued at work, but they are deadly on the 405 or the 10 or they are deadly in New York on the I–5 as they go from Hobart Yard down around to 10 or 210 West to San Bernadino to get a train to go Barstow or Winslow, Arizona.

So the idea of if we look at fatigue and we look at limbo time, we are looking at it in isolation. A person can just as easily have an accident on the highway, and this presents a public risk just like if they were on the job, a public risk. When we hold people in limbo time, our membership lives in a jet lag society. Can you imagine being in jet lag for 30 to 40 years?

We don't know when we are going to go to work. We don't know how long we will work. We don't know when we are going to get off, and we don't know how long we will be off. In between that, we are supposed to put marriages and bar mitzvahs and Little League and children on hold, and the result of that lifestyle is called divorce, called troubled children. It is terrible for family values. But the carriers say they need this in order to be able to have a demand service.

I appreciate what the carriers are doing today. I went to Mr. Dealy one time that I can remember and talked to him about a problem involving Phoenix crews. It was taken care of, and we never had any other problem. There are many good ideas out there. Unfortunately, there is not enough of them. Unfortunately, I have a political organization. I can't get some things ratified that will save lives because, as Mr. Dealy said, I got mileage hogs. They passed the Hours of Service Act jokingly to keep them from making all the money and being on duty 24 hours a day.

So as we struggle between labor and management to try to search for an answer, where we can't get there, we call on you. We call on you to do what has been requested today.

There is only thing I have disagreed with about Mr. Boardman's testimony, and that is we would hate to see the act completely repealed. We would like to add the rulemaking to it because we are just afraid that the number of hours could be raised or the amount of rest could be reduced.

We would like to see that it be science-based. We have tried to do it collective bargain-based and I believe the railroads have tried to do it operationally-based and sometimes we just can't get to

where both of us need to be. They can't do it my way which is unreasonable, and I can't do it their way which is unreasonable. We would like to see it based on science.

We need to have the limbo time eliminated it. Call limbo time what it is. You are on somebody's property. You are under their supervision. You are under their discipline. You can't go get a beer. And so, to sit down and say that you are not on duty, I think is a myth. When I am off duty, I am off duty. When I am on somebody else's property and they are in control of me, I am not off duty, whatever you want to call it.

We need to address the calling time in relationship to fatigue. Some of our people are called multiple times and offered multiple jobs and woken up all hours of the day and night.

We would like to have the correction to allowing sleeping quarters in certain railroad yards.

We would like to have certification for conductors. We feel like that is needed to have qualified, trained people. A member of this Committee, I think became aware of our communication problems. July the 27th at this table, Mr. Hamberger, Mr. Stem and Mr. Boardman all said that we probably need to do something about training. I left this committee room and called the President of my union and said gee, we have got something on training. We can move forward.

And he said, well, I just met with Mr. Bob Allen in Chicago to try to handle it through contract negotiations, and the nicest words I can say is he demurred.

How do we get a deal? We have an instance of where in the State of Illinois where a piece of legislation passed through the House unanimously. The railroads had concerns about the penalty portion. Rail labor, rail management and the people from the Assembly met and corrected the language. The bill passed the Senate and because we had an agreement between rail labor, rail management and government, we thought it was over. God Bless their legislative people that are like Mr. Hamberger and those here. Somebody forget to tell the legal department. So the rail sued in Federal court to overturn their own language and were successful.

I have in front of me what we call Letter 2 out of the last National contract. It says: This confirms our understanding with respect to Article 4, Service Skills, Document A agreement of this date. The parties agree to the earliest opportunity. In the next National round bargaining round, the matter relating to existing service scales in effect on each participating road to training and experience shall be addressed.

That is 2002. I have been in negotiations two years. We haven't quite got around to talk to that. Now it says it is the first thing we are going to talk about. Well, we talked about health and welfare, and we talked about one person train crews, and we talked about a lot of other things. At what point can my partner and I sit down and make a deal that is a deal?

When we reach out with our hands and shake hands, I believe the person I am shaking hands with I can trust. Unfortunately, some of the times within a major corporation, those people in other departments don't recognize or appreciate all that went into make that partnership, whether it is the legal department, whether it is

the labor negotiations department or other people. It is very difficult for us to sit here and say, gee, we are really open to being disappointed again.

So as we move forward dealing with fatigue and we move forward dealing with safety overall, we are open. We are ready, but we need your help. We can't get there by ourselves. We have tried. There has been progress, and Mr. Dealy has done some wonderful things on his railroad, but we can't get to the solutions, I believe, to protect both our members and the public.

Thank you.

Mr. PARKER. Thank you, Madam Chair, Mr. Shuster, members of the Subcommittee. On behalf of my International President, Dan Pickett, it is an honor for me to testify on fatigue in the rail industry.

I am the Legislative Director for the Brotherhood of Railroad Signalmen and also have 34 years of rail service. We support the testimony from my brothers at the table.

Our lives depend on qualified trainmen. Signalmen install, maintain and repair the signal system that railroads utilize to direct train movements. Signalmen also install and maintain the grade crossing signal systems used at highway railroad intersections which play a vital role in ensuring the safety of highway travelers.

The rail industry is moving more freight today than ever before with fewer employees. This is a critical point that must be acknowledged. Through mergers and the railroads' quest to eliminate workers, railroad staffing levels are at an all time low. In the past years, those numbers have increased as the railroads need to train new people to fill the increased vacancies as a result of baby boomers retiring. This trend of retirees outnumbering new hires is expected to continue for the next 10 years.

As a result, current railroad workers are working longer hours. A 12 to 16 hour day is not unusual for railroad workers and in many cases it is the norm. The railroads are abusing their most important resource, railroad workers.

The BRS seeks to amend the Hours of Service Act for signalmen by eliminating the four hour emergency provision due to its abuse by the railroads. The Hours of Service Act allows individuals performing signal work to work 12 hours in a 24 hour period with an emergency clause provision calling for an additional four hours of service in a 24 hour period. When the act was expanded to include signalmen, it was intended to a 12 hour law.

This is how the railroads originally applied the law. If a signal employee needed additional time to correct a signal problem, he would inform his lower level supervisors of the 12 hour limit. The supervisor would determine if the employee could finish the work within 12 hours or if another signalman employee could be called to finish the repair work. This worked for years.

However, through gradual creep, railroads have mutated the act into a 16 hour law. Many railroads now consider any signal problem an emergency. Signal employees are routinely instructed to work the 16 hour limit. Many railroads authorize outright violations of the act by ordering signalmen employees to continue working until repair work is completed. That is why it is up to Congress to remove the four hour emergency provision. This discretion com-

bined with the railroads' tendency to push the limits of the law has morphed the act and is contrary to the intentions of the 1976 Congress.

Of greater concern is when a BRS member can work 20 hours in a 24 hour period without adequate rest. The cumulative effect of the law on the individual is that he is allowed to work a total of 20 hours of service within a 32 hour period. While the employee has had 12 hours off, he has gotten virtually no sleep.

This situation is exasperated further when railroads require signalmen personnel to work an additional four hours under the emergency provision. If an emergency occurs at the end of his shift, the railroad will require him to work an additional four hours. The cumulative effect of the law on the individual would now be that he is allowed to work a total of 24 hours of service within a 40 hour period with virtually no sleep. This type of work schedule is a recipe for disaster.

The BRS asks that the Hours of Service Act be amended to require that employees performing signal work receive at least eight hours of extra rest during a 24 hour period. Our request is due to the fact that many of the railroads willfully abuse the act. For example, when the railroad receives emergency calls prior to the end of eight hours of required rest, they will delay calling signal personnel until eight hours have passed since the end of their scheduled shift.

Chairman Oberstar has gone on record, calling for legislation that strengthens the act, stating: I believe that the safety of railroad workers and the safety of the general public which all too often are the victims in these train accidents should not be relegated to a negotiation between management and labor. This Congress has a responsibility to prevent fatigue.

Madam Chair, I could not agree more with Chairman Oberstar. The railroads have manipulated the 12 hour Congressional Hours of Service Act into a 16 hour law.

The situation is even worse in the industry than what I have explained so far. The BRS is currently engaged in National negotiations with the railroads. The railroads want work provisions that allow them to subcontract out safety-sensitive signal work to the lowest bidder. The reason for that is contractors are not covered under the Hours of Service Act.

Madam Chair, an adequately staffed signal department with well trained and well rested signalmen is needed to make the critical safety-sensitive decisions that are routinely part of our daily duties. Signalmen employees often work alone in the worst weather conditions and some of the most demanding terrain, and it is imperative that these workers have the opportunity to perform their duties after receiving adequate rest.

There is much to accomplish to eliminate fatigue for rail signalmen and the rail industry as a whole in order to make the Nation's railroads safer for communities across the Country and rail workers. Experience teaches us that it is Congress, that it is Congress, that it is Congress that must provide the leadership to make safety a reality. I hope we can work together to see that improved safety practices become a reality.

On behalf of rail labor and the Brotherhood of Railroad Signalmen, I appreciate the opportunity to testify before this Committee. Thank you.

Ms. BROWN. Thank you and thank everyone for their testimony.

Let me just say before I begin with my questioning, to a person, I feel very strongly that we would like for, and maybe I am meddling at this point, but we would like to see an agreement between the rail and labor. I don't know what you do. You go into a room, you lock the door and failure is not an option. We don't really want to deal with that up here. I am telling you. We would like for you all to come up with an agreement, and some of the issues that I hear you discuss are things that you need to resolve.

Now I know all about signalmen. My brother is one for over 30 years. You have got a rock in a hard place. They want more time, they want more flexibility, but they like the money. They want the hours. So you have got to work with them and you have got to work many of these issues.

You all are very close to coming up with an agreement. I think maybe the last meeting you had was in Las Vegas. Maybe you need to go somewhere up here where is rainy and snowy and not a wonderful place to be and lock the door.

With that, I will get into questions.

Mr. SHUSTER. Would you yield?

Ms. BROWN. Yes, sir. Yes, sir.

Mr. SHUSTER. I couldn't agree with the Chairwoman more. The last thing I think you said was you were meddling. I think that is what they are inviting us to do, and I think that is the last thing you want is for the Federal Government because it has been my experience the Federal Government is going to just screw things up worse.

So I couldn't agree with the Chairwoman more. Come to an agreement amongst yourselves and don't have us interject. I think it is going to be terrible for everybody, not only bad for you folks in the rail industry but bad for the American people. It is going to mean that we are not going to get shipments on time or get the goods to market.

I couldn't agree with the Chairwoman. Go lock yourself in a room somewhere there is no golf, no beer and no TV and force yourselves to work that agreement.

Ms. BROWN. No sunshine.

Mr. SHUSTER. I better stop there or we are going to get in trouble.

I thank you for yielding.

Mr. BRUNKENHOEFER. In other words, you don't want us to go to Jacksonville in your district. You would prefer that we went up to Mr. Oberstar's district.

Mr. SHUSTER. I could find a place for you in Central Pennsylvania that there is not much fun going on.

Ms. BROWN. Anyway, one of the things, the camp cars that you showed us in the video, my understanding, Mr. Hamberger, is only one railroad continues to use that.

Mr. Dealy, I don't understand. It looks like slave quarters to me. I hate to use such a strong term. Why is it that is the only railroad that is still using those camp cars?

Mr. HAMBERGER. It is my understanding that your understanding is correct, that is, that it is one railroad only still using the camp cars. Further, it is my understanding that they are in the process of transitioning out of those camp cars over time and they will be providing housing in hotels or motels consistent with labor agreements.

Ms. BROWN. Like most of the railroads, is that correct?

Mr. HAMBERGER. Like all the other Class 1s do, that is correct. But I will reiterate what I mentioned last week. There are FRA standards, and I would hope that if that camp cars were not in accord the FRA standards, that would have been reported to the FRA.

Ms. BROWN. There has been a lot of discussion about limbo time. Is this something that is paid for?

Explain to me because my understanding in talking to the workers, some of it is maybe manageable and some of it can run up to five or twelve hours. While they are there, they have to be alert and to be vigil, and so they are really still working.

Mr. DEALY. I will take that one, first, Chairwoman Brown.

Ms. BROWN. OK, yes, sir.

Mr. DEALY. One, they are paid. Two, they are not required to perform duties. Three, from a management perspective, speaking for BNSF and I set the policy, if we know a train crew is not going to make their destination and we know they are not going to make their destination, it is our policy to get them off the train and to their tie-up point within 12 hours.

Now there are a lot of times where things happen. In Congressman Lipinski's territory, I will talk about two brief cases here. One of them was in his district over the last two days. In Lisle, Illinois, we had a trespasser, not at a road crossing, step in front of one of our trains and was killed. That shut the railroad down for about five or six hours, and that happened all of sudden, unpreventable, unforeseeable. We reacted to it as quick as we can. We had crews on duty that couldn't get into Chicago because all the routes were closed, and we couldn't get them off the train quick enough because we couldn't get to them in traffic. There are situations like that.

I had one in northern California yesterday. A crew was on a train for 18 hours. That is unconscionable. But they were in the Feather River Canyon, a rockslide came down, and we got to them as quick as we could, and believe me, it was as quick as we could.

So limbo time comes in a couple of different shapes and sizes. The most heinous of them all is when we know a train crew is not going to make their destination and we don't get them off their train. We are solidly, from a policy perspective, in agreement that that is not the right thing to do and we need to get them off the train. But we don't require employees to do any work while they are on the train after 12 hours.

Ms. BROWN. Would you say that this is how the emergency time is being used?

Mr. DEALY. I am sorry. I don't understand.

Ms. BROWN. The emergency time, for example, the two areas that you just mentioned.

Mr. DEALY. Right, they would be under emergency, yes, ma'am.

Ms. BROWN. I would consider that an emergency.

Mr. DEALY. There is also one other issue in emergency now. There is a service law and it generally comes in snowstorms where we actually would have a crew work over the 12 hour law and then file that as a known violation-exception to the FRA, that is was safer to work them over to get them into a point where we could get to them rather than let them sit in the snowstorm just because the 12 hour law had hit them.

Ms. BROWN. I would like labor to respond.

Mr. PONTOLILLO. Briefly, Madam Chair, thank you.

With respect to the camp cars, what FRA has published actually are guidelines, not enforceable regulations where there is any sort of penalty if a railroad like the NS did not meet those standards. There are merely guidelines.

On the question of limbo time, Mr. Dealy makes a very good point. Our system operates 24/7 in all sorts of climate, in all sorts of weather, expected and unexpected, and there are situations. I had, I guess, after I had worked about five or six years, I was in a situation where I was told in the middle of a snowstorm, you have to violate the Hours of Service. That is really not what we are talking about here, but it is more the systemic type of issues.

Railroad A that I mentioned before, which is not BNSF, 334,000 incidents over a six year period is just more than unexpected weather.

Briefly, also on the pay issue, it is not as simple as the industry suggests. Under the National agreement, you get paid the miles of the run. If you are on a 325 mile run and you do that in 9 hours, you make the same amount of money as you do if you outlaw on the line of road and then it takes another 8 hours of limbo time to get you back in. You get the pay for the mileage regardless of how, and then you only get additional pay or overtime depending on the length of the run and how long it takes you to work out the over miles. On a 325 mile run, you do not go on overtime until after 20 hours. So the crews aren't losing money out there, but they are sitting there basically for nothing until the mileage runs out. Now that is in the national agreement.

It is true that in the last several years, there have been some local agreements and there are some system agreements where in limbo time situations, the crew will begin to receive additional pay. I believe that sort of financial incentive probably does help reduce the limbo pay situation if it could be straightened out at the table. I agree with you, Ms. Brown and Mr. Shuster. Unfortunately, the management guy you would have to lock up is not on this panel today in order to get that deal done.

Mr. PARKER. Madam Chairwoman, I would like to speak.

Ms. BROWN. I think you are getting the message.

Mr. PARKER. I would like to speak on the emergency time. There are devastating times for signalmen when maintenance away production gang come and we spend days and days and days at a time. There are some employees where there is a problem with overtime. When it comes to situations like that, when it comes to rest and overtime, rest takes precedence.

There are times when you are working a signal circuit, and your time is gone, and the railroads will say, that signal circuit is caus-

ing the crossing gate to go down, so now we declare this an emergency for protection of the public.

As we stated in our testimony, the railroads will use any circumstance and situation to make us work past our 12 hour period. It is devastating. Anytime they want to call it an emergency or tell us to work past the Hours of Service Law, they do that.

Ms. BROWN. Mr. Parker, are they paid for the overtime?

Mr. PARKER. Yes, they are paid for the overtime, but the problem is they need more employees to fulfill some of that, some of that time. There are some people who all their time is spent on the railroad.

Ms. BROWN. The question about the camp car video, can labor respond to that? Is this being negotiated?

Mr. PONTOLILLO. I believe that the BMWED has attempted on numerous occasions to negotiate it with Norfolk Southern. I can't speak personally. We can supply greater details, but if it is similar to many other rail union negotiations, NS is probably looking for something in return.

Ms. BROWN. Well, Mr. Hamberger, you will give us that response in writing.

Mr. HAMBERGER. Yes, ma'am.

Ms. BROWN. Mr. Shuster?

Mr. SHUSTER. Thank you.

I can go back to the last hearing we had, and I will keep saying this over and over again. I am trying to get my hands around and my brain around all these issues. For me, it is extremely important to have some points of reference, and those become the statistics. I was told and I am aware you can make the statistics move a little bit, but if I can see how you got your statistics, I can figure out how you moved them or what you did. I need that kind of information.

Mr. Pontolillo, did I pronounce that correctly?

Mr. PONTOLILLO. Yes, sir.

Mr. SHUSTER. The numbers that you put forward, they sound like big numbers to me, but I have no point of reference so I am not sure. Mr. Hamberger in the rail industry comes up here and says that 83 percent of the rail workers are on duty less than 200 hours per month and 95 percent or less are under 250 hours per month. Now I can dive into the numbers and figure out how he got it.

If you folks in labor, can give me those kind of numbers so I can handle it better, it will help me as we move forward.

I agree with the Chairwoman, I hope we don't have to do anything on this because I think it would be much better served if you did it. So that is something that I need coming from you folks.

A question I have about the declaration of emergencies, I understand Mr. Parker brought that up and that has been on the increase. Whoever wants to take it first, management or labor, tell me about it. Has there been an increase in emergencies, declaration of emergencies, and why do those occur?

Mr. HAMBERGER. I am not sure I can answer the delta over time, but we have done a little research on the number of such declarations in talking to the railroads. If a signalmen has to work more than 12 hours, that has to be filed with the FRA. So there is a re-

pository at the FRA that keeps track of the number of times that a person is asked to exceed the 12 hours of all the crew tours of duty, if you will, that are out there.

I know for a fact with Mr. Dealy's railroad, that number in 2006 was .08 percent—.08 percent of the number of times a BRS person went out to work that they were asked to spend more than 12 hours. It is my belief and understanding and we will get those data for you, that the other railroads are all less than 1 percent as well. So I don't see that as the widespread abuse of the emergency.

If I could just make one further point, I am sorry Mr. Kuhl left because his area in New York just got 10 feet of snow, and certainly that is going to demand a lot of checking of grade crossings and a lot of work on signal work and you can't staff up to have people sitting around waiting for a 10 foot snowstorm however many years they come. Mr. Parker referenced the negotiations about contracting out, and certainly that is one of the reasons that we need to have that authority, so that you can put the resources when there is a disaster like that and a need, that you can put more resources out there. Anyway, that is one of the issues that is begin dealt with at the bargaining table.

Mr. SHUSTER. Has then been more, a greater number of declarations of emergencies over the past? Is that what you said?

Mr. HAMBERGER. I don't have that information. All I know is the real number is that it is less than 1 percent for the Class 1s and I just happen to know Mr. Dealy's is .08 percent. Whether or not that is more than the past, I don't know, but just as a real number, it seems to me to not be a crisis if it is less than 1 percent.

Mr. SHUSTER. One percent, I must have misunderstood you.

Mr. HAMBERGER. So you take a look at all of the shifts that a BRS employee works. Of all those shifts over the course of a year, how many times were they asked to work more than 12 hours? They have to be reported to the FRA if they are.

Mr. SHUSTER. Less than 1 percent?

Mr. HAMBERGER. Less than 1 percent.

Mr. SHUSTER. Mr. Parker?

Mr. PARKER. The problem is it is not defined in the act. Any supervisor on the railroad track can say that this is an emergency, and a signal employee has no other alternative but to do exactly what he says. They also know how to manipulate the time of the signalmen. You go sit over here for a while. You go do this. You go do that.

Depending on the individual, the problem is not a need of contract. The problem is a need of more employees. We have had a shortage of employees for a long time. Territories have been increased, more responsibility, more testing, more things to do. It is something that the railroads could do something about.

If it is an emergency, if it is a snowstorm, if it is a fire, if it is an icestorm, we understand that. That is an act of God. We understand that is an emergency. That is not what w are talking about. We are talking about when a lower line supervisors or a vice president declares an emergency just to keep you out there rather than call somebody else just to keep you out there so he can have somebody available for the next day.

We need a definition. I am telling you it is devastating to us for 20 years,30 years, five year employees. We have to do what we are told. What is the word they use for when you have no protection for reporting incidents? Whistleblower. We have no whistleblower protections on the railroad. It is just devastating for the things we have to do in the name of so-called emergency.

Mr. SHUSTER. I see my time has expired. I yield back.

Ms. BROWN. Mrs. Napolitano?

Mrs. NAPOLITANO. Thank you, Madam Chair.

On that point, Mr. Parker, I have discussed with the Chair the possibility of adding some kind of protection to whistleblowers because that seems to be an issue that keeps coming up again and again, that there is no provision. There is no safety for those employees who are trying to protect not only the infrastructure of the railroad but their own safety and safety of those areas where they go through. So that is a good point.

There are many, many questions, and most of you already probably have heard me talk over and over again. L.A., the biggest sample, we are going to be increasing rail traffic through my whole district six to tenfold. You talk about a train every six to ten minutes. I want to be assured that whatever railroad, be it UP or BNSF, going through my district, the rest of the district, the rest of California too, is not only trained, experienced, not tired, not fatigued because that has seemed to be a big player in some of the accidents that I have heard about.

Now I am not sure. You have told me you have enough trained employees, and yet I hear time and again that you do not have enough trained personnel, adequately trained personnel. I certainly would want some of the organizations to tell us what about the training the employees are receiving. Is it adequate? Are there questions in regard to the length of time, to the type or methodology rather used?

What is it that we can ask that be given to all employees to protect them and the rail cars and the public?

Mr. PARKER. We signed an agreement with one railroad five years ago, six years ago, ten years ago to have advanced training. It has never happened. Sometimes the training is a film. The majority of the time, the training is from an older maintainer. A lot of the older maintainers are gone from the experience. You would just be surprised at the lack of training that we have.

Mrs. NAPOLITANO. No, I wouldn't because I have heard about it.

Mr. PARKER. OK. I had an old maintainer when I began as a signal maintainer, and there was no training as a signal maintainer at the beginning. You went to school eventually but not for long, and the school was set up not for training, for testing, probably to get rid of some people.

He taught me to survive. He said do this, do that, do that, so this switch can go. I learned how. I learned to survive. He taught me to survive until I learned exactly what I was doing. Without the expertise of the older fellows, the railroads have no desire, speaking of my own experience and some of the others. They just don't believe in training for signals.

We have vital circuits. It is just so vital. The nightmare that the signal maintainers have to go through, knowing there is some lack

of knowledge. Sometimes with the new crossing systems that come in, they may bring a salesman to teach you, but they just do not invest in proper training for the signalmen.

Mrs. NAPOLITANO. Would it be more appropriately called on the job training?

Mr. PARKER. On the job training if you have someone there who has the experience to give you on the job training, but we need them to fulfill their agreement with advanced training.

Mrs. NAPOLITANO. Yes?

Mr. BRUNKENHOEFER. Mrs. Napolitano, the Federal Government has regulations on all of us. In the last round of the safety bill, we did drug testing which has turned out to be good—we need to work on that together some more—and we have what is known as personal liability. I have a responsibility to comply with a Federal regulation or if I don't comply with that Federal regulation, I can be fined or removed, banned from the industry.

In our wish list, we would like that the Federal Railroad Administration would set training standards for both labor and management so that we would make sure that we are being adequately trained to comply with the Federal regulations to protect ourselves and protect our public.

Mrs. NAPOLITANO. Thank you.

One of the things, and I am almost out of time, is the cost to the industry gentleman. Mr. Hamberger, while in California, the only way I can bring the railroad to comply with some of my community's requests to do certain things in their own back yard is by going to the FPPC, the State regulatory, to do fines on them. Is there another way that we may be able to get better compliance?

I know that I had one representative for one railroad for the whole West Coast including Hawaii, and when I called, he was either not available or was very not understanding is putting it mildly. I certainly would want those that have requests to make that would help bring compliance to the community's request or at least addressing the issues to be able to help address some of the issues that have been brought up today.

Mr. HAMBERGER. Probably a long answer, I have a request in to meet with you. I would like to be able to come in and, with the railroads, BNSF and UP, and talk through some of the specifics you have voiced in the last couple of hearings, that I would like to get a little more detailed understanding so we can make sure we can respond properly.

Mrs. NAPOLITANO. The last question, you can answer it, is because you have had some findings from the research that was done over fatigue. Have you reviewed them? Have you found out whether some of them can be implemented? What about some of the work that should be done?

Mr. HAMBERGER. Mr. Dealy is in charge of doing that.

Mr. DEALY. Sure, I think some of it points to earlier testimony, but it really does come back down to looking at the modeling that the two individuals talked about in the panel ahead of us. I think it directly applies on the small group of employees that I referred to that do work a lot, and we would just as soon they take days off. We would be all in favor if there was mandatory off time for

those, and we think it does fit the modeling that Dr. Sherry and Dr. Hursh have done.

If I could just touch on the question you said earlier because you asked a good question. One, do you have enough people and, two, are they adequate trained?

Right now I am surplus 100 people. I know my counterpart with Union Pacific because both of us operate through your district, we both have a surplus of employees. Two, we have worked with the unions in the last two months to keep them on the payroll even though economics probably would dictate we furlough them. So we have worked through some innovative ways to keep them around, so they can continue to get training. Then thirdly, both the training program for our conductors and for our engineers are by agreement with the UTU and the BLE and actually the UTU training agreement also applies for a UTU coordinator on each seniority district to supervise the training.

Mrs. NAPOLITANO. Sir, after 9/11, a lot of the personnel was deleted. Are you comparing the statistics after 9/11 or before 9/11 where you had full complement and you did not fill all of those positions?

Secondly, as we have heard the testimony, you are utilizing less and less personnel on the trains themselves.

Mr. DEALY. Well, before and after 9/11, we had two men, two person train crews, conductor and engineer, so that really didn't change.

Two, I am talking current state when I said we have plenty of people right now. We still plan to hire this year. We all know the pain of running short of employees. That is not a good thing, and we all have intentions of staying ahead of this. We have it in our business plan to stay ahead of it with really still aggressive hiring programs, and we will still hire at BNSF in the neighborhood of 1,500 employees this year even though right now I have got 1,000 surplus. We know that because we have a good idea of what the retirements are going to be, and we think we understand what the growth rate is going to be, particularly out of southern California this year.

Mrs. NAPOLITANO. I am sorry. There is apparently a response to that.

Mr. BRUNKENHOEFER. Railway Age off the web site, February the 7th, between mid-December, 2005 and mid-December, 2006, Class 1 employment in railroads increased 1.63 percent to a total of 167,558 according to Surface Transportation, where the largest employee group was transportation train engineers which rose to 75,815 during the period, an increase of 3.10 percent. The second largest group was the maintenance away structures decreased 1 percent to 34,000. They were laying them off.

The biggest percentage increase was the category of executives, officials, staff assistants whose numbers increased 6.37 percent to 10,148. So, yes, they are hiring.

But are they hiring at the rate, one, that business is growing? God bless Dave and the sales department that got business growing. Are they hiring fast enough to cover the business that is growing and retirements?

I would say that if I am understanding correctly, recent growth in business has been at the double digit level for the last several years. God bless them. But at the same time, the overall hiring numbers, at least according to the numbers quoted by the Surface Transportation Board, do not reflect that other than we are getting a lot more supervision. For every one employee in the category of operating the trains, we are getting two supervisors hired.

Mrs. NAPOLITANO. Thank you, sir, and thank you for your indulgence, Madam Chair.

Ms. BROWN. I am going to go to Mr. Lipinski for the last question, but let me just ask you quickly.

I went to the training program that CSX had, Mr. Brunkenhoefer, in Atlanta, and my understanding is they are training 24 hours. In some of the I guess railroads, they are training as many as they can accommodate. This is a good problem for the industry, and I think maybe we need additional training programs for people that have been there. Maybe it took a five man crew and they actually didn't run the train until after they had been there for a number of years, by themselves. I guess with the technology, the industry has changed.

Mr. BRUNKENHOEFER. Ms. Brown, put me down in the Amen corner down at the AME at 11:00 on a Sunday morning. I am in agreement with you. I would just like somebody like the FRA to set some standards to make sure that everybody gets quality training because the trains that they handle are all the same all over the United States. And so, all we want is if somebody has got something good, let us apply it everywhere.

Ms. BROWN. Help me now. The trains may all be the same, but the conditions are not always the same.

Mr. BRUNKENHOEFER. Amen.

Ms. BROWN. All right, Mr. Lipinski?

Mr. SHUSTER. Thank you, Madam Chairwoman.

I just want to point out one thing. I just want to tell Mr. Brunkenhoefer, who I normally call Broken Rail but I wasn't sure. This is the first time in this formal surrounding that I addressed you.

Mr. BRUNKENHOEFER. I hope you forgive me for not wearing my jacket.

Mr. SHUSTER. That is perfectly all right, but I knew you knew what statistics were.

Mr. BRUNKENHOEFER. Thanks very much.

Mr. LIPINSKI. I just heard you fire off several of them, so I appreciate that.

Ms. BROWN. Mr. Lipinski?

Mr. LIPINSKI. Thank you, Madam Chairwoman. I get to go clean-up, otherwise known as last, and I know everyone is ready to get out of here. A couple things I just want to mention here a little bit.

Mr. Dealy, I don't know. I may have misunderstood you. I just want to make clear that this tragedy that occurred was in Berwyn that happened yesterday. I wasn't sure if that was what you had said, but I didn't want to interrupt you.

Mr. DEALY. I stand corrected, Congressman. Thank you.

Mr. LIPINSKI. The issue of the camp cars is something that certainly has been brought to my attention many times, and certainly

seeing this video makes it very clear what a terrible situation. I just imagine trying to get sleep in there. I just want to make sure that we do get that cleared up about what is going on, if this is something that, as Mr. Hamberger said, NS is going to end. I just want to make sure.

Mr. HAMBERGER. I don't want to overstate that. It is my understanding they are in a transition phase, but I do know, as Mr. Pontolillo indicated, they are in discussions with the unions on that exact path. So I don't want to say that it is over, but I think they are discussing it with the unions.

[The information received follows:]

Written Response on Norfolk Southern's Use of Camp Cars

February 13, 2007 Hearing

Norfolk Southern has supplied the following answer:

- In practice, camp cars really mean trailers. Some labor agreements negotiated by BMWE provide for employees to be housed in trailers, subject to certain conditions. The Federal Railroad Administration has promulgated standards for the use of camp cars and trailers.

- If BMWE thinks that a railroad is not complying with its labor agreements respecting lodging, it may file a grievance. That grievance can then be resolved under the dispute resolution procedures of the Railway Labor Act, including binding arbitration.

- If the union wants to change a provision in a labor agreement (including a provision respecting lodging) it may propose such a change during collective bargaining. The union should not be permitted to end-run the collective bargaining process by asserting that a provision of a labor agreement -- to which it originally agreed -- is unsafe.

The reality is that Norfolk Southern has begun to transition some workers from camp cars to motels, especially on the former Norfolk and Western. Even in this case, however, the railroad will likely continue to house some workers in camp cars in isolated areas where sufficient motel lodging is not available. Further, Norfolk Southern hopes to be able to reach an agreement that would permit moving workers on the former Southern Railway out of camp cars on some reasonable basis.

Mr. PONTOLILLO. We will supplement our response and let you know exactly what our people are telling us. Thank you.

Mr. LIPINSKI. I thank you.

Mr. Broken Rail, I will go ahead and use that, although it is a simple German name there that we could probably really pronounce, but I guess this works well.

I just want to make sure. I heard this now brought up a couple of times about this issue in Illinois. We are working on getting that straightened out, aren't we?

Mr. BRUNKENHOEFER. I expect that Mr. Szabo who is our State Director will be making a request to that particular. This is a problem when you win a lawsuit that says it is federally preempted. Now it looks like we are going to have to come to you and this Committee and ask that we have a Federal law to solve the problem in Illinois.

It is not a problem just in Illinois, but we were trying to address this at the State level. We thought we had successfully done it. Unfortunately, we misunderstood. We thought a deal was a deal, and so we will be approaching this Committee to add language to the safety bill to address it.

Mr. LIPINSKI. I have spoken with Mr. Szabo. I know that others have also and Chairman Costello has, it being an issue directly with Illinois although, as you say, it also applies elsewhere. Every week, well, the last two weeks, I have heard about this issue regarding Illinois, so I will have to work on that.

That is all. I yield back, Madam Chairwoman.

Ms. BROWN. Mr. Shuster?

Mr. SHUSTER. I just want to congratulate you in your judgment today, Madam Chair. Where everybody else left in the Federal Government at 2:00, those of you who are going to leave at 5:00 are not going to have the traffic to deal with tonight. So you can all thank the Chairwoman for her great insight into that.

Mr. PONTOLILLO. We appreciate that very much too.

Ms. BROWN. I hope we don't have ice.

Let me just thank the witnesses for their valuable testimony and the members for their questions.

Again, the members of the Subcommittee may have some additional questions. I know I do. I am going to put them in writing.

With that, this hearing is adjourned.

[Whereupon, at 4:40 p.m., the subcommittee was adjourned.]

Written Statement of
Joseph H. Boardman
Administrator
Federal Railroad Administration
U.S. Department of Transportation

before the
Subcommittee on Railroads, Pipelines, and Hazardous Materials
Committee on Transportation and Infrastructure
U.S. House of Representatives

February 13, 2007

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February 13, 2007

Chairwoman Brown, Ranking Member Shuster, and other members of the Subcommittee, I am very pleased to be here today, on behalf of the Secretary of Transportation, to testify regarding the issue of fatigue and its relationship to the safety of railroad operations. In my testimony last July 25th regarding the broader topic of railroad safety human factors, I outlined eight requirements that must be addressed in order to maximize safety and minimize risks:

1. The worker's task needs to be well defined, and the rules and procedures for its accomplishment must be effective, clear, and unambiguous.
2. Rules and procedures must be well understood, and skills must be practiced.
3. Everyone must be accountable.
4. The organization must nourish a positive safety culture.
5. All personnel must learn how to work constructively together.
6. Individual employees must be fit for duty—rested, free of alcohol and drugs that could impair their faculties, and free of other disabling medical conditions.
7. Technology must be part of the solution, not part of the problem.
8. Impediments to working safely must be identified and removed.

Clearly, these elements are not mutually exclusive, and none can be satisfied with full assurance at any given point in time. Our institutions and our people, including ourselves, are imperfect, and given to occasional error. But each of us can do better if we are provided an appropriate work environment, and we can put in place supporting structures that will catch us when we fall. Since I testified on human factors last July, the Federal Railroad Administration (FRA) has been busy with a variety of human-factor initiatives, among them publication of a proposed rule addressing key railroad operating rules and the management of programs of operational tests. Indeed, one of the pillars of FRA's National Rail Safety Action Plan is the reduction of accidents caused by human factors, and that involves addressing the serious problem of fatigue among railroad employees.

It is particularly timely that the Subcommittee should call for testimony on the subject of fatigue. We have progress to report, and we intend to submit to Congress a rail safety reauthorization bill that will include an important new provision on hours of service reform.

Background

For each of us to be fully effective in our work, we need to be well rested and alert. The issue of fatigue is particularly critical to the safe discharge of duties in railroad operations. This was first recognized by the Congress 100 years ago, with passage of the Hours of Service Act.

What is "fatigue"? In order to be scientifically sound, we will use the definition found in the Department of Transportation's (DOT) March 1999 policy statement on fatigue: "a complex state characterized by a lack of alertness and reduced mental and physical performance, often accompanied by drowsiness." Fatigue certainly includes lack of alertness (i.e., sleepiness), but also involves compromised attention to detail and diminished ability to reason rapidly and clearly in order to respond to changing circumstances. The DOT policy statement goes on to summarize the sources of fatigue.

> Fatigue may be caused or exacerbated by any or all of the following: lack of sleep, disruptive work/rest cycles, neurological conditions, excess mental or physical workload, exposure to extreme physical conditions, emotional stress, the use of drugs or alcohol, illness, and/or monotony.

FRA has sought to promote railroad employees' fitness for duty through enforcement of the hours of service laws (which, since 1994, have been codified as positive law at 49 U.S.C. 21101 et seq.), as well as through joint efforts with railroads and employee organizations, research, analysis, and participation in the North American Rail Alertness Partnership (NARAP). In addition, both FRA and the National Transportation Safety Board (NTSB) have sought to understand the role of fatigue in significant rail accidents.

When I appeared before the Subcommittee last July, I reviewed some of the programs in which we were participating that were directed at risk reduction with respect to fatigue. Today, I'd like to review with you the culmination of rapid developments that have occurred over the past several years that have improved our understanding of the origins and dimensions of fatigue and that have provided better tools for fatigue prevention and mitigation. Then I'd like to describe some of the new efforts underway to address fatigue, and finally I'd like to ask for your consideration of the hours of service reform provision that FRA intends to submit.

Growing Knowledge of Fatigue, Better Tools to Prevent and Mitigate It

Both railroads and employee organizations are heavily invested in their work practices and collective bargaining agreements. Railroads owe their shareholders a duty to make a reasonable profit, and they owe their customers reliable service. Labor organizations must consider the interest of some members in maximizing earnings. Neither labor nor management is inclined to undertake or sustain initiatives that, however well intentioned, do not contribute to the overall well-being of the industry in a way that

can be clearly established. Railroads operate 24 hours each day, and the demands of the market are constantly shifting. Take these factors together, and they describe a situation that is hostile to fatigue management. Let me be clear that it is not the railroad executives, or the rail labor executives, or their colleagues who are hostile. Quite the contrary; rather, it is the institutional situation.

Accordingly, it has been critically important that we clearly understand the true dimensions of the fatigue problem and that we formulate approaches that can effectively address the problem while avoiding unnecessary disruptions of stakeholder expectations and transportation service.

Over the past two decades, significant progress has been made in sleep science and in our understanding of the role of fatigue in our daily lives. The NTSB has played a salutary role in calling out fatigue as a factor in at least 18 rail accidents since 1984. FRA-funded research has used an integrated strategic planning and evaluation strategy of field data collection, laboratory simulations, and analysis and evaluation of Fatigue Management Systems to enrich our knowledge of fatigue as it affects employees in a wide range of railroad occupations. This multi-faceted research has resulted in a strategic fatigue roadmap for FRA that identifies work scheduling as one of the top policy issues, and a key starting point for addressing the fatigue problem in the rail industry today.

FRA's analysis of data gathered by our Switching Operations Fatality Analysis (SOFA) Working Group indicates that fatigue (largely related to biological rhythms or time of day) was likely responsible for more than 22 percent of the risk of SOFA severe incidents from 1997 through 2003. Last July, FRA released the Collision Analysis Report, which identified compromised alertness as a likely significant factor in 29 percent of the collisions reviewed in detail by a panel of railroad subject matter experts representing labor, management, and the Federal government.

On November 29, 2006, we announced the release of an important new study entitled Validation and Calibration of a Fatigue Assessment Tool for Railroad Work Schedules (the Validation Study), which confirmed the applicability of a Department of Defense fatigue model to railroad operations. The Summary Report from that study described the relationship between fatigue and human-factor train accidents. The study is the largest and most rigorous of its kind, based on review of 30-day work histories of locomotive crews involved in 400 human-factor and 1,000 other train accidents. The data from the model validation study showed that there is a reliable relationship between the time of day of human-factor accidents and the expected, normal circadian rhythm. This circadian pattern was not reliably present for accidents not caused by human factors. The risk of a human-factor accident was increased by 20 percent by working during the hours from midnight to 3 a.m.

The results of this accident analysis study indicated that a fatigue model could predict an increased risk of human-factor accidents under certain conditions that cause fatigue. A bio-mathematical fatigue model, known as SAFTE (Sleep, Activity, Fatigue, and Task Effectiveness), was used to estimate crew cognitive effectiveness based entirely

on work schedule information and opportunities to obtain sleep. Effectiveness is a metric that tracks speed of performance on a simple reaction-time test and is strongly related to overall cognitive speed, vigilance, and the probability of lapses. The model rates effectiveness on a scale from 0 to 100. There was a reliable linear relationship between crew effectiveness (fatigue) and the risk of a human-factor accident: as crew effectiveness declined, human-factor accident risk went up. No such relationship was found for accidents not caused by human factors. This result satisfied the criteria for model validation. The risk of human-factor accidents was elevated at any effectiveness score below 90 and increased progressively with reduced effectiveness. There was a reliable time-of-day variation in human-factor accidents, but not in accidents not caused by human factors. Human-factor accident risk increased reliably when effectiveness was below 70, a value that is the rough equivalent of a 0.08 blood alcohol level or being awake for 21 hours following an eight-hour sleep period the previous night. Below an effectiveness score of 70, accident cause codes (codes defined by FRA that indicate the factors that caused the accident, such as passing a stop signal or exceeding authorized speed) were of the sort expected in situations involving fatigue, confirming that the relationship between accident risk and effectiveness was meaningful. If an individual had an effectiveness score of less than or equal to 50, his or her chance of having a human-factor accident was increased 65 percent.

Although the Validation Study was designed to test a fatigue model rather than determine the role of fatigue in specific accidents, the data from the study necessarily imply two conclusions:

- From the data available, the majority of human-factor train accidents do not involve fatigue.

- However, a significant number of the most serious accidents (e.g., violation of a mandatory directive or failure to comply with a stop signal) do appear to include fatigue as a significant factor.

FRA has explored the dimensions of the fatigue issue in the working lives of not only train crew members but also other categories of railroad employees. In a final report dated October 2006, entitled Work Schedules and Sleep Patterns of Railroad Signalmen. FRA posits that signal maintainers could be adversely affected by unscheduled trouble calls on top of their normal eight-hour workdays. This survey-based study was facilitated by the Brotherhood of Railroad Signalmen. In a final report published in December 2006, entitled Work Schedules and Sleep Patterns of Railroad Maintenance of Way Workers, FRA researchers described the challenges that track workers face in remaining well rested. This report was facilitated by the Brotherhood of Maintenance of Way Employes Division. It is important to note that neither of these studies described any situation of egregiously overscheduled employees. Rather, the studies provide an enhanced foundation for fatigue management in those occupations.

The Collision Avoidance Working Group (CAWG), which produced the Collision Analysis Report referred to above, examined 65 main-track train collisions in which

human-factor causes contributed to trains exceeding their authority by passing a stop signal, failing to comply with a restricted speed signal, or entering territory without authority. CAWG found that 19 of the 65 accidents (29 percent) involved "impaired alertness" (defined as failing to take appropriate actions to avoid the accident). In the accident sample for the model validation study, 38 percent of similar accidents had effectiveness scores of 70 or below. Nearly all of the 19 CAWG collisions occurred between midnight and eight in the morning, which indicates a strong circadian effect.

Industry, FRA, and Joint Fatigue Management Efforts

In the railroad safety effort, our common perception of the problem of fatigue is perhaps best exemplified by the service crisis of 2004. In that year, a major Western railroad found itself with too few employees and more traffic than it could efficiently handle. The result was clogged main lines, hundreds of "recrews" daily (as legal limits on hours of service stopped trains en route), confusion and delays in getting crews off trains, and some serious accidents that may have arisen from fatigue. Other carriers faced challenges as well. Some local labor agreements that might have acted as a check on the problem had been abandoned, either by the railroad or the labor organizations. FRA tried to help through the Safety Assurance and Compliance Program, but solutions did not take effect for some time. All concerned will freely concede that it was not their finest hour.

We are past that period of time, but we know that over-scheduling can and does occur, and the future will have its own challenges. The national rail system is very robust and capable, but it is subject to disruptions from natural disasters, unexpected service demands, and infrastructure needs that are not promptly addressed. These circumstances, and everyday difficulties, present the risk that work schedules may not be effectively managed.

Even given the best work-scheduling practices, fatigue remains a concern in any transportation mode because opportunities for rest must be effectively utilized, and individual employees may be prevented from taking advantage of these opportunities by sleep disorders, poor sleep hygiene, the demands of normal family life, or other factors. It is critically important that employees know how to get effective rest and that they appreciate the importance of doing so. As will be discussed below, FRA has provided tools and funding to assist the railroad industry in evaluating work schedules, and these efforts are sure to continue.

Over the past decade, labor and management, supported by FRA, have made significant efforts to address these needs. At the national level, NARAP serves as an ongoing forum for dialogue regarding present challenges, results of research, and products of voluntary efforts. Railroads and rail labor organizations have made significant efforts to deliver fatigue training programs and ensure ongoing awareness. Major railroads have adopted policies to permit individual crew members to take restorative short naps on board trains while stopped.

Railroads, sometimes in concert with labor organizations, have tried a remarkable variety of scheduling options to prevent fatigue. Among the options implemented by the carriers are assigned workdays (e.g., either seven days on and one day off, or eight days on and two days off); minimum undisturbed rest hours (normally 10 hours); automatic markups (employees returning from extended absences not assigned duty until the next day);[1] and use of "call windows," in which employees are assigned a specific time period for reporting for duty.[2]

While the industry has taken significant steps toward addressing fatigue issues, the various mitigation measures implemented have resulted in only limited success at either the industry-wide or carrier-system-wide level. This variance is due to a number of factors ranging from operating idiosyncrasies (market demands), to staffing and retention issues, and provisions in collective bargaining agreements. While programs related to minimum undisturbed rest are common throughout the industry, implementation varies significantly between carriers and even among specific locations within one carrier's organization. For example, a carrier's policies related to minimum undisturbed rest hours at one location may be mandatory, while at another location the policies are optional. This dichotomy also exists for other fatigue mitigation measures.

As evidenced by analysis of data in the Validation Study, which included the worst of the service crisis, these efforts have had some success. The Validation Study clearly reflects the fact that, assuming that the railroad operating employees have taken advantage of sleep opportunities, most of these employees work at a high level of effectiveness most of the time. However, given the very uneven application of fatigue countermeasures in the industry, we cannot say that the threat of fatigue-caused accidents and injuries has abated. Clearly, then, more comprehensive responses are warranted.

Given the availability of the recently validated and calibrated SAFTE fatigue model, there are new opportunities to schedule the work of railroad operating employees more carefully. To hasten the implementation of corporate fatigue risk management strategies, FRA has initiated a complementary effort to develop a workforce fatigue risk management tool called the Schedule Fatigue Risk Management (SFRM) Tool. This tool uses the same methodology as the Validation Study but is able to process work schedule data from an entire workforce and provide standardized reports to assist a company in evaluating levels of work schedule-induced fatigue that exist at specific work sites or

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[1] Automatic markup procedures help to ensure that employees returning from extended leave have the opportunity to obtain adequate rest prior to a duty assignment. Prior to implementation of these procedures, employees returning to work could be assigned duties commencing at midnight regardless of their sleep patterns during leave. In the absence of these procedures, employees could experience symptoms of fatigue in the form of performance degradation and diminished cognitive abilities. The collision between Union Pacific Railroad Company (Union Pacific) trains near Delia, Kansas on July 2, 1997 (RAR-99/04) resulted, in part, from the absence of adequate markup procedures

[2] The use of call windows is intended to provide an employee a predictability indicator, within a specific period of time, of his or her next scheduled duty assignment. Call windows are normally four-hour periods, e.g., 8:00 a.m. to noon, and the selection of a specific call window is governed by collective bargaining agreements, including seniority rights.

collisions at highway-rail crossings. Given the subject of this hearing, I will focus only on the fatigue provision of the bill.

To help improve the alertness of railroad operating personnel, the bill would permit FRA, as the Secretary's delegate, to replace the hours of service laws with scientifically based regulations, after first seeking consensus recommendations from the agency's Railroad Safety Advisory Committee. The hours of service laws, first enacted in 1907 and currently delegated to FRA to administer, contain no substantive rulemaking authority over duty hours. FRA's lack of regulatory authority over duty hours, unique to FRA among all the safety regulatory agencies in the Department, precludes FRA from making use of almost a century of scientific learning on the issue of sleep-wake cycles and fatigue-induced performance failures. FRA's general safety rulemaking power under chapter 201 of title 49 would provide ample authority to deal with the entire subject of maximum work periods and minimum rest periods in light of current research on those subjects; however, the hours of service laws effectively bar such a rational regulatory initiative because the chapter 201 authority may be used only to supplement the pre-1970 railroad safety statutes, not to supplant them. Where the hours of service laws set a rigid requirement, e.g., maximum on-duty and minimum off-duty periods for train crews, a regulation could not lawfully vary from them. FRA would refrain from adopting new requirements relating to fatigue if the agency determines that voluntary activities are adequately addressing topics of concern, and the agency would be authorized to allow a railroad to comply with an approved fatigue management plan as an alternative to compliance with the usual regulatory regimen. The regulations that would be issued under the provision would be subject to review under the Congressional Review Act (5 U.S.C. 801) as the sole and exclusive means of review.

Conclusion

Fatigue presents risk in any mode of transportation, as well as in other industrial workplaces. The railroad industry and its employees understand the factors that cause fatigue, and they have made significant strides in addressing them. Nevertheless, fatigue continues to contribute to railroad accidents and personal injuries. We must do better in preventing and managing it.

I think a reasonable person could look at the objective situation and find much basis for optimism. Consider these points:

- Although, by all accounts, fatigue is still a problem, it is not at epidemic levels in the industry. This means that we should be able to address the fatigue that does remain, at an affordable cost to employers and employees.

- Thanks to the growing body of knowledge regarding accident causation, we know that we have an issue that we cannot avoid. The time to hesitate, if there was such a time, is certainly over now.

- The Validation Study and other work now confirm our ability to create models that can undergird future crew scheduling, and a major railroad is already working with FRA to make use of it. We have the potential to manage this issue using a performance-based approach.

- Leaders of rail labor organizations are showing courage by taking on this issue, and this Congress has shown a bipartisan interest in addressing fatigue in the railroad industry.

- The Department of Transportation intends to offer an important hours of service reform proposal that promises real change in this safety-critical area.

When you put all of this discussion together, it is good news for safer rail transportation and for the people who provide it. We can do better in helping to keep rail employees alert and effective through careful scheduling of work, and we can help those employees contribute through training, awareness efforts, and management of sleep disorders. We are eager to move forward with all of the efforts I have described. Thank you for the opportunity to address this important issue.

Questions to the Honorable Joseph Boardman
for the Record of the February 13, 2007 Hearing
before the
House Subcommittee on Railroads, Pipelines, and Hazardous Materials

1. You mentioned in your testimony that signal maintainers could be adversely affected by unscheduled trouble calls on top of their normal 8-hour workdays. What does that mean? How will the Administration's bill address this?

Response:

Signal maintainers typically work nominal eight-hour shifts. However, they may receive one or more unscheduled assignments outside those hours due to various unexpected conditions. These conditions might include power out at a grade crossing signal location following an electrical storm, a false restrictive signal indication due to unknown causes, or a hazard detector tied into the signal system that is continuously alarming without an apparent reason. Depending upon the reason, these events may constitute emergencies under the hours of service laws, allowing service up to a total of 16 hours (the sum of the ordinary statutory maximum of 12 hours and the additional four hours allowed under the statute in an emergency).

The current law presents particular difficulties because it permits a signal maintainer to credit up to one hour spent in return travel from the final trouble call as time off duty, cutting into the required period of rest (eight or ten hours, depending upon whether the service was continuous). So, if the Administration's rail safety bill were enacted, FRA would be required to review this statutory structure and allowed to use the flexibility of regulations to endeavor to correct clear problems.

Let me be clear that signal maintainers generally are responsible for a geographic territory, and it is important that they be reasonably available to address safety issues and to help maintain the fluidity of the system. But if the maintainer is to be required to work long hours on a particular day, the maintainer should start that period well rested and should receive adequate restorative rest following that period.

In addition, signal employees who, as part of their duties, transport a signal gang to a location at which it performs work, are currently subject to the hours of service regulations of the Federal Motor Carrier Safety Administration (FMCSA), which are applicable to drivers of commercial motor vehicles, as well as to the requirements for signal employees under the hours of service laws. Because these two sets of requirements provide different limitations and are structured quite differently, it is difficult for railroads and employees to comply with both sets of requirements. If FRA had regulations applicable to signal employees, FRA and FMCSA would have the flexibility necessary to try to resolve this issue, by agreeing on a definition of time on duty for these employees that includes all activities regulated as such by either agency, and then applying one standard or the other.

2. As you know, "wreck and relief" train crews may work beyond the 12-hour maximum shift in cases of emergency. Is the FRA aware of any instances where the "wreck or relief" train exception from the Hours of Service Act is abused?

   Response:

   FRA is not aware of any pattern of abuse with respect to this provision.

3. The testimony of the Brotherhood of Railroad Signalmen reports that railroads commonly violate the Hours of Service Act for signal workers, particularly when it comes to emergency situations. Could you comment on this?

   Response:

   There is apparently some disagreement or misunderstanding as to the definition of an "emergency" under the law. Prior to enactment of Hours of Service Act provisions addressing signal service in 1978, the same term was applied to the work of dispatchers and block operators. In that context, it was well established that temporary staffing shortages could justify emergency service. In effect, that is what happens in the case of signal service much of the time when a trouble call occurs, due to the physical remoteness of many of the locations to which the signal maintainer must respond and the importance of a timely response.

   The Brotherhood of Railroad Signalmen was involved in development of the law, as was the Federal Railroad Administration, and staff advises that this general principle was well understood at the time. Indeed, the law was amended shortly after passage because labor and management complained that FRA was reading it too restrictively, limiting the availability of signal employees. Years later, I think what we have here is a complaint, which may be well founded in certain particulars, that the current situation is more extreme given the extent of the work required to be performed and the frequency with which signal maintainers are called upon to respond to emergencies.

   Should the legislation be enacted, FRA would look forward to taking a careful, fact-based approach to review of this issue.

4. The Brotherhood of Railroad Signalmen reports that railroads are increasingly turning to outside contractors to do signaling work because they are not bound by the Hours of Service Act. Are contractors bound by the Hours of Service Act, and if not, should they be covered?

   Response:

   The law does not currently cover employees of signal contractors, because the definition of a signal employee under the law is limited to "an individual employed by a railroad carrier." In all areas of its work over the past decade, FRA has sought to ensure the contractor employees have the same level of training and are subject to the same substantive requirements as railroad employees. Although this is an issue to be determined by

rulemaking, FRA believes that it deserves careful review and would be initially disposed to including contractor employees.

5. Currently the Hours of Service are set by Congress. If Congress grants that decision-making authority to the FRA, would the FRA increase the existing maximum limit on duty hours for train crews or signalmen during a normal work day?

Response:

There would be no purpose in conducting a rulemaking in this area if we did not think it was possible to be ***more protective*** of public and employee safety, and we believe there are opportunities to do so. So I cannot imagine any general increase in hours.

Are there outside cases where it's useful to flex the current maximums in order to accomplish better results in terms of safety while holding down costs? Perhaps, and given the costs of tightening up, we shouldn't take them off the table before they are discussed. Take the case of a train crew whose hours of service expires after a broken coupler knuckle in an area with limited accessibility due to snow and ice. The crew had adequate notice of the assignment and plenty of rest before coming on duty. It's now 5:00 p.m., when the body clock says to stay awake. The crew could be left on the train pending arrival of transportation, which might legitimately take three or more hours, or in about 45 minutes it could bring the train down the pass and into the yard where a relief crew awaits, after which a suitable rest period would be provided. In this kind of case, it's safer for the employees and the van driver for the employees to work a little longer rather than ride in a contract van under adverse weather conditions. The relief crew would also be less subject to slipping and tripping hazards when approaching the lead locomotive. I think we should be able to discuss those kinds of cases, so long as we are trying to apply common sense, and so long as we don't create loopholes that can be abused.

Employee organizations understandably worry that exceptions will become the rule. That does not have to be the case, and building fatigue management into the regulatory structure will ensure that it does not.

6. Please say more about your pilot Close Call Confidential Reporting System. What sorts of insights do you hope to gain in regards to worker fatigue?

Response:

The Close Call Monitoring and Reporting System is a process for proactively collecting and analyzing leading indicator data, and for improving the safety reporting culture for the railroad industry. Currently, the safety reporting systems in the railroad industry, including FRA's, are reactive systems for reporting accidents that often trigger punitive actions and therefore may result in the withholding of critical safety-related information. While reactive systems are valuable in identifying safety issues, the typically small number of accidents that are reported in such systems hinders effective trend spotting and other analyses. Close Call systems report many more events and thereby allow safety problems to be identified and

corrected before accidents occur. Moreover, Close Call safety reporting systems can significantly reduce accidents and injuries by creating a trusting environment in which critical safety-related information is openly shared for analysis, instead of being actively withheld to mitigate punishment or liability. Similar safety data reporting systems have been successfully and cost-effectively implemented in the aviation industry for more than a decade. A Close Call Workshop held in April 2003, introducing this framework to the industry, was enthusiastically received and resulted in individual railroads and labor willing to develop and implement pilot programs. Three railroads (Union Pacific Railroad Company, BNSF Railway Company, and Canadian Pacific Railway) have agreed to participate in the project. The project has been implemented at the Union Pacific site in North Platte, Nebraska, and will be implemented at the other sites successively. The Close Call system became active on February 1, 2007, when it received its first report from the Union Pacific site in North Platte. The project plan includes a program evaluation component to allow documentation of the project's performance.

Experience in other industries indicates that there is a very high benefit accruing to the implementation of close call systems relative to their cost. For example, in the chemical industry, Syncrude showed a $1,000,000 annual cost savings in insurance costs for workers' compensation and property damage. Norwegian State Railways experienced a 37-percent reduction in lost work time and a 40-percent reduction in accidents over a two-year period. Based on estimates from other industries, the U.S. railroad industry could save over $200,000,000 yearly through reductions in repairs, fatalities and injuries, cargo damage, and lost workdays. Because there are many more close calls than accidents or incidents, FRA expects the Close Call Confidential Reporting System to provide a more complete picture of fatigue in the railroad industry than is currently available. While the fatigue model study has provided information about the role of fatigue in human factor-caused accidents, we do not know the full extent to which fatigue contributes to errors and degraded performance in the rail environment. This information could be obtained from analysis of close calls and provide the basis for fatigue management plans that are tailored to specific operations that are at risk due to fatigue.

7. What steps has the FRA taken to require the rail industry to cut down on limbo time, or the time when a crew is not released from duty and traveling to their final release destination?

Response:

"Limbo time" includes time awaiting transportation to the point of final release and time in transportation to the point of final release. I think the complaints from employees have focused on time awaiting transportation. Deadhead transportation itself has been a fact of life in the railroad industry for many years, and in many places the time spent in deadhead transportation has actually declined as crew vans have been deployed rather than leaving crews on trains to destination. But in the 2004-2005 service crisis there were many cases of crews left on trains for many hours. That still happens in some cases.

FRA has the distinction of having lost this battle in the courts, twice, while managing to appear on both sides of the case. In the end, the Supreme Court said that time awaiting

transportation was limbo time. We have to agree that the decision is consistent with the plain meaning of the statute.

FRA did use the Safety Assurance and Compliance Program to focus the attention of management and labor on serious crew management issues where they appeared, specifically including a sharp focus on getting crews off trains. We had successes and failures in that arena. FRA is actively supporting Union Pacific Railroad's program to address crew scheduling and wellness.

Our Rail Safety Oversight Managers remain available to work with railroads and employee organizations on these issues. But nothing substitutes for regulatory authority to use if you need it. Because the hours of service laws occupy this field, we have not had that authority.

Additional Questions for the Record
Submitted on behalf of Congresswoman Grace Napolitano

1. On October 16, 2004, a Union Pacific freight train derailed 3 locomotives and 11 cars near Pico Rivera, California releasing a small amount of hazardous material. UP estimates that this derailment caused $2.7 million in damages to the Pico Rivera area. The National Transportation Safety Board (NTSB) noted that the cause of the Pico Rivera accident was a failed pair of insulated joint bars due to fatigue cracking. NTSB's statement said, "FRA requirements regarding rail joints in Continuous Welded Rail (CWR) track are ineffective because they do not require on-the-ground visual inspections or nondestructive testing adequate to identify cracks before they grow to critical size and result in joint bar failure."

   On March 15, 2004, the NTSB made 2 recommendations to the FRA on this issue:

   - Require all railroads with CWR track to include procedures that prescribe on-the-ground visual inspections and nondestructive testing techniques for identifying cracks in rail joint bars before they grow to critical size.
   - Establish a program to periodically review CWR rail joint bar inspection data from railroads and FRA track inspectors and, when determined necessary, require railroads to increase the frequency or improve the methods of inspections of joint bars in CWR.

   Has the Federal Railroad Administration implemented these recommendations? If not, why not?

   Response:

   Yes, FRA issued an interim final rule on November 2, 2005, and a final rule on October 11, 2006, both addressing the inspection of joints in CWR to promote joint integrity and detect cracks in joint bars. The final rule was unanimously supported by FRA's Railroad Safety Advisory Committee (RSAC), and key staff from the NTSB and the California Public Utilities Commission participated in its development.

The final rule establishes a schedule for inspecting joints in CWR that takes into consideration track class (operating speed of trains over the track), gross tonnage over the line, and passenger service. The final rule emphasizes on-foot visual inspections. Nondestructive testing, using ultrasonic probes, has been used to evaluate joint bars, but there is presently no evidence that the process reliably detects cracks better than visual observation. FRA has also developed an optical recognition system for vehicle-based visual inspection that is being tried by several railroads. Of course, our rule focuses first on promoting joint integrity in such a way that fewer cracks will be generated.

The final rule also requires that railroads submit fracture reports for all cracked or broken joint bars found in CWR during required inspections. This data, along with FRA inspection data, will be reviewed by FRA and the RSAC to chart future actions.

2. How are the Federal Railroad Administration and the Federal Highway Administration working with states and localities to support the construction of grade separation projects?

Response:

Grade separation programs, along with crossing consolidations, are the most effective answer to grade crossing risks. Unfortunately, grade separation projects are extremely expensive, and thus should be weighed against investing in other types of less-costly improvements at multiple crossings. SAFETEA-LU devotes a significant portion of the Highway Safety Improvement Program (approximately 18% of HSIP funding or $220 million per year) to highway-rail crossing improvements, including grade separation projects. The legislation also requires projects to be developed using a data-driven approach, consistent with a State's Strategic Highway Safety Plan. Other sources of funding to support crossing safety improvements, including grade separation projects, are available in addition to these Federal monies. Decisions on whether or not to support a grade separation project are made by State and local authorities, who may choose to initiate such projects to address more than safety concerns, such as to promote highway user mobility.

Both FHWA and FRA personnel in the field strongly encourage State and local officials to plan based on the opportunities present on rail corridors using a systemic approach, rather than focus narrowly on individual crossings. This facilitates discussion of crossing consolidation and may also involve grade separations where conditions warrant.

3. Is there technology available to inspect joint bar cracks? Can it detect hairline fractures within joint bars? How is this equipment being used?

Response:

There are technologies available to inspect for internal material flaws and external hairline cracks for steel. These include magnetic-particle; visual, enhanced with fluorescent penetrants; ultrasonic; and electro-magnetic acoustic. To utilize these techniques the joint bar must be removed from the track and subjected to the inspection process. Attempts have been made to conduct ultrasonic inspection with the joint bar in place, with very limited

success. FRA has developed a vehicle-borne, optically-based joint bar inspection system that utilizes high-resolution cameras to obtain an image of the joint bar. Automated detection algorithms highlight cracks, and railroad personnel review the image to determine the validity of a crack. Two North American railroads have recently acquired the technology for installation on their inspection cars. This approach inspects the visible area of a joint bar as installed—approximately 45 percent of the joint bar surface area—for hairline cracks, and can inspect joint bars at a speed of 50 miles per hour.

4. The Union Pacific Railroad Company has been replacing track in 1.5 mile segments along the Alameda Corridor East in Los Angeles County. This has closed multiple Grade crossings for 4-5 days. The city of Industry and Los Angeles County emergency service officials have said that the initial track work was costing them $50,000 in order to create Emergency Service Centers along the railroad. These centers allow emergency service providers to serve communities that may be cut off from emergency services due to the grade crossing closures. Multiple cities in East Los Angeles have claimed that the railroad company has not given them enough time to prepare for the closures.

   When railroad companies close down multiple grade crossings for track work, it forces cities to provide additional emergency services in order to have access on both sides of the track for emergencies. Are railroad companies required to repay emergency service agencies for this added service?

   Are railroad companies required to provide cities and communities with notice of when railroad crossings are going to be closed due to track work?

   Response:

   There are no Federal requirements about which we are aware that would govern these circumstances.

5. As I stated previously, on October 16, 2004, a Union Pacific freight train derailed 3 locomotives and 11 cars near Pico Rivera, California releasing a small amount of hazardous material. The National Transportation Safety Board (NTSB) noted that the cause of the Pico Rivera accident was a failed pair of insulated joint bars due to fatigue cracking. NTSB and FRA informed me that they would be testing the cracked joint bar from this accident to better understand how it happened and how we can prevent it.

   What were the results of the NTSB and FRA tests?

   Response:

   The NTSB took custody of the joint bars involved for examination in its metallurgy lab. An examination of the bars occurred on November 4, 2004, and a report was completed on March 4, 2005. The NTSB can provide the specific recommendations from the report, but the report states that the north bar broke from a pre-existing fatigue crack in the bottom gage corner of the bar, which led to the joint failure at the rail ends. The joint had also exhibited

signs of distress, such as rail end batter and delaminating of the insulating material, and the south bar had an additional pre-existing crack (though not at the rail ends). This accident was a prime reason for FRA's issuance of a final rule on October 11, 2006, requiring periodic, on-foot visual inspections of joints in CWR. The required inspections are intended not only to locate bars that are already cracked, but also to identify conditions that could adversely affect joint integrity before any failure occurs, such as conditions that existed at the joint involved in this accident.

6. States can play an important role in assisting FRA with ensuring safety along the rail lines. Why has FRA been so reluctant to allow states to regulate the railroads in order to provide a safe environment for their residents? What role do you feel states should play in assisting with railroad safety and regulation?

Response:

FRA works within the context of a compact embodied in the Federal Railroad Safety Act of 1970. At that time, it was widely agreed that there was insufficient regulation of rail safety by both the Federal Government and the States. That compact in effect said that there would be strong Federal regulations, "as necessary," for "all areas of railroad safety." Where present, State regulations were left in place until FRA or another delegate of the Secretary of Transportation acted to address the subject matter. Once the Department of Transportation covered the subject matter of the State regulation, the State regulation was allowed to continue in force only if it was not inconsistent with the Federal regulation, addressed an essentially local safety hazard, and did not impose an unreasonable burden on interstate commerce. State rail agencies were also given an important role in helping to enforce the Federal regulations.

FRA has sought to strengthen that compact by creating a State rail safety participation program in which approximately 30 States enforce the Federal rail safety laws and by welcoming labor, railroads, the States, and other interested parties into the RSAC, where we can identify safety needs and address them through a consensus process. Both the State Rail Safety Managers Association and the American Association of State Highway and Transportation Officials are active members of the RSAC.

From the point of view of practicability, it is important to note that developing safety programs that are effective requires a large body of technical expertise that is costly and difficult to assemble. We think the best way to build successful programs is by pooling our knowledge and resources and working together.

FRA welcomes State participation in the development and enforcement of national standards, which can best meet the needs of all concerned.

[redacted] of the Transcript of the Testimony by Mr. Boardman for the February 13, 2007, Hearing of the Subcommittee on Railroads, Pipelines, and Hazardous Materials

Mr. BOARDMAN. Congresswoman, in response to your questions about railroads' fatigue-related education and training programs for their employees, let me say that FRA has monitored the status of fatigue-related training in the railroad industry over the past several years through the North American Rail Alertness Partnership, a joint labor-management-FRA coordinating body, and through contact with employees locally in the context of specific research projects.

In order to ensure that the Subcommittee receives the most current information on this topic, FRA has solicited and compiled pertinent information from the Association of American Railroads (AAR) and several major railroads, which we have marked as FRA Exhibits A and B, respectively, and which we now ask to submit for the record of this hearing.

The information from the AAR includes a copy of a draft report sponsored by the AAR and written by Dr. Patrick Sherry, a noted expert on fatigue in the railroad industry and a witness at this hearing, entitled Current Status of Fatigue Management In the Railroad Industry. We understand that Dr. Sherry submitted this draft report on September 15, 2006, for the record of the Subcommittee's July 25, 2006, hearing on human factors. The AAR informs FRA that "[t]he final version [of the report] has additional information and is . . . at the publisher for final edits and proofreading." The Executive Summary of the draft report provides the following overview of railroads' fatigue-related education and training programs for employees:

> Railroads have engaged in a major effort to develop and disseminate information on the factors that influence human fatigue, the countermeasures that can be used to address it, and the impact of fatigue on performance. Significant efforts have been made to develop

> and disseminate educational materials to railroad employees in all of the major railroads. These range from short safety videos describing the dangers of sleep deprivation to more sophisticated training materials including at least a dozen videos on special topics related to fatigue management, a computer based education program that can be completed on line, brochures, educational materials for employees and families, and even educational materials designed for elementary school students. The FRA co-sponsored a major effort to educate family members and children of railroad employees to the effects of fatigue and offer suggestions as to how family members could support and encourage fatigue management. Most importantly the railroads have incorporate fatigue education in their required periodic training for employees. These efforts have resulted in the "institutionalization" of the dissemination of fatigue management information as part of the railroad's "way of doing business. In essence, fatigue management has begun, as one railroad management executive put it "to become standard operating procedure."

Page 5. Chapter 3 of the draft report covers fatigue education and training in detail. It discusses various forms of conveying information on fatigue, from the development and distribution of videos and pamphlets for employees and supervisors, through the conduct of computer-based online training of individual employees (e.g., at http://www.du.edu/~psherry/narap/update.html), to the coaching of individual employees in conjunction with a study of the use of actigraphs.

The material that FRA seeks to submit for the record also includes information from major railroads on their fatigue education efforts. The following major railroads responded to FRA's requests for such information: BNSF Railway Company; Canadian National Railway; CSX Transportation, Inc.; Norfolk Southern Corporation railroads; and Union Pacific Railroad Company. Programs vary, and it is difficult to generalize, but in most cases the major railroads--

* provide fatigue training to all newly hired operating employees; and
* include fatigue training in periodic safety training for all operating employees.

In addition to the educational and training programs related to fatigue that railroads offer to their employees, FRA, in partnership with various railroads and railroad labor organizations, conducts pilot research programs that involve a form of fatigue training, e.g., the coaching of

employees who participate in the research. Together, these efforts are designed to enhance an awareness of fatigue management programs and thereby provide an opportunity for improving the safety and health of the industry's employees.

I want to emphasize that there is no claim from any of the major parties, and certainly not from FRA, that further enhancements in employee training are not indicated. Working in consultation with major labor organizations, FRA is putting in place an additional, Web-based tool that will give employees direct access to the most recent and relevant findings in sleep research and practical suggestions for good sleep hygiene. This tool will be of particular value to employees of regional and short line railroads who may have limited access to employer-provided training. Without question, consideration of fatigue management in the context of hours of service reform, as proposed in the Department of Transportation bill, will require a sharp focus on employee training.

Attachments: FRA Exhibit A–Draft report, Current Status of Fatigue Management In the Railroad Industry

FRA Exhibit B–1. Fax from BNSF Railway Company (BNSF) attaching descriptions of computer-based training courses offered by the National Academy of Railroad Sciences, BNSF's training facility at Overland Park, Kansas. (Courses relevant to fatigue issues are checked.)

2. E-mail from the Canadian National Railway (CN) summarizing its fatigue training program, with three CN

brochures

3. E-mail from CSX Transportation, Inc.
4. E-mail from Norfolk Southern Corp. railroads' (NS) and attachment listing NS initiatives on work/rest education and training
5. E-mail from Union Pacific Railroad Company's (UP) and attachment listing UP videos and brochures on various subjects, including alertness, which are distributed free to employees upon request

Final Draft

Current Status of Fatigue Management In the Railroad Industry

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Supplemental Testimony Submitted to the

U.S. House of Representatives

Committee on Transportation and Infrastructure

Subcommittee on Railroads

July 25, 2006

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Executive Summary

Since the Author's last review in 2000, the US railroad industry has continued to its effort to manage fatigue related risk in its operations through a combination of educational efforts, adjustments to work schedules, sleep disorder screening programs, collaborating in the development of a scientific model of fatigue and alertness and experimentation with technological aides to fatigue management. Although the emphasis has shifted from specific work schedules to a more flexible approach, in some cases the industry has achieved as high as 85% scheduled operations. Elsewhere the industry has utilized a modified scheduling such as the 7-on 3-off approach called the 7-3 overlay that provides employees with optional designated days off. In addition, the majority of the industry has moved towards a practice of a minimum of 10 hours undisturbed rest following an 8 hour period of duty.

The opportunity for major improvement still exists in the industry and joint efforts between labor and management to resolve these issues are needed. While some of the work schedules provide for designated time off, the possible effects of restricted sleep and accumulated sleep debt on performance will require additional attention. Because the industry is built around a continuous 24/7 operating system progress needs to be made to address the cumulative effects of fatigue that may result from the number of consecutive days worked. In addition, operational practices have yet to address the circadian nature of the fatigue on human performance. Current practices also do not take into account the so-called "limbo time" spent off-duty but on the train awaiting transport. While not an immediate safety issue, these time periods contribute to total time awake and subsequent hours asleep. Labor and management need to work on these problems together because the existing pay structure provides incentives to both labor and management to maintain the status quo and provides incentives for employees and management to push the limits of the envelope in of fatigue and human performance.

The railroads have experimented with a number of different work schedule options. Different approaches were tried in different locations in keeping with the lesson that "one size doesn't fit all" in the railroad industry. Various compressed schedules (7 on- 3 off, 8 on – 3 off, 10 on – 5 off, etc.) were tried. Some are still in effect today. However, with the impact of 9/11 and the turbulence in the economy there has been some consolidation in approaches with railroads focusing on achieving a scheduled railroad, a 7-on/3-off overlay (BNSF), use of meet and return (CN), and the implementation in many locations of a mandatory 10 hours undisturbed rest rule have become the norm. Additional progress towards improved predictability of start times is needed.

The National Transportation Safety Board (NTSB) has indicated that fatigue is a possible contributing factor in the 18 accidents investigated in a ten year period and has investigated over seventeen accidents that were thought to have fatigue as a possible contributing factor. However, given the fact that there are close to 10 million crew starts in a given year, with relatively few accidents identified as having fatigue as a causal

factor, it is difficult to quantify the contribution of fatigue to railroad safety. The railroad industry has acknowledged the role of fatigue and has engaged in considerable effort to attempt to manage the effects of fatigue related risk in the railroad operating environment. It should be apparent however that fatigue, while present, needs to be carefully managed from a *risk-based* perspective as opposed to a *prescriptive* mandate applied system-wide.

Fatigue has been addressed through the utilization of a number of different counter measures outlined in an industry statement dated on February 23, 1998 which noted that an effective Fatigue Countermeasures Program (FCP) should consider, but is not limited to, the following:

a. Education and Training
b. Employee and Train Scheduling Practices (e.g., line-ups, calling times, work/rest cycles, relief-staffing, employee availability, shift predictability)
c. Emergency response requirements short-term (e.g., derailments) and extended (e.g., natural disasters)
d. Alertness strategies (e.g., napping, employee empowerment)
e. Evaluation of policies and procedures (e.g., effects on fatigue issues)
f. Rest environments (e.g., lodging)
g. Work environments
h. Implementation strategies and review of FCP effectiveness.

Railroads have engaged in a major effort to develop and disseminate information on the factors that influence human fatigue, the countermeasures that can be used to address it, and the impact of fatigue on performance. Significant efforts have been made to develop and disseminate educational materials to railroad employees in all of the major railroads. These range from short safety videos describing the dangers of sleep deprivation to more sophisticated training materials including at least a dozen videos on special topics related to fatigue management, a computer based education program that can be completed online, brochures, educational materials for employees and families, and even educational materials designed for elementary school students. The FRA co-sponsored a major effort to educate family members and children of railroad employees to the effects of fatigue and offer suggestions as to how family members could support and encourage fatigue management. Most importantly the railroads have incorporated fatigue education in their required periodic training for employees. These efforts have resulted in the "institutionalization" of the dissemination of fatigue management information as part of the railroad's "way of doing business." In essence, fatigue management has begun, as one railroad management executive put it "to become standard operating procedure."

The railroad industry has improved its sleep disorder screening and updated its procedures for ensuring that railroad employees are fit for duty. A safety advisory was issued by the FRA, following the determination by the NTSB that the probable cause of the November 15, 2001, Canadian National/Illinois Central Railway CN/IC accident in Clarkston, Michigan, was crewmembers' fatigue primarily due to the engineer's

untreated and the conductor's insufficiently treated obstructive sleep apnea. The Safety Board examined the adequacy of rail industry standards and procedures for identifying and reporting potentially incapacitating medical conditions. The NTSB recommended (NTSB, 2002) that the railroad industry update its medical screening procedures to include sleep disorders. The resulting combined efforts of the railroad industry, labor, and the FRA have resulted in a new safety advisory that addresses the need to screen for the effects of health and physical conditions that might impact safety on the railroad -- specifically the need to screen for sleep disorders. Work is in progress on developing a set of medical standards that will include sleep disorders and other factors that might affect alertness.

In April of 2003 the Canadian Minister of Transport put into effect new rules for fatigue management in the rail industry affecting both Canadian and US railroads with Canadian operations. The new rules set a maximum of 12 hours for a single shift. The rules also allow an employee to work more than one shift per day, up to a maximum of 18 hours in total. In addition to daily limits, the new rules also included a weekly cap of 64 hours. Previously, no explicit weekly cap existed. Most importantly, the new rules also required that fatigue management plans be filed with Transport Canada describing industry plans for addressing fatigue on the railroad. This rule required most US railroads with operations in Canada to draft fatigue management plans and submit them to the Canadian government.

Two new efforts to improve technology associated with fatigue management have included efforts to validate a mathematical model that enables the prediction of the likely level of fatigue at a given point in time based on previous work/rest history. Railroads have provided work/rest histories and accident data to the FRA to support the validation process. In addition, several studies have looked at the use of actigraphs in the operating environment as a means of providing accurate measurements of the effects of work/rest practices in the operating environments. An actigraph is a wristwatch-like device that records wrist movement. Decreased movement indicates the person is probably asleep and data from the device can be used to track sleep / wake cycles. Also, the use of performance feedback actigraphs has been examined as well. These show considerable promise to be useful tools for the industry in order to evaluate levels of work at different points on a railroad and to objectively measure any changes resulting from a countermeasure. While FRA has also said the model could be useful for determining whether fatigue might have contributed to an accident there is general agreement that models are far from able to serve as a fitness for duty screening device for an individual employee.

This monograph reviews previous data, practices, projects and programs that have continuing significance and describes the current educational interventions, recent technological developments, scheduling approaches, and both previous and current scientific developments on human fatigue as it applies to the railroad industry. It also discusses a variety of interventions that have been tried in an attempt to address fatigue in the railroad industry. The study concludes with a review of the current status of fatigue countermeasures and identifies a number of key features found in successful programs.

Chapter 1. The Background

The Early Years

The development of the rules and practices regarding work and rest in the railroad industry dates from the early 20th century. Congress enacted the Hours of Service Act in 1907 to enhance railroad safety by limiting the number of hours that railroad engineers and other railroad employees can work. The Act was subsequently revised in 1969, 1976 and 1988. Currently, locomotive engineers and other transportation employees can work a maximum of 12 consecutive hours followed by at least 8 hours off duty.

In 1872 an article the Saturday Review concern with fatigue on the railroad and its relationship to accidents was noted in a characterization of railroad operations as an experience in which trains, "fly through junctions where the nodding pointsman has wakened with a start to turn the switches," as a speeding train approaches.

Hugo Munsterberg (1913), the father of industrial psychology, noted that, "We have in the literature concerned with accidents in transportation numerous popular discussions about the destructive influence of loss of sleep on the attention of the locomotive engineer." Subsequently, in 1917 a task force of scientists gathered to study the effects of fatigue on vehicular accidents. In 1937 Congress passed hours of service regulations for commercial drivers to address these concerns (additional discussion below). However, due to the ever-changing complexity of the demands faced by drivers and operators in all modes of transportation, this topic continues to be the focus of intense study (Sherry, Bart, & Atwater, 1997). Over the past few years there have been increased efforts to address the problems of fatigue in the railroad industry. A USDOT/FRA report in 1991 (Pollard, 1991) identified causes of railroad employee fatigue. These are: uncertainty about the time of one's next assignment, excessive working hours, long commutes and waiting times before beginning work, unsatisfactory conditions for sleeping at some terminals, and the decision not to rest during the day even when subject to call the next night. Suggestions for remedying the situation included: a minimum of eight hours notice before being called to work, greater predictability in scheduling trains, and division of assignments according to blocks of time.

Traditionally, locomotive and train crews work a 9.5-hour day. The work period can begin at any time during the day or night. The assignment begins with a phone call announcing the assignment, typically one-and-half to two hours in advance. Crews are expected to report for duty in that time. Upon reaching at the railroad facility, the crews go on duty and may immediately depart on their train, wait for the train to arrive, or may travel by vehicle to another location to reach their train. Once on the engine, crews usually remain on duty for a continuous period until the end of the duty period. However, upon completion of the run crews might have to wait up to an hour or more for transport to arrive at the terminal or lodging facility. After completing their paperwork, the crews are considered off-duty and have at least eight hours before they can be required to be on

duty again. During this time they must eat, sleep, attend to family business and otherwise rest. The typical engineer or conductor will work approximately 20 duty starts over a 30-day period.

A decade and a half ago, the NTSB pointed out, in its 1985 report on collisions in Wiggins, Colorado, and Newcastle, Wyoming that railroad crews are subjected to the most unpredictable work/rest cycles in the transportation industry. Soon thereafter, the 1988 Thompsontown, PA accident apparently caused by an engineer falling asleep and resulting in four crewmember fatalities stimulated Congressional concern over the hours of service. The NTSB first addressed the issue of operator fatigue in transportation in 1989 in three recommendations issued to the Secretary of Transportation calling for research, education, and revisions to existing regulations. These recommendations were added to the Board's Most Wanted List in 1990, where the issue remains to this day.

The 1990's

FRA responded with several projects that explored various aspects of crew performance and hours of service including a study of crew scheduling issues and locomotive diaries. In the first phase of the work, interviews were conducted with crew-management and crew-scheduling personnel at seven Class I roads. Focus groups with engineers were also conducted at three locations. The information gathered was used to prepare a report, "Issues in Crew Scheduling," published in 1991.

A later report by the GAO (GAO, 1992) found that railroads were essentially complying with the Hours of Service Act. In fact, it was found that 99.4 % of the time engineers were given at least 10 hours off duty following a work period of 12 or more hours. Further, the investigators found no instances in which an engineer received less than 8 hours off duty in any 24-hour period. It was also found that engineers rarely worked more than two consecutive shifts with fewer than 9 hours off duty between shifts. The report indicated that reducing the maximum number of hours allowed per shift from 12 to 10 would have little effect on the number of accidents that occur. It was found that only 4.5% of all human factors caused accidents occurred after 10 hours in an engineer's shift. The report cautioned that reducing the "maximum allowable work/off-duty periods from the current 12 hours on, 10 hours off cycle to a 10-on, 10-off cycle could increase the variability – the change in work period start times from day to day – of engineers work cycles." The report cited research that suggested that variability in work cycle start times disrupt natural human sleep-wake cycles, which in turn can lead to fatigue.

The GAO study found that more human factor caused rail accidents occurred from 2 a.m. to 6 a.m. than in any other 4-hour segment. Incidentally, the overall accident rate (which includes all causes) between 2 a.m. and 6 a.m. was higher than at other times. "The start time variability of engineers work cycles was quite pronounced during the 2 a.m. to 6 a.m. time period." The report authors speculated that, "Higher levels of start time variability increase the likelihood that engineers will experience fatigue." (GAO, 1992, p. 3)

In the early part of 1990, the railroad industry recognized the importance of the fatigue issue and began to study as well as to educate its employees. The railroads also began to distribute booklets and videos describing health habits and bean to look at the levels of fatigue within its workforce.

At a July 1992 Congressional hearing, conducted by Representative Al Swift, Chairman of the House Subcommittee on Transportation and Hazardous Materials, the GAO presented its study entitled "Engineer Work Shift and Schedule Variability." While this review concluded that carriers were complying with the Hours of Service Act and that most work shifts are less than 10 hours, the study expressed concern about schedule variability.

A 1992 study (Kuehn, 1992) observed four engineers operating under two different simulated schedule regimens, a normal schedule and a fatigue work schedule. The study concluded that deterioration in engineer performance, regardless of schedule, coupled with the irregular sleep/work patterns of the subjects suggest the need for continued research which focuses on sleep work patterns and performance. While as a group the study participants did not differ in overall performance in the simulator, they were observed to incur speed limit infractions, failures to blow the horn for crossings, rapid throttle changes, and application of excessive train forces. Thus, specific instances of performance decrements were observed.

In 1992 railroads began a study of work/rest and fatigue issues in the railroad industry. The industry initiated the formation of a Work Rest Task Force with a number of participants from the Association of American Railroads, major railroads, and representatives from the Brotherhood of Locomotive Engineers (and Trainmen) and the United Transportation Union. The Task Force sought to better understand the issue by investigating a number of questions concerning crew scheduling, shift length, start frequency, start variability, and the occurrence of accidents and injuries. This effort included an evaluation of more than 5 million employee schedule records and lead to some preliminary conclusions in late 1994. Continued analysis suggested a relationship between incidents and work schedules but the Task Force was unable predict the occurrence of accidents based on work schedules. Nonetheless, the work of this Task Force paved the way for additional measures throughout the industry.

In November of 1995, The Department of Transportation published a report titled "Focus on Fatigue" (DOT, 1995). The report documents the activities and projects supported by the DOT in the area of fatigue. According to the document "FRA's fatigue research is concentrated on those jobs most directly responsive for the safe operation of trains, i.e. locomotive engineers and dispatchers." Two research projects were identified in the report as being directly related to railroad activity. These included "Enginemen Stress and Fatigue: Phase II" a study designed to determine whether work schedules that comply with hours of service requirements resulted in stress and fatigue of such magnitude to cause safety concerns. Preliminary results suggested that performance deteriorated over the course of testing. The FRA also sponsored the development of a

device designed to measure fatigue affected neurobehavioral functioning thought to be related to fitness for duty of employees reporting for work.

In 1995 the NTSB and NASA in cooperation with the Department of Transportation sponsored a symposium on fatigue. The conference was thought to be a first step in raising awareness and educating diverse groups in the transportation industry to address the fatigue issue. One presenter at the conference, summed up the intent of the proceedings in his address: "An important theme expressed throughout the entire symposium was that *there is no magic bullet* to eliminate human fatigue in transportation operations.... Every participant is encouraged to take some action to educate, address a scheduling issue, use a countermeasure or apply some piece of knowledge.... to improve transportation safety." (NTSB, 1995).

Also in 1995 the FRA simulation of railroad work schedules study was followed up by a more recent study of 55 engineers monitored while operating on two different railroad work schedules (Thomas, Raslear, and Kuehn, 1997). The first schedule group was designed to run "faster" than another group running "slower" in terms of frequency of train operations. Engineers operated trains in a simulator for a ten-hour shift. Participants had at least an average of 9.3 hours off duty for the "fast" group and 12 hours off duty for the "slow" group. Results showed that the "slow" group got about 6.1 hours of sleep per night compared to 4.6 hours for the "fast." Performance measures in this simulation included number of missed horns sounded at crossings and cumulative pounds of fuel used. Results showed that the "fast" group missed about one third more horns at crossings than did the "slow" group. Furthermore, the simulation showed that the "fast" group would have used about 200 pounds more fuel per trip segment than did the "slow" group.

In 1995 a collaborative effort between major Canadian railroads and their employees launched *CANALERT*, the first fatigue countermeasures program which included a scientific evaluation of effectiveness. Using small but representative samples of railroad employees, this program utilized scientific principles of human fatigue to pioneer basic techniques that would be the foundation for later efforts. These include Time Pool scheduling (employees given predictable future work assignments), additional rest between assignments, improved lodging facilities and on-duty napping. At this same time, several other railroads began experimenting with provisions allowing additional rest on demand and scheduled time off.

In 1997 one US railroad compared the effects of two types of fatigue countermeasures: time windows and assigned days off to the fatigue levels of members of a control group receiving no fatigue countermeasures. Statistically significant results indicated the effectiveness of these countermeasures for reducing fatigue levels in railroad employees. Subsequently, additional investigations have been initiated that were designed to add to the knowledge of the effective countermeasures.

In late 1997, the Federal Railroad Administration invited labor and management to form the *North American Rail Alertness Partnership* or NARAP. This group was formed with the intention of collaboratively applying resources that address fatigue as a human factor cause of accidents, incidents, and injuries in the railroad industry. Many of the speakers at the 1998 Congressional hearings commented that NARAP was an important part of the current effort to address fatigue in the railroad industry.

In September of 1998 hearings were held by the Senate Committee on Surface Transportation. Statements were submitted by members of the unions, the Federal Railroad Administration, the Association of American Railroads, and various scientific authorities on the subject of fatigue. The President of the Brotherhood of Locomotive Engineers (and Trainmen) noted "Through a cooperative approach, rail labor and the railroad industry can ensure fatigue countermeasures are a part of railroad culture. Through the AAR Work/Rest Task Force, NARAP, and a Canadian project called CANALERT, this industry has moved further and faster to address the problem of fatigue than any other mode of transportation." (Monin, 1998) The Executive Vice President of the Association of American Railroads suggested that "While fatigue in the workplace has been studied for many years, there is still much to be learned about how to apply the acquired scientific knowledge to operational settings. Great strides have been made by the cooperative efforts of rail labor and management to explore a variety of fatigue countermeasures." (Dettmann, 1998)

The formation of the NARAP partnership created a forum for the discussion and dissemination of current scientific information, a discussion of the results of pilot projects, and a venue for the exchange of views around important policy issues. This partnership is significant for the simple fact that it is unique in the transportation industry. NARAP also serves the industry by assisting in the education of key labor and management personnel as well as driving the understanding of fatigue issues throughout various organizations. All member organizations have a voice in the activities of the group. As a result of this process NARAP members have agreed on several key points that should be included in fatigue management plans in various organizations. No other coalition has been formed in other modes of transportation to address the issues of fatigue on neutral ground. This partnership is one of the key reasons why the railroad industry is the leader in fatigue countermeasures in the transportation industry.

The AAR Work Rest Task Force continued its efforts to address the fatigue concerns in the industry. The Task Force collaborated with the North American Rail Alertness Partnership (NARAP), consisting of members from FRA, rail labor unions, and the railroad carriers, to identify the key principles of an effective fatigue countermeasures program. Based on the recommendations from NARAP on February 23, 1998 a committee of senior railroad executives officially endorsed a list of key counter measures that they would seek to implement. According to the recommendations an effective Fatigue Countermeasures Program (FCP) should consider, but is not limited to, the following:

a. Education and Training
b. Employee and Train Scheduling Practices (e.g., line-ups, calling times, work/rest cycles, relief-staffing, employee availability, shift predictability)
c. Emergency response requirements
short-term (e.g., derailments) and extended (e.g., natural disasters)
d. Alertness strategies (e.g., napping, employee empowerment)
e. Evaluation of policies and procedures (e.g., effects on fatigue issues)
f. Rest environments (e.g., lodging)
g. Work environments
h. Implementation strategies and review of Fatigue Counter measures programs effectiveness.

The railroad industry was among the first to adopt a set of principles for fatigue management in the transportation industry (Sherry, 2003). This set of principles led to an increase in the number of efforts to introduce education and scheduling practices. These practices have been documented in the previous version of this series. Considerable progress was made in identifying approaches to scheduling and time off that would alleviate fatigue without seriously interfering with railroad operations. Subsequently, a number of innovative scheduling projects were initiated along with efforts to develop education and training programs.

The NTSB published a review of the safety efforts of the railroad industry with respect to fatigue in 1999. The following points are taken from the Board's report:

1. Since 1989, the U.S. Department of Transportation initiated a wide range of research projects to address the issue of operator fatigue in the transportation environment, with the exception of pipeline operations.

2. Since 1989, the Federal Aviation Administration, the Federal Highway Administration, the Federal Railroad Administration, and the Federal Transit Administration developed and disseminated various educational materials, including brochures and videotapes, to the industry on the detrimental effects of fatigue in the transportation environment. The Research and Special Programs Administration and the U.S. Coast Guard need to make a more concerted effort to develop and disseminate educational information on fatigue in pipeline and marine operations, respectively.

3. Despite the acknowledgment by the U.S. Department of Transportation that fatigue is a significant factor in transportation accidents, little progress has been made to revise the hours-of-service regulations to incorporate the results of the latest research on fatigue and sleep issues.

As a result of this safety report, the National Transportation Safety Board made the following safety recommendations:

To the U.S. Department of Transportation:

Require the modal administrations to modify the appropriate *Codes of Federal Regulations* to establish scientifically based hours-of-service regulations that set limits on hours of service, provide predictable work and rest schedules, and consider circadian rhythms and human sleep and rest requirements. Seek Congressional authority, if necessary, for the modal administrations to establish these regulations. (I-99-1) (Supersedes I-89-3)

To the Federal Railroad Administration:

Establish within 2 years scientifically based hours-of-service regulations that set limits on hours of service, provide predictable work and rest schedules, and consider circadian rhythms and human sleep and rest requirements. (R-99-2)

The New Millennium

The Safety Board's 1999 study of the role of operator fatigue in transportation industries argued that the problem of fatigue was very prevalent. An operator of a vehicle without adequate rest, in any mode of transportation, was seen to present an unnecessary risk to the traveling public. The Safety Board concluded that the laws, rules, and regulations governing this aspect of transportation safety are archaic and are not adequate to address the problem. This report was generated during the time that the hours of service rules for motor carriers were being hotly debated.

Hours of Service

In 1995, Congress ordered the FHWA to revise the existing commercial motor vehicle HOS rules.[1] Specifically, it provided that the FHWA should issue an advance notice of proposed rulemaking dealing with a variety of fatigue-related issues pertaining to commercial motor vehicle safety (including 8 hours of continuous sleep after 10 hours of driving, loading, and unloading operations, automated and tamper-proof recording devices, rest and recovery cycles, fatigue and stress in longer combination vehicles, fitness for duty, and other appropriate regulatory and enforcement countermeasures for reducing fatigue-related incidents and increasing driver alertness (US Court of Appeals, 2004)).[2]

The motor carrier hours-of-service regulations were developed in 1937 and remained essentially unchanged until 2003 when the Federal Motor Carrier Safety Administration issued a new rule on hour-of-service regulations. Aviation limits were addressed in the Civil Aeronautics Act of 1938 and the Federal Aviation Act of 1958. In 1985, domestic flight limitations and some commuter limitations were updated; flag and supplemental operations were not. The work-hour regulations for marine are specified in Title 46 United States Code 8104 and date back to the early part of the 20th century. The Oil Pollution Act of 1990 contained work-hour limitations for tank personnel of 15 hours per 24 hours and 36 hours per 72 hours.

[1] (US Court of Appeals, 2004)
[2] (US Court of Appeals, 2004)

In April 2003, FMCSA issued the first significant revision to the HOS regulations in over 60 years. [3] The new regulation provided an increased opportunity for drivers to obtain necessary rest and restorative sleep, and at the same time reflect operational realities of motor carrier transportation. According to Laux:

> The rules specified a 14-consecutive-hour window, after which a property-carrying commercial motor vehicle driver would not be allowed to begin driving, although such a driver is allowed to continue to do other work, which must be charged against the overall 60 hours in 7 days or 70 hours in 8 days on-duty time limit. A property-carrying driver is allowed to drive for up to 11 hours after having 10 hours off duty.[4]

The new HOS rules were struck down in July of 2004, by the US Court of Appeals because the FMCSA had failed to consider the effects of the hours-of-service rules on driver health, as required by Congress. Congress passed legislation in the so-called "highway bill", in September 2004, that extended for another year the current federal hours-of-service rules for commercial motor carriers.[5] However, On August 19, 2005, the U.S. Department of Transportation's Federal Motor Carrier Safety Administration (FMCSA) announced the new hours-of-service (HOS) regulations.[6] The new rule contains most of the major provisions of the 2003 hours-of-service regulations with the exception of sleeper berth and short haul regulations.[7]

The Final Rule, promulgated in April 2003 (Federal Register 22,456, 2003) included the following provisions: (from the FMCSA web site: www.fmcsa.dot.gov/rules-regulations/adminsitration/fmcsr/395.3.htm)

> 395.3 Maximum driving time for property carrying vehicles (subject to exceptions in 395.1)
>
> (a) No motor carrier shall permit or require any driver used by it to drive a property-carrying commercial motor vehicle, nor shall any such driver drive a property-carrying commercial motor vehicle:
>
> (1) More than 11 cumulative hours following 10 consecutive hours off duty; or
>
> (2) For any period after the end of the 14th hour after coming on duty following 10 consecutive hours off duty, except when a property-carrying driver complies with the provisions of 395.1(o) or 395.1(e)(2).
>
> (b) No motor carrier shall permit or require a driver of a property-carrying commercial motor vehicle to drive, nor shall any driver drive a property-carrying commercial motor vehicle, regardless of the number of motor carriers using the driver's services, for any period after

[3] (NTSB, 1999, pg. 24)
[4] (Laux, 2004)
[5] (Laux, 2004)
[6] http://www.fmcsa.dot.gov/rules-regulations/topics/hos/HOS-2005.htm
[7] http://www.fmcsa.dot.gov/rules-regulations/topics/hos/HOS-2005.htm

(1) Having been on duty 60 hours in any 7 consecutive days if the employing motor carrier does not operate commercial motor vehicles every day of the week; or
(2) Having been on duty 70 hours in any period of 8 consecutive days if the employing motor carrier operates commercial motor vehicles every day of the week.

(c) [*Moreover* .. (added by author)]

(1) Any period of 7 consecutive days may end with the beginning of any off duty period of 34 or more consecutive hours; or
(2) Any period of 8 consecutive days may end with the beginning of any off duty period of 34 or more consecutive hours.[8]

The sleeper berth provision for the 2005 rule reads as follows:

- CMV drivers using the sleeper berth provision must take at least 8 consecutive hours in the sleeper berth, plus 2 consecutive hours either in the sleeper berth, off duty, or any combination of the two.[9]

The new short haul provisions for the 2005 rule were as follows:

Drivers of property-carrying CMVs which do not require a Commercial Driver's License for operation and who operate within a 150 air-mile radius of their normal work reporting location:

- May drive a maximum of 11 hours after coming on duty following 10 or more consecutive hours off duty.
- May not drive after the 14th hour after coming on duty 5 days a week or after the 16th hour after coming on duty 2 days a week.[10]

As noted previously, following considerable debate, discussion, testimony and review the 2003 rule was adopted with minor modifications in 2005 and became law. The new rules increased the time that truck drivers must rest in a twenty-four hour duty period. Drivers were also given the opportunity to increase their rest from eight hours to ten. In addition, the total number of hours that a driver can be on duty was changed from 15 to 14 hours. The new regulation permits drivers to spend eleven hours on duty, which is one more hour than previously permitted. Drivers are not allowed to drive after being on-duty for 60 hours in a seven-consecutive-day period or 70 hours in an eight-consecutive-day period. This on-duty cycle may be restarted whenever a driver takes at least 34 consecutive hours off-duty. Short-haul truck drivers (those drivers who routinely return to their place of dispatch after each duty tour and then are released from duty) may have an increased on-duty period of 16 hours once during any seven-consecutive-day period.

Another significant change is that the new regulation requires drivers to include as work hours the time spent waiting at loading docks or refueling. Thus, under the new

[8] [68 FR 22516, Apr. 28, 2003]

[10] http://www.fmcsa.dot.gov/rules-regulations/topics/hos/HOS-2005.htm

rule, delays at loading docks and refueling could become quite costly to trucking companies as they directly impact the availability of driver operating time.

This rule is noteworthy for the railroad industry for several reasons. First, it represents a significant change in the amount of time that drivers are expected to rest. Currently railroad personnel are also expected to obtain needed rest in an eight hour period. Previously, eight hours was thought to be sufficient time for drivers to recover from a duty period. This change was made on the basis of the accumulated scientific evidence which pointed to a longer time needed for recovery. Second, the amount of time that a driver is on-duty, regardless of whether they are driving or not, was considered a more accurate indicator of the extent to which a person was likely to be fatigued. Time awake was considered the more relevant variable in determining fatigue. In contrast, a railroad employee is not considered to have exceeded the hours of service if he or she is not actually operating the equipment. In short, congress has set a precedent by recognizing and changing the hours of service for the trucking industry, the science is the same for the railroad industry. In making the new rule considerable effort was expended to obtain the needed scientific evidence to support the new rules. The scientific evidence, based as it is upon human performance, is applicable to the cognitive task of driving a truck or a locomotive. Accordingly, since there are many similarities between the two operations and both involve human drivers and therefore human performance, the conclusions drawn about the effects of circadian rhythms, the performance of drives on restricted or partial sleep deprivation schedules, issues of recovery time or amount of time off needed to recover. The industry should continue to consider the effects of research and regulation in the trucking industry and to determine its applicability and usefulness in the railroad environment.

At the same time that the FMCSA was working on the commercial motor vehicle regulations the railroad industry was also working on several initiatives. For example, in 2000 several US railroads implemented scheduling programs designed to give employees designated days off. These various programs consisted of schedules that permitted employees to know in advance when they would be able to be off-duty and when they would have to work. One particularly popular initiative, the 7/3 overlay has been widely used to provide employees a regular 7 day work cycle followed by 3 days off. These rest days are not mandatory however and may be worked at the discretion of the employee. Variations on this approach are being used by different railroad such as an 8 and 2 or a 10 and three in some locations.

Safety Board Investigations of Railroad Accidents

Three more recent accidents have also triggered additional developments relative to fatigue. The first accident investigated by the Safety Board (DCA-03-FR-001) involving a Union Pacific Railroad Company near Des Plaines, Illinois on October 21, 2002, At about 10:38 p.m.,, a westbound train struck an eastbound train that was moving through a crossover at Norma Interlocking in Des Plaines, Illinois. The lead 3 locomotives of the striking train, as well as 6 cars positioned 20 cars behind the locomotives, derailed. Three cars of train eastbound train derailed, and three others were

damaged. About 5,000 gallons of diesel fuel from the derailed locomotives spilled onto the ground. The two crewmembers of the striking train sustained non-life-threatening injuries.

The investigation of the accident revealed that the engineer had most likely fallen asleep just prior to the collision and was thus unable to safely operate the train. The NTSB also noted that, "Contributing to the engineer's falling asleep was likely his use of prescription medications that may cause drowsiness, as well as his lack of sleep in the 22 hours preceding the accident." The effects of the medication and lack of sleep likely combined to make the situation extremely unsafe.

A second accident occurred near Clarkson, Michigan where at 5:54AM, November 15, 2001 two CN/IC trains collided. Southbound train 533, traveling at 13MPH, struck northbound train 243 after failing to obey the stop indication before proceeding on to the mainline track. Both crewmembers of northbound train 243 were killed and the two crewmembers of southbound train 533 were seriously injured.

The Safety Board concluded that the untreated obstructive sleep apnea, and resultant chronic fatigue, experienced by the engineer of train 533 likely incapacitated him to the point that he did not attempt to stop the train prior to the collision with train 243. It was also noted that the conductor of train 533 also likely suffered incapacitating fatigue as a combined result of his unpredictable schedule (he was on the extraboard) and his insufficiently treated sleep apnea.

NTSB investigations into the background of the engineer revealed that he passed the re-certification physical examination and did not indicate any sleep related problems, nor did the examination inquire about such problems. It was discovered however, when reviewing the medical records from his private physician, that the engineer complained of "snoring with pauses" and was ultimately told that he likely suffered from obstructive sleep apnea and that such a condition could impair his ability to operate either his car or the train safely. It was recommended that he undergo a sleep study, however, he did not do so. A conductor who worked with this engineer on several other occasions indicated that the engineer would fall asleep while operating the train and would have to be awakened to respond to a signal or to blow the horn at a grade crossing.

Investigation into the background of the conductor also revealed that he too suffered from obstructive sleep apnea, however, results of the company provided physical examination did not indicate that the conductor was being treated for apnea. Although he had been using a Continuous Positive Airway Pressure (CPAP) device since being diagnosed, he never returned to the clinic to ensure that the CPAP was in fact working effectively. He reported that he did not feel that device was working very well and that he often felt tired.

The NTSB offered the following recommendations:

To the Canadian National Railway:

Require all your employees in safety-sensitive positions to take fatigue awareness training and document when employees have received this training. (R-02-23)

To the Federal Railroad Administration:

Develop a standard medical examination form that includes questions regarding sleep problems and require that the form be used, pursuant to 49 *Code of Federal Regulations* Part 240, to determine the medical fitness of locomotive engineers; the form should also be available for use to determine the medical fitness of other employees in safety-sensitive positions. (R-02-24)

Require that any medical condition that could incapacitate, or seriously impair the performance of, an employee in a safety-sensitive position be reported to the railroad in a timely manner. (R-02-25)

Require that, when a railroad becomes aware that an employee in a safety sensitive position has a potentially incapacitating or performance impairing medical condition, the railroad prohibit that employee from performing any safety-sensitive duties until the railroads designated physician determines that the employee can continue to work safely in a safety-sensitive position. (R-02-26)

The significance of these accident investigations is the fact that both of them were influenced by medical conditions and the employees compliance with the subsequent treatment that had been prescribed. In the first accident the medications had an unfortunate side effect when combined with the work schedule to produce an unsafe situation. In the second accident, both crewmembers had diagnosed sleep disorders but had discontinued treatment resulting in an unsafe circumstance.

The recommendations of the Safety Board have influenced the railroad industry. First of all, the Federal Railroad Administration issued a safety advisory ((Notice of Safety Advisory 2004-04; Effect of Sleep Disorders on Safety of Railroad Operations (Oct. 1, 2004; 69 Fed. Reg. 58995) relative to the assessment and diagnosis of sleep disorders. The FRA advisory included the assertion that "Approximately 35% of all train accidents reported to FRA are attributed to human factors, of which fatigue, and more particularly, sleep disorders, play an undetermined role. Most employee casualties in train incidents and non-train incidents also involve a human factor component." This recommendation also led to a review of the pre-employment medical screening and engineer recertification screening.

Sleep disorder screening is not new to the railroad. As early as 1998 the former Conrail expanded its alertness and fatigue program to include sleep apnea screening and treatment. The program was offered to approximately 9000 employees who worked in

safety critical positions. Information packets were provided to supervisors and union representatives and later confidential questionnaires were mailed directly to the employees. Because confidentiality was critical to assuring employees that participation in the program would not negatively impact employment, Conrail employed the services of Dr. Martin Moore-Ede to conduct the sleep disorder assessments and to provide all respondents information about their personal results. Dr. Moore-Ede had earlier collaborated with Transport Canada to develop the CANALERT project with Canadian railroads and labor. Employees identified as borderline or high risk for sleep apnea by the initial screening questionnaire were contacted by phone to discuss their results and encourage them to receive treatment.

Railroad Division	Surveys Mailed	Surveys Returned	High Score	Borderline Score	Low Score	Participants To Date
1	1,117 (2/96)	155 (15%)	65 (42%)	27 (17.5%)	73 (43%)	44
2	2,255 (3/96)	265 (12.4%)	80 (40.6%)	45 (16.7%)	128 (43.7%)	46
3	2,015 (4/96)	154 (8.1%)	67 (40.9%)	24 (14.6%)	73 (44.5%)	TBD
4	2,195 (5/96)	230 (10.5%)	84 (36.5%)	34 (14.8%)	112 (48.7%)	TBD
5	1,258 (6/96)	116 (9.3)	51 (44%)	12 (10.3%)	53 (45.7%)	TBD
Totals	8,940	971	352	142	439	90

Two temporary sleep laboratories were set up at two different locations. Of the 168 respondents, 68 were identified as likely to be experiencing sleep apnea. A total of 44 of the 168 later agreed to participate in the screening program and following an initial consultation 15 employees received testing. Later, an additional 13 employees agreed to receive testing but were not available during the testing phase at their location. These individuals were referred to a Sleep Disorder Center for examination. Complete test results available on 10 patients were as follows:

- Four patients had severe obstructive sleep apnea
- Three patients had moderate to severe periodic limb movement syndrome with mild to moderate sleep apnea
- Three patients had mild or minimal sleep apnea not requiring treatment
- Of these 10 patients, six were prescribed Continuous Positive Airway Pressure (CPAP).
- One person refused the CPAP treatment but five others initiated treatment with the devices.

The program demonstrated that the practical result of a screening program was to identify about 5% of the sample as likely having a sleep disorder. This is about the same as would be expected in the population as a whole, working in the railroad industry or otherwise. Due to the fact that the survey respondents volunteered to participate in the study they were most likely more motivated than most people to complete and return the survey. While we are unsure of the true incidence of sleep apnea in the railroad population these survey data provide one estimate of the prevalence in that might be somewhere around 6 to 8 percent (68/1117 or 95/1117). These results are consistent with those of other studies that have found an incidence of 4-8 percent in men and 2-4 percent for women in the general population. Thus, a small percentage of the workforce is likely

at risk for these types of disorders. Screening programs and medical examinations would likely identify persons who are at risk for these conditions and minimize the risk of accidents results from excessive sleepiness.

The third major accident investigated by the NTSB where fatigue was a contributing factor was the collision of a UPRR train and a BNSF train at Macdona, Texas in June 2004. Here the findings cited fatigue and the inability of the UP crew to respond to signals and properly operate the locomotive. The Safety Board concluded that "Contributing to the crewmembers' fatigue was their failure to obtain sufficient restorative rest prior to reporting for duty because of their ineffective use of off-duty time and Union Pacific Railroad train crew scheduling practices which inverted the crewmembers' work/rest periods." The Board speculated that the unpredictable UPRR work schedules may have "encouraged them to delay obtaining rest in the hope that they would not be called to work until later on the day of the accident." (NTSB, July 25, 2006) This accident and subsequent investigation raises questions about schedule unpredictability and decisions that employees make relative to their own fatigue that increase the risk of operational errors and lack of attention to safety sensitive tasks. The challenge of educating railroad employees and managing high risk situations due to fatigue is a critical challenge faced by the industry.

Collision Analysis Working Group (CAWG)

Several labor organizations in collaboration with the FRA and a representative from the Short Line Association (SHL) undertook a re-analysis of the data collected in the original Switching Operations Fatality Analysis (SOFA) Group study. The members of the CAWG group were all members of the original SOFA group. According to the text, "Information contained in this report – including the Findings, Discussions, and Recommendations – is based solely on the review and analyses of 65 maintrack train collisions occurring from 1997 through 2002. CAWG did not consider results of other investigations, reviews, and analyses of main track, or other types of collisions. CAWG results are specific to its data." (CAWG, pg. viii) The data and facts surrounding these accidents and injuries, 14 of which resulted in a fatality, were examined by the CAWG group who examined the facts of the cases and made a determination as to whether fatigue was a possible cause of the accident. The assessments of these causes were corroborated by a sleep expert who also reviewed the facts available in the cases. The CAWG group and the sleep expert agreed that 19 out of the 65 accidents had fatigue or alertness as a possible contributing factor. Interestingly, all of these cases occurred between midnight and 6 am. The report concludes that fatigue was a possible contributing factor in 29.3% of the accidents. This is a very significant conclusion.

The results of this study are important in that they raise a number of questions about the role of fatigue in the occurrence of accidents and fatalities in railroad operations. The methodology utilized was limited to a subjective review of accident

information by a panel of legislative representatives from various labor organizations and two accident investigators from the FRA. Greater confidence in the results could have been obtained if standardized methods for determining reliability of both rating criteria and agreement among raters had been employed and provided. Furthermore, given the lack of a control group, the small sample size which limits the generalizability of the conclusions, the lack of clear and objective criteria for defining fatigue and alertness, and the possibility of a variety of competing hypotheses or contributing factors that could not be ruled out these results must be interpreted with a great deal of caution and considered preliminary at best. Nevertheless, this is an important first step in beginning to develop an approach to identifying the possible contributing factors to accidents that occur. At the very least, however, follow-up studies should be conducted, with a larger sample size and more rigorous methodology that will enable a replication of these initial tentative conclusions.

The results of this study are important in that they raise a number of questions about the role of fatigue in the occurrence of accidents and fatalities in railroad operations. However, given the small sample size which limits the generalizability of the conclusions, the lack of clear and objective criteria for defining fatigue and alertness, and the possibility of a variety of competing hypotheses or contributing factors that could not be ruled out these results must be interpreted with a great deal of caution. At the very least, however, follow-up studies should be conducted, with a larger sample size that will enable a replication of these initial tentative conclusions.

Legislation and Liability

The New Jersey State Senate passed legislation, known as "Maggie's Law," on June 23, 2003. Named after a child who was fatally-injured in an accident caused by a fatigued driver, the law establishes fatigued driving as recklessness under the existing vehicular homicide statute (N.J.S.2C:11-5). This legislation overwhelming passed both chambers of the state legislature and represents the first bill in the nation to specifically address the issue of driving while fatigued. The bill defines "fatigue" as being without sleep for a period in excess of 24 consecutive hours.

As can be seen from this brief review, while the issue of fatigue in the railroad industry has been recognized for almost 100 years, serious efforts to manage fatigue with scientific studies and actual field tests only began in the last fifteen years. These include experiments with scheduling changes, time windows, napping policies, technological measures for counteracting fatigue, educational seminars, instructional videos, sleep hygiene and study materials. In addition, thousands of hours of meetings and discussions have taken place to work through the issues, brainstorm, and plan projects programs and policies that would lead to more effective management of fatigue. Some of the actions of the railroad industry have served as a model for other modes addressing similar concerns. Most feel that the railroad industry, while still having a long way to go,

has made progress in acknowledging the role of fatigue in continuous operations and attempting to devise counter measures to deal with these issues.

Given the previous work in this area and the current legislative climate it was decided that an updated study of the current status of fatigue countermeasures was needed. The purpose of this monograph is to briefly review the development of fatigue counter measures in the railroad over the past decade. This will be followed by a description of the current fatigue counter measures in the railroad industry. The present document will also attempt to summarize much of what is known in about fatigue in the transportation industry. Finally, an assessment and summary of current status is offered.

Chapter 2. Scientific Studies of Sleep Fatigue and Performance

The effects of sleepiness, sleep loss, and fatigue have been the focus of literally hundreds of studies dating back to a study conducted by Patrick and Gilbert (1896) at the University of Iowa. These scientists studied the effects of keeping a group of subjects awake for over 90 hours. Using performance tests measuring reaction time, motor speed, and memory they demonstrated the deleterious effects of sustained wakefulness.

The "modern" study of sleep and performance began with the work of Williams (1959) who demonstrated that there was a progressive increase in reaction time across days of sleep deprivation. These findings were evident regardless of the nature of the reaction time task, the duration of the task, and whether the person received feedback on how they were doing. Dinges & Kribbs (1991) summarized Williams studies and noted that "both the number and duration of lapses increased dramatically as sleeplessness increased over three days, resulting in an increase in the unevenness of performance (From Monk, 1991, pg. 103). Dinges and Kribbs (1991) further noted that "there have been dozens of reports on sleep loss from numerous causes (leading to performance unevenness (variability) increasing on RT tasks involving sustained attention (e.g., Angus and Heslegrave, 1985; Bonnet, 1985, 1986; Dinges et al., 1987, Glenville et al., 1978; Herscovitch and Broughton, 1981, Lisper and Kjellberg, 1972; Tilley and Wilkinson, 1984, Wilkinson and Houghton, 1982) (as cited in Dinges 1991, pg 103)

Rhodes, Heslegrave, Ujimoto, et al (1996) reported that air traffic controllers perceived some degree of performance impairment the end of an 8-hour day and evening shift, but significantly greater performance impairment at the end of an 8-hour midnight shift. In fact, the degree of performance impairment at the end of an 8-hour midnight shift was similar to that of the end of a 12-hour day or evening shift. In terms of sleep, when air traffic controllers (ATCs) worked the midnight shift, they reported only about 5 hours of sleep on a daily basis and only about 6-6.5 hours on day shifts. As people age, their sleep may become "less deep" and controllers reported more difficulty with shift-work beginning between 35-39 years of age. Luna, French, and Mitchal (1997) also reported that ATCs on the night-shift of a forward rapid rotation shift schedule (current shift starts at a later hour than the prior shift) appeared to be falling asleep and reported increasing confusion and fatigue.

Some recent studies have begun to shed light on effects of work schedules that are more similar to those of railroad locomotive engineers. For example, Dinges et al. (1997) studied 16 young adults that had their sleep restricted to an average of 4.98 hours per night for seven consecutive nights. Three times a day they were assessed on their subjective sleepiness, mood, and performance on a psychomotor test (PVT), probed memory, and serial-addition testing. This sleep schedule resulted in statistically

significant cumulative effects on performance. These results essentially demonstrate the cumulative effect of a sleep debt over a week long period.

In 2002 a study looked at the fatigue levels of train drivers and dispatchers in the British rail system. Results of a study of 126 male train drivers and 104 rail dispatchers showed that shift schedule and sleep length were explanatory variables in a model of sleepiness. Severe sleepiness was reported in 59% of train drivers and 50% of the dispatchers on night shifts and 20% and 15% for day shifts. Results showed that the odds of experiencing severe sleepiness was significantly higher in the night versus the day shift. Interestingly, the risk for increased sleepiness decreased as train drivers became older, while there was not change whatsoever with dispatchers. Most importantly, however, is that as the length of the increased the risk of sleepiness increased at a rate of 15% for each hour of the shift while sleepiness risk decreased by about 15% per hour during sleep. Unfortunately, the amount of time off did not appear to have any relationship to the amount of sleepiness. The authors concluded that adjustments in shift start-times, shift length, and off-duty time designed to increase amount of sleep off-duty were likely to result in decreased levels of sleepiness on the railroad. The authors suggested that adjustment of shift length, start time, and duration would assist in the management of fatigue and sleepiness in railroad employees. (Harma, M; Sallinen, M.; Ranta, R.; Mutanen, P.; Mueller, K., 2002)

Another study tested the effects of sleep restriction on vehicle operation. Twenty two subjects were assessed in a laboratory and on the highway while driving 10 hours in five different sessions. Sleep restriction produced significant performance degradation even though wake time and driving times were relatively short. Under the restricted sleep condition, some drivers presented and increase of 650 milliseconds compared to the laboratory condition. This delay is equivalent to an increase of 23 meters in braking distance at 75 miles per hour. (Phillip, Sgaspe, Taillard, Nicholas, 2005)

An interesting study of restricted sleep was conducted on 48 healthy adults over a 14 day period undergoing several conditions of 4, 6 or 8 hours of sleep per night. Chronic sleep restriction involved randomized sleep doses of 4, 6, or 8 hrs in bed per night pus total sleep deprivation for the equivalent of 3 nights. Results suggest that chronic restriction of sleep to 6 hrs or less per night produces cognitive performance deficits equivalent to up to 2 nights of total sleep deprivation. Thus, it appears that even relatively moderate amounts or doses of sleep restriction can seriously impair waking performance. During the study the participants were unaware of the increasing cognitive deficits. Physiological sleep responses to chronic restriction did not mirror waking neurobehavioral responses, but cumulative wakefulness in excess of a 15.84 hrs predicted performance lapses across all 4 experimental conditions. The results suggest that chronic sleep restriction of 6 hrs or less per night produced cognitive performance decrements equivalent to up to 2 nights of total sleep deprivation. In other words even moderate sleep restriction can seriously impair humans (Van Dogen, Maislin, Mullington, Dinges, 2003). Similar findings were also reported by Jewett, Dijk, Kronauer, and Dinges (1999).

Sleep Deprivation and Performance

Considerable attention has focused on the similarity in cognitive performance found between persons who have consumed alcohol and amount of sleep deprivation. While there are several criticisms of this approach, the attention that such studies have generated has focused discussion on the detrimental effects of prolonged sleep deprivation.

The first study of this sort was published by Dawson and Reid (1997) published in *Nature,* the prestigious British journal. This study demonstrated that healthy young adults who ingested 10-15 grams of alcohol every 30 minutes until they reached a blood alcohol level of 0.10% had cognitive performance that was similar to that of persons who had remained awake for 28 hours. Using a test of eye-hand coordination administered every 30 minutes, performance steadily declined in both conditions. A significant correlation between the relative performance of the alcohol consuming and the sleep deprived participants demonstrated a significant correlation between the two and showed that effects of moderate sleep loss on performance are similar to moderate alcohol intoxication.

Arnedt, Wilde, Munt, and MacLean (2001) compared the effects of alcohol use and sleep deprivation on driver performance using a simulator. Using healthy young adults the investigators demonstrated that as blood alcohol concentration increased, tracking variability, speed variability, and off-road events increased, while speed deviation decreased, with the result of Ss driving faster. Interestingly, similar decrements in tracking and speed variability were found for 18.5 and 21 h ours of wakefulness as those for 0.05 and 0.08% blood alcohol levels, respectively. The findings suggest that impairments in driving found at relatively modest blood alcohol levels found with exceeding the legal limit will occur in individuals awake for over 18.5 hours.

Similar findings were obtained by Falleti, Maruff, Collie, Darby, McStephen, (2003); Fairclough & Graham. (1999); Stein, Allen, Cook, (1985); and Williamson, Feyer, Mattick, Friswell, Finlay-Brown, (2001). The overall conclusion suggested by these studies is that when persons are awake for even what would be considered moderate amounts of time (18- 22 hrs) the result in cognitive performance is similar to what can be expected when persons have exceeded the legal limit of blood alcohol concentration. Thus, while sleep deprivation of this magnitude does not result in the gross motor deficit seen with alcohol impairment the cognitive deficits are noticeable and approximate a level not tolerated by society when it comes to the operation of motor vehicles. Therefore, one must question the safety of vehicle operation when such levels of fatigue or sleep deprivation are present.

Lamond et al. (2004) completed a study recently that looked at the looked at performance impairments associated with night shift work and impairments following alcohol ingestion. Study participants were given alcohol every hour until their blood alcohol level reached 0.10%. In another condition, participants worked seven simulated 8 hour shifts. Cognitive performance was measured at hourly intervals using the PVT. As

expected, as blood alcohol level increased performance decreased. In addition, performance declined significantly over the first six simulated night-shifts. Performance impairment was varied over the course of the week with larger deficient observed after the first two shifts and lesser impairments observed following the third shift. However, these were greater than those obtained by persons having a blood alcohol content of .05%

While these studies are an interesting illustration of the similar effects of alcohol ingestion and fatigue, the latter can be overcome to some extent by various countermeasures such as caffeine or a nap while an intoxicated person can only return to sobriety by waiting until the alcohol has been metabolized.

Fatigue and Performance

Pilcher and Hufcutt's (1996) review of partial sleep deprivation findings have direct implications for the railroad industry. Given that the conditions of railroad work as noted above are characterized by variable start times and shift lengths the working conditions closely approximate the definition of partial sleep deprivation. Partial sleep deprivation in other words occurs when individuals are given the opportunity to sleep less than 5 hours of sleep in a 24 hour period. Their results suggested that cognitive performance was more affected by partial sleep deprivation over days than either short ($\leq$ 45 hrs) or long (>45 hrs) duration total sleep deprivation. In other words, given the erratic nature of railroad work schedules it is likely that sleep schedules would be more similar to the partial sleep restriction than acute total sleep deprivation.

That this is likely the case was recently demonstrated by Sherry (2005) in an actigraphic study of railroad employees sleep it was found that the average amount of sleep per 24 hour period for the entire group of 33 individuals was 6.32 ± 1.68 ranging from a low of 2.75 average hours of sleep per 24 hour period to a high as 10.02 hours of sleep. It was estimated that as many as 45.5% of the individuals averaged less than 5.93 hours of sleep or less during the assessment period. Thus, a substantial portion of the work force was similar to the partial sleep deprivation conditions described by Pilcher & Hufcutt (1996).

Rhodes, Heslegrave, Ujimoto, et al. (1996) found that performance errors in air traffic controllers increased 15% - 18% over a five-day midnight schedule workweek. In addition to perceived performance decrements, performance changes across various shifts were also demonstrated. The authors found that sleeping in the "morning (daytime) and in the evening resulted in significantly greater losses of sleep than sleeping during the night, with evening sleeps being 1.5 times shorter than day sleeps (3.5 hours vs. 2.2 hours, respectively, of lost sleep for a single sleep period - group means). In other words it appears controllers in the study got much less sleep during daytime and evening sleeps." (pg. xix) The results of these partial sleep deprivations on performance were significant as well. For example, using reaction time, reasoning, and spatial relations tasks, Air Traffic Controllers performance began to deteriorate 5 - 10% on the second

midnight shift and by the fourth midnight shift a reduction in performance of 10 - 18% from baseline was observed. For the evening-day-day-midnight-midnight (EDDMM) shift, significant performance deterioration did not occur until the midnight shifts with a 6 - 12% reduction in reasoning, spatial orientation, and pattern recognition. For the EEDDMM shift, performance impairment of 5-15% was evident during the second day shift and during the midnight shift. This may be due to the fact that the length of the work day interferes with the person's ability to obtain rest in the time available a condition that is likely present in the railroad workforce.

Phillip et .al. (2003) found that under restricted sleep truck drivers had an increased reaction time of 650 milliseconds over baseline. The authors indicated that this would translate into an increase of 23 meters in breaking distance at a speed of 75 miles per hour.

Several sleep dose–response studies have been conducted which present strong evidence on the impact of restricted sleep over time. In a dose response study investigators are attempting to determine the relationship between amount of sleep and various behavioral outcomes. It is of great interest to know the specific number of units (i.e. Minutes or hours) of sleep that are required or necessary to produce specific levels of performance. Or put another way, the number of hours of sleep needed in order to maintain maximum performance. Or, at what point is the number of hours of sleep insufficient to produce optimal or even minimal levels of performance. In the first study, Dinges et al. (1997) found that 16 healthy young adults, who had their sleep restricted to an average 4.98 hrs per night for 7 consecutive nights, reported higher levels of subjective sleepiness and had significantly longer reaction times on performance tasks.

A study of the effects of various levels of sleep restriction was conducted in a laboratory setting with commercial truck drivers. Balkin et al. (2000) had participants sleep for three, five, seven, and nine-hour time in bed conditions respectively, and showed dose-dependent performance impairment related to sleep loss. Performance in the three hour sleep group typically declined below baseline within two to three days of sleep restriction. Performance in the five hour sleep group was consistently lower than performance in the seven and nine hour sleep groups. In contrast, performance in the seven and nine hour sleep groups was often indistinguishable and improved throughout the study. Virtually no negative effects on performance were seen in the nine hour sleep group.

This study is interesting from the railroad perspective in that it points to the importance of arranging work schedules so that individuals can obtain at least 7 hours of sleep. In the railroad operational environment under high demand situations it is likely that there will be an opportunity to get at most 6 hours sleep due to the fact that there is a minimum of 8 hrs undisturbed with at least a two hour call for wake up and commute time. In other words, it is necessary that there be at least the opportunity to get 7 hours of continuous uninterrupted sleep to be able to maintain performance over a period of time. This suggests then that if individuals are expected to work long hours, over consecutive

days, it will be necessary for an individual to be able to obtain at least 7 hours of sleep in a 24 hour period in order to maintain maximum performance levels.

Balkin et al. (2000) found that following chronic sleep restriction, the first eight hours in bed (6.5 hours of sleep) was insufficient for restoration of performance on the PVT task. During the four day recovery phase (eight hours in bed each night), five and seven hour sleep groups showed minimal or no recovery, remaining consistently below the nine hour sleep group and below their own baseline levels for the PVT. The three hour sleep group showed some recovery for the PVT on the first day and more on subsequent days but also remained well below their own baseline and below the performance of the other groups. Subjects' recovery to baseline or near baseline levels of performance on the PVT often required a second or third night of recovery sleep. These data suggest that after sleep debt has occurred (three, five, seven hours time in bed) a single bout of eight hours of night sleep leads to recovery but not full recovery. While further sleep is required for full recovery, the number of subsequent sleep periods to reach full recovery is unknown. For the three hour group, the data suggests that even three nights of normal sleep (eight hours spent in bed on each night) is not sufficient to restore performance to baseline levels (depending on the task). Balkin et al. (2000) conclude that "this suggests that full recovery from severe, extended sleep restriction may require more than three nights of normal-duration sleep" (p. 2-85).

Belenky et al. (2003) examined a subset of the Balkin et al. (2000) study by examining the PVT data. For persons in a 3 hour condition performance on reaction time measures declined steadily over the 7 day period. For persons in the 5 and 7 hour conditions, performance initially declined followed by stabilization period. In the 9 hr group performance remained at the baseline levels. During the recovery period the performance levels did not return to baseline levels even after 3 days of recovery. Reaction times and lapses of the 3 hr group showed an initial recovery but only to the levels of the 5 and 7 hr condition, not baseline.

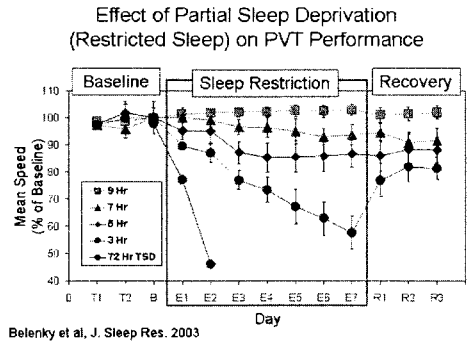


Figure 1. Sleep restriction and performance (permission pending).

Van Dongen, Maislin, Mullington, and Dinges (2003) also studied the effects of chronic sleep restriction by examining the effects of 4, 6 , or 8 hour sleep schedules on 48 healthy adults over 14 day period. Results indicate that restriction of sleep to 6 hrs or less per night produced cognitive performance deficits equivalent to up to 2 nights of total sleep deprivation. Cumulative wakefulness in excess of a 15.84 hrs predicted performance lapses across all 4 experimental conditions. Thus, it appears that even relatively moderate amounts of restricted sleep can seriously impair cognitive function.

Surprisingly, participants were largely unaware of these increasing cognitive deficits. Even mild restriction in the hours of sleep (5 hours a night rather than 7½) has been shown to result in progressive daytime sleepiness which is evident on the first day following a night of sleep restriction and worsens with successive such nights. The resulting sleepiness is only recoverable by rest. One night of rest following 1 week of sleep restriction only partially reverses the problem (Dinges, Pack, & Williams, et al., 1997). Artificial fragmentation of sleep also rapidly results in an increasing tendency to fall asleep (Roehrs, Merlotti, Petrucelli, et al., 1994). Plus, it has been demonstrated that sleepiness is influenced by time of day, increasing significantly in the early hours of the morning. Of particular interest from these findings however is the fact that a mild sleep restriction of less than six hours of sleep, can result in a performance decrement that persists despite opportunities for recovery sleep. Further research is clearly needed to determine quantify the amount of recovery time needed to reverse the effects of full or partial sleep deprivation over time.

Williamson, Feyer, Friswell & Finlay-Brown, (2000) looked at the effectiveness of professional long distance truck drivers working two consecutive 16 hour periods separated by six hour breaks. This was studied in a simulation mode as the hours of work would not have been legal. The results showed again that in rested drivers there were no significant fatigue effects after 16 hours of work, but that after only a six hour continuous rest break, significant fatigue effects occurred by around the middle of the second 16 hour shift. This indicates that longer hours or work may be possible provided that they are balanced by an appropriate period of longer rest.

Summary: Partial sleep deprivation can have a measurable impact on performance and characterizes much of railroad operations. The fact that the railroad industry is characterized by rules which permit an employee to be awakened after only 6 hours of sleep is similar to the definition of partial sleep deprivation that Pilcher and Hufcutt (1996) used in their meta-analysis. Their findings indicated that the negative effects of partial sleep deprivation were about 40% greater than either short or long duration total sleep deprivation. Consequently, conditions which promote partial sleep deprivation contribute to reduced cognitive performance.

Taken together these studies (Dinges et al., 1997; Belenky et al., 2003; Van Dongen , 2003) have provided consistent and strong evidence documenting the negative impact of restricted sleep on performance over time. For the railroad industry in particular, with the two hour call procedure these data suggests a need for attention to the lower levels of restricted sleep as a limit to minimum time needed to recover. These

studies suggest that the effects of even partial sleep restriction can lead to noticeable reductions in performance. Accordingly, it should be apparent that there will be a need to minimize the occurrence of partial sleep reduction situations in the railroad working environment.

Sleep and Accidents

A New Zealand study investigated the relationship between fatigue and accidents in the forest industry. Using self-report measures feelings of fatigue were frequent in as sample of 367 workers, with 78% of workers reporting that they experienced fatigue at least "sometimes." Results of regression analyses showed that number of breaks and specific job/ tasks were associated with fatigue levels. In addition, "close calls" or near-miss situations were more likely among persons with higher levels of fatigue. Actual accidents were associated with length of time at work, ethnicity, and having had near-miss incidents. (Lilley, Feyer, Kirk, Gander, 2002)

A Swedish study of 126 male train drivers and 104 rail traffic controllers found that severe sleepiness was reported in 49% of the locomotive engineers and 50% of the dispatchers on shifts. Shift length increased the risk of self-reported severe sleepiness by 15% for each hour of the shift and main sleep period decreased the risk by 15% for each hour of the main sleep. Nevertheless, the risk of severe sleepiness was not consistently related to the amount of time off before beginning a shift alone. Other factors such as task complexity and previous work days may also influence these feelings. (Haermae, Mikko; Sallinen, Ranta, Mutanen, and Mueller (2002).

In the medical field, Todd, Reid, and Robinson (1989) found significantly lower levels of patient care associated with 12 hour shifts.

Rosa and Bonnet (1993) studied the effects of an 8 hour versus a 12 hour schedule in a sample of male utility workers. Cognitive performance/alertness data and self-report measures were obtained 2-4 times per week from study participants who worked a traditional 8 hr/5-7 day schedule then, additional data was obtained after a new 12 hr/2-4 schedule was implemented. Significant reductions in performance were found even after 10 months of adaptation to the 12 hour work schedule. Furthermore, participants obtained less sleep as the week progressed which were most noticeable on 12-hr night shifts. These progressive declines were correlated with decreased positive mood.

Another self-report study of fatigue and occupational injury was conducted by Melamed & Oksenberg, (2002). Self-report measures (including the Epworth) were administered to a sample of 532 non-daytime shift workers. A total of 22.6% had elevated scores on the Epworth and statistical analysis indicated that during the two-year period prior to the procedure, the odds of having a work related injury were 2.23 times higher even after controlling for type of factory, job and other environmental conditions.

Baldwin and Daugherty (2004) studied medical residents using a retrospective questionnaire. Results indicated that residents averaging 5 or fewer hours of sleep per

night were more likely to report serious accidents or injuries, interpersonal conflict at work, alcohol consumption, and use pharmaceutical aids to prevent sleeping and stay alert. Most notably, they were also more likely to report working in an "impaired condition" and having made significant medical errors.

Barger et al (2005) completed a similar study a national sample of 2737 first year medical residents completed on on-line survey resulting in 17,003 monthly reports over a twelve month period. The reports provided information on hours worked, number of extended work shifts, motor vehicle crashes, near-miss incidents, and incidents involving involuntary sleeping. The results of the study showed that the odds of being involved in a motor vehicle crash after an extended work shift were 2.3 times greater than after having completed a regular shift. Interestingly, in a prospective analysis, a single extended workshift in a month increased the monthly risk of a motor vehicle crash by 9.1 percent and increased the monthly risk of a crash during the commute from work by 16.2 percent. When a person worked five or more extended shifts, the odds of falling asleep at the wheel or stopped in traffic was 2.39 and 3.69 respectively.

Summary

Taken together these studies suggest a number of important considerations relevant to the railroad industry. Research continues to support the existence of a relationship between increased hours of wakefulness and decreased cognitive performance and alertness. Variable results have been obtained with these studies suggesting that reaction time is most noticeably affected however, in some studies reaction time decreased but accuracy was maintained. The implications for performance in the rail industry suggest that to the extent that prolonged wakefulness occurs, similar incidents might also occur.

Despite the findings in the lab and with other occupations, the risk of accidents operating rail equipment after extended wakefulness has yet to be conclusively documented. There have been studies which have documented an increase in accidents in the hours between 2 am and 6 am. However, the number of accidents was not conclusively related to time on duty. Results of accident investigations by the Safety Board have prompted recommendations; however, in most cases there is a suggestion that fatigue may be a contributing factor. Despite the lack of conclusive evidence, the railroad industry has acknowledged that fatigue is present in the operational setting and needs to be managed.

Chapter 3. Education and Fatigue Management

Education was one of the primary fatigue countermeasures included in the recommendations of the Work Rest Task Force (AAR, 2000). Education is no substitute for getting enough sleep, the only method for reducing fatigue. However, for individuals to take advantage of available tools and resources they need proper training and an understanding of the effects of fatigue on safety, job performance and well-being. All of the railroads have tried to educate their employees to the dangers of fatigue and the possible risks associated with operating equipment under fatigue conditions.

The current state of fatigue can be likened to that of seat belts about 10 years ago. When the seat belt laws came into effect many people simply ignored them and went about their driving without giving a second thought to using a seat belt. Through a concerted educational effort and public awareness campaign and in some cases vigorous ticketing by the authorities, the use of seat belts increased dramatically. If people are to be motivated to use the tools available to them to combat fatigue it will be necessary to address fatigue through education and a vigorous public awareness campaign.

Earlier we noted that Pilcher and Hufcutt (1996) found that as the number of hours of wakefulness increased that reaction time increased and overall cognitive performance decreased. Summarizing data from 19 original research studies meta-analytic results reveal that sleep deprivation is negatively correlated with human performance. In addition, decreases in positive mood states tend to be more affected by sleep deprivation than cognitive performance. Somewhat surprisingly however, the effect of partial sleep deprivation or restricted sleep on performance was noticeably greater on performance functioning than either long-term or short-term sleep deprivation. In fact, the authors noted that partial sleep deprivation had a much stronger overall effect on the dependent measures than either short-term or long-term sleep deprivation. Specifically, participants in partial sleep-deprivation conditions performed *two standard deviations below the mean of normal non-sleep* deprived study participants compared to approximately one standard deviation for either short or long-term sleep deprivation. The researchers noted, "Although most of the sleep research community may concur with these results, there are a surprising number of scientists outside the sleep research field who have concluded that sleep deprivation has no profound effect on performance." (pg. 323) A similar situation most likely exists in the railroad industry where most understand that sleep deprivation is a fact of life yet few recognize or admit to the reduction in performance that follows short, long or even partial sleep deprivation. Thus, education is likely needed at all levels including professional and non-professional alike.

Education was a key component identified by the Work Rest Task Force and the NARAP groups. Railroads agree this is an essential activity in the development of an effective fatigue countermeasures program. The railroads and the FRA have engaged in a number of activities designed to develop and distribute educational material to the members of the railroad workforce to increase the likelihood that they will be better prepared to deal with and address fatigue in their work.

These efforts have resulted in a number of different products such as video tapes and pamphlets and CBT training programs. These programs, examples of which are at (http://www.du.edu/~psherry/narap/update.html), provide railroad employees with an understanding of the physiological aspects of fatigue, the impact of fatigue on performance and safety, and how to increase alertness through improved sleep hygiene.

One of the major findings of our study of the railroad industry has been that educational efforts began with the attempt to provide all employees with an introduction and an overview of the role of fatigue and circadian rhythms in the sleep and performance link. In other words, the railroads began to recognize that human fatigue was going to need to be addressed and that it could present a potential risk for employees. With the result of interactions with the key experts in the field they were able to identify and design short training courses that would educate the workforce as to the essential factors in diet, schedule, sleep habits and patterns, and the like that would lead to optimal performance.

In 1996 for example, the BNSF began developing a wide range of countermeasures to improve safety and efficiency and reduce fatigue on the railroad. The curriculum is representative of that found on other railroads. A primary effort was to provide Fatigue Information and Lifestyle training to the workforce and their families. The railroad covered the entire workforce (more thanr 28,000 people). The program was based on a seminar conducted by the NASA Ames Research Center Fatigue Countermeasures Program and reviewed by their staff for scientific accuracy.

The program covered a number of key areas in sleep hygiene education. The first topic dealt with the issues of physiological factors. It addressed the importance of the 24 hour nature of the railroad operations and the need for employees to be concerned about the possible effects of fatigue on the alertness and performance. While the course did not specifically state that fatigue causes accidents it included information the fact that the NTSB has identified fatigue as a contributing factor to several accident.

The BNSF program explained that fatigue is caused by a number of factors including sleep loss, the circadian rhythms of the human body, and work schedules. No matter how long a person's "day," the circadian clock still enforces an approximately 25-hour sleep wake cycle. Studies of the change in body temperature over a 24 hour period of sleep and wakefulness demonstrate the presence of the circadian effect. Additional research indicates that the circadian clock is affected by the presence of sunlight. So, when people are working in the night hours there is a tendency for the organism to experience the effects of fatigue. The body appears to respond to the changing nature of the daylight hours and to become entrained as it were to a natural clock that corresponds to the natural change in day and night periods. Other cues have been found to affect the setting of the natural clock such as certain social cues like meals and other activities. The overall goal of the education program was to alert railroad personnel to the need to take into account these factors when planning their work and rest activities.

The training materials explained that it is not possible to quickly reset the circadian clock to a new environmental time or to a work schedule change. A railroad worker experiencing an irregular work schedule may find it difficult to adjust. If the body adapts to a day-night cycle with a 24 hour clock then the body may not be expected to adapt to sudden changes and shifts in work schedule. It may take some time for the body to appropriately change in order to be able to function at a time when it was previously expecting to be sleeping. Research seems to suggest, that employees must realize that circadian adaptation to any one work rest pattern is minimal and that workers will revert easily to being day active on their days off.

Although somewhat predictable, shift work also creates problems for workers due to the fact that the body is entrained to be in a particular circadian cycle and that this cycle then will respond to the expected day – night pattern that is typically adapted to when not working shift work. Thus, circadian rhythms of shift workers are usually only partially adapted to their current work/rest scheduled. In addition most shift workers revert to being day active people when their shift duties expire. So, in railroad workers the shift work issues with the circadian rhythm are confounded with the social cues of day and night waking.

The effect of railroad operations on sleep is such that the irregular work periods interrupts or interferes with the regular patterns of sleep. The interference with the circadian rhythm makes it more difficult for the individual to sleep the amount prescribed by the natural rhythm. A person may become sleep deprived and even more fatigued by the extended periods of wakefulness. Slower working rotations such as changing the hours of work every 1 to 2 weeks is likely more effective and gives the circadian clock more time to get synchronized on a given work/rest schedule.

The training program stressed the importance of getting regular sleep. While unusual work hours on the railroad may be a factor, the work schedule is not the only cause of fatigue. Individual sleep rest and work habits can all combine to make it less likely that a person will be alert or feel fatigued when trying to perform their duties.

Employees were informed that sleep changes with age and that sleep becomes less deep as a person ages. This also leads to the likelihood of more disrupted sleep. While the total amount of nocturnal sleep increases with age, older individuals may find their sleep becomes more fragmented. Thus, older employees need to become more vigilant to ensure that they plan for more sleep opportunities.

The information presented not only relates to work but is equally important for employees when they are off duty. The modern economy requires 24-hour operations and railroad employees are more likely to be challenged because they may be awake when most people are sleeping. The education programs provide the tools for employees to increase their ability to successfully manage fatigue.

The course also discusses the effects of alcohol and medication on a person's ability to remain alert. Alcohol taken in sufficiently large quantities can affect alertness

by disrupting the various stages of sleep. Alcohol also acts in an interactive and additive fashion when an individual is already fatigued. The combination of alcohol and fatigue can lead to more impaired performance and a greater propensity for sleepiness. Many over the counter medications come with warnings about driving or operating heavy machinery. The instructional materials provided in these courses are designed to ensure that the individuals realize that they are more likely to be drowsy and less alert when they are operating the locomotives if they have taken either prescription or non-prescription medication.

Adopting a more holistic approach to the need to educate employees to the effects of shift work on railroad employees was initiated by the Canadian Pacific Railway. They published a book entitled "Shifting to Wellness" in 1999. This book acknowledged that "Workplace performance is a function of personal lifestyle and wellness." (pg. iii) Furthermore, the book recommended that railroad shift workers become more aware of the effects of fatigue on their health and work life including the "need for sleep, nutrition, stress and an overall healthy lifestyle." (pg. iii). The program asserts that fatigue is a multifaceted and multi-determined phenomenon – not just due to the effects of a work schedule alone, but due to many different factors and also affected by individual choices and individual differences as well.

The table of contents of "Shifting to Wellness" reflects the change in focus from a simple "get more rest" approach to one in which a wide array of factors need to be considered. For example, the chapter headings include: Biological Clock, Fatigue, Alertness, Readiness for Behavior Change, Eating Wisely, Active Living, Managing Time, Managing Stress, and Involving the family.

In addition to these issues noted above, training courses typically include a discussion of the role of sleep disorders. These conditions, which can affect the alertness and performance of individuals during their waking periods, are somewhat rare. However, they can occur and do cause individuals to feel drowsy and sleepy during work times.

The principles in these educational programs have been reinforced with regular updates and are quite helpful in assisting the individuals in learning to moderate their habits somewhat.

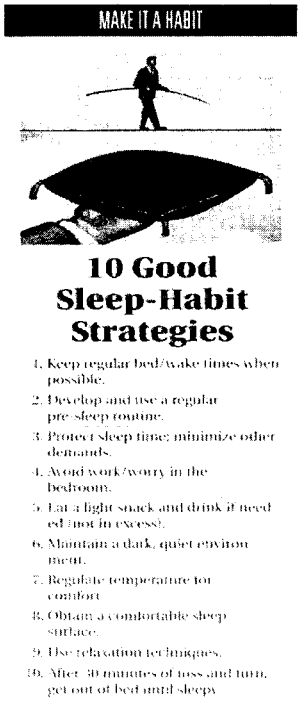


Figure 2. UPRR Educational Brochures.

The Union Pacific Railroad has been at the forefront of developing new and innovative educational materials to effectively communicate fatigue information to its workforce. Materials are professionally produced using state of the art information, marketing and graphics techniques. The materials have captured the essentials of their message and conveyed them to the railroad employees in a visually appealing and effective manner. A complete listing of the educational videos and brochures is available in Figure 3.

Recognizing that managers will come into contact with employees who have questions about fatigue related issues, the UPRR has also developed educational materials for its managers.

Videos

Fatigue and Family Support - This video helps reconcile the need for sleep with the need to be part of a family, including tips on how families can support shift workers.
History of Drowsy Driving - A light-hearted look at what happens when people who are suffering from fatigue get behind the wheel.
Insomnia - This video offers strategies for those times when you are unable to fall asleep or stay asleep.
Napping - This video outlines Union Pacific's Napping Policy and provides guidelines and recommendations for napping.
Sleep Basics - A primer on sleep basics, this video acquaints you with the circadian clock, how your sleep habits affect fatigue and what happens when you lose sleep.
Sleep Deprivation - Lack of sleep is costly to employees as well as the company. This video explains why and also discusses lack of motivation and response.
Sleep Disorders - Created by the Kansas City Southern, gives insight into signs and symptoms of sleep disorders, as well as treatment options available.
Strategies for Living - This video features strategies for managing fatigue, including good sleep habits and explains how your lifestyle affects your level of fatigue.
Sweet Dreams - An entertaining look at fatigue, this video describes sleep disorders and what you can do about them.
Z-9 Adolescents and Sleep - This informative video is your guide to adolescent sleep issues.

Brochures

Alertness Management Guide -This guide outlines the physiology of fatigue, along with strategies to improve your everyday performance.
Drowsy Driving - This brochure acquaints you with the characteristics of drowsy driving and how they contribute to accidents. It also offers strategies you can use before driving and while driving to stay safe.
Drugs, Alcohol and Fatigue - Long hours and irregular schedules can result in sleep loss and fatigue. These stressors are especially significant for workers in substance abuse recovery. This brochure offers information on alertness, fatigue and relapse prevention.
Fatigue and the Family - This brochure is for all employees who work long or erratic hours, travel or just plain work hard.
Fatigue Concerns and Myths - This brochure addresses some common myths about fatigue and demonstrates why this issue is relevant to all UP employees.
Good Sleep Habits - A variety of sleep habits can promote good sleep quality and quantity, both at home and on the road. This brochure offers strategies to help you get to sleep and stay asleep.
Guide for Day Sleepers - Designed for employees and their family members, this guide provides suggestions to help you get rest during the day, at home or while away.
Jet Lag - This brochure will familiarize you with the symptoms of jet lag and strategies to prevent or alleviate those symptoms.
Lodging Facilities - This brochure identifies factors in the sleep environment that can affect the quality and amount of sleep you get, along with tips on how to make your environment more conducive to good sleep.
Managers' Alertness Travel Guide - This brief guide provides information about the physiology of fatigue and jet lag, in addition to offering strategies to improve your performance on the road.
Planning Your Emergency Response - Designed for employers and managers who must respond to unscheduled or emergency work activities, this brochure will help you develop a plan of action for coping with fatigue before, during and after unscheduled events.
Pocket Guide to Alertness - This quick-reference guide will help you identify symptoms of fatigue or decreased alertness.
People Matter - Project AM/PM is a world-class alertness management initiative designed to protect the health and well-being of Union Pacific employees.

Figure 3. Industry Videos and Brochures.

The BNSF developed a short course based on the fatigue counter measures program designed by NASA. This course was presented to all Train, Yard and Engine (TY & E) employees in the late 90's. More recently, the BNSF has converted this course to an on-line course that is available to all BNSF employees. The course includes a number of key topics that are designed to address the sleep hygiene issues faced by railroad employees. They include discussion of circadian rhythms and the body clock, the need for appropriate amounts of sleep, and the use of various countermeasures.

In addition to these efforts, BNSF has also published several educational brochures addressing various fatigue issues. One brochure published in late 1998 was entitled, "Overview of Alertness Strategies." Six more brochures were published in 1999:

1. *Questions and Answers about Fatigue and Alertness;*
2. *Causes and consequences of Fatigue;*
3. *The Physiology of Sleep;*
4. *Napping Strategies;*
5. *Rest Environments; and*
6. *Diet/Exercise/Medications.*

BNSF also purchased the video "Day/Night Strategies for Shift Workers" developed by the National Sleep Foundation for use in educational and safety meetings with employees.

Combined Industry Efforts

After the initial effort by the railroads to educate their workforce regarding fatigue and its effects on operational activities and the various countermeasures available, the various railroads then each began to independently develop educational programs and materials for ongoing education of their respective employees.

In 2000, the FRA sponsored the development of a prototypical web site that was used to demonstrate how fatigue education information could be distributed to industry representatives. Subsequently, a group of labor and management representatives of the North American rail industry, concerned about fatigue and alertness in the workplace determined that a jointly sponsored web site could be developed. The web site was designed with the idea that it would be devoted to increasing awareness of the issues related to human fatigue and alertness in the railroad industry. One of the main goals of the web site is to promote awareness through the use of educational content information and course work. Members of the rail industry have agreed to support the project for three years.

The web page developers have agreed to provide the following:

1. Develop and maintain a web page for the rail industry with information periodically reviewed for up-to-date and accurate information by a panel of scientific experts.
2. Periodic updates on new research of interest to the industry will be posted on the subscriber section of the web page.
3. Information on fatigue countermeasures for railroad employees.
4. Educational material for subscribers that can be used by their individual organizations
5. Serve as a resource, repository and clearing house for fatigue related information.

The current web page is available at www.narap.net

Individualized Coaching

A pilot project was initiated on the Union Pacific Railroad designed to determine the effectiveness of individualized feedback and coaching on the extent to which individual railroad employees could be encouraged to change their behavior. The study was conducted in conjunction with the use of actigraphs which will be discussed in another section of this report.

The principle behind this approach is to focus on the individual and their specific responsibility for taking care to address individualized sleep hygiene issues. Accordingly, the importance of providing information to railroad employees on how best to utilize their off time and how to make good decisions about the amount and timing of sleep is essential. A significant component of any fatigue countermeasures program is the belief that individuals must be able to make effective use of their

The program was designed to work with a sample of locomotive engineers. Participants were asked to gather baseline data that could then be used to assist them in identifying possible behaviors that could be changed. Twenty-nine Engineers wore the actigraphs for thirty days. These devices were loaned to us from the Walter Reid Army Institute of Research, and were later used in a research project in that Iraq required the immediate deployment of several of the performance watches, thus leaving only 15 units to loan to the study. As a result, it was necessary for us to adjust the timeframe in which the study was conducted.

Individualized Feedback Sessions

Individual Feedback Sessions with study participants were then used to provide participants with information about the extent of their work/rest sleep wake cycle and behavior. Descriptive definitions of the information obtained from the sleep watch were discussed and each participant's real time data was provided to them. Specifically, researchers discussed the following:

	Dimension	Explanation
1.	Duration	Minutes from start to end of sleep interval
2.	Wake Minutes	Total minutes scored as Wake
3.	Sleep Minutes	Total minutes scored as Sleep
4.	Percent (%) Sleep	Percent of minutes scored as Sleep
5.	Sleep Latency	Minutes to start of 1st 20-minute sleep block. Coded as a 20 minute sleep block when a minimum of 19 minutes of sleep are recorded
6.	Wake after Sleep Onset	Minutes awake during 0-0 interval
7.	0-0 Duration	O-O Intervals are sub-intervals of the Down Intervals (down intervals represent the major sleep period of the day, when subjects are in bed and trying to sleep) that estimate the true sleep period.
8.	Wake Episodes	Number of blocks of contiguous wake epochs
9.	Mean Wake Episode	Mean duration of Wake Episode (minutes)
10.	Longest Wake Episode	Duration of longest Wake Episode (minutes)
11.	Mean Sleep Episode	Mean duration of Sleep Episode (minutes)
12.	Longest Sleep Episode	Duration of longest Sleep Episode (minutes)

Although researchers had access to even more in depth data, not all dimensions were discussed as it could prove confusing to an individual who has not previously studied sleep and sleep patterns. Through prior experience, we have learned that discussing key dimensions proves effective in helping Engineers to understand their individual sleep/wake patterns but that there is an optimal level of information to discuss – if the concepts are too in-depth and detail oriented participants get confused and lose interest. If the basics are discussed, participants become aware of how their sleep may be determined by their behavior and can then compare their sleep/wake patterns over the length of the study to see, objectively, what changes have occurred.

Participants were provided with a hard copy of their results, both in the form of a color coded chart where periods of sleep and activity were visually demonstrated and easy to understand and in the form of a written report that discussed the above dimensions. A University of Denver folder containing a cover sheet, a glossary of actigraph terms, suggested fatigue countermeasures, and the participants report (coded by number versus name in case the participant misplaced the report contents) was given to each person.

Following the receipt of work/rest information, a coaching session was held with each participant. The goal of these coaching sessions was to provide an intervention tailored to each individual that:

- Identified areas in need of improvement
- Identified three goals to address
- Discussed methods for making change
- Discussed how to use the information from the watch

Coaching Sessions

Individuals from the research team met with participants individually for approximately 60 minutes to provide feedback regarding the participants' sleep behaviors. Based on this information, participants set specific goals in order to improve sleep hygiene.

The research team then reviewed strategies to help participants reach their goals. These strategies included presentation of performance actigraphs and how such self-monitoring devices could be used in conjunction with fatigue countermeasures to help participants increase sleep. Again, participants were asked to maintain a sleep log. Members of the research team contacted participants via telephone and e-mail during the intervention phase to monitor progress and address possible concerns or questions.

Feedback was provided through the use of *Actigraph Technology,* specifically, performance feedback actigraphs or sleep watches were used. Prior to receiving the performance feedback actigraphs, individuals received training and education on individual cognitive-behavioral directed change management techniques designed to improve personal fatigue management hygiene. Specifically, researchers assisted study participants in identifying habits that could interfere with utilizing the knowledge and feedback obtained from the performance feedback actigraphs.

Within the scientific literature, there is a notion that feedback of any type can have a positive effect on safety behavior. The basic idea comes from operant theory (Skinner, 1953) as well as cognitive – behavioral theories on behavior change (Beck, 1993). Kinicki, Prussia, Wu, and McKee-Ryan (2004) found that cognitive processing of performance feedback is more likely to determine an individual's response to that feedback as compared to characteristics of the feedback itself, such as specificity and frequency. Hence the way in which feedback is delivered and then processed is an important determiner of behavioral change. As yet, it cannot be said with any certainty that feedback alone will increase performance as individuals may choose to ignore feedback for many reasons including task characteristics and personality variables. Research studies suggest that it is a combination of factors that work together to affect performance. To understand which factors have the ability to alter behavior, this study of performance feedback was done to assist in understanding the effects that performance feedback related to work/rest patterns may have on an individual's behavior.

Instruction on how to interpret the performance reading as well as instruction on various fatigue countermeasures was provided. For example, if an individual saw that his or her performance reading was in the 70's and knew that he or she was likely to be called to work in the evening, the merit of napping instead of completing domestic chores was discussed and emphasized. Two weeks after the performance watches were distributed, a researcher called each individual to inquire about how the watch was working and to address any questions and/or concerns that were presented.

Specifically, the protocol for goal setting was as follows:

1. "Based on what you have learned from your actigraph results, what behavior would you like to change"?
    a. Example: "I need more sleep"
        i. Suggestions: white noise, black-out curtains, turn off phone, etc.

2. After explaining the performance actigraph, and demonstrating how the watch worked, a researcher discussed with the participant how to use the performance reading to make decisions regarding work/rest. For example, researchers would say the following:

> The Performance Actigraph that you will be wearing will give you an estimate, based on the amount of sleep you have had in the last 24-48 hours, of your overall performance efficiency at any given moment. In other words, the Performance Actigraph will keep track of the amount of sleep you have obtained and will calculate, using a mathematical algorithm, how well you can be expected to perform. The information from the Performance Actigraph should be used to guide you in your decision to increase the amount of sleep that you are getting. This can be in the form of a nap or a longer period of sleep, the use of caffeine, stretching, etc.
>
> It will take approximately 48 hours for the watch to become accurate in the performance readings that it displays. The range of numbers reported will be from, approximately, 68 to 97. You will never receive a reading of 0% if you are diligently wearing your watch as the watch is not calibrated in that manner,. However, if you take your watch off and leave it sitting for an extended period of time, the reading will approach zero.
>
> Here is an example of how the watch can be used:
>
>> You are 2X out and your performance reading is 78%, instead of mowing the lawn or going to a film, you should take the opportunity to take a nap.

The researcher would then ask the person to provide an example of another scenario to ensure that the he or she understood how to use the information correctly.

The following suggested fatigue countermeasures were discussed with each participant who in turn was encouraged to utilize these techniques when performance watch readings were low or when he or she was feeling tired.

1. Rest breaks and napping:
    a. In general, the effects of napping, following the elimination of sleep inertia (or grogginess), have positive effects on performance that can be seen as long as 4 hours after a nap has been taken.
    b. Naps as short as 20 minutes can be helpful.
    c. Naps can maintain or improve alertness, performance, and mood.
    d. Some people feel groggy or sleepier after a nap. These feelings usually go away within 1-15 minutes, while the benefits of the nap may last for many hours.
    e. The evening or night worker can take a nap to be refreshed before work.
    f. Studies show that napping at the workplace is especially effective for workers who need to maintain a high degree of alertness, attention to detail, and who must make quick decisions.

2. Caffeine:
    a. Should be used in moderation.
    b. Don't use 4 hours before sleep.
    c. Use decaffeinated beverages just after waking up so that caffeine will have a greater effect when needed to combat fatigue.

3. Maximize the likelihood of getting 8 hours of uninterrupted sleep to decrease fatigue:
    a. White noise (e.g., a small fan).
    b. Dark window covers.
    c. Phone ringer volume turned down.
    d. Ear plugs.
    e. Working with family to educate them on the importance of, and your need for, uninterrupted rest.

4. Take naps whenever possible. The closer you are to getting 8 hours of sleep in a 24 hr period the more effective you will be. Taking short naps, if that is all that is available, is better than not sleeping.

5. Stretching:
    a. Take a short walk, do some simple stretching exercises.
    b. Regular, light exercise such as walking has been shown to decrease fatigue.
    c. Relaxation exercises (e.g., deep breaths).

6. Drink plenty of fluids:
    a. Dehydration has been correlated with fatigue.

7. Diet:
    a. Try to eat three normal meals per day.
    b. Eat healthy snacks, avoiding foods that may upset your stomach.
    c. Drink less fluids before going to sleep.
    d. Avoid heavy meals close to bedtime.
    e. Eat a light snack before bedtime.
    f. Don't go to bed too full or too hungry.
    g. Avoid nicotine.

8. Exercise:
    a. Helpful in obtaining overall health.
    b. Should be avoided before sleep.

9. Alcohol:
    a. Don't stop for a drink after work; although at first you may feel relaxed, alcohol disturbs sleep.

10. Promoting Alertness at work:
    a. Talking with co-workers can help keep you alert and co-workers can be on the lookout for signs of drowsiness in each other.
    b. Try to exercise during breaks -- take a walk around the building, shoot hoops in the parking lot, or climb stairs.
    c. Exchange ideas with your colleagues on ways to cope with the problems of shift work. Set up a discussion group at work.

Prior to discussing the above fatigue countermeasures, participants were encouraged to identify what positive changes they could make in their environment to assist in the promotion of more restful sleep.

Initially clients had a very difficult time identifying changes that could be made. Many held the belief that improvements to sleep were impossible to make because of their work schedule. However, through much discussion and brainstorming, researchers assisted Engineers in identifying specific changes that could be made on a personal level. This often required asking the participant probing questions about his or her life. If, for example, an Engineer was hard pressed to identify what he or she could change, a researcher would ask about the following:

- Sleep environment?
- Eating habits (especially prior to sleep time)?
- Exercise habits?
- Alcohol intake?
- Water intake?

- Children in the home?
- Pets in the home?
- Concerns/worries?
- Divorce/other personal trauma?
- Pre-sleep rituals?

Answers to these questions were then used to design interventions on a person to person level. So for example, if an Engineer indicated that he or she had two 70 pound dogs that slept in the same bed or that he or she commonly ingested a heavy meal prior to bedtime, the researcher would help the person understand how these occurrences may affect both the quantity ad quality of sleep.

After identifying and recording areas of concern and behaviors for change, the researcher would then ask the participant how confidant he or she was that these changes could successfully be made. At all times researchers encouraged the participants to be realistic in his or her expectations.

In order to "prep" the participant for change, he or she would also be asked to identify possible obstacles to achieving the stated goals as well as strategies for overcoming those obstacles.

In many cases principles of learning and behavioral change were relied upon to assist the researchers in facilitating change. During the coaching sessions researchers encouraged participants to reflect on what is commonly termed the ABC's of behavior. Specifically, "A" stands for antecedent; "B" for behavior; and "C" for consequence, for clarity sake, here is an example; an Engineer tells a researcher that he or she always has a few alcoholic beverages to assist him or her with falling asleep. The researcher then explains that sleep studies have showed that while alcohol may help an individual to fall asleep more quickly, it ultimately leads to more disrupted sleep (tossing and turning) after a few hours. So in this example the "A" is alcohol, the "B" is trying to sleep, and the 'C" is disrupted sleep. Similarly, this concept can be used to help an individual understand how eating a carbohydrate laden heavy meal prior to bedtime can disrupt sleep as can caffeine ingested less than four hours prior to bedtime.

The intense coaching sessions were conducted so that an individual had better insight into what may be affecting his or her behavior and what changes could be made to alter negative practices and to increase the likelihood that more restful sleep could be obtained.

Engineers seemed to connect well with the research staff and to take these coaching sessions seriously, as evidenced by the extreme nature of the personnel information that was shared. It this safe environment, researchers heard about familial problems and issues that were not common knowledge.

Chapter 4. Scientific Models of Fatigue

Attempts to develop models to predict and explain natural phenomena date back to Archimedes (287-212 BC) who is credited with the defining the principle of the lever and inventing the compound pulley. According to various sources he is believed to have discovered the law of hydrostatics, which states that a body immersed in fluid loses with equal to the weigh of the amount of fluid it displaces. This discovery was thought to have been made when Archimedes stepped into his bath and perceived the resulting amount of water that overflowed.

In modern times statistical or mathematical models are used to predict and explain a number of different natural phenomena such as hurricanes, thunderstorms, and the average temperature, oil production and other important phenomena. However, models are only that, models. In statistics, it is taken for granted that "All models are wrong but some are useful" and, "Remember that all models are wrong: the practical question is how wrong do they have to be to not be useful," (attributed to George Box a professor of statistics at University of Wisconsin). (Box & Draper, 1987).

In psychology attempts to model human behavior and learning were undertaken in the heyday of behavioral psychology and culminated in the work of Clark Hull and Kenneth Spence at the University of Iowa. Later, Borbely (1982) in a classic article advanced the two process model of sleep regulation. The proposed model suggested that sleepiness increases during waking hours and declines during sleep. The process was thought to interact with a circadian process and was quantitatively modeled originally by Dan and Beersma 1984).

Since then a number of models of the sleep wake and performance behavior have been proposed. These were reviewed by Borbely and Achermann (1999) and were discussed in detail at a workshop in Seattle, WA in 2005. Results of the comparison of these models was discussed in detail in a number of papers that were later published.

Dawson & Fletcher

An Australian team worked to develop and devise a mathematical model that can account for the effects of sleep and wake cycles on work related settings. Roach, Fletcher & Dawson (2004) described the development of FAID which was developed primarily to be used in work-related settings and in particular with respect to duty rosters. According to Roach, Fletcher & Dawson (2004) the FAID model is based on "the fatigue value of work periods and recover value of non-work periods are dependent on their length, circadian timing, and recency. The overall fatigue level for an in individual at any point in time is the net worth of the fatigue and recovery tokens that he/she has accrued over the previous 7 days." (pg. A67). "The major advantage of this approach is that it does not require sleep times as an input but rather assigns a recover value to time away

form work based on the amount of sleep that is likely to be obtained in non-work periods. Thus, FAID can be used to predict work-related fatigue associated with any duty schedule using hours of work as the sole input." (page A67)

The FAID model is based on the assumption that fatigue increases the longer a person is at work. In addition, work periods that occur during the midnight hours are more fatiguing than those that occur during daylight. Furthermore, the FAID model assumes that fatigue follows the circadian rhythm that has been found with the oscillating core body temperature. The circadian rhythm of core body temperatures has been set to vary over a 24 hour period with a peak level of alertness at 17:00 h and a minimum level of alertness at 05:00 h.

Dawson and Fletcher (2001) reported on their efforts to validate the model. Using previously published data the authors made comparisons between measures reported in the published works and the predictions of their model. Data provided in Dinges et al. (1997) study measures sleepiness, mood and performance in young adults during a sleep restriction protocol. The study was designed to parallel the amount of sleep typically obtained by shift work employees; namely greater than 4.5 hrs per night but less than 6.5 hrs per night. A total of 16 individuals were studied over 7 days of sleep restriction. Study participants completed the psychomotor vigilance task (PVT) and their lapses (reaction times 500 ms and PVT duration of the slowest 10% of reaction time responses were used as the measurement of interest).

Results reported by Dawson and Fletcher (2001) indicated that a correlation of r=.92 was obtained between the observed data and the predictions.

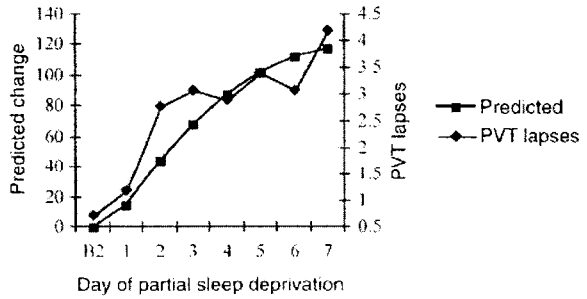


Figure 1. Mean (for testing at 10:00, 16:00 and 22:00 hours) relative performance on a 10-min visual psychometer vigilance task (PVT) for 16 participants across the final baseline day (B2) and 7 days of partial sleep deprivation (mean sleep 5 h) against predicted relative change.

Figure 4. Comparison of FAID Model to predicted data. (permission requested.)

Dawson and Fletcher (2001) describe several other validation studies in which they compared the predications of the model and concluded, "Model predictions were correlated against psychomotor vigilance task lapses (r = 0.92) and reaction time responses (slowest 10%, r = 0.91) as well as sleep latency (r = -0.97). Further correlations were performed on four measures from a 64 h continuous sleep deprivation study; that is objective vigilance (r = -0.75) as well as subjective performance (r = -0.75), sleepiness (r = 0.82) and tiredness (r = 0.79). ...The results indicate that model predictions correlate well across a range of objective and subjective measures." (pg. 475).

In developing the FAID model, the authors have provided a description of the procedure that they used to validate the cut-off values of their modeling software. Based on previous research comparing the neuropsychological performance of sleep deprived individuals with that of persons with various blood alcohol levels it was possible to calibrate the FAID scores to reflect "high fatigue" levels associated with real world behaviors. In others words, high FAID scores could be associated with scores on other measures which had been produced by persons with continuous sleep deprivation and with neuropsychological performance similar to high blood alcohol content levels. Accordingly, a FAID score of 80 is likely produced after 21-22 hrs of wakefulness. Similarly, a score of 80 points reflects the neuropsychological performance produced when an individual has a blood alcohol level over 0.05%. Thus, "performance impairment at 80 fatigue points is at a level that would not legally be permitted in a motor vehicle operator if it were due to alcohol intoxication in most countries." (Dawson & Fletcher, 2001, pg. 481)

In the modeling workshop, according to Roach, Fletcher & Dawson (2004), the FAID model ranked as high as first and as low as sixth in its ability to predictions of the neurobehavioral data provided in the scenarios to be tested. Roach, Fletcher & Dawson (2004) concluded that:

> The differences in predictive power between models *were relatively small* (italics added) compared with the difference between model prediction and experimental data. (pg. A68)

Akerstedt

Folkard & Akerstedt proposed a ""three process model of sleep and alertness" (TPMA) (Folkard & Akerstedt, 1987). Their work from the Modeling workshop is described in Akerstedt, Folkard, and Portin (2004). The three process model uses subjective sleepiness data obtained from several studies. The three processes postulated include: sleepiness (c), time awake (s), and the wakeup or sleep inertia component (w). Alertness then is predicted to be the sum of S + C.

Attempts to validate the model have been based on both real world and laboratory studies using ratings of subjective alertness and EEG analyses as criterion variables. Data has also been gathered on operational performance using driving simulators and performance on psychomotor vigilance tests (Akerstedt, Folkard, & Kecklund, 1993 as cited in Akerstedt, Folkard, & Portin, 2004)).

Circadian Technologies

The Circadian Alertness Simulator (CAS) was also evaluated at the modeling workshop (Mallis, Mejdal, Nguyen, & Dinges, 2004). The CAS model includes both a circadian component and different factors for different types of work related activity. The model provides users with a plot of activity level and alertness level as well as a fatigue index. Validation efforts have been conducted "in sleep and alertness studies in workers with irregular, regular, and or rotating work schedules, comparisons of simulated and actual see and alertness, and correlations between a fatigue index and accident rates in transportation.... The model was developed for use in 24 hour transportation and shift work operations and is currently tailored for irregular work schedules in the transportation industry." (pg. A7)

At a recent congressional hearing Dr. Martin Moore-Ede, CEO of CTI, described the model and its uses in the transportation industry. He explained that CTI has developed the CAS model which is now used as the basis of their fatigue management plan. The process started with the development and validation of a Circadian Alertness Simulator (CAS) model which predicts not only levels of fatigue risk (as a fatigue Risk Score) but also the rate of DOT recordable accidents. The model produces a fatigue-risk score between 1 (low risk) and 100 (high risk) which is calculated from an employees work-rest pattern over the preceding seven day period. According to CTI, the average fatigue risk score of US truck drivers is approximately 40. Given these scores, the probability of a DOT recordable accident is strongly associated with the risk of fatigue scores reaching 60-70 and above. When a person obtains a score of 90 on the CAS there is a 50% probability of having a DOT recordable accident in the near future.

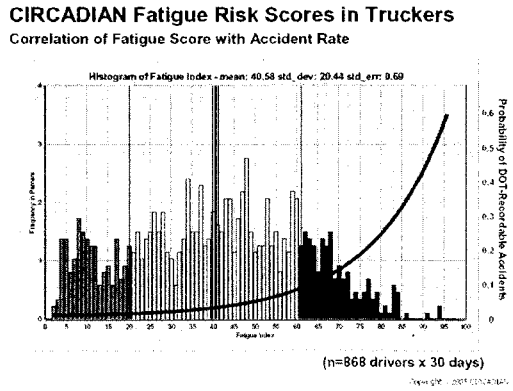


Figure 5. Use of the CAS in transportation. (permission pending.)

According to Dr. Moore-Ede, in real world applications actual truck-driver work rest histories are obtained from various sources such as driver logs or on-board monitoring devices. These data are then used to produce a Fatigue Score that provides an estimate of

the degree of fatigue risk that an individual driver is exposed to at the time of measurement. The Fatigue Score is then provided to drivers, dispatchers, safety managers and operations managers for use in decisions about how to meet operational expectations while managing the risk associated with fatigue.

This modeling tool forms the basis of the **Fatigue Risk-Informed Performance-Based Safety** management approach that has been utilized by CTI consultants in their work throughout the transportation industry. The approach has also been used successfully with other industries such as fire prevention and nuclear power plants. The principle is that if railroads measure and monitor the specific risks, then government regulators can require the operators of the regulated industries to focus their attention and creative energy on ways to reduce those specific risks, without prescribing cumbersome rules on the exact interventions by which the safety goal should be met. Because of the variety of conditions and agreements across the railroad industry and the different terrain and length of time needed to complete various runs the one size fits all approach does make sense in the railroad industry. Recent findings from the San Antonio study (Sherry, 2005) for example, revealed that a majority of the employees were working at an optimal level of alertness with a low risk of fatigue.

Results of the modeling workshop showed that the CAS model was the best in terms of predicting the hourly alertness levels for a sample of locomotive engineers. On other data sets the CAS model faired about as well as the other models tested. As Van Dongen (2004) states "not one model clearly stood out as the overall best or worst....The models were capable of predicting the data of scenarios 1 [88 hours of wakefulness in a laboratory setting] and 3 [extraboard locomotive engineers] fairly well." (pg. A35)

Hursh et al.

Hursh et al. (2004) described the SAFTE model used in the Fatigue Modeling workshop. The authors postulate several processes that determine the performance effectiveness at a given point in time. The homeostatic process is a linear mathematical function in which a person's ability to perform basic cognitive tasks declines at a steady rate over time. The rate at which cognitive performance declines has been derived from other studies and estimated to be about 1% per hour. Differences in the rate of decay may vary according to the type of task that is being performed such as simple reaction time or basic arithmetic. The sleep restoration function varies according to the time of day but is estimated to be fully restored after a little more than 6 hours of sleep. The sleep inertia process is also estimated in the model and, based on the findings of Dinges, Orne, and Orne (1985) and Balkin et al. (2002) is thought to affect performance for as much as two hours after waking up. The circadian process is also included in the SAFTE model and is hypothesized to affect both sleep and performance. The authors state that the circadian process influences cognitive performance such that there is a "gradual rise during the day with a plateau in the afternoon and a rapid decline at night that closely parallels published studies of body temperature." And further, "Circadian rhythm combines with a gradually depleting reservoir process resulting in a bimodal variation in cognitive effectiveness" based on the data obtained from other published studies. (Hursh

et al, 2004). The SAFTE model is particularly strong in that it combines an estimate for a phase shift that might occur if the individual were to end up performing cognitive tasks in a different time zone following air travel. The model includes parameters that estimate "jet lag" that describes the degree of performance or impairment that would obtain in different time zones.

The SAFTE Model has been described in some detail by the authors as a "three-process quantitative model" (pg. a44) (Hursh et al., 2004). The model was developed for use with military personnel to estimate performance in the military field setting. The most recent version of the model was developed based on data obtained from the Sleep Dose Response Study (Balkin et al., 2000) which has also been used in the construction of the Fatigue Avoidance Scheduling Tool (FAST) (Eddy & Hursh, 2001). The model is conceptualized as a sleep reservoir which influences processes which influence the capacity of an individual to perform cognitive processes and complete tasks. With each unit of time that a person is awake the components and capacity of the sleep reservoir is decreased over time. The reservoir is restored in accordance with the intensity and quality of sleep obtained over time. Sleep intensity is directly affected by the time of day and sleep quality is affected by various real-world demands. The model output, level of effectiveness, is modulated by the circadian effects of time of day, and the depletion or accumulation of the sleep reservoir. Thus, the SAFTE model is similar to that suggested by Folkard and Akerstedt (1987).

The SAFTE model has been validated by fitting a mathematical model to the observed data obtained from laboratory sleep deprivations studies that have tested the sleep dose response effect with impressive results. Model predictions against data published by Angus and Heslegrave (1985) showed a high level of accuracy and a good fit with the data (R^2=0.98). Similarly, using the dose-response data of Balkin et al. (2000) the predictions of the SAFTE model again show a very good fit with the data (R^2=0.94).

Results of the modeling workshop showed that none of the models did very well overall. All of the models predicted the subjective ratings and the performance data for the scenario with extended wakefulness. However none of them, "could predict the sleep dose-dependent build-up of impairment over the multiple days of sleep restriction" (Van Dongen (2004) page A32). The SAFTE model was the most accurate in predicting sleepiness for scenario 2 partial sleep deprivations, and third best for predicting alertness in locomotive engineers. However, differences between the models were small and do not support the superiority of one over another at this time.

The SAFTE model is a very sophisticated and powerful tool with which to examine cognitive performance and reaction time as a function of sleep and wake periods. The model fits the best experimental data available quite well and has been tried in several different operational settings. As Hursh and his colleges note however, the usefulness of the models depends on the how to "bridge this gap between laboratory metrics of performance and performance in the natural environment of work and war."

(page A52). The Federal Railroad Administration is currently sponsoring a validation effort using work schedule data supplied by several railroads. As stated in a May 16, 2005 announcement:

> "FRA is accelerating its ongoing research aimed at validating and calibrating a fatigue model (which has already been proven in the laboratory by the Department of Defense) that can be used to (I) more precisely determine the role of fatigue in human factors accidents and (ii) improve crew scheduling by evaluating the potential for fatigue given actual crew management practices. When the model is properly validated, it will be made available to railroads and their employees as foundation for developing crew scheduling practices based on the best current science. The work plan for model validation will also provide a much more precise accounting of the role of fatigue (including acute fatigue, cumulative fatigue, and "circadian" or time-of-day effects) in train accidents.[11]

General Comments

The various papers and critiques of the results of the modeling workshop produced a number of different responses. Criticisms of the models and their results resulted in a number of important comments related to general model development and continued work. A summary of these comments is included below produced the following:

1) *Individual predictions.* Typically the models are validated by estimating the extent to which they account for overall group performance or group means. Using the models to attempt to explain or evaluate individual behavior will carry some degree of error. Thus, there will be a need to specify the extent to which the predictors are accurate.

2) *Predication accuracy.* How accurate are the model predications? Most psychological tests provide a standard error of measurement or a confidence interval so that users may evaluate the accuracy of the numerical predictions and the confidence within which those predictions can be assumed to be accurate. Typically, with other psychological tests a stand error of measurement is included that permits the user to assess the confidence with which the scores can be viewed. For example, IQ scores are typically reported with a range of plus or minus 3 points. Similarly, in large scale survey studies results are typically reported with an accuracy level of 3 – 5 percentage points. Model estimations need to provide such information as well.

2) *The outcome scales.* Some of the models have been developed to predict subjective ratings of sleepiness using the Karolinska Sleepiness Scale, others

[11] FRA Safety Action Plan:
http://www.fra.dot.gov/downloads/Safety/action_plan_final_051605.pdf

using performance on the PVT. The parameters used to model the pattern of subjective sleepiness may not be exactly the same, they are probably similar, but, Modeling subjective sleepiness Validation of the output from the models is generally geared towards the prediction of group not individual behavior.

4) *Real world accuracy*. Dinges (2004) called for additional research to validate these models in the real world.

Attempt at Model Validation

Dinges (2004) and others (Raslear and Coplen, 2004; Friedl, Mallis, Ahlers, Popkin, and Larkin, 2004) recommended that models be evaluated according to real world criteria and along with similar calls for validation by. These authors identified the need to develop models that will be useful in the operational environment. According to Friedl et al. (2004) in order to be useful in the operational environment such models must be "validated in specific field settings and be proven useful and useful for prediction of some important aspect of performance" (pg. A193).

A study conducted by the Sherry (2005), with the support of the railroad industry, sought to provide some initial data on the validity of the SAFTE Model in an operational setting. The SAFTE model has been of particular interest to individuals in the rail industry that is characterized by work schedules that have irregular start times and varying lengths of duration. Under current law, a train employee must have at least eight consecutive hours off duty following the completion of a work period. An employee who has been on duty for 12 consecutive hours may not return for duty until that employee has had at least 10 consecutive hours off duty. It is common practice in the rail industry at away from home terminals to transport road crews by cab from a train or terminal to a motel. If the crew is at a remote location, it may take an hour or more for the crew to reach its rest location. Thus, a twelve hour shift can become 13 or even 14 if the crew has to wait for its relief to arrive before being transported to the terminal. Upon arrival at their home terminal the employee usually has to drive home. Because crews are called at least two hours before they are to report for duty, a crew member may actually have only five hours or less of uninterrupted rest.

In the rail industry, locomotive engineers are required to undergo a certification exam every two years. This is equivalent to renewing one's driver's license to operate a motor vehicle on the highways. The purpose of this exam is to ensure that engineers continue to be proficient at knowledge of the rules as well as basic train handling techniques. Individuals are assigned a specific date and time at which they are expected to complete the 3 hour recertification exam. Successful completion of the exam results in continuation of a license to operate a locomotive in the railroad.

Locomotive engineers typically work various irregular work schedules. In advance of the required test of demonstration of proficiency it is common for a locomotive engineer to work in their normal fashion up to the day preceding the

recertification exam or simulation. Thus, these recertification exams provide a naturally occurring opportunity to assess the impact of sleep and rest on human performance. Also, they present the opportunity to assess the adequacy of existing models to predict actual real work performance on a task that is extremely critical to continued employment.

The validation study sought to provide some initial field study data on the validity of the SAFTE Model in an operational setting by obtaining predictions of performance effectiveness from the SAFTE model and comparing them to the scores on the engineer recertification exam as required by law.

Participants for the current study were 176 individuals who reported for test on whom work schedule data were also available. Anonymous data were obtained from the archival records of a large rail transportation company. Accordingly, due to the anonymous nature of the study based on archival data held on file by the company we were unable to obtain additional data. Thus, little demographic information was available on these individuals as these data were obtained after the individuals had completed the testing.

To determine the degree of operational proficiency needed to operate a locomotive the railroad company used a simulation and assessment program called NetSim. These are computer administered software simulations that assess the individual's ability to operate a locomotive over a predefined section of railroad terminology. Successful completion of the simulation is required to maintain certification as a locomotive engineer. Simulations consist of a monitored 90 minute episode in which the locomotive engineer operates controls to respond to real life situations such as crossings, speed restrictions, hazards, etc. which are presented to them via a video tape administration that is synchronized with the time clock of a locomotive control panel. The individuals completed the NetSims at their assigned time and receive a pass-fail, a total score, and scores on specific aspects of performance such as speed control, use of breaks, etc.

The archival data for a major Midwestern rail transportation company were investigated. A random sample of individuals who completed the NetSims during a predetermined time were captured. The archival data were matched with other information on the work rest history of the same individual. The average efficiency score, as well as the lowest efficiency score, for the 10 work periods (not ten days) prior to the simulation run were identified. Statistical analyses were then conducted to determine the existence of relationships, if any, between scores generated from the FAST model and performance on simulators.

The analysis of the SAFTE model was conducted using a simple univariate correlation approach. This method compared the relative change in one variable to the unit change in another variable. Due to the fact that the data were archival no manipulation of the actual conditions (e.g. hours of sleep, etc) was performed. Thus, the

causal relationship between the two variables can not be inferred due to the *non-experimental* nature of the investigation.

The archived scores of individuals who completed the NetSim simulation test, the recertification test, were obtained from the company. These results obtained the pass/fail scores, total number of items correct, break wear, fuel consumption, draft forces and general information on train handling. Next, these scores were matched with the work/rest schedules also obtained for the individual engineers who completed the simulator performance tests. Data were obtained during the period 2/12/2002 and 9/11/2002. These data were analyzed to determine the relationship between hours of rest available and various performance indicators from simulation scores. In all, information was available on 175 simulator runs.

Data from the work schedule history was entered into the FAST/SAFETE software. The resulting output provided the estimates of the individual's likely cognitive effectiveness or "efficiency" on a particular task, in this case reaction time. These efficiency scores were then paired with the *actual* output obtained as a result of completing. Average daily efficiency scores obtained for the work schedule on the days preceding and on the day of the actual simulator run were calculated. These average efficiency scores were taken as indicators of the average level of readiness to perform a given task. In addition, the efficiency score obtained on the actual day of the simulation, estimated on the basis of the work schedule provided, was used as well.

Results of the correlational analysis of the NetSim scores and work rest schedule data used to generate the FAST/SAFETE scores revealed a non-significant relationship between the FAST Efficiency scores and the scores on the NetSims.

As the Efficiency Score increased, number of items correct remainder decreased. The *remaining score* is the number of points on the test that *remain* after the penalty points are deducted. So, the higher the remaining scores, the higher the score on the test. Results indicate that as the efficiency score approaches 100 the test score decreases slightly. In other words, the higher the FAST score the *poorer* the score on the simulation. This is not in the expected direction and points to problems with the model. This is a very interesting counterintuitive finding. Essentially, as FAST efficiency scores increased we would hope that remaining score or test score would also increase, which did not occur with this data set. Actual pass/fail scores on the test did appear to correlate at a non-significant level ($r = -.130$, $p \leq .103$) on the actual date of testing. This result means that as the efficiency scores increase, the likelihood of passing decreases (on the graph a fail is scored as a 0 and a pass is scored as a 1). A counterintuitive result was produced. (Sherry, 2005)

These results demonstrate the lack of relationship between a model validated on laboratory data obtained under controlled conditions. The model was certainly accurate and had a good fit with the control data. These findings suggest that there is a lack of relationship between scores on the FASTSAFTE model and real work activities such as those found in the NetSim engineer recertification test. While the initial models appear

to be promising based on the laboratory data on which they were derived, there is little evidence to suggest that the model actually corresponds to real life performance.

Additional research examining the validity of sleep models relative to real life measures of performance are clearly needed and, as discussed earlier, is currently underway.

Current Status and Implementation of Modeling Approaches

The US railroad industry is piloting the use of modeling and a risk based approach on one of the Class I railroads. Since 2003 the Union Pacific Railroad has been implementing the use of the FAID model in reviewing its operations to manage fatigue. In 2003 the UPRR contracted with the University of South Australia and Professor Drew Dawson to review their operations and crew scheduling approaches and to assist in the identification of scientifically based fatigue countermeasures for the railroad.

The first major step in applying a scientifically based model to the railroad operational environment is to gather the relevant data on the work schedules that make up the various pools and extraboards throughout a system. The UPRR has in excess 400 different agreements governing work assignments in various locations throughout the system. Each of these agreements defines a work territory and group of people dedicated to performing the work and the terms of that agreement.

In the railroad industry, many of the work agreements are characterized by a rate that individuals will earn per mile. Consequently, the number of miles that are available in a run will generate more earnings. In addition, in many cases the work agreements or contracts include a range – including a minimum and maximum number of miles that are deemed targets in the contracts. These mileage targets are monitored by both labor and management on a regular basis. The numbers of employees assigned to a pool or extraboard are adjusted to enable the employees who have made the agreement to be able to ensure that they are achieving their mileage goals. Person working those agreements then are working to obtain their mileage goals and the company is also trying to maximize these arrangements.

When persons work the jobs in the pool then they are expected to sign up for a particular work assignment and to work as the trains arrive in their location. Accordingly, as the traffic ebbs and flows there is a demand on the individuals in the location to be able to work the traffic. If the traffic increases individuals may be expected to work more frequently as the amount of traffic consumes the available labor. As traffic slows then individuals will work less frequently. Again, since annual earnings are based on the number of miles worked and the number of miles worked was related to the number of trips worked, then there is a cycle of work and rest that becomes optimal that is needed to ensure earnings. Thus, the business demands of the operation, the number of crews, and the amount of traffic, all interact to create a work environment.

It is possible then to examine the work history of employees at any railroad to examine the amount of time worked and the amount of time off. At UPRR a commitment was made to use the FAID model to assess the fatigue levels of the various work schedules on the system. The time and effort to apply the model to the data was considerable and required the efforts of crew management specialists, computer programmers, payroll and accounting, and safety and health psychology experts. Work histories of individuals throughout the UPRR system needed to be obtained and reformatted. Once the data was properly formatted it was then analyzed using the FAID model. These work histories were entered into the FAID model and analyses of the work histories, in comparison to the threshold values of the FAID model were examined.

A summary of the results of these analyses, computed for the interval between Jan 2003 and December 2005, is presented in Figure 4 and reveals that the majority of the employee work schedules are found in the Good range as measured by the model. In fact, for the 20 months included in the study only the Southern region falls into the Fair region for two months.

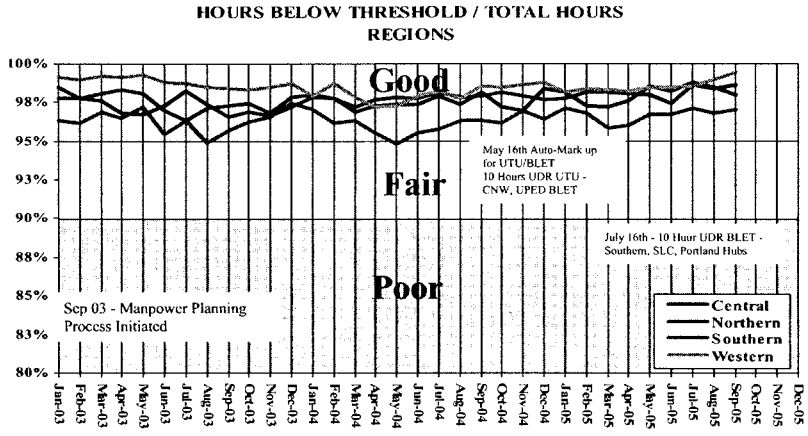
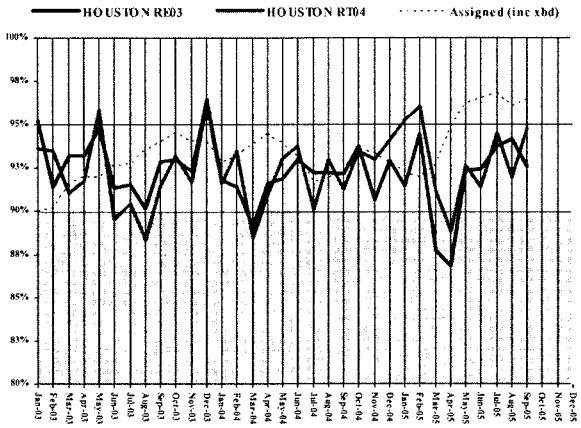


Figure 6. Percentage of boards over threshold.

These data and recommendations were presented by the UPRR at a meeting of federal, labor, and other key industry representatives and recognized experts in fatigue in November of 2005. The purpose of the meeting was to inform the railroad community of the UPRR activities and to request their input and reactions.

HOURS BELOW THRESHOLD / TOTAL HOURS



Following the initiation of these analyses using the FAID model additional countermeasures were put in place that were able to improve the overall functioning of the system. For example, in May of 2005 the automatic 8 am markup for UTU employees was initiated. Traditionally employees returning from a vacation or other absence would return to work at 12:01 am on their appointed day. Under this new provision, their first assignment after the absence would not begin before 8 am allowing a full night of sleep before work. A mandatory 10 hours rest requirement for some employees. was also instituted. This was followed in July with the addition of the BLE to the agreement. Improvements in the FAID scores for the system are noticed following the addition of these countermeasures.

It should be noted that the lines in Figure 6 and 7 represent averages which mean that some scores will be above and some below the average. As can be seen in Figure7 they are reflected with corresponding drops in the Houston area in the Southern Region during the same time periods (Aug – 03 and Apr-04 and Apr - May - 05) in which the scores fell below 90%. Note that there has been steady improvement since those months in 2005.

On the basis of these and other data provided it can be seen that for the most part there are only a small number of work schedules that are at risk for fatigue according to the FAID model. More importantly, the FAID model identifies that there are may be fatigue risk, however, all of these schedules are currently functioning within the existing hours of service and do not mean that persons are working in such a way as to be a safety risk. The safety risk has yet to be established scientifically and most scientific data

suggest that while there is a reduction in effectiveness after 20-21 hours of wakefulness this reduced performance is likely less than 10% of optimal efficiency.

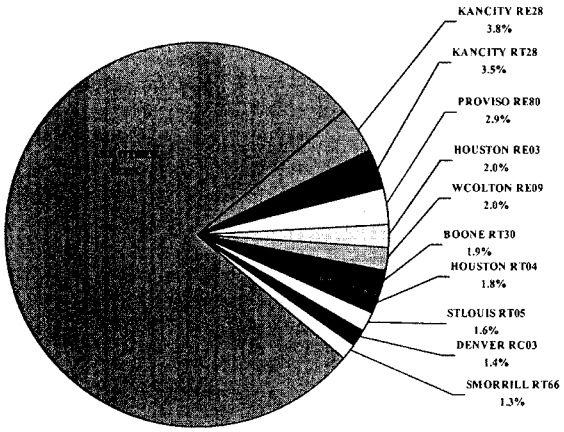


Figure 8. Percent of boards below threshold during 2005.

Figure 8 shows that 78% of the boards did not exceed FAID threshold levels during 2005. In fact it appears that in one location Kansas City boards exceeded threshold only about 3.7% of the time.

Since initiating this analysis UPRR has developed a series of action steps that it uses to manage fatigue. Specifically, all workgroups in the UP network are *risk-ranked* nationally and regionally as well as by service unit and board. These data are monitored by the General Director of Crew Resources and discussed with appropriate operational and safety groups as needed.

A standard report, that includes the graphs presented in Figures xx and xx, can be generated in a few as 24 hours by Crew Management, and reviewed for the identification of fatigue. This standardized report then provides a key mechanism for conducting a fatigue risk assessment.

Where a workgroup exceeds the allowable time over threshold [FAID > 90] there is a clearly specified 'corrective action' process that is undertaken by the crew scheduling team and other relevant groups where necessary [e.g. Labor Relations, Dispatch, etc]. In general, this process is designed to be risk-based, such that attempts to reduce Fatigue Related Risk (FRR) where it poses the greatest hazard.

In general, workgroups with the highest percentage of time below the threshold are considered 'at greatest risk'. However, risk is a relative term and based on the FAID model those with the least sleep opportunity. Furthermore, it is important to note that this analysis does not take into account the contribution of non-work related factors (i.e. an individuals' behavior during the sleep opportunity).

It is also important to be aware that this ranking process occurs within the constraints of current HOS regulations. There is no suggestion that the ranking process identifies unsafe working practices, but rather, those where employees have the least degree of sleep opportunity.

When an 'at risk' location has been identified it will be modeled using a second piece of software developed by UPRR [The Boardgame]. This software can then be used to analyze possible schedule data, identify hypothetical causes of the possible problems and then model the impact of various schedule changes or countermeasures on of any proposed solutions. The proposed solutions can be further studied using the FAID model.

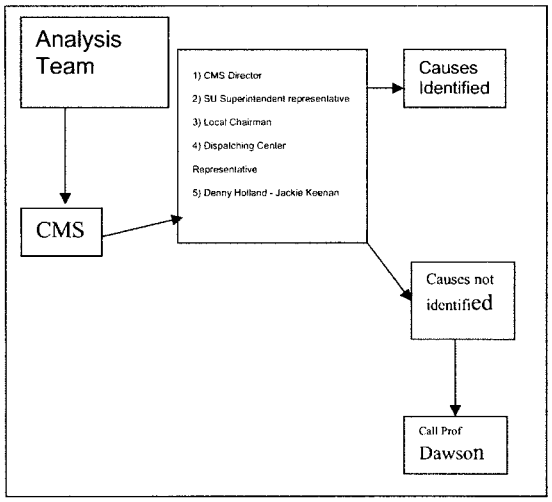
This software program (Boardgame) uses historical data on train movements to simulate the effect of different fatigue countermeasures strategies on average

Some common strategies that can be modeled include:

- varying the number of staff/turns on the pool,
- changing the number of staff/turns on the extra-board,
- altering minimum break times,
- introducing work-rest cycles,
- introducing fixed start windows, etc.

The crew-scheduling department in with safety, labor relations, and operations can use this tool to assist in identifying solutions that will be mutually acceptable and also have a high probability of reducing fatigue risk.

The software program ("Boardgame") is just one tool to be used in dealing with fatigue risk reduction efforts. The UPRR Crew Management staff has developed a flow chart and decision tool to be used when they identify a board or roster that may have a higher fatigue risk. The crew management staff has determined that they will bring together an analysis team consisting of various on-site experts. These individuals will consult the crew management data and then begin a step by step process of determining what might be contributing to the occurrence of a schedule that could lead to FAID scores occurring below threshold. The team gathers relevant information and discusses various possibilities. If the team is able to identify the relevant causes then they make a recommendation to crew management who in turn make recommendations to operations and personnel. If the team is unable to come to a conclusion then they will likely bring in outside experts.



Summary

The development of a scientifically based method for accurately assessing and quantifying the extent to which an employee might be at risk for operating equipment in a fatigued state has been undertaken by a number of different investigators around the world. The seven mathematical models that have received the most attention were studied together in a conference sponsored by the Department of Defense and the Department of Transportation in 2004. The results of the so-called modeling workshop have led to further research and development as well as attempts at model validation. The models are clearly in need of additional empirical validation and support. Nevertheless, the UPRR has taken the lead in applying one of the models to its work schedules and attempting to manage the fatigue risk associated with the schedule in a particular location. As has been mentioned before, the results of the analyses conducted by the UPRR demonstrates that fatigue risk affects a small portion of the entire railroad operation. Consequently, a prescriptive "one size fits all approach" is likely to do more harm than good.

The UPRR has broken new ground with the utilization of a sophisticated modeling tool as a key component of a risk based approach to the management of fatigue. This approach is consistent with current thinking regarding a risk-based approach to fatigue management and other safety issucs in the work place The establishment of a accountable process for assessing the existence of fatigue related risk and acting on the fatigue risk assessment data that they have collected is commendable. Initial efforts have also been underway to development an industry wide approach to utilization of this technology.

Chapter 5. Scheduling Efforts

The use of work schedules is another way that the railroad industry has attempted to address the effects of fatigue on the railroad industry. These efforts are designed to stabilize schedules to enable employees to have the maximum amount of time available to work and the maximum amount of time to be able to obtain rest at the a desired location.

Typically, in the freight railroad industry a person is required to be available for work on an as needed or on call basis. The employee is usually able to bid onto a particular work assignment that will operate from a home to an away terminal. The individual signs up for a work assignment, typically called a pool assignment. In a pool assignment the individual is assigned a train on a first in first out basis. As trains arrive at a terminal a crew is assigned to the train and expected to report for duty to operate a particular train to a particular destination. Most of the pools operate on a continuous basis, and in large terminals trains are typically called every 30-60 minutes. This is due primarily to the operational constraints of the physical facilities of the yard etc.

Given that crews are called on a 24-hour basis, start times and end times for duty periods vary considerably over the course of a 24-hour seven day a week period. In other words, generally speaking, for freight pools in most parts of the country, there will be no consistent work schedule for the individual. These types of continuous operations then will necessitate that an individual will likely have a work schedule that will be variable. Railroads have typically dealt with this aspect of the work by ensuring that sufficient time off between trips exists for people to be able to obtain needed rest to recover from work assignments and to then be able to successfully return to work.

In the most extreme cases a person might experience the minimum least 8 hours off between work assignments, as required by law. This means that the person will have at least 8 hours between the time that they are relieved of duty and "tie-up" at the terminal and then return to active duty at the terminal for the next shift. However, this 8-hour rest period could include the typical 2-hour call prior to the next assignment and other activities such as travel between the work location and home or lodging, when away from home.

In most cases however, individual employees have a longtime period between work shifts or trips. For example, data provided by the Canadian Pacific Railway indicates that the average length of time on duty is about 9.93 hours.

By agreement several different situations have occurred. For example, in many locations a person who has worked more than 10 hours is eligible for additional time off duty if they wish. If an employee has worked almost 12 hours then they are entitled to more time off. Under current law, a train employee must have at least eight consecutive hours off duty following the completion of a work period and during the prior 24 hours before the employee may go on duty. An employee who has been on duty for more than

12 consecutive hours may not return for duty until that employee has had at least 10 consecutive hours off duty.

The following Figure 9 demonstrates the various scenarios that are possible. The table shows that if the individual has worked a specified number of hours then they are entitled to a certain amount of time off.

Time On Duty	Time Off – Undisturbed
Less than 12 hours	8 hours
> 12 hours	10 hours off

Figure 9. Hours of Duty and Time Off.

In practice, individual railroad companies have adopted a variety of approaches that deal with the amount of time off that a person has had. Recently, the Union Pacific Railroad adopted a 10 hrs undisturbed rest policy for all road work assignments. Coupled with the calling times this means crews have at least 11 and one-half or 12 hours off between assignments. This appears to acknowledge the need for longer rest periods. However, it should also be noted that the length of time off between trips is often much longer than 8, 10 or even 12 hours. In some locations the time off between trips can be at least 24-36 hours. This is due to the fact that the employees are working in locations that have large distances between terminals and crews can accumulate their requisite monthly mileages in fewer trips. So, they are able to work the maximum and obtain a decent income with decent time off. In other locations, the distance of a run is short and thus individuals must work more trips in order to be able to obtain a good salary for their lifestyle.

The other issue that occurs in the railroad work environment is the number of days off between trips. The period is not predictable in many locations where there is no specific assigned amount of time (beyond the minimum). In other words, no days off. While much of the general population has a work schedule of five days on and two days off, the freight railroad industry has not adopted this type of work-rest schedule. The reasons are many and include the unpredictable nature of traffic as discussed earlier as well as the structures of labor agreements that have evolved over time. This means that there are no regular weekends.

The amount of time off that is available to individuals is a matter of contractual agreement. Labor organizations and their management counterparts have developed agreements that do not include scheduled days off. This ensures that individuals will be able to work a maximum amount of time and generate the maximum amount of earnings for their efforts. Unfortunately, this comes at a price for leisure time.

Scheduling crew starts and time off is one way of managing fatigue. Over the past decade a number of different approaches have been tired. Starting with the CANALERT project and later the BNSF Spokane Project, significant efforts were made to develop work rest schedules that would minimize the risk of fatigue. These scheduling efforts were investigated thoroughly and evidence was reported in earlier versions of this

monograph. However, due to the importance of these projects in demonstrating the effectiveness of the scheduling approaches in minimizing fatigue and improving alertness they are summarized here again.

CANALERT

Through the combined efforts of Canadian National, Canadian Pacific and VIA Rail, in conjunction with The Brotherhood of Locomotive Engineers a task force was formed and Circadian Technologies[12] was hired to provide assistance to address fatigue issues and charged the various railroads to develop policies and procedures to deal with the crew rest and fatigue problems. As a result a pilot project in Calgary and Jasper was initiated in 1995 called CANALERT. The following are the major components of the project.

Timepools

Effective April 27, 1997 the East (Brooks) and West (Laggan) districts began assigning crews within time pools that represented three specific time windows of operation. Please note that the agreements for Engineers and Conductors are almost identical. Employees who bid into these pools were required to specify their preferred Timepool within the specific pool and assignments were made according to seniority. Within each timepool crew assignments were made on a first out basis. To provide some flexibility, each timepool overlapped the next one by an hour. During this overlap period crews could continue to be called from the prior timepool until it was exhausted. Crews would then be called from the next timepool during the overlap period.

Pool	Overlap	Duty Period	Total Duty Cycle	
Lark	0500 –0600	0600 – 1500	1 hr + 9 hr	10 hr Window
Owl	1400 – 1501	1501 – 2359	1 hr + 9 hr	10 hr Window
Cat	2300 – 0001	0001 – 0559	1 hr + 6 hr	7 hr Window

Figure 10. Canalert Time Pool Duty cycle

The timepools were designed to minimize the likelihood that a person would be working in a time period that interrupts their natural circadian rhythm. Included in the scheduling process was the concept of a Protected Zone, the time within a timepool when, according to a person's circadian clock, they would be most likely to fall asleep (and also the time when a person would most likely be sleeping and therefore, the most likely time for a person to receive recuperative sleep.) To prevent and protect employees from being on duty at a time during which they would usually be sleeping, employees who have not had at least 3 hours of Circadian Rest (rest during their Recuperative period) were scheduled to complete their trip prior to the time of the Protected Zone. The

[12] Dr. Martin Moore-Ede was a key member of the planning team for CTI in collaboration with Transport Canada..

Protected Zone is that time that was established as being the most likely recuperative period for the employee. The recuperative zones for the various pools were as follows:

	Overlap	Duty	Recuperative Zone	Protected Zone	Special
Lark	0500 – 0600	0600 –1500	1700 –0900	0300 – 0700	0100 – 0300
Owl	1400 –1501	1501 – 2359	2000 – 1200	0700 – 1100	0400 – 0700
Cat	2300 – 0001	0001 – 0559	0800 – 2100	1800 – 2200	0400 – 0800

Figure 11. Protected Time Zones

In addition to establishing these recuperative zones and protected zones, labor and management agreed that the normal running times of certain classes of trains (expedited vs. general freight) should be considered when calling a person for duty. For example, an employee in the Lark Time Pool at their away from home terminal is called at 2130 hours to handle a lower speed train. Under normal circumstances the employee might wish to accept to call in order to get home promptly. However, the CANALERT '97 agreement precludes the employee accepting the assignment, as the person would require at least 6 hours to complete the trip as this would cause the employee to be on duty during the Protected Zone.

CANALERT '97 -Off Duty to Order Requirement

All Other Trains	400 Series Trains	Combination DH Service
Larks	Larks	Larks
0500 – 2100 1.5 hr call 0030 – 0659 Max 1.5 hr call Plus 3 hrs rest 2330 – 0659 Min of 30 min call plus 3 hrs rest 0700 – 1.5 hr call	0500 – 2200 1.5 hr call 0030 – 0659 Max 1.5 hr call Plus 3 hrs rest 2330 – 0659 Min of 30 min call plus 3 hrs rest 0700 – 1.5 hr call	0500 – 2300 1.5 hr call 0030 – 0659 Max 1.5 hr call Plus 3 hrs rest 2330 – 0659 Min of 30 min call plus 3 hrs rest 0700 – 1.5 hr call

Figure 12. Time Zone Service Periods

Minimum hours of rest rules were also established. The existing provision of 10 hours rest plus call was changed to a mandatory six hours of rest plus call at the home terminal.

Improved Rest Facilities Existing bunkhouses had been stationed next to the train yards. The bunkhouses at the Blue River, B.C. bunkhouse were given specific improvements including added soundproofing to interior walls, blackout curtains, and white-noise generators to mask disruptive noises.

Enroute Napping Policy An innovative napping policy was established at this time. Whenever a train arrived at a siding where a delay was expected, the engineer could notify rail traffic control and request a 20-minute opportunity nap. Engineers were provided with mattresses and blindfolds to aid in "napping." If the engineer was continuing to operate during a timepool's protected zone, a negotiated nap was permitted.

Terminal Napping Facilities Rest facilities with comfortable chairs in a quiet location were established in the Calgary and Jasper terminals. These were available for engineers to rest as they waited for their trains or for recuperative rest at the end of a trip prior to driving home.

Locomotive Cab Audio System Just as motorists listen to the radio to increase alertness, it was felt that special headsets might reduce fatigue by decreasing noise, improving communication and by providing stimulating music. Music was provided through a cassette tape (automatically preempted by the locomotive's communication radio.)

Lifestyle Training and Individual Counseling A four-hour training program called "Managing a Road Lifestyle" was developed for employees and their families.

Evidence

Volunteers were recruited to participate in the study. To volunteer for the project an engineer simply bid the chosen subdivision for a 6-month commitment. Of the forty engineers who volunteered, 16 were assigned to the "lark" pool", and 12 each to the "cat" and "owl" pools.

Volunteers agreed to keep a daily sleep log and to be wired to a portable EEG for three randomly selected round trips during baseline and post-testing.

A separate set of 10 volunteers were also recruited in the Montreal area as part of the VIA Rail project.

Time Pools.

Time pools were popular with 80% of the volunteers indicating that they were reasonably or extremely effective at increasing alertness and decreasing fatigue. Approximately 85% reported that they found that the time pools improved their family and social life.

Spokane Time Pool Project

A project was initiated in April 1997 on the BNSF Railroad that was designed to give employees the opportunity to start work at fixed pre-determined time windows. (Sherry, 2003) These Time Windows were available by bid primarily to members of the Pasco Pool and enabled the employee not only to protect only the time period specified but also to have specified assigned days off. In addition, the extra board was also given an opportunity to work an 8-3 format (work 8 days and then have three (3) assigned days off.) Individual engineers and conductors participated in this project for a period of 90

days. After the completion of the initial 90 days the union members voted to extend the agreement another 30 days however, the project was eventually cancelled by mutual agreement of labor and management

A variety of measures were employed to assist in evaluating the effectiveness of the project. The majority of the findings indicated an overall positive effect for the project. For example, significant differences pre and post for the Time Widows sample were found for the Stanford Sleepiness Scale –LW ($F(1,34)=7.501$, $p<.010$), and Hours of Sleep in the Last 24 hours ($F(1,36)=5.472$, $p<.025$).

There were significant improvements in measures of fatigue. For example, at post testing respondents described themselves as less fatigued, less sleepy over the prior week's trips, and as getting more sleep in the last 24 hours. No differences were found on number of naps or average daily hours of sleep in the last 72 hours or week.

Comparing the Time Windows participants with those on the Extra board significantly lower levels of sleepiness were found for the Time Widows participants on the Stanford Sleepiness Scale –LT ($F(1,32)=3.798$, $p<.032$), and the overall rating of Improved Fatigue Levels ($F(1, 32)=4.335$, $p<.021$). No differences on the other scales were noted.

After the experimental phase it was decided that a comparison between employee fatigue levels before the project began and thirty (30) days after its completion would enable a more accurate comparison between employees. This would allow a comparison of the employee's ratings of fatigue when they were under a countermeasures program and when there were no countermeasures in place.

In order to achieve this comparison an additional survey was administered to employees in the Pasco Pool and the Extra board thirty days following the completion of the TWP. These results were then compared with those obtained at the end of the TWP project alone.

There were a number of significant differences between employee's ratings at the end of the TWP and thirty days following its completion. Most interesting was that employees reports of amount of sleep obtained in the last 24 and 72 hours was significantly different ($p<.05$) with the extra board reporting 8.47 hours and the Pasco Pool reporting only 7.34. Further, for the Stanford Sleepiness Scale – LW there in a non-significant trend suggesting that the Pasco Pool was slightly sleepier than the Extra board.

Interestingly, there was also an increase in the number of countermeasures used reported by the members of the Extra board. For example, the Extra board reported using slightly more stretching than the Pasco Pool ($p<.052$) and slightly more Relaxation techniques to help sleep off duty ($p<.042$).

In terms of satisfaction, the Extra board appeared to be more satisfied with their jobs and with the BNSF than the Pasco Pool employees. This suggests that the Time

Windows Project participants did in fact feel that they lost something. At the end of the follow-up period the members of the Pasco Pool without the TWP were working more hours, getting less sleep, and feeling more fatigued than they were during the TWP. A graphic display of sleepiness levels as measured by the Stanford Sleepiness scale measured is displayed in Figure 12. Similarly, hours of sleep at pre, post, and follow-up is also displayed in Figure 13.

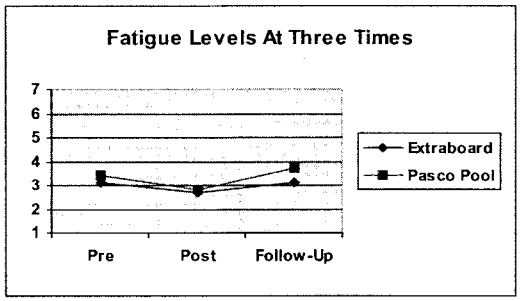


Figure 13. Fatigue Levels at Pre – Post and Follow-Up

In addition to measuring fatigue levels, hours of sleep also changed over the course of the project. During the TWP hours of sleep was greatest for both the TWP and the Extra board. However, thirty days after the cessation of the project hours of sleep had decreased and almost returned to pre project levels.

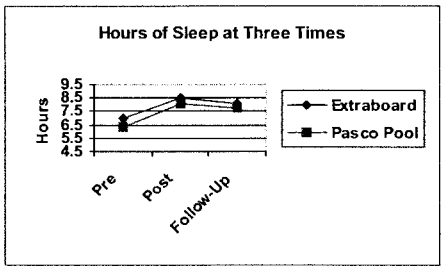


Figure 14. Hours of Sleep at Pre Post and Follow-up (Sherry, 2003).

Fatigue levels for study participants in comparison to the control group are shown in Figure 14. These results indicate that during the period of the study fatigue levels improved in comparison to those of a similar location on the BNSF system. The data show that the two locations were not significantly different in fatigue levels, as measured by the Stanford Sleepiness Scale, at the beginning of the study and at the follow-up. However, there were significant differences (* indicates P<.05) between the two

locations at the end of the experimental period (post). In other words, when the scheduling arrangements returned to their pre-experimental condition (at the three month three-month follow-up) the fatigue levels also returned to the pretest levels. Thus, the fatigue countermeasures employed produced the desired results by reducing fatigue at the Spokane location.

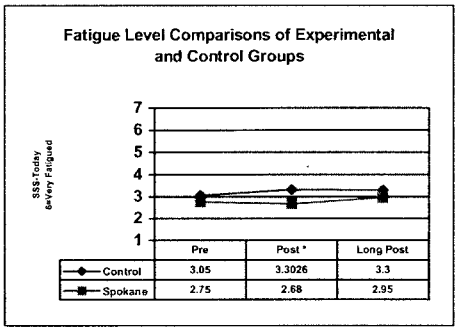


Figure 15. Comparison of Fatigue between TWP and Control (Sherry, 2003).

Comments

This was the first example of a project that included all employees, pool crews and extra board, working between two points. It was also the first example of a Time Windows project that uses Time Windows to control the start time variability. The Buffalo-Toledo project on Conrail had a 10-hour window, which can still lead to persons having a disruption of the circadian cycle. In this project participants knew exactly when they were going to work, regardless of train arrival or departure times. In addition, having assigned days off allowed participants the opportunity to recoup sleep debts. Finally, the inclusion of the napping policy makes this program one of the most comprehensive and thorough implemented to date.

Two criticisms have been leveled at the Spokane Time Windows project. First, time away from home was not controlled in this project. Unfortunately, for persons in this pool it is not uncommon to have long time away periods (in excess of 14 hours). Thus, the satisfaction with the program suffered because of this. A second criticism was that the program costs were too high. This was due in part to the fact that participants were guaranteed a wage consistent with their previous year's performance during the same time period. Unfortunately, there was a 14% reduction in traffic during this time period as compared to the previous year resulting in lowered revenue for the subdivision.

BNSF began a large number of fatigue countermeasure initiatives underway that involve scheduling, napping, and education. The Time Windows Project was noteworthy in its attempt to address start time variability, hours of rest, and assigned days off. The improvement in assigned days off resulted in employees having a greater likelihood of recouping any sleep debts they may have incurred.

UPRR San Antonio

Sherry (2005) conducted a study, sponsored by the FRA and the UPRR, on the work schedules of UPRR employees in the San Antonio area was sponsored by the FRA. This study was conducted with Union Pacific Railroad Train and Engine employees reporting for duty to the San Antonio Kirby Yard from November 3rd through November 8th 2004. During that time, questionnaire assessment of 283 Train and Engine employees occurred (out of a possible 356 who reported for duty), yielding a response rate of 79.5%. The sample consisted of 137 Engineers and 128 Conductors, 18 did not indicate their craft. In addition, in consultation with labor and management, a total of 40 Engineers and Conductors were identified from several Pools and Extraboards to wear Actigraphs during a 30 day period.

Results of the Epworth Sleepiness Scale (Johns, 1991), a self-report measure of sleepiness, indicated that a substantial portion of the respondents scored in the high to very high range for sleepiness (50.5%), while 49.5% of respondents scored in the normal range. Scores on this instrument were significantly higher than scores obtained by two other, previously studied, railroad locations.

POOLS[13]	N	Mean	Std. Deviation
Laredo-Eng (RE35)	5	6.9520	1.40981
Houston-Eng (RE42)	2	7.1850	.71418
Hearn-Eng (RE46)	1	3.7100	.
DelRio-Cond (RT30)	1	7.0300	.
Laredo-Cond (RT32)	3	6.1600	1.05702
Houston-Cond (RT41)	2	6.5450	1.74655
Hearn-Cond (RT45)	1	5.4900	.
EXTRABOARDS[14]			
Engineer-EB (XE40)	4	7.0825	.59673
Engineer-EB (XE-30)	4	7.3975	2.08031
Conductor-EB (XT30)	5	5.4483	.83741
Conductor-EB (XT40)	2	5.0950	1.18087
Total	30	6.4094	1.40447

Figure 16. Average amount of sleep for pools and extraboards.

Actigraph measurements were obtained for 30 study participants, and are summarized in Figures 15 and 16. Measurements for individuals on the results of the actigraph assessment indicate that the average amount of sleep per 24 hour period for the entire

[13] Note: The terms in the table refer to engineer and conductor pools and extraboards. For example, Houston-ENG is the designation for the Houston locomotive engineer freight pool. Similarly, the DelRio-Cond (RT30) refers tot ch Conductor's freight pool and its corresponding identification number.

[14] Note: Engineer-EB (XE40)refers to one of two Engineer extraboards and its corresponding identification number. Similarly, Conductor-EB (XT40) refers to the Conductors Extraboard.

duration of the study, was 6.40 (±1.40) ranging from a low of 3.71 average hours of sleep to a high of 10.02. This is consistent with other published statistics such as those reported in the 2002 "Sleep in America Poll" shift workers average 6.5 hours of sleep in a 24-hour work day period (NSF, 2002).

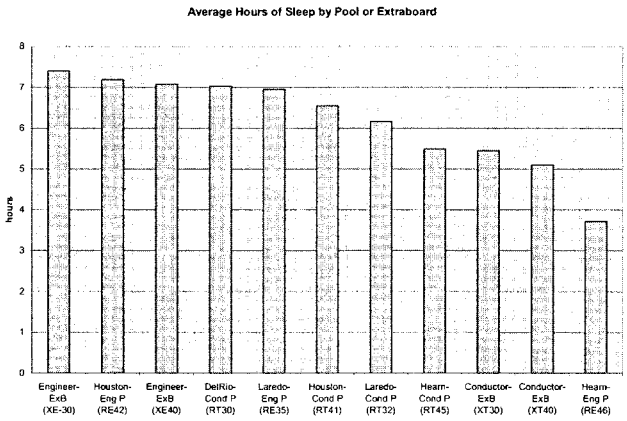


Figure 17. Average hours of sleep for selected pools and extraboards.

Figure 16 represents the results of the actigraph analysis of the work schedules for railroad employees in the San Antonio Kirby Yard area. As can be seen most of the work groups receive on the average, 6 hours of sleep or more. The conductor extraboards in this study appeared to have the lowest average amount of sleep. Thus, eight out of eleven work groups were found to obtain amounts of sleep about equal to or less than shift workers in other industries (NSF, 2002).

There are several conclusions that can be drawn from these findings. On the average, employees working railroad work schedules are able to obtain about the same amount of sleep as US shift workers in general. There are some schedules for which railroad employees are able to obtain more sleep that average US shift workers and some for which they receive less. These results suggest that not all work schedules in the railroad industry are problematic. In fact, many work schedules provide more opportunities to obtain rest than that obtained by typical shift workers. The results obtained appear to be the result of a number of factors including local agreements, traffic patterns, and workforce availability.

Coal Fields

The situation with respect to the average length of time on duty appears to be about the same since the previous reports were filed (GAO, 1992, 1993). Data was obtained from the AAR for 150 employees that worked over a 10 month period in the Wyoming-Nebraska coal fields. As can be seen from Figure 9 there is a range of hours worked peaking at 12 hours. The average length of time that railroad operating employees are on duty ranges from less than 1 hour to 12 hours. Railroad employees of course are required by law to go off duty after the hours of service expire. The data indicate that the average

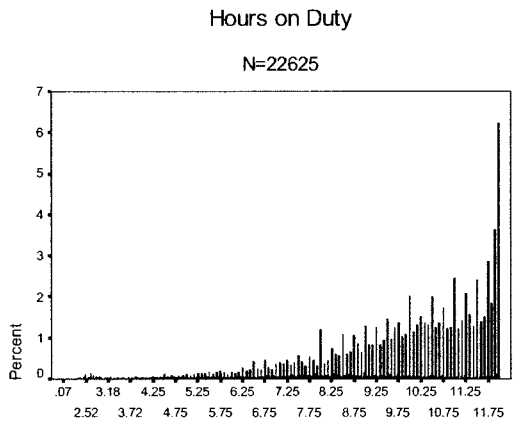


Figure 18. Hours off Duty Prior to a trip and Hours on Duty.

	Time Off Duty	Time on Duty
# Trip Starts	11143	22625
Mean	25.1636	9.6091
Median	15.5000	10.0800
Mode	8.00	12.00
Std. Deviation	17.97512	2.09523
Minimum	8.00	.07
Maximum	72.92	12.00

Figure 19. Statistics for Coal Fields

Amount of time on duty for this sample of employees was 9.6 hours with a median of 10.08 and a standard deviation of 2.1. Just under 50% of the sample works 10

hours or less with an equal number working between 10 and 12 hours. This standard deviation indicates that employees worked 9.6+- 2.1 about 66% of the time. In fact, examining the distribution of shift lengths we can see that a little more than half of the sample worked less than 10 hours.

Hours off between trips averaged 25.07+-17.92 with a minimum of 8 and a maximum of 72. The data show that 75.9% of the sample received 12 hours or more time off before beginning a trip. To prevent skewing the data, time off that most likely included vacations (time off exceeding 73 hours) was excluded from the analysis. The distribution of the data is bi-modal reflecting the fact that a substantial portion of the sample receives nearly 48 hours or two days off between trips.

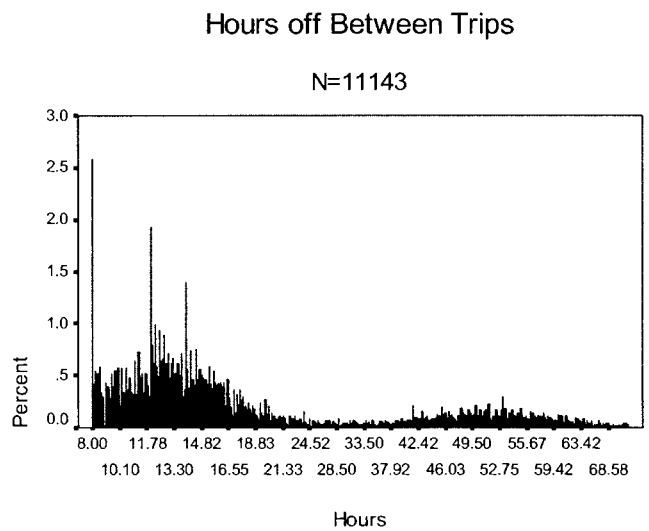


Figure 20. Hours off between trips.

While this data is limited to a particular region of the country and one major Class I railroad it does reflect the practices on one major railroad and the fact that this area operates effectively with such a work schedule. While accident statistics by individual were not available, the data reflect the prevailing approach that railroads are using to address the demands of the work schedules on employees. This is providing time off between trips for rest and sleep.

Overlays - BNSF

Some of the railroad carriers have developed a set of countermeasures that offer railroad employees predetermined voluntary opportunities to take time off. The BNSF has developed a voluntary system known as an "overlay." Under this system, a person will agree to be available for work 7 consecutive days followed by three days off. BNSF reports that as many as 100+ locations have adopted the overlay system. An important component of this approach is reducing unexpected vacancies by providing an incentive for employees to remain available for work during their assignment periods. The provisions usually include a penalty for laying off during this time period. Employees are not paid curing their assigned times off but their overall earnings are about the same as they would have been under the traditional "first in first out" approach.

A possible concern is that employees may choose to voluntarily continue working during their "off" period. This means that an individual will be able to work "as much as they want" and if they choose they can work additional extra hours or trips to maximize their income. While this is good from a productivity standpoint (and may have made the program more acceptable to employees) it does mean that individuals may not fully utilize their recovery periods to rest and prepare for additional work assignments.

While we have not studied any of the locations that have implemented an overlay policy, the concept shows considerable promise. From a fatigue perspective, it mirrors the common knowledge that at least two nights off between trips are needed to be able to fully recover from the effects of sleep deprivation. For all practical purposes the overlay seems like a good arrangement. There is time off to recover from extended work shifts, there is time off to address family and leisure time.

Scheduled Railroad - NS

Many of the carriers believe that the ultimate solution to addressing fatigue on the railroad has to do with the development of a so-called scheduled railroad. In this scenario, the various railroads are designed to operate trains at specific times. There are varying degrees of what this means. For example, a scheduled assignment might be developed to deal with mining operations. Here, a crew would likely report to work at a specific time work a specific number of hours and then return to their terminal. Other similar circumstances include yard jobs, industry switch jobs or work trains. All of these assignments have a specific start time and ends time typically associated with their activity. These types of jobs begin to approach the traditional industry shift schedule and are more manageable and have less serious impact on fatigue issues.

The Norfolk Southern railroad has indicated that it has approximately 85% of its employees on "scheduled" assignments. This means that the employees are scheduled to "show-up" at a specific time. In addition, along with these assignments the majority of individuals also have a minimum 10 hours of undisturbed rest after a duty period. This approach was agreed to by labor and management under a verbal agreement entered in to in 1997. This approach is very beneficial in that it provides a both predictability and

opportunity for recovery. The CSX has also been moving in the direction of becoming a scheduled railroad.

Mid-route switching – CN

CN central has developed an approach to managing crew fatigue that is unique in the railroad industry. Currently, crews that work on the CN are able to return to their home terminal at the end of a work shift because of the fact that crews switch trains midway between the home and away-from-home terminal. The train crews then return to their home terminal on a train traveling in the opposite direction that they began. Such a scenario is effective in that it improves quality of life and likely also improves sleep quality due to the fact that employees are able to sleep in their own home.

At this point approximately 65% of the workforce is covered by this type of a work schedule.

CSX

Several railroads have adopted what is called the "assigned time off" approach. Under this approach employees are scheduled to have a specific day off. For instance, at CSX, the employees have been given a specified two days off after every 8 days on duty. This means that a person knows well in advance what their days off will be and can plan accordingly.

The assigned days off does not address the issues with respect to the circadian issues. In other words, persons who are on these schedules are working variable starts and end times and have little ability to know when or how long they might be on duty. However, assigned days off does present an important improvement by allowing a regular predictable period for recovery sleep.

Union Pacific Railroad

As discussed in Chapter 4, UPRR has utilized software designed to evaluate a particular work schedule and estimate the overall level of fatigue that might be associated with the particular schedule. Then, by providing the feedback and information to the railroad employees who would be working such a schedule railroad employees are able to evaluate the extent to which this schedule would be likely to result in fatigue or not.

In several locations on the UPRR system railroad employees have been provided with the software necessary to evaluate various work schedules. The existing work schedules are entered into the software and then evaluated by the software. Next, the railroad employees are asked to consider alternative work schedules. In the program that the UPRR has developed the railroad employees are asked to consider whether or not they would like to utilize a particular work schedule. Following the evaluation of the

schedule from both a fatigue perspective and other lifestyle and financial perspectives the local work force is able to decide if a new schedule should be adopted.

Several locations have utilized this approach to evaluate their work schedules from a fatigue standpoint. The software is made available to the workforce upon request. The approach can then be used effectively by both management and labor in evaluating proposed changes to work schedules. In addition, the FADE model has been applied to entire systems and focused on how the entire UPRR system is able to be evaluated using the software.

This approach has considerable promise in that it utilizes a scientifically validated model to address the specific work schedules that employees utilize. In addition, due to the fact that temporary employees are able to utilize the data from the work schedules to address potential changes they can anticipate and investigate changes that might be made from a fatigue standpoint beforehand.

A further advantage of this approach is that it utilizes a fatigue model to address the likely effects of work schedule changes and is then capable of utilizing and

The model was evaluated along with a number of other models at the Seattle Modeling Workshop (Van Dongen et al., 2004). The FADE Model faired about as well as any of the models that were presented.

UPRR North Platte/Marysville Scheduling Project

UPRR has initiated a pilot scheduling project that utilizes scheduled start times. This agreement between the UPRR and the BLE-T is a very unique effort to manage fatigue, provide predictability and improve quality of life.

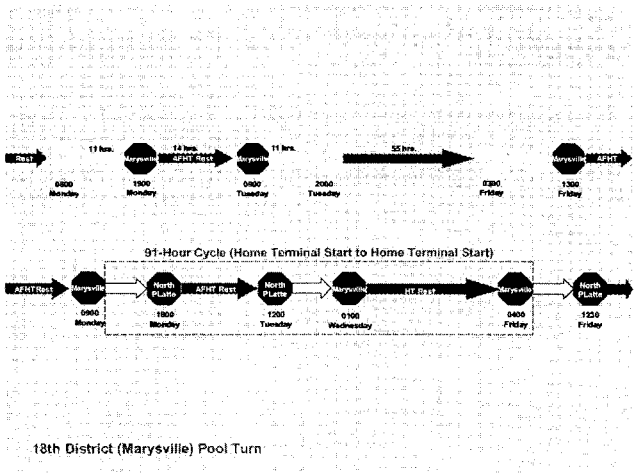


Figure 21. UPRR Scheduled Start Time Freight Pool.

The project began as an "employee engagement" process that allowed employees and local management to develop schedules that considered both employee needs and organizational operating requirements. The initial efforts were supported by software developed in Australia (FAID & "Boardgame") that offered local employees and managers the opportunity to develop and test potential solutions based on retrospective data.

The scheduling team developed a structured scheduling program that built on the traditional rhythm of the work pools. For example, it was determined that a properly functioning pool rotated (employee called from the home terminal) approximately every 91 hours. Therefore, as a solution, it was fixed that employees would report at the home terminal for duty every 91 hours.

This eliminated the need for calling at the respective home terminals, created predictable schedules and rest periods and ultimately reduced unscheduled absences. Attached is a schematic drawing depicting the basic operation of the North Platte/Marysville project. The employees have been very positive about this program. Crew resources management has also been very supportive as well.

Chapter 6. Technological Countermeasures

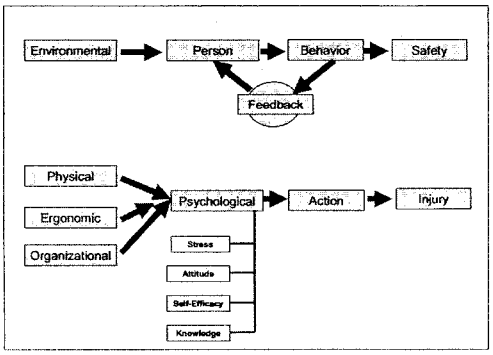
During the past few years there have been several attempts to investigate the effectiveness of some technological countermeasures as a means of assisting railroad employees to deal more effectively with fatigue. These efforts have been evident in the study of the effects of performance actigraphs on the sleep and rest schedules of railroad employees.

One of the first studies involving actigraphs was reported by Sherry (2004). Actigraphs were used to obtain readings on the extent to which the employees at a particular location were obtaining the required rest. Next, the information was fed back to the employees that they were able to utilize these data to make decisions.

Galesburg-BNSF

This project was designed to obtain individual participation in the monitoring of fatigue through the use of individual fatigue monitors (Sherry, 2004). Research has suggested that a combination of factors work together to affect performance. To understand which factors have the ability to alter behavior, further study of performance feedback was needed. The goal of this study then was to determine whether individual feedback devices, such as actigraphs (which are essentially motion detectors that are able to keep track of the amount of body movement that occurs), could be useful for helping railroad employees better plan their sleep and wake activity.

Figure 22. Factors affecting safety.



As can be seen from the Figure 22 Sherry (1992) argued that the effects of person and organizational behavior on the behaviors that lead to safe work performance are significant. However, there are several other factors that in turn influence behavior. Behavior is influenced by the effects of antecedents, consequences, and actions that precede a specific behavior and is paramount to understanding and eventually controlling the behavior that is deemed to be risky or even unsafe. Thus, the person is influenced by feedback from the environment and the consequences of their behavior. Again, Sherry, using a behavioral approach to safety, attempted to identify the antecedents (A), behaviors (B), and the consequences (C) of those behaviors. This ABC

approach to understanding the effect of feedback on work performance was useful in changing the behavior of the employees of a railroad car repair facility.

Several investigators have continued to elaborate on the behavioral based models. Krause, Hidley and Hodson (1990) promoted the idea that a safety focused corporate environment needed to be created so as to sustain the behaviors that needed to be changed. Knipling and Olsgard (2000) identified a cluster of 16 behaviors common to drivers history of vehicle-related accidents and injuries. Geller (1998) evaluated *behavior*-based feedback interventions (BBIs) designed to increase the safe-driving practices of nineteen 44 year-old pizza deliverers. He focused on goal-setting and feedback techniques, including: (a) non-numerical goals in an awareness and promise card intervention; (b) non-numerical goals mandated as company policy; (c) participative and assigned group goal setting and feedback; (d) group goal setting and feedback with added public individualized feedback; (e) individualized feedback and competition; and (f) private individualized feedback paired with dynamic, static, or dynamic and static goals.

Measuring fatigue in the workplace is a complex process. It is common to use both subjective and objective measures of fatigue and alertness to evaluate the impact of a countermeasure, as multiple measures allow the investigator to triangulate the truth and produce a more convincing conclusion. There are four kinds of measures that are typically used in measuring fatigue; physiological, behavioral, subjective self-report and performance measures.

The current project was designed to obtain individual participation in the monitoring of fatigue through the use of individual fatigue monitors. The goal of this study was to determine whether individual feedback devices, such as actigraphs, could be useful for helping railroad employees better plan their sleep and wake activity. Project participation consisted of the completion of a consent-form, several survey questionnaires, a daily sleep log, and wearing an actigraph, which measured sleep and work during the course of the project.

A total of 29 individuals originally agreed to wear an actigraph sleep watch, 24 hours a day, for two consecutive thirty-day periods. Actigraphs are devices that detect motion. They are able to keep track of the amount of body movement that occurs. They are mechanical and do not harm the individual wearing them. They do not keep track of pulse or electrical activity. They must be worn continuously but should be taken off for showering or bathing or vigorous exercise. Various studies over the years have demonstrated a very strong relationship between body movement and sleep.

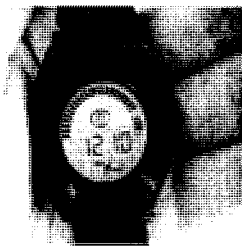


Figure 23. Image of an actigraph.

In addition to wearing the sleep watch, participants were asked to complete a daily sleep log that cataloged their activities for each of the thirty days. This was a simple task, whereby a participant would account for their actions according to a legend

(e.g., "s" = sleep/ "w" = work/ etc.). Age of survey respondents ranged from 22 to 65 years, with a mean of 41 years of age. The average number of years of education reported was 13.29, indicating that the average Galesburg survey respondent had a high school degree as well as one additional year of post high school education. Number of years as a railroad employee ranged from 1 to 46, with the average tenure as an employee being 13.97 years. Eight, or 28%, of these 29 participants discontinued participation in the study during the first month. Thus, a total of 21 participants completed this study in its entirety.

During the first month of the study all participants wore the same type of non-performance actigraph to gather baseline activity data on each participant. At the end of the first thirty-day period Time 1 sleep logs were collected, the Time 2 survey was administered, and the battery in each actigraph was changed to ensure continual motion recording. During the second meeting with each participant the performance monitoring actigraphs were randomly distributed to half of the sample. A total of ten participants received the performance watches and eleven participants received the non-performance watches. Each of the individual's who received the performance watch were given instruction on how to interpret the performance reading as well as instruction on various fatigue countermeasures. For example, if an individual saw that his or her performance reading was in the 70's and knew that he or she was likely to be called to work in the evening, the merit of napping instead of completing domestic chores was discussed and emphasized. Finally, approximately two weeks after the performance watches were distributed, a researcher called each individual to inquire about how the watch was working and to address any questions and/or concerns that were presented.

At the end of the first month of the study, each participant received a $25.00 gift certificate to a local restaurant. Similarly, at the end of the second month each participant received an additional $25.00 gift certificate, for a combined total of $50.00 for wearing an actigraph for two months.

The assessment instruments that were administered at each phase consisted of a survey that included a number of questionnaires: Stanford Sleepiness Scale; Epworth Sleepiness Scale; Denver Job Satisfaction Scale; Denver Fatigue Adjective Checklist; Denver Sleepiness Scale; Denver Depression Scale; Denver Anxiety Scale; Denver Stress Scale; Denver Quality of Life Scale; Shift Work Index – Exhaustion; Shift Work Index – Depression; Shift Work Index - Quality of Life; Actigraph Monitoring; Sleep and Activity Logs. A complete description of these measures can be obtained from the authors. Detailed explanations of the methods are available in Sherry (2004).

To understand the effects of individualized actigraph feedback on fatigue management in railroad engineers, comparisons on the study measures were conducted between the performance feedback and the non-performance actigraph wearers. Results of repeated measures analysis of variance revealed that statistically significant differences in subjective levels of alertness were found between the participants wearing the performance feedback actigraphs and those who did not wear the devices. On the Shift

Work Index alertness measure a significant main effect over time was found for study participants (F (1, 5) = 7.912, p<.037).

Comparison of Feedback vs Non-Feedback Groups

		N	Mean	Std. Deviation	p<
Has Performance Reading on the Sleep Watch Helped You	Feedback	10	2.6000	1.0750	.679
	NoFeedback	8	2.3750	1.1877	
	Total	18	2.5000	1.0981	
Has Sleep Watch Helped You Manage Your Fatigue	Feedback	9	3.5556	1.6667	.038
	NoFeedback	7	1.7143	1.4960	
	Total	16	2.7500	1.8074	
Has Sleep Watch Helped You Monitor Your Fatigue	Feedback	9	4.4444	1.1304	.002
	NoFeedback	7	1.7143	1.7043	
	Total	16	3.2500	1.9494	
Recommend the Performance Sleep Watch	Feedback	10	3.9000	1.1972	.125
	NoFeedback	7	3.0000	1.0000	
	Total	17	3.5294	1.1789	
More Aware of Fatigue Due to Sleep Watch	Feedback	10	3.9000	1.2867	.019
	NoFeedback	8	2.2500	1.3887	
	Total	18	3.1667	1.5435	
Sleep Watch Use if Available at Low Cost	Feedback	10	2.9000	1.5239	.168
	NoFeedback	8	1.8750	1.4577	
	Total	18	2.4444	1.5424	
If Under $100 Would You Purchase Sleep Watch	Feedback	10	2.6000	1.5776	.332
	NoFeedback	8	1.8750	1.4577	
	Total	18	2.2778	1.5265	
If Improvements Were Made Would You Use Sleep Watch	Feedback	10	3.5000	1.2693	.146
	NoFeedback	8	2.5000	1.5119	
	Total	18	3.0556	1.4337	
Increased Naps Due to Performance Readings	Feedback	9	2.4444	1.9437	.225
	NoFeedback	6	1.3333	1.0328	
	Total	15	2.0000	1.6903	
More Prepared to Deal with Fatigue Because of Watch	Feedback	9	3.3333	2.0000	.121
	NoFeedback	6	1.6667	1.7512	
	Total	15	2.6667	2.0237	

Figure 24. Results of ANOVA on Feedback vs. Non-feedback groups.

For those engineers that wore the performance actigraph, the most robust finding indicated that the performance sleep watch helped those individuals monitor their fatigue levels (F(10, 18)= p<.038), and seven out of nine respondents indicated that the watch helped them to monitor their fatigue to a "Very Great Degree" – the highest rating available. Similar findings were also noted for whether the performance actigraph helped one "manage fatigue" as well as be "more aware of fatigue" in comparison to the non-feedback condition.

When the participants in the experimental group were asked to rate the degree to which they would recommend the performance sleep watch to others, the mean response was 3.90. Thus, 80% of participants would recommend the sleep watch to others to a "Considerable or Very Great Degree". This suggests that for these participants the performance readings were useful and could be helpful to other railroad employees.

Similarly, when asked to what degree the watch made the users more aware of their need for rest and sleep, the mean response was 3.90, thus indicating that the watch made them more aware of their need for rest/sleep to a "Considerable Degree". In fact, 70% of engineers in the experimental group indicated that the performance readings made them more aware of their fatigue levels to a "Considerable or Very Great Degree". Again, this suggests that for this group, the performance readings increased their awareness of the need for rest. Finally, approximately 56% of participants felt more prepared to "deal with fatigue" as a result of the performance readings on the actigraph.

Conclusion

Overall, study participants in the experimental group found the performance actigraph to be a useful tool for fatigue management. In addition, there were statistically significant improvements in subjective alertness for persons wearing the performance feedback actigraphs in comparison to those individuals who did not wear them. In general, participants wearing the performance actigraphs indicated that the watch helped participants in the experimental group monitor their fatigue levels. Small sample size is a limitation of this study. Interestingly, however, the trends were in the predicted direction suggesting that if the sample size had been large, a significant effect may have been detected.

These studies of performance actigraphs were designed to increase an individual's ability to control their own behavior by providing additional information regarding their sleep and activity patterns. Hopefully, by giving the individual greater information they would be able to improve their sleep hygiene behavior and ultimately improve their functioning and safety in the workplace.

Chapter 7. Sleep Disorders

As noted in Chapter 1 the FRA issued a safety advisory following the NTSB investigation of the Clarkson, MI accident. This advisory raised concerns regarding the need to identify those individuals possibly suffering from a sleep disorder such as sleep apnea. The FRA also called for the identification of best practices in the diagnosis and treatment of sleep disorders and related medical conditions and the need for treatment of those disorders as a precaution in the prevention of fatigue related accidents.

Sleep disorders, and sleep apnea in particular have been studied over the last thirty years as possible contributors to the occurrence of fatigue and consequently as a contributing factor to the occurrence of motor vehicle accidents.

As early as the late 80's researchers (George et al., 1987; Findley, 1988), according to Pakola, Dinges, & Pack (1995), identified the fact that persons suffering from sleep apnea were anywhere from two to seven times as likely to report an accident as controls. Phillip et al. (2005) noted that drivers that involved in traffic accidents had a higher rate of sleep disorders than controls. Patients admitted to hospital for emergency treatment following an accident were 6.5 times more likely report an accident if they were suffering from sleep apnea than not.

Teran-Santos, Jimenez-Gomez &v Cordero-Guevara (1999) found that patients with a high apnea-hypopnea ratio were 6.3 times more likely to be involved in a motor vehicle accident than those with a lower ratio. Howard et al. (2004) in a study of 2432 commercial truck drivers in Australia found that sleepiness as measured by the Epworth Sleepiness Scale (Johns, 1991) was associated with a greater risk of accidents.

Pack et al. (2006) studied 1391 individuals with commercial vehicle driver's licenses (CDL) living within a 50 mile radius of the University of Pennsylvania. Study participants completed a number subjective as well as cognitive performance measures including reaction time, lane changes, and symbol substitution. Results indicated that 17.6 percent of the CDL holders had mild sleep apnea, 5.8% had moderate and 4. 7 percent had severe sleep apnea. These prevalence rates are consistent with those of the general population. The study also showed that the occurrence of sleep apnea was significantly associated with both increased age and degree of obesity.

The importance of accurate diagnosis and treatment of Obstructive Sleep Apnea Syndrome (OSAS) was highlighted by Phillip et al.(2005) who reported that "more than 800,000 drivers were involved in OSAS-related motor vehicle collisions in the year 2000. These collisions cost approximately 15 billion dollars and 1400 lives in the year 2000. In the United States, treating all drivers suffering from OSAS with Continuous Positive Air Pressure treatment (CPAP) would cost 3.18 billion dollars, save 11.1 billion dollars in collision costs and also save 980 lives annually." (pg. 32)

The report by Pakola, Dinges, and Pack (1995) documented the existence of regulations and practices guiding the granting of drivers licenses in the US and several other countries including Canada, Australia, Sweden, and the Netherlands. The report noted that in the US the Federal Motor Carrier regulations specifically state that conditions that are likely to cause loss of consciousness or blackouts are considered sufficient for cancellation of or denial of a license to operate motor vehicles. At the time the report was written seven states were identified that had regulations or guidelines that specifically mentioned sleep apnea and narcolepsy as conditions that could be prohibitive of driving. The Federal Highway Administration produced a report in 1991 (FHWA, 1991) that specifically identified a number of pulmonary diseases that could lead to suspension or denial of drivers licenses.

The FRA recommendations were designed to promote the fitness of employees in safety-sensitive positions by doing the following:

1 Establishing training and educational programs designed to inform employees of the potential for performance impairment as a result of fatigue, sleep loss, and sleep deprivation.
2 Ensure that employees' medical examinations include assessment and screening for possible sleep disorders and other associated medical conditions and:
   a) Develop standardized screening tools
   b) Develop a good practices guide for the diagnosis and treatment of sleep disorders
   c) Develop an appropriate list of certified sleep disorder treatment centers.
3 Request that employees in safety-sensitive positions voluntarily report sleep disorders.
4 Develop policies that prohibit employees with sleep disorders from performing any safety-sensitive duties until properly treated.
5 Implement policies and procedures to:
   a) Promote self-reporting of sleep-related medical conditions by protecting the medical confidentiality of that information
   b) Encourage employees with diagnosed sleep disorders to participate in recommended evaluation and treatment; and
   c) Establish dispute resolution mechanisms that resolve current fitness of employees who have reported sleep-related medical conditions.

From a fatigue perspective, the NTSB recommendations and the subsequent FRA safety advisory have contributed to an increase in awareness on the part of the industry, the labor organizations and management of the importance of sleep disorder screening. The railroads have made a concerted effort to increase their efforts to educate the workforce and to screen and identify those persons with sleep disorders. The proper identification of sleep disorders has been seen as an important precautionary measure to prevent the occurrence of events similar to those that occurred at Clarkson.

As noted above (see page 18) a 1998 study of a sample of railroad employees also indicated that the prevalence of sleep disorders was about the same as that of the general population. A variety of sleep disorders have been identified. These disorders have been

found to affect fatigue, sleepiness and alertness in persons identified with these conditions.

Disturbances in sleep and wakefulness associated with working irregular hours are not considered biological or clinical disturbances of sleep. These pathological disturbances in sleep and wakefulness must meet various diagnostic criteria in order to qualify as clinical conditions.

There are several different types of sleep disturbance: insomnia, which refers to too little sleep; hypersomnia, which refers to too much sleep; and parasomnia, which refers to deviation from normal sleep patterns. Some authorities estimate that about one third of the population suffers from disturbed sleep (Bixler, Kales, Soldatos, Kales, & Healy, 1979; Liljenberg, Almquist, Hetta, Roos, Agren, 1988).

According to these specialists, in order to meet the criteria of chronically disturbed sleep a person must suffer some form of sleep disturbance at least every other day for a period of three weeks. These disturbances must involve either taking to much time to fall asleep (more than 45 minutes), repeated waking (more than 5 times per night), waking up too early (more than 60 minutes) or getting one and a half hours less than the required 8 hours of sleep. Moreover, any of these symptoms must also be accompanied by disturbances in performance or daytime functioning. Insomnia is present in about 5 to 6 percent population. In most cases insomnia is thought to be the result of learned psychological responses. Persons suffering from insomnia often report high levels of anxiety associated with worries, traumatic events, or prolonged stress from work or other sources. Depression is another common source of disturbed sleep. Depressed patients often report obtaining less sleep, have difficulty falling asleep, intermittent awakening, and early morning waking. Treatment usually involves some form of psychological intervention including cognitive restructuring and relaxation training.

Hypersomnia, the desire for more sleep, usually manifests itself as a difficulty in staying awake. Criteria for diagnosing this condition are a consistent inability to remain awake in typical everyday situations such as traveling as a passenger in a car, watching TV, listening to a lecture, or reading a newspaper. Common causes of hypersomnia that have received increased attention recently are snoring and sleep apnea which both have excessive sleepiness as associated symptoms. Approximately 30 percent of men and 20 percent of women experience snoring. Recent studies have demonstrated that snoring reduces both the quality and duration of sleep as a result of short periods of waking. Snoring has also been connected to the occurrence of high blood pressure. It is hypothesized that sleep apnea is the result of temporary blockage of the respiratory pathway due to excess fatty tissue in the throat or a relaxation muscles of the throat. When the person has difficulty breathing, a startle response occurs causing the person to momentarily wake up in order to restore breathing. Interestingly, the person is unaware of the recurrent awakening that occurs throughout the sleep period. Unfortunately, the repeated awakenings reduce deep sleep and REM sleep. REM sleep (Rapid Eye Movement) is a recurring portion of a normal sleep pattern associated with dreaming and believed to restore brain function. A person suffering from sleep apnea experiences

extreme tiredness during the day. Recent research has begun to look at the relationship between sleep apnea and accidents.

There are several treatments for sleep apnea and excessive snoring. Sleeping on one's side can help and surgery can be used to remove obstructions. Weight loss may aid in decreasing the amount of fatty tissue in the throat. Another treatment is the wearing of an appliance in the mouth to keep the airway open. Known as CPAP, continuous airway pressure, the procedure has been shown to be successful.

Parasominas are disturbances during sleep, which disrupt but do not prevent sleep. The most common are nightmares, sleep walking, restless legs and bruxism or gnashing of teeth. While these disorders are not the result of working in a railroad environment, the co-occurrence of these disorders in conjunction with an irregular working schedule found in railroad settings may perhaps lead to increased risk for performance decrements. Consequently, railroad companies have sought to engage in identification of persons with sleep disorders to minimize the likelihood of problems arising.

The screening program initiated by Conrail in 1998 was one of the first of its kind. Subsequently other railroads also undertook to educate their employees regarding the nature of sleep disorders. Several railroads also used the same screening procedures adopted by the former Conrail.

In 2005 the Work/Rest Task Force drafted the following statement that was agreed to by senior railroad officials as well as the leadership of the BLET and UTU. Several websites now include discussions of these issues and other communications have been prepared to broadcast the information throughout the industry.

> *Sleep disorders, like any other medical condition potentially affecting the safe performance of essential job functions or the safety of co-workers or the general public, require an individual assessment of the employee diagnosed with the condition to determine medical fitness for service and the necessity of any appropriate reasonable accommodations. The carrier s medical policy for assessment of sleep disorders is intended to neither diminish in any way the employee s responsibility for failure to comply with operating and safety rules, nor infringe upon an employee s rights under an existing collective bargaining provision.*

This statement represents a progressive and thoughtful response to the identification of medical conditions that might lead to a person being unable to safely operate a locomotive. In addition, the industry has also undertaken to develop a pilot program designed to screen individuals for the presence of sleep disorders such as sleep apnea. In particular, this program which is being conducted in conjunction with the Union Pacific Railroad and the University of Pennsylvania is noteworthy in that it offers study participants the opportunity to utilize a self-administered home assessment device

designed to screen for the presence of sleep disorders. The study began on July1 2006 and is designed to obtain 400 volunteers over a ten month period. Employees are invited to participate in the study when they are notified of their upcoming engineer recertification exam. The goals of the study are to: determine the prevalence of sleep disorders in the population, develop a process of screening that is acceptable to all the stakeholders, assess follow-up compliance with recommendations, and finally to determine future research needs. A particularly note-worthy aspect of this program is the fact that study participants will be able to use an in-home sleep data detection device. This is being developed in response to the concern of many participants that the sleep study needed to diagnose the presence of a sleep disorder requires one to check in to a hospital overnight. Many patients find this procedure unusually intrusive and are unwilling to participate. In addition, the nature of the procedure may have a negative impact on earnings. Consequently, this study is being watched very closely to determine the effectiveness of this new and innovative approach.

At it's September 21 meeting, FRA's Rail Safety Advisory Committee, which includes railroads, labor organizations FRA and NTSB is expected to form a Working Group to explore new medical fitness for duty issues for safety sensitive employees.

Chapter 8. Napping in Railroad Settings

The most effective counter measure to reduce fatigue and improve alertness remains getting sufficient sleep. Unfortunately, it is not always possible to obtain sufficient sleep when working in the 24/7 operating environment of the railroad. One countermeasure that has been adopted by some of the railroads has been to permit controlled napping under special circumstances. Napping was first instituted as a counter measure as part of the CANALERT project in 1995 and later adopted several other railroads in 1998. It is not universally applied however, because of different operating practices on different railroads.

The scientific evidence supporting the positive benefits of napping in operational settings is quite impressive. Dinges and Broughton (1989) first summarized the available literature on naps in their volume on the characteristic behavioral and medical aspects of napping. They argued that naps may be beneficial and have positive effects if a person's sleep needs are not being adequately met. In fact they wrote that Trichopoulos et al found that there was a reduction in Coronary Heart Disease in populations where a 30 minute siesta was occurred. (pg. 306) They also wrote that "To the extent that naps facilitate functioning in situations involving limited sleep opportunities during circadian phases of increased sleep pressure, they have a potentially important role to play in sleep scheduling to optimize alertness. (pg. 304)

Most studies of short on-duty naps may not be directly applicable to operational environments and to shift work. An exception is the NASA Ames Research Center study on planned cockpit napping. (Rosekind et al., 1994). The study demonstrated that on-duty naps, averaging 25 minutes in length, improved performance and alertness in aircrews on long-haul flights. The Ames study appears to be well designed and does support on-duty napping as a promising intervention in a controlled operational setting. Dinges (1995) commented however, that the Rosekind et al. (1994) report demonstrated five "fundamentally important points about using planned napping as a fatigue countermeasure strategy":

(1) It was possible to safely and effectively plan ahead of time for when a nap would be taken
(2) It was possible for every operator to fall asleep in a reasonable period of time
(3) Sleep inertia did not pose a serious problem because 20 minutes was allowed for its dissipation prior to assuming duties
(4) As in laboratory studies the nap improved objective measures of alertness ... but did not eliminate feelings of fatigue
(5) The beneficial effects of a single nap were most evident on night flights, when control crews showed increasing fatigue relative to crews allowed a nap. (p. 51)

In general, napping, after sleep inertia has been overcome, has positive effects on performance that can be seen as long as 10 hours after a nap has been taken. However, it appears that napping research that utilizes a methodology readily generalizable to the on-duty activity of railroad employees is scarce. Thus, definitive conclusions about the effects of napping on the actual day-to-day performance for railroad employees are premature. Further study of the duration and timing of naps in the work/rest cycle, and sleep inertia is needed to clarify the best utilization of this technique.

Dinges, Whitehouse, Orne, and Orne (2000) studied the effects of a two hour nap on 41 volunteers during a period of 56 hours of wakefulness. The naps were strategically placed near the circadian peak or trough and following 6, 18, 30, 42, or 54 hrs of wakefulness. Tests every few hours consisted of psychomotor and cognitive tasks, as well as mood scales completed at the beginning, middle, and end of each bout. Eight performance and 24 mood parameters were compared between groups and after the naps. Despite continued deterioration over time consistent with the circadian peak or trough the naps appeared to slow or mitigate the decline in cognitive performance but not mood. The timing of the nap also appeared to have no relationship to subsequent performance. Thus, naps were seen to have a beneficial effect on the cumulative effect of sleep deprivation.

Macci, Boulos, Ziad, Simmon, & Campbell, (2003) examined the effects of an afternoon nap on subjective alertness and cognitive performance in 8 truck drivers in after partial sleep deprivation on a simulated night shift. Naps were obtained during a 3 hour period in an afternoon setting. Persons in the no-nap condition remained awake. Both conditions were followed by a simulated driving session. Participants completed a pre-nap testing session followed by post nap testing at midnight, 2:30 am, 5am, and 7:30 am. In the nap condition, the subjects showed lower subjective sleepiness and fatigue, as measured by visual analog scales, and faster reaction times and less variability on cognitive performance tasks. Thus, a 3-hour after noon nap resulted in significant performance improvements in the subsequent midnight shift worked 7 to 14 hours after the nap.

Tietzel and Lack (2001) examined the effects of napping following a night of restricted sleep. During a 3-wk period, 12 individuals participated in a repeated measures design comparing the effects of no naps, 10-min, and 30-min afternoon naps following 4.7 hrs night sleep. Both cognitive measures of performance and subjective measures of alertness were obtained before naps and 5, 35, and 60 min after napping. Results show there was significant improvement in subjective alertness and cognitive performance immediately following the 10 minute naps over the no nap condition. Interestingly however, alertness and performance measures failed to show improvements immediately following the30 nap but did improve one hour after the nap occurred. The authors suggest that the decreases in performance and alertness may have been the result of so-called sleep inertia.

Brooks and Lack (2006) studied the effects of naps of different lengths in a sample of participants who slept at home and then completed laboratory assessments

following naps later in the afternoon. Five-minute naps had little effect compared to the non-nap conditions. However, 10-minute naps produced immediate improvements in subjective sleepiness and cognitive performance and these benefits lasted for as long as 155 minutes. Next, 20-minute naps produced performance improvements approximately 30 minutes after the nap was completed that lasted for slightly over two hours. Finally, the 30-minute naps were followed by reduced alertness and performance immediately following the nap but improvements lasting up to 155 minutes after the nap. Overall, a 10-minute nap was most effective. The results of sleep inertia were present in this study.

Song, Fuen; Danmin; Chen, Zuhuai (2003) studied the effect of naps during a 40-hour sleep deprivation experiment. Eight male medical students volunteered and during the study did simple typing and short-term memory tasks in different time periods for 8 hours. The participants took 3 30 min/ naps at 1:00 PM in the afternoon of the 1st day and 2nd day and at 1:00 in the morning when they were monitored by computer. The results of the effect of sleep deprivation on short-term memory improved the students' RT in short-term memory tasks.

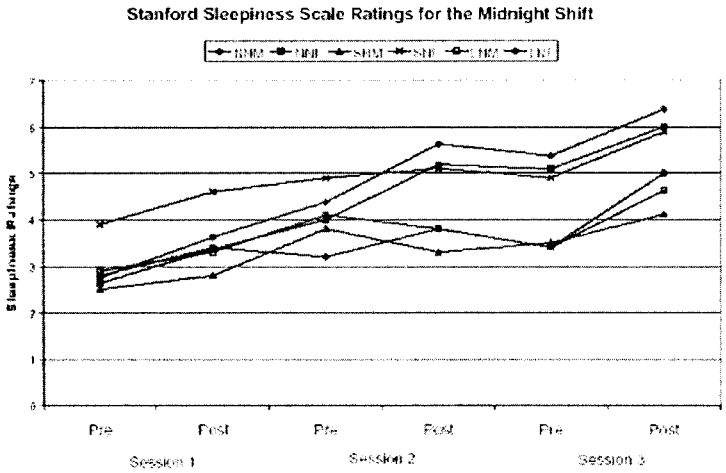


Figure 25. Sleepiness by Nap Condition – Rocca et al. (2000) - permission pending.

In 2000 Rocco, Compretore, Caldwell, and Cruz studied the effects of short and long naps on night shifts. Sixty air traffic controllers were randomly assigned to either a long nap (two hours) a short nap (45 minutes) or a no-nap condition. Study participants completed three early morning shifts followed by a rapid rotation to a midnight shift on the fourth day. Using repeated measures analysis of variance on both objective measures of cognitive performance and subjective ratings of sleepiness results indicted that the naps were beneficial to person on the midnight shifts. The longer nap resulted in better performance than the shorter naps. As can be seen from the accompanying figure, the

results indicate that subjective ratings of sleepiness were significantly higher for persons in the no-nap condition than either the long or the short nap conditions.

Arora et al. (2006) studied 40 medical interns assigned to a nap scheduled for 2 weeks of every month over a one year period. During the other two weeks of the month they were on a regular no-nap schedule. Results of the study that used actigraphs to measure sleep and wake minutes revealed that interns in the napping condition obtained significantly more sleep, about 41 minutes, on the average, than those in the non napping condition. Moreover, they also reported less overall fatigue as well.

Driskell and Mullen (2005) conducted a meta-analysis of the effects of napping on work place behavior that results in several recommendations on the utilization of naps for improved performance. Taken together with other findings in this section we can draw several conclusions. In conclusion, several summary points about napping can be made:

- A "nap" may be defined as any sleep that is less than 50% of an individual's average nocturnal sleep length (Dinges et al., 1989)
- Napping can be either voluntary or involuntary
- Planned napping may be an effective fatigue countermeasure in certain controlled settings (Rosekind et al., , 1994)
- Sleep loss increases the likelihood of napping at any time
- The napping environment should be conducive to sleep
- Napping can be followed by sleep inertia depending upon how fatigued/sleepy the person is prior to a nap
- Many studies show that naps can improve alertness and performance under specific controlled conditions
- Shorter naps (5-10 minutes) may be less likely to result in sleep inertia but still improve performance (Brooks & Lack, 2006).

Most of the major railroads have adopted a napping policy that permits employees operating rail equipment to avail themselves of short naps (30 – 45 minutes in length) under controlled circumstances if the opportunity permits. Other industries have begun to follow suit, for example, an article in the August 26 2006 edition of USA today by noted that "Employers, such as Southington, Conn.-based manufacturer Yarde Metals, which has a Nap Room, are waking up to the fact that sleep deprivation can have a bottom-line impact. At 10e20, a New York-based global search marketing and Web solutions company, President Chris Winfield makes sure employees are supplied with free Starbucks coffee and Red Bull energy drinks. "It's coffee in the morning and Red Bull in the afternoon," he says. "We have a lot of legs shaking, but the work gets done." (Armour, 2006). The article goes further noting BNSF Railway policy defining conditions under which naps on the job may occur, including the fact that they are not to exceed 45 minutes and that one employee on the crew must remain awake during the other person's nap.

According to Baxter and Kroll-Smith (2005, pg. 43) "The NASA-sponsored research on airline pilots has undoubtedly done the most to … helped spread the

workplace nap among shift workers (pg. 43)" and they note further that in a study of human relations professionals 15.4 percent of companies surveyed either permit or openly encourage breaktime naps, 32.4 percent permit naps if they are taken discreetly, 20.7 percent forbid naps but do not discipline employees who nap at work, and 31.5 percent forbid naps and discipline employees caught napping on the job (Mardon, 2000).

After interviewing key informants from several major industries, including Union Pacific Railroad , the Baxter and Kroll-Smith (2005) concluded that

> *"Once a tactical, jerry-rigged private rebellion against the discipline of work, the workplace nap is an increasingly normalized activity that is integrated into the work role and the work day. Napping is tolerated or introduced at work to increase mental acuity and amplify efficiency in ever-demanding work environments. ...The nap and larger alertness management movement is designed to improve safety and performance.... Normalizing the workplace nap begins with the burgeoning world of sleep research. (pg 50-51)"*

Thus, these noted sociologists have documented the changing workplace attitudes towards the work place nap. In an effort to improve performance and safety whilst accommodating the need for 24/7 continuous operations the scientifically determined value of a short daytime nap is seeing increased utilization in the modern work setting.

Summary

Napping is accepted as a fatigue counter measure in most major US railroads. Several of the roads have detailed written polices outlining the steps and procedures that need to be followed in order to ensure both employee safety. This has followed documentation in the scientific literature that clearly supports the value of short naps as a means of restoring alertness and effective cognitive performance. While there are some instances of performance decline following a nap, (sleep inertia) these appear to be short-lived and related to the length of the nap. The long-term benefits of napping would appear to outweigh the brief effects of sleep inertia. Moreover, with proper management of the nap and limiting the duration to no more than 15-20 minutes the effects of sleep inertia seem minimal.

Chapter 9. Summary and Conclusions

Over the past five years a number of new developments have occurred in the transportation industry relative to fatigue. We have seen developments in the regulatory arena for commercial motor vehicle drivers, increased awareness of the role of sleep disorders in transportation safety, educational efforts, new efforts at scheduling, development of scientific models, technological counter measures, and an increase in the popularity of a risk-based approach to fatigue management.

Regulation

In the area of regulation, the Federal Motor Carriers legislation was very significant. The implications for the rail industry are unclear. A recent review of the Railroad Hours of Service regulations by Sherry, Belenky, and Folkard (2006) concluded that significant change to the actual regulation were likely not necessary. However, the adoption of a risk-based approach to managing fatigue, similar to the Canadian approach, that has been adopted by the Union Pacific and that is being considered by other railroads is extremely promising. The essence of this approach is the identification of work schedules or working conditions that may have a greater fatigue related risk to then make recommendations regarding operating practices or crew scheduling matters. This approach was presented to a scientific panel and representatives of both the Federal Railroad Administration and the labor organizations and received a very positive response.

In addition, also consistent with the recommendations of Sherry, Belenky, and Folkard (2006) the railroad organizations have adopted a 10 hour undisturbed rest policy in many locations as well as 7:00 AM markups.

Changes in the regulation that are prescriptive are probably impractical and would likely have significant unintended negative consequences that would outweigh the desired benefits. Furthermore, the application of the scientific principles varies from situation to situation. Consequently, continued efforts to develop a fatigue related risk management approach and the establishment of fatigue counter measures plans than can be successfully audited and reviewed would likely be a more practical solution that would allow for the flexible application of scientific principles.

My recommendation is to encourage the railroad industry to adopt a risk-based approach and to develop fatigue counter measures plans that can be reviewed by external groups on a regular basis. This could be done voluntarily, be more in line with scientific principles and more effectively than with a piece of legislation.

Education

Great progress has been made in the railroad industry as a result of the efforts made to educate the work force. Providing individuals with needed information,

delivered though a variety of media and methods, the industry has made great strides. Additional work is needed however, as the focus has been on the education of the rank and file. Continued efforts to educate management of both the railroad companies and the labor organizations, on the identification of fatigue related risk, and appropriate counter measures needs to be undertaken.

The development of the Educational Web Site will be an important resource, but, continued efforts to identify best practices and techniques are also needed. A course specifically designed for executives, a set of recommended practices, perhaps vetted by a scientific panel would add provide much needed guidelines to an unfortunately rather subjective and individualized approach. Utilization of the recommended coaching techniques developed for the *Actigraph Individualized Feedback Study* (Sherry, 2004) would be a first step.

Sleep Disorder Screening

In the last three to five years considerable progress has been made in educating the railroad industry and its employees regarding the risks associated with sleep disorders. Screening programs and educational programs have been put in place. In addition, efforts to identify medical conditions that might influence fitness-for-duty have also been improved. In short, there has been a great deal of progress in this area, that is likely to improve as studies currently being conducted of self-report screening tools, in – home assessment devices , and additional educational efforts get underway.

Technology

Technological developments have been largely experimental. The actigraphs studies that provide feedback on effectiveness conducted by the author are promising but unfortunately dependent upon models that are still under development.

Nevertheless, technological aids that can assist individuals in monitoring and planning their own alertness and sleep hygiene will continue to be of interest. If nothing else these studies have shown that there is a desire on the part of railroad employees to have good information coupled with knowledge of effective counter measures to deal effectively with the demands of railroad work schedules.

Scheduling

Scheduling programs have been challenging to implement due to the relationship between scheduling, earnings, costs and profit. Several years ago the labor unions and the railroad companies experimented with different types of schedules, time windows, 7-3's, 8-3's, 10-5, 11-3, etc. Very few of those programs remain.

Some railroads have attempted to increase the proportion of scheduled time trains; one railroad in particular has had considerable success with this approach. However, there are still the unscheduled extraboard crews that make up a much smaller percentage

of the work forces and day to day activity of railroad operations. It is this small percentage that requires some attention. Efforts to target interventions to manage fatigue related risk are more efficient uses of limited resources.

The overlay program, the meet and return programs and the assigned days off programs have been in place for several years. They have been well received and appear to be cost effective as well thus ensuring their continued operation. The scheduled start time program also appears to show promise as well.

Existing pool schedules and extraboards may also operate well, with little fatigue risk, as was shown in some of the data reported. The utilization of fatigue models to evaluate schedules is also a technique that has been used on one railroad and is being considered by others. Consequently, progress is being made in this area.

Conclusion

Following the investigation of a number of pilot activities in the late 90's the railroad industry has seen a consolidation of its efforts in the use of overlay, assigned time off, and meet and return scheduling programs. These are becoming standard approaches to managing fatigue related risk. An increase in the amount of scheduled train traffic has also been noted. Increased awareness of the sources signs and effects of fatigue related to sleep disorders and sleep habits has also been seen. The railroad industry has seen consolidated utilization of these fatigue counter measures along with napping programs. Sleep disorder screening, and educational programs. Finally, a very promising move towards the adoption of a fatigue risk management program has been initiated with considerable interest shown by several key industry organizations.

References

Åkerstedt, T.; Kecklund, G. (2001). Age, gender and early morning highway accidents. *Journal of Sleep Research, 10, 105-110.*

Akerstedt, T., Folkard, S., & Kecklund, G. (1993). *The prediction of intentional and unintentional sleep onset.* In Harsh J, Ogilvie, R, Eds. Sleep onset. Washington, DC: American Psychological Association.

Akerstedt, T., Folkard, S., & Portin, C. (2004). Predictions from the Three Process Model of Alertness. *Aviation, Space, and Environmental Medicine*, 75, A75.

Åkerstedt, T., Kecklund, G., & Knutsson, A. (1991). Manifest sleepiness and the spectral content of the EEG during shift work . *Sleep: Journal of Sleep Research & Sleep Medicine*, 14, 221-225.

Angus, R.G., and Heslegrave, R.J. (1985). Effects of sleep loss on sustained cognitive performance during a command and control simulations. *Behavior Research Methods, Instruments, and Computers*, 17, 55-67.

Arora, V, Dunphy, C, Chang, VY, Ahmad, F., Humphrey, HJ, Meltzer, D. (2006) The effects of on duty napping on interns sleep time *and fatigue. Annals of Internal Medicine*, 144, 11, 856-7.

Armour, S. (2006, August 21). Companies try to help workers sleep more. USA TODAY.

Arnedt, J. T.; Wilde, G. J. S.; Munt, P. W.; MacLean, A. W. (2001). How do prolonged wakefulness and alcohol compare in the decrements they produce on a simulated driving task? *Accident Analysis & Prevention*, 33, 337-344.

Baldwin, D. C. Jr.; Daugherty, S. R. (2004). Sleep Deprivation and Fatigue in Residency Training: Results of a National Survey of First- and Second-Year Residents. *Sleep: Journal of Sleep and Sleep Disorders Research*, 27, 217-223.

Baldwin, D. C. Jr.; Daugherty, S. R. (2004). Sleep Deprivation and Fatigue in Residency Training: Results of a National Survey of First- and Second-Year Residents. *Sleep: Journal of Sleep and Sleep Disorders Research*, 27, 217-223.

Baldwin, D. C. Jr.; Daugherty, S. R.; Tsai, R.; Scotti, M. J. Jr. (2003). A National Survey of Residents' Self-Reported Work Hours: Thinking Beyond Specialty. *Academic Medicine*, 78, 1154-1163.

Balkin, T., Braun, A.R., Wesensten, N., Jeffries, K, Varqa, M., Baldwin, P., Belenky, G., and Herscovitch, P. (2002). The process of awakening a PET study of regional brain activity patterns mediating the reestablishment of alertness and consciousness. *Brain*, 125, 2308-2319.

Balkin, T., Thome, D., Sing, H., Thomas, M., Redmond, D., Wesensten, N., Williams, J., Hall, S., and Belenky, G. (2000). *Effects of sleep schedules on commercial motor vehicle driver performance. U.S. Department of Transportation, Federal Motor Carrier Safety Administration.* Study Objective I: Field Study – Actigraphic assessment of the sleep of CMV drivers over 20 consecutive days; Study Objective II: Laboratory Study – The sleep dose/response (SDR) study.

Barger, L. K.; Cade, B. E.; Ayas, N. T.; Cronin, J. W.; Rosner, B.; Speizer, F. E.; Czeisler, C. A.; Harvard Work Hours, Health, and Safety Group (2005). Extended Work Shifts and the Risk of Motor Vehicle Crashes among Interns. *New England Journal of Medicine*, 352, 125-134.

Baxter, V. and Kroll-Smith, S. (2005). Normalizing the Workplace Nap: Blurring the Boundaries between Public and Private Space and Time Current *Sociology*, January 2005, Vol. 53(1): 33–55 SAGE.

Beck, A. T. (1993). Cognitive therapy: Past, present, and future. *Journal of Consulting and Clinical Psychology*, 61, 194-198.

Belenky, G., Wesensten, N. J., Thorne, D. R., Thomas, M. L., Sing, H. C., Redmond, D. P., Russo, M. B., & Balkin, T. J. (2003). Patterns of performance degradation and restoration during sleep restriction and subsequent recovery: A sleep dose-response study. *Journal of Sleep Research*, 12, 1-12.

Bixler, E., Kales, A., Soldatos, C., Kales, J., & Healy, S. (1979). Prevalence of sleep disorders in the Los Angeles metropolitan area. American *Journal of Psychiatry*, 136, 1257-62

Bonnefond, A.; Muzet, A.; Winter-Dill, A.; Bailloeuil, C.; Bitouze, F.; Bonneau, A. (2001). Innovative working schedule: Introducing one short nap during the night shift. *Ergonomics*, 44, 937-945.

Bonnet, M.H. (1985). Effect of Sleep Disruption on Sleep Performance and Mood. *Sleep*, 8, 11-1.

Bonnet, M.H. (1986). Performance and Sleepiness as a function of frequency and of Sleep Disruption, *Psychophysiology*, 23, 263-271.

Borbely, A. (1982). A two process model of sleep regulation. *Human Neurobiology*, 1, 195-204.

Borbely, A., & Achermann, P. (1999). Sleep homeostasis and models of sleep regulation. *Journal of Biological Rhythms*, 14, 557-568.

Box, G.E.P., & Draper, N. R. *Empirical model building and responses surfaces*. Wiley: NY.

Brooks A; Lack L. A brief afternoon nap following nocturnal sleep restriction: which nap duration is most recuperative? *Sleep,* 29(6):831-840.

Cole, R.J., Kripke, D.F., Gruen, W.F., Mullaney, D.J., and Gillin, J.C. Automatic sleep/wake identification from wrist activity. *Sleep,* Vol. 15, 1992, pp. 461-469.

Connor, J.; Whitlock, G.; Norton, R.; Jackson, R. (2001). The role of driver sleepiness in car crashes: A systematic review of epidemiological studies. *Accident Analysis & Prevention*, 33, 31-41.

Cooper, C. L. *Safety and Human Organizations*. John Wiley: New York, 1998.

Czeisler, C. A. (2004). Work Hours and Sleep in Residency Training. *Sleep: Journal of Sleep and Sleep Disorders Research*, 27, 371-372.

Daugherty, S. R.; Baldwin, D. C. Jr. (1996). Sleep deprivation in senior medical students and first-year residents. *Academic Medicine*, 71, S93-S95.

Dawson, D., & Fletcher, A. (2001). A quantitative model of work-related fatigue: Background and definition. *Ergonomics*, 44, 144-163.

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

Dinges, D., & Broughton, R. (Eds.). (1989). *Sleep and Alertness: Chronobiological, Behavioral, and Medical Aspects of Napping*. New York: Raven Press.

Dinges, D. F. (1995). *The performance effects of fatigue*. In Proceedings of the Fatigue Symposium. National Transportation Safety board/NASA Ames Research Center, November 1-2.

Dinges, D. (2004). Critical issues in development of bio-mathematical models of fatigue and performance. *Aviation, Space, and Environmental Medicine*, 75, A181-191.

Dinges, D., & Graeber, R.C. (1989). Crew fatigue monitoring. Flight Safety Foundation: *Flight Safety Digest*, 65-75.

Dinges, D. F., & Kribbs, N. B. (1991). Performing while sleepy: Effects of experimentally induced sleepiness. In T. H. Monk (Ed.) *Sleep, Sleepiness, and Performance*. New York: Wiley.

Dinges, D. F.; Orne, M. T.; and Orne, E.C. (1985). Assessing Performance upon Abrupt Awakening from Naps during Quasi – Continuous Operations. *Behavior Research Methods, Instruments, & Computers*, 17(1), 37-45.

Dinges, D. F.; Orne M. T.; Whitehouse, W. G.; Orne, E. C. (1987). Temporal Placement of a Nap for Alertness: Contributions of Circadian Phase and Prior Wakefulness. *Sleep,* 10 (4), 313-329.

Dinges, D., Pack, F., Williams, K, Gillen, K., Powell, J., Ott, G., Aptowicz, C., and Pack, A. (1997). Cumulative sleepiness, mood disturbance, and psychomotor vigilance performance decrements during a week of sleep restricted to 4-5 hours per night. *Sleep,* 20 (4), 267-277.

Dinges, D. F.; Whitehouse, W. G.; Orne, E C.; Orne, M T. (1988). The benefits of a nap during prolonged work and wakefulness. *Work & Stress*. 2(2) 139-153.

Doghramji, P. P. (2004). Recognizing Sleep Disorders in a Primary Care Setting. *Journal of Clinical Psychiatry*, 65, 23-26.

Drake, C. L., Roehrs, T. A., Burduvali, E., Bonahoom, A., Rosekind, M., & Roth, T. (2001). Effects of rapid versus slow accumulation of eight hours of sleep loss. *Psychophysiology,* 38, 979-987.

Driskell, J. & Mullen, B. (2005). The efficacy of naps as a fatigue countermeasure: a meta-analytic integration. *Human Factors*, 47 (2), 360-377.

Eddy, DR; & Hursh, SR. (2001). *Fatigue Avoidance e Scheduling Tool (FAST)*. Brooks, AFB, TX: Human Effectiveness Directorate, Biodynamic and Protection Division, Flight Motion Effects Branch, 2001. AFRL-HE-BR-TR-2001-0140, SBIR Phase 1 Final Report.

Fairclough, S. H.; Graham, R. (1999). Impairment of driving performance caused by sleep deprivation or alcohol: A comparative study. *Human Factors*, 41, 118-128.

Falleti, M. G.; Maruff, P.; Collie, A.; Darby, D. G.; McStephen, M. (2003). Qualitative similarities in cognitive impairment associated with 24 h of sustained wakefulness and a blood alcohol concentration of 0.05%. *Journal of Sleep Research*, 12, 265-274.

FHWA (1991). Conference on Pulmonary/Respiratory Disorders and Commercial Drivers. Federal Highway Administration, FHWA-MC-91-004.

FMCSA , (2003) http://www.fmcsa.dot.gov/rules-regulations/topics/hos/HOS-2005.htm. Federal Motor Carriers Safety Administration.

Findley, L.J., Unverzagt, M.E., & Suratt, P.M. (1998). Automobile accidents involving patients with obstructive sleep apnea, American Review of Respiratory Disorders, 138, 337-340.

Fletcher, A., & Dawson, D. (2001). A quantitative model of work-related fatigue: Empirical evaluations . *Ergonomics*, 44, 475-488

Fletcher, A., & Dawson, D. (2001). Field based validations of a work-related fatigue model based on hours of work . Transportation Research Part F: Traffic Psychology and Behaviour, 4, 75-88.

Fletcher, A., Dawson, D. (2001). A quantitative model of work-related fatigue: Empirical evaluations. *Ergonomics*, 44, (5), 475-488.

Fletcher, Lamond, den Heuvel, & Dawson (2003). Prediction of performance during sleep deprivation And alcohol intoxication using a quantitative model of work-related fatigue. Sleep Research Online, 5(2)67-75,

Folkard, S., Åkerstedt. T. (1987). Towards a model for the prediction of alertness and or fatigue on different sleep/wake schedules. In Oginski, A, Pokorski, J., Rutenfranz, (eds.) Contemporary advances in Shiftwork research, Krakow.: Medical Academy, 1987: 231-240.

Friedl KE, Mallis MM, Ahlers ST, Popkin SM, Larkin W. (2004). Research requirements for operational decision-making using models of fatigue and performance. *Aviation, Space, and Environmental Medicine*;75(3 Suppl):A192-9.

Gander A survey of forest workers in New Zealand: Do hours of work, rest, and recovery play a role in accidents and injury?

Geller, E.S. The psychology of safety. CRC Press, New York, 1998.

George CF (2001) Reduction in motor vehicle collisions following treatment of sleep apnea with nasal CPAP. Thorax , 56, 508–12.

George, C.F., Nickersn, P.W., Hanly, P.J., Millar, T.W., Kryger, M. H. (1987) Sleep apnea patients have more automobile accidents. Lancet, 8556, 447.

Glenville, M., Broughton, R., Wing, A., & Wilkinson, R.T. (1978). Effects of Sleep Deprivation on Short Duration Performance Compared to the Wilkinson Auditory Vigilance Task, *Sleep*, 1, 169-176.

Government Accounting Office (1992a). Railroad Safety: Engineer Work Shift Length and Schedule Variability. GAO/T-RCED-92-68.

Government Accounting Office (1992b). Railroad Safety: Engineer Work Shift Length and Schedule Variability. GAO/RCED-92-133.

Government Accounting Office (1993). Railroad Safety: Human Factors Accidents and Issues Affecting Engineer Work Schedules. GAO-/RCED-93-160BR.

Grant, J. S. Concepts of fatigue and vigilance in relation to railway operations. *Ergonomics*, Vol. 14, No. 1, 1971, pp. 111-118.

Guzzo, Jette, & Katzell. The effects of psychologically based intervention programs on worker productivity: A meta-analysis. *Personnel Psychology*, Vol. 38, No.2, 1985, pp. 275-291.

Härmä, M.; Sallinen, M.; Ranta, R.; Mutanen, P.; Müller, K. (2002). The effect of an irregular shift system on sleepiness at work in train drivers and railway traffic controllers. *Journal of Sleep Research*, 11, 141-151.

Herscovitch, J. & Broughton, R. (1981). Performance deficits following short-term partial sleep deprivation and subsequent recovery oversleeping, *Canadian Journal of Psychology*, 35, 309-322.

Horstmann, S.; Hess, C. W.; Bassetti, C.; Gugger, M.; Mathis, J. (2000). Sleepiness-related accidents in sleep apnea patients. *Sleep: Journal of Sleep Research & Sleep Medicine*, 23, 383-389.

Howard ME, Desai AV, Grunstein RR, Hukins C, Armstrong JG, Joffe D, Swann P, Campbell DA, Pierce RJ (2004) Sleepiness, sleep-disordered breathing, and accident risk factors in commercial vehicle drivers. *American Journal of Respiratory and Critical Care Medicine*, 170, 1014–21.

Hursh SR ; Redmond DP ; Johnson ML ; Thorne DR ; Belenky G ; Balkin TJ ; Storm WF ; Miller JC ; Eddy DR. (2004). Fatigue models for applied research in warfighting. *Aviation, Space, and Environmental Medicine*; 75(3) Suppl: A44-53;

Jewett, M. E.; Dijk, D.; Kronauer, R. E.; Dinges, D. F. (1999). Dose-response relationship between sleep duration and human psychomotor vigilance and subjective alertness. *Sleep: Journal of Sleep Research & Sleep Medicine*, 22, 171-179.

Jewett, M. E.; Dijk, D.; Kronauer, R. E.; Dinges, D. F. (1999). Dose-response relationship between sleep duration and human psychomotor vigilance and subjective alertness. *Sleep,* 22(2) 171-179.

Johns, M. (1991). Anew method for measuring daytime sleepiness: the Epworth sleepiness scale. *Sleep,* 14(6), 540-545.

Kandelaars, K. J., Fletcher, A., Eitzen, G. E., Roach, G. D., & Dawson, D. (2006). Layover Sleep Prediction for Cockpit Crews During Transmeridian Flight Patterns . *Aviation, Space, and Environmental Medicine*, 77, 145-150.

Kinicki, A. J., Prussia, G. E., Wu, B., & McKee-Ryan, F. M. (2004). A Covariance Structure Analysis of Employees' Response to Performance Feedback . *Journal of Applied Psychology*, 89, 1057-1069.

Knipling, R.R., & Olsgard, P. J. *The behavioral power of on-board safety monitoring feedback.* Paper presented at the 10th Annual Meeting of the Intelligent Transportation Society of America (ITS America), Boston, May 1-4, 2000.

Krause, T. R., Hidley, J. H., & Hodson, S. J. (1990). *The behavior based safety process: Managing involvement for an injury free culture.* Van Nostrand-Reinhold, New York.

Lamond, N.; Dorrian, J.; Burgess, H. J.; Holmes, A. L.; Roach, G. D.; McCulloch, K.; Fletcher, A.; Dawson, D. (2004). Adaptation of performance during a week of simulated night work. *Ergonomics*, 47, 154-165.

Lamond, N.; Dorrian, J.; Burgess, H. J.; Holmes, A. L.; Roach, G. D.; McCulloch, K.; Fletcher, A.; Dawson, D. (2004). Adaptation of performance during a week of simulated night work. *Ergonomics*, 47, 154-165.

Laux, P. M. (2004). Hours of Service: Revisiting the Rule. Driving Force Magazine, http://www.drivingforcemag.com/index.php?id=385.

Liljenberg, B., Almquist, M., Hetta, J., Roos, B., & Agren, H. (1988). The prevalence of insomnia: The importance of operationally defined criteria. *Annals of Clinical Research*, 20 (6), 393-398.

Lilley, R.; Feyer, A.; Kirk, P.; Gander, P. (2002). A survey of forest workers in New Zealand: Do hours of work, rest, and recovery play a role in accidents and injury? *Journal of Safety Research*, 33, 53-71.

Lisper, H., & Kjellberg, A. (1972). Effects of 24-hour sleep deprivation on rate of decrement in a 10-minute auditory reaction time task. *Journal of Experimental Psychology*, 96, 287-290.

Luna, T. D. (1997). Air Traffic controller shiftwork: What are the implications for aviation safety? A Review. *Aviation, Space, and Environmental Medicine*, 68, p. 69-79.

Luna, T., French, J., & Mitchal, J. (1997). A study of USAF air traffic controller Shiftwork: sleep, fatigue, activity and mood analyses. *Aviation, Space, and Environmental Medicine*, 68, p. 18-23.

Macchi, M. Mila; Boulos, Ziad; Ranney, Thomas; Simmons, Lucinda; Campbell, Scott S. (2002). Effects of an afternoon nap on nighttime alertness and performance in long-haul drivers. *Accident Analysis & Prevention*, 34, 825-834.

Mallis, M.M, Mejdal, S., Nguyen, T.T., & Dinges, D. (2004). Summary of the key features of seven bio-mathematical models of human fatigue performance. *Aviation, Space, and Environmental Medicine*, 75, 3, A4-A14.

Mardon, S. (2000). *Shiftwork Practices, 2000*. Cambridge, MA: CTI.

Melamed, S.; Oksenberg, A. (2002). Excessive Daytime Sleepiness and Risk of Occupational Injuries in Non-Shift Daytime Workers: An addendum. *Sleep: Journal of Sleep and Sleep Disorders Research*, 25, 48.

Melamed, S.; Oksenberg, A. (2002). Excessive Daytime Sleepiness and Risk of Occupational Injuries in Non-Shift Daytime Workers. *Sleep: Journal of Sleep and Sleep Disorders Research*, 25, 315-321.

Munsterberg, H. (1913). *Industrial Efficiency*. New York: Houghton Mifflin.

NSF (2002). *2002: Sleep in America Poll*. National Sleep Foundation, www.sleepfoundation.org.

NTSB, (2002). Collision of Two Canadian National/Illinois Central Railway Trains near Clarkston, Michigan, November 15, 2001. NTSB: RAR-02-04

Pack, A., Maislin, G., Staley, B., Pack, F., Rogers, W., George, C., Dinges, D. (2006). Impaired Performance in Commercial Drivers Role of Sleep Apnea and Short Sleep Duration. *American Journal of Respiratory and Critical Care Medicine*, 174. pp. 446-454.

Pakola, S., Dinges, D. & Pack, A. (1995). Review of regulations and guidelines for commercial and noncommercial drivers with sleep apnea and narcolepsy. *Sleep,* 18 (9), 787-796.

Petersen, D. *Human error reduction and safety management*. Aloray Press, New York, 1984.

Philip, P.; Sagaspe, P.; Moore, N.; Taillard, J.; Charles, A.; Guilleminault, C.; Bioulac, B. (2005). Fatigue, sleep restriction and driving performance. *Accident Analysis & Prevention*, 37, 473-478.

Phillip, P., Sagaspe, P., Taillard, J., Moore, N., Guilleminault, C., Sanchez-Ortuno, M., Akerstedt, T., & Bioulac, B. (2003). Fatigue, sleep restriction, and performance in automobile drivers: A controlled study in a natural environment . *Sleep: Journal of Sleep and Sleep Disorders Research*, 26, 277-280.

Phillips, R. (2000). Sleep, watchkeeping and accidents: A content analysis of incident at sea reports. *Transportation Research Part F: Traffic Psychology and Behaviour*, 3, 229-240.

Pilcher, J, & Hufcutt, A. (1996). Effects of sleep deprivation on performance: A meta-analysis. *Sleep,* 19 (4), 318-326.

Pollard, J. K. *Issues in Locomotive Crew Management and Scheduling.* USDOT Report # DOT/FRA/RRP-91-06, 1991.

Radun, I.; Summala, H. (2004). Sleep-related Fatal Vehicle Accidents: Characteristics of Decisions Made by Multidisciplinary Investigation Teams. *Sleep: Journal of Sleep and Sleep Disorders Research*, 27, 224-227.

Raslear TG, Coplen M. (2004). Fatigue models as practical tools: diagnostic accuracy and decision thresholds. *Aviation, Space, & Environmental Medicine*. 2004 Mar;75(3 Suppl):A168-72.

Reason, J. Managing the management risk: New approaches to organizational safety. In B. Wilpert and T. Quale (Eds.), *Reliability and safety in hazardous work systems*. Psychology Press, Ltd., Hove, UK, 1990.

Rhodes, W., Heslegrave, R., Ujimoto, K.V., et al. (1996). *Impact of shift work and overtime on air traffic controllers – Phase II: Analysis of shift schedule effects on sleep, performance, physiology and social issues.* Final report TP12816E, Transportation Development Centre, Transport Canada.

Roach, G., Fletcher, A., & Dawson, D. (2004). A model to predict work-related fatigue based on hours of work. *Aviation, Space, & Environmental Medicine*. 2004 Mar;75(3 Suppl):A61-69.

Rocco, D., Compretore, C, Caldwell, L., Cruz, C. (2000). *The effects of napping on night shift performance.* DOT/FAA/AM-00/10.

Roehrs, T., Merlotti, L., Petrucelli, N., Stepanski, E., & et al. (1994). Experimental sleep fragmentation . *Sleep: Journal of Sleep Research & Sleep Medicine*, 17, 438-443.

Roehrs, T.; Burduvali, E.; Bonahoom, A.; Drake, C.; Roth, T. (2003). Ethanol and Sleep Loss: A "Dose" Comparison of Impairing Effects. *Sleep: Journal of Sleep & Sleep Disorders Research*, 26, 981-985.

Rosa, R. R.; Bonnet, M. H. (1993). Performance and alertness on 8 h and 12 h rotating shifts at a natural gas utility. *Ergonomics*, 36, 1177-1193.

Rosekind, M. R.; Gander, P. H.; Miller, D. L.; Gregory, K. B.; Smith, R. M.;Weldon, K. J.; Co., E. L.; McNally, K. L.; Lebacqe, J. V. (1994). Fatigue Operational Settings; Examples from the Aviation Environment. *Human Factors*, 36(2) 327-338.

Sassani A, Findley LJ, Kryger M, Goldlust E, George C, Davidson TM (2004) Reducing motor-vehicle collisions, costs, and fatalities by treating obstructive sleep apnea syndrome. *Sleep*, 27, 453–8.

Sherry, P. (1992). *Peer involvement and behavioral safety: A case study.* Paper presented at the annual meeting of the American Association of Railroads Safety Conference, Little Rock.

Sherry, P. (1991). Person environment fit and accident prediction. *Journal of Business and Psychology*, 2, 123-132.

Sherry, P. (2003). Fatigue in Transportation. *Clinics in Occupational and Environmental Medicine*, 3, 131-148.

Sherry, P (2004). Individualized Feedback on Fatigue Related Performance Effectiveness Using Ambulatory Wrist Monitoring Actigraphy. *Sleep,* 27, A407.

Sherry, P. (2005). *Final Report On the Assessment of Fatigue in Train and Engine Employees of the Union Pacific Railroad in the San Antonio Area.* National Center for Intermodal Transportation, University of Denver.

Sherry, P. (2005). A Fatigue Model and Job Performance: Testing the validity of model predictions for locomotive engineers. A paper presented at the Annual Meeting of the 2005 International Conference on Fatigue Management in Transportation Operations, Seattle, Washington , September 2005.

Sherry, P., Bart, S., & Atwater, J. Distractibility, fatigue, job stress, and accidents in long haul truck drivers. Paper presented at the annual meeting of the Rocky Mountain Psychological Association, Reno, Nevada, 1997.

Sherry, P., Belenky, G., & Folkard, S. (2006). Hours of Service Regulations in the US Railroad Industry: Time for a Change. *Transportation Law Journal*, (in press).

Skinner, B. F. (1953). Some contributions of an experimental analysis of behavior to psychology as a whole. *American Psychologist*, 8, 69-78.

Song, G., Huang, F., Miao, D., Li, Q., & Chen, Z. (2002). [The effect of naps during a 40-hour, sleep-deprivation period on short-term memory]. *Psychological Science (China)*, 25, 603-604.

Stein, A. C.; Allen, R. W.; Cook, M. L. (1985). The interaction of alcohol and fatigue on driver simulator performance. Proceedings of the American Association for Automotive Medicine, 29, 91-104.

Stutts, J. C.; Wilkins, J. W.; Osberg, J. S.; Vaughn, B. V. (2003). Driver risk factors for sleep-related crashes. *Accident Analysis & Prevention*, 35, 321-331.

Teran-Santos J, Jimenez-Gomez A, Cordero-Guevara J (1999) The association between sleep apnea and the risk of traffic accidents. Cooperative Group Burgos-Santander. *New England Journal of Medicine*, 340, 847–51.

Tietzel, Amber J. & Lack, L. (2001). The short-term benefits of brief and long naps following nocturnal sleep restriction. *Sleep,* 24, 293-300.

Tilley, A., & Wilkerson, R. (1984). The effects of a restricted sleep regime on the composition of sleep on performance. *Psychophysiology*, 21, 406-412.

Todd, C.; Reid, N.; Robinson, G. (1989). The quality of nursing care on wards working eight and twelve hour shifts: A repeated measures study using the MONITOR index of quality of care. *International Journal of Nursing Studies*, 26, 359-368.

Trichopoulos, D; Tzonou, A; Christopoulos, C; Havatzoglou, S; Trichopoulou, A. (1987). Does a siesta protect from coronary heart disease? *Lancet*, 2 (8553) : 269-70.

Van Dongen, H. (2004) Comparison of Mathematical model predictions to experimental data of fatigue and performance. *Aviation, Space, and Environmental Medicine*, 75(3), A15-A36.

Van Dongen, H. P. A.; Maislin, G.; Mullington, J. M.; Dinges, D. F. (2003). The cumulative cost of additional wakefulness: Dose-response effects on neurobehavioral functions and sleep physiology from chronic sleep restriction and total sleep deprivation. *Sleep,* 26, 117-126.

Vineet, A, Dunphy, C., Chang, V, Ahmad, F., Humphrey, H. , and Meltzer, D. (2006). The effects of on-duty napping on intern sleep time and fatigue. *Annals of Internal Medicine*,144.11 (June 6, 2006): 792(7).

Weller, D., & Sherry, P. (1992). Role of supervisor support in buffering the stress-strain relationship. A paper presented at the APA/NIOSH Conference. Washington, D.C.

Wilkinson, R., & Houghton, D. (1982). Field test of arousal: A portable reaction timer with data. *Human Factors*, 24, 487-493.

Williamson, A. M.; Feyer, A.; Mattick, R. P.; Friswell, R.; Finlay-Brown, S. (2001). Developing measures of fatigue using an alcohol comparison to validate the effects of fatigue on performance. *Accident Analysis & Prevention*, 33, 313-326.

Wylie, C. D. (2005). Sleep, Science, and Policy Change. *New England Journal of Medicine*, 352, 196-197.

Federal Railroad Administration Exhibit B–

1. Fax from BNSF Railway Company (BNSF) attaching descriptions of computer-based training courses offered by the National Academy of Railroad Sciences, BNSF's training facility at Overland Park, Kansas. (Courses relevant to fatigue issues are checked.)

2. E-mail from the Canadian National Railway (CN)summarizing its fatigue training program, with three CN brochures

3. E-mail from CSX Transportation, Inc.

4. E-mail from Norfolk Southern Corp. railroads' (NS) and attachment listing NS initiatives on work/rest education and training

5. E-mail from Union Pacific Railroad Company's (UP) and attachment listing UP videos and brochures on various subjects, including alertness, which are distributed free to employees upon request

Locomotive Cab Communication
Seat Time: 62 minutes

Locomotive Cab Communication is a course made up of five lessons. Each lesson provides information related to serious rail incidents that have occurred in the industry. Employees and supervisors will review the events that have led to tragic consequences. In addition, existing and new safety and operating rule strategies designed to prevent such occurrences from happening in the future will be reviewed.

Lessons
Tragic Consequences from Poor Communications (13 minutes)
Effective Communications During Safety Briefings (12 minutes)
Avoiding Distractions and Non-Communication (10 minutes)
Type of Crew Communication (17 minutes)
Communication Strategies (10 minutes)

National Academy of Railroad Sciences
Computer-based Training Courseware Catalog

Fundamentals

Closed Loop Safety Process: Overview
Seat Time: 15 minutes

In this lesson, students will learn about BNSF's formula for calculating risk, methods to sustain accident reductions, the five steps of the Closed Loop Safety Process and requirements for each step. Students will also learn about the tools available to support each step, and the importance of the Closed Loop Safety Process in achieving desired risk and accident reductions.

Crew Resource Management
Seat Time: 70 minutes

This course is designed to help supervisors increase crew awareness of working safely, efficiently, and productively. Case studies emphasize the importance of work principles related to job knowledge and skills, safety and awareness, communication and cooperation, and conflict resolution. Five lessons are included to help supervisors practice the principles covered in the program.

Lessons and Case Studies
Introduction (10 minutes)
Crew Member Proficiency (10 minutes)
Situational Awareness (15 minutes)
Communications and Teamwork (20 minutes)
Conflict Resolution (15 minutes)

Introduction to Railroading
Seat Time: 180 minutes

This introductory course consists of six lessons. The first two lessons provide an overview of the railroad industry and explain how railroads provide transportation services to a myriad of customers. Lessons three and four demonstrate the equipment, technology, and systems necessary to run the railroad, tracing evolution from the machine age to the computer age. In the final two lessons, the student discovers how teamwork and fellowship are the forces that make the railroad run smoothly and, most of all, safely.

Lessons
Introduction (15 minutes)
Business of Railroading (25 minutes)
Railroad Systems of North America (70 minutes)
Machine Age to Computer Age (25 minutes)
Team Railroad (15 minutes)
Safety First, Safety Always (30 minutes)

National Academy of Railroad Sciences
Computer-based Training Courseware Catalog

Fundamentals

Science of Sleep and Fatigue
Seat Time: 30 minutes

We live in a "round-the-clock" society. People have become accustomed to the advantages of extended hours of operation for everything from grocery stores to banking services. However; these advantages can create strain on one's time and energy. As demand for nonstop service increases, so does the demand for nonstop work schedules. This training is designed to address the problems of managing fatigue and alertness in the workplace, and help railroad employees effectively manage their sleep schedules to help ensure a safe work environment.
In this training module, students will learn about:

- Sleep cycles
- How sleep loss affects job performance
- Cumulative sleep loss
- Substance and situations that can affect sleep
- Misconceptions about sleep

Security Awareness for Freight Employees
Seat Time: 65 minutes

Rules compliance is one of the most important factors in keeping the railroad secure. In this presentation, the student will learn why it is critically important that all railroad employees redouble their alertness for suspicious people and unusual events on company equipment or property. The modules also explain steps that should be taken if an employee believes a situation should be investigated by proper authorities.

Lessons
What is Security (20 minutes)
What is Your Role in Reducing Risk? (10 minutes)
What Do You Look For? (20 minutes)
What is Your Top Priority? (10 minutes)
What Are You Doing to Prepare? (5 minutes)

National Academy of Railroad Sciences
Computer-based Training Courseware Catalog

Fundamentals-BNSF & Federal Policies

FRA Post-Accident Testing
Seat Time: 65 minutes

FRA Post-Accident Testing is a special kind of drug and alcohol testing. This course specifies what kind of accidents or incidents trigger the requirement for FRA Post-Accident Testing on railroad employees and who may or may not be tested under the law. The course provides a step-by-step blueprint for how to initiate, perform, and follow-though on testing, including complete information on how to handle test results.

Lessons
Introduction & Testing Authority (5 minutes)
When to Test (15 minutes)
Who to Test (15 minutes)
How to Test (25 minutes)
Test Results (5 minutes)

Hearing Conservation
Seat Time: 10 minutes

This program is designed to teach employees about the hazards of noise and potential exposure sources. Employees and supervisors will learn when hearing protection is required, the impact that noise can have on quality of life, types of hearing protection available and company offered audiometric services to test employee hearing.

Hours of Service
Seat Time: 40 minutes

Certain railroad employees are subject to "Hours of Service" regulations of the FRA. This course explains the Hours of Service work restrictions that affect TY&E employees, as well as the differences in requirements for yardmasters and control operators. The course further defines how the laws apply under special circumstances, such as emergencies. Students will learn how to calculate hours of service and keep accurate records of time on duty. There are three lessons with review sections.

Lessons
Basic Requirements (15 minutes)
Special Circumstances (15 minutes)
Record Keeping (10 minutes)

4

Information from Canadian National Railway:

From: bob.keane@cn.ca [mailto:bob.keane@cn.ca]
Sent: Friday, March 30, 2007 05:04 PM Eastern Standard Time
To: Lanman, Ken <FRA>
Subject: RE: Fatigue Management / Alertness Strategies

Ken,

CN has tried to "Engineer" out the need for fatigue training programs by the implementing and expanding its use of Precision / Scheduled Railroad operation, its use of turn-around service so our people can be home each night and sleep in their own bed. Our unique hourly agreements with the running trades. As with any safety issue, one of the best ways to reduce risk is to reduce variability and uncertainty.

In addition to the informational pamphlets (electronic copies attached) and other countermeasures discussed in our Fatigue Management / Alertness Strategies, New hire Operating employees are shown a video entitled "LIFESTYLES", with discussion regarding rest, nutrition and general wellness following the video. The video is approximately one hour, with follow-up discussion lasting up to another hour.

So, to sum up:
- Yes, CN has a specific program for its new operating employees
- Between 1 and 2 hours are allotted for the training
- The training is given to new operating employees during their new hire training program.

We also send out periodic messages regarding wellness issues and lifestyle pointers.

I hope this information is helpful. If you have any questions, please let me know.

Be Safe

Bob

1a Science of Sleep 12/9/02 1:02 PM Page 1

Facts on shift workers and sleep

- People who work shifts sleep 2 hours less than day workers.
- The average amount of sleep required for optimal functioning of the human body is 7½ - 8½ hours per night.
- Because sunlight and darkness strongly influence the circadian clock, we experience the strongest desire to sleep between midnight and six a.m.

NORTH AMERICA'S RAILROAD

[redacted] Rhythms

The human body naturally follows a 24-hour period of daytime (wakefulness) and nighttime (sleepiness). This rhythm is regulated by an internal circadian or biological clock.

The circadian clock regulates many important metabolic functions, such as sleeping, waking, digestion, body temperature, heart rate, urine excretion and hormone production.

The body uses cues from the environment (light and dark cycle), meal times, exercise or work schedules to keep the various rhythms on track. For example, as dawn approaches, there is an increase in light. Our internal circadian clock responds to the light by increasing core body temperature. As the body temperature rises it signals the urge to urinate. We respond by waking up and going to the washroom. In this example the circadian clock stimulates specific body processes to increase, i.e., metabolism, alertness, urinary excretion. At night, the opposite occurs where the circadian clock signals the body to decrease many metabolic processes.

Core body temperature reaches a high point in late afternoon between 4:00 and 7:00 p.m. and reaches its low point between 4:00 and 6:00 a.m. Alertness closely follows the rise and fall of body temperature. However, there is one exception. This occurs in early afternoon when the circadian rhythm dips between 1:00 p.m. and 5:00 p.m. This is typically the time of day when most people feel a significant drop in energy, concentration and physical strength.

Not only is there a natural dip in the circadian rhythm after lunch, the food you eat can also cause a severe drop in mental alertness. For breakfast and lunch, avoid foods that are high in fat or sugar such as donuts, pop, greasy eggs or sausages. It is a good idea to combine low-fat protein and non-starchy carbohydrate foods at mealtime. Keep meals small and light, and eat frequently to allow the body to absorb nutrients better. This will help maintain stable levels of blood sugars as well as avoid the mental energy drop often experienced after eating breakfast or lunch.

Understand that a natural dip in the circadian rhythm will affect your alertness. You will catch your "second wind" later in the afternoon.

If you work during the night, it is important to maintain a consistent eating and sleeping schedule. Understanding the circadian clock and its influence on metabolism will help you to plan your sleep and schedule naps prior to work. For example, if you work a night shift, try to nap in the afternoon when there is a natural drop in alertness. As well, the type and quantity of food, and time of day that you eat will affect your mental performance. Even so, the single most important factor for optimal performance is to consistently sleep at the same time, for at least 7½ to 8½ hours in every 24-hour period.

1

The Science of Sleep

The Alertness Series is part of the health and safety training provided by CN.

This program is designed to help employees minimize the adverse effects fatigue can have on health and safety in the workplace and at home.

CN

The Science of Sleep

In today's global economy, the delivery of goods and services requires many companies to operate on a 24-hour basis. Fatigue is a major concern because the human body requires adequate, quality sleep in order to function optimally. Sleep is the primary ingredient that enhances the development and maintenance of all body tissues.

The human sleep pattern is divided into two categories. The first category is Non Rapid Eye Movement (NREM) sleep. NREM sleep is the quiet and restful phase of sleep. NREM sleep is divided into four stages of progressively deepening sleep. Rapid Eye Movement Sleep (REM) is also known as "dream sleep" and is the second category of sleep in which the brain is active.

Each sleep cycle is approximately 90 minutes and it contains both NREM and REM sleep. The human sleep cycle is repeated four to six times during each seven- to eight-hour sleep period.

Stages of NREM Sleep

Sleep stages do not occur randomly through the course of the night. In fact, a clear 90-minute sleep cycle occurs repeatedly over the entire sleep period. Each 90-minute cycle includes Non Rapid Eye Movement (NREM) and Rapid Eye Movement (REM) sleep. There are four stages of NREM sleep. Typically, the "lighter" stages of NREM sleep occur first. Each subsequent stage is characterized by progressively slower brain wave activity (measured by an electroencephalogram).

The first stage of NREM sleep proceeds from wakefulness to drowsiness to sleep, where the individual is drifting in and out of consciousness. Stage I sleep lasts from 5 - 15 minutes.

The second stage of NREM sleep is often referred to as the "first true stage of sleep." Stage II sleep presents a slower EEG (electroencephalogram) reading, a further decline in muscle tone and the disappearance of eye movements. Stage II is considered to be light sleep, which may last 30 - 40 minutes. Most of the total time an individual sleeps each night will be in stage II.

Stage III of NREM is moderately deep sleep and stage IV is deep sleep. These final stages of sleep are called Delta sleep and are characterized by the slowest EEG recordings and further reductions in muscle tone. Delta sleep is the most important sleep for physical restoration and recovery. During Delta sleep, metabolic processes such as the heart and breathing rate slow, digestion slows and eventually stops, blood pressure and body temperature also decline. The body slows metabolic processes to allow vital systems (heart, lungs, stomach) to rest.

Delta sleep appears to serve a purpose in healing by regulating body temperature, fighting infection, and enhancing growth and preservation of the body tissues. You will have the longest periods of Delta sleep during your first several 90-minute sleep cycles. This restorative stage of sleep lasts 30 - 40 minutes. As you approach your normal waking time you will sleep less in stage IV and more in stage II.

REM Sleep

Deep sleep results in a decline in the functioning of all major organs and body systems. The body slows down all major processes to such a degree that periodic stimulation is required. REM sleep or dream sleep provides this necessary stimulation. REM sleep is opposite the quiet restful staging of NREM sleep. REM sleep stimulates the body to the point where brain waves measured through an EEG appear as if the individual is awake.

Muscle tone during REM sleep achieves its lowest state even though there may be muscle twitches and rapid eye movements. REM sleep is characterized by well-formed dreams. Blood flow to the brain increases 200 times normal rate when an individual is dreaming. As well, blood pressure, the heart and breathing rates may fluctuate dramatically during REM sleep.

Of interest is that the body is paralyzed during REM sleep, hence the decline in muscle tone. Paralysis is thought to be a means of preventing us from acting out our dreams.

Scientific researchers theorize that the benefits of REM sleep are based on an individual's subjective sense of mental well-being. One theory suggests that dreaming is a method of interpreting and reorganizing all the information accumulated by memory during waking hours. Other studies explore REM sleep's role as necessary for memory processing and consolidation.

Did you know...

- Most people who work shifts sleep at least 2 hours less a day than the average day worker.
- Staying awake for more than 20 hours has similar effects on the mind and body as being intoxicated.
- Sleep-deprived workers can be a risk to themselves and other employees who work with them.
- Science has found that in order for the human body to function optimally, it requires 7½ - 8½ hours of sleep every 24 hours.

CN
NORTH AMERICA'S RAILROAD

Partners in Responsible Care®

09/08

Do's and Don'ts

Before Rest

Do

Before Bedtime

Follow a consistent, relaxing routine to prepare your body for sleep. Like a warm bath or shower, or read a book, paper or magazine that does not "activate" the brain. Listen to relaxing music and avoid stressful mental or physical activities.

Light

Sleeping during the day can be extremely difficult. Be sure to darken your bedroom. Install light blocking and sound absorbing window coverings. If necessary, use eye shades to block the light.

Sound

Try to avoid any noises that may disturb your sleep. Unplug the telephone and turn off your cell phone. Soundproof your room by installing heavy carpeting and drapes. If necessary, wear ear plugs to further block noise. White noise machines are intended to aid sleep by producing a non-involving constant sound that buffers external noise. Air conditioners and fans also produce a soft, constant background noise that will aid sleep.

Don't

Food

Do not drink caffeine for at least four to five hours before going to bed. This includes coffee, tea and colas. Drink water and fruit juices during the second half of your shift as they won't compromise sleep. Avoid eating high protein foods such as meat, seafood, eggs, cheese or peanut butter just before you sleep. These foods may hinder your mental energy. Eating high fat or spicy foods may upset your stomach, affecting the quality of sleep. If hungry or thirsty at bedtime, eat a smaller portion of a low fat food.

Tobacco

Cut back on tobacco consumption. Shift workers often smoke cigarettes to help stay alert. Nicotine is a highly addictive substance that actually deprives the body of oxygen, making the smoker feel even more fatigued. As well, when you sleep, the body continues to crave nicotine, which will disturb or wake you. Smoking reduces sleep by about 30 minutes each night on average.

Alcohol

Do not drink alcohol before going to bed. Even though it may help you to relax, alcohol affects the length and quality of sleep. Deep sleep is required for complete physical restoration, and alcohol causes fragmented sleep.

Alertness Series 2

How to Get Better Rest

The Alertness Series is part of the health and safety training provided by CN.

This program is designed to help employees minimize the adverse effects fatigue can have on health and safety in the workplace and at home.

CN

The Importance of Quality Sleep

Sleep is as important to your health as exercise or eating a well balanced diet. Occupational demands and/or lifestyles associated with a high-tech, modern society have resulted in large segments of the population routinely reducing the amount of time spent sleeping. Researchers have estimated that 90 percent of people in modern industrialized societies suffer from chronic "sleep deprivation." People who are chronically sleep deprived have reduced attention, memory capacity and recall. This results in a greater incidence of errors, accidents and uncontrolled sleep attacks.

We need 7½ to 8½ hours of sleep in every 24 hour period for optimal performance. The true essence of sleep is that it simply promotes subsequent wakefulness. The stability of wakefulness, alertness, and how well the brain functions cognitively and emotionally all depend upon an adequate amount of quality sleep. If you don't sleep enough, your mental alertness and physical strength will be reduced, even though you may not be aware of it.

Benefits of REM Sleep

REM sleep, or the dream state of sleep, is thought to be strongly associated with long-term memory consolidation. One theory suggests that dreaming is a method of interpreting and reorganizing all the material accumulated by memory during waking hours. Without adequate REM sleep it appears that some memories from the previous day may be lost. An example of this could be something as simple as not remembering where you last placed your car keys.

Benefits of Non-REM Sleep

Non-REM sleep is the quiet and restful phase of sleep when many physiological processes such as the heart rate, breathing rate, blood pressure and digestion slow down. Scientific researchers have noted that sleep appears to serve a purpose in restoration of the physical body, thermoregulation, immune function, growth, and preservation of the body.

Benefits

Achieving a solid block of quality sleep that includes all the stages in Non-REM and REM sleep will benefit the body in several ways.

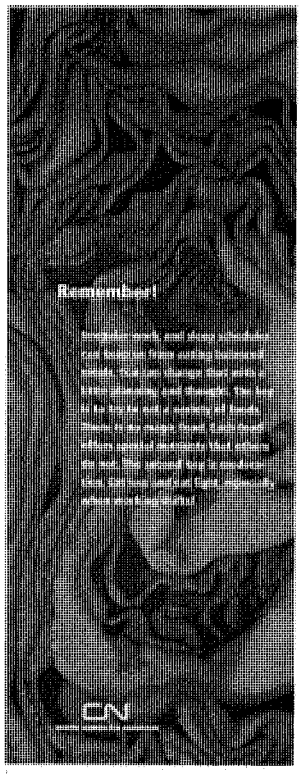
1. **Recovery:** Rest gives your mind and body a break from the physical and mental stresses of the day. There is indirect evidence that emotional stability may be a function of adequate sleep. REM sleep is believed to affect an individual's psychological (mental) well-being.
2. **Regeneration:** Rest allows your body to "restock" by supplying nutrients and replenishing lost energy stores. Sleep enhances the functioning of the immune system to fight infections the body has been exposed to.
3. **Rebuilding:** Physical work throughout the day causes muscle fibers to break down. Sleep signals the secretion of growth hormone which helps repair the breakdown of muscle fibers. Much of the repair of these fibers occurs during deep delta sleep (stage III & IV).

What to do to get Better Rest

Getting substantial, quality sleep can be a challenge for many people – especially for shift workers. Recognize that sleep has a profound effect on physical and mental well being. Make sleep a priority by preparing your mind and body for sleep. Establish a regular bedtime and waking schedule, and adhere to it as often as possible.

Strategies for Night Workers

After working the graveyard shift, try to decrease your exposure to light. On the ride home be sure to wear dark glasses to keep the morning sunlight from activating your metabolism, which naturally elevates in response to daylight. Our bodies follow a circadian rhythm of consolidated wakefulness during the day and consolidated sleepiness at night. If sunlight triggers the circadian clock to kick start your metabolism, you may miss your window of opportunity to fall asleep. After working a night shift, go to sleep as soon as you can.



Guidelines for Diet and Eating Patterns

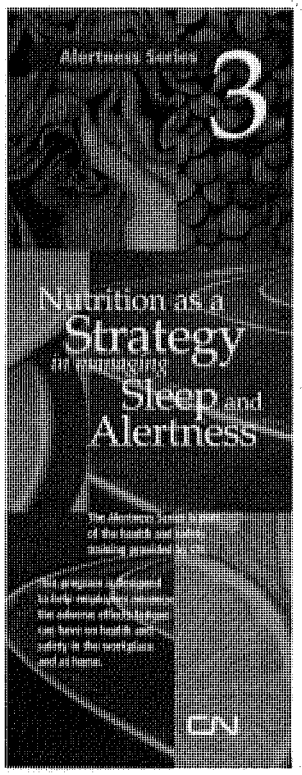
1. Be sure to break-the-fast. No matter when you sleep in a 24-hour period, be sure to eat breakfast. Include a portion of protein to avoid mental sluggishness after lunch. Avoid simple sugars such as soda pop, donuts or cookies, as they will make you feel tired and less able to concentrate.
2. Eating a heavy meal or too much food at one time can also cause drowsiness. Try eating smaller meals on a more frequent basis. Snacking three or four times during your shift will not cause the after-lunch drop in mental energy. Eating less and eating light will help you to stay alert, especially if you work the night shift. This strategy will also reduce some of the digestive complaints of shift workers.
3. Skipping meals will result in fatigue. If you are having trouble concentrating or thinking clearly, skipping meals could be the culprit. The brain depends on glucose (carbohydrates) to fuel its activity. Frequent skipping of meals will exhaust glucose reserves, leaving your brain with an energy deficit.
4. Avoid meals that are high in saturated fats. For example, eating fried foods, such as hamburgers and French fries, leads to sluggishness, slow thinking and fatigue. Fats have been found to inhibit the synthesis of neurotransmitters by the brain.
5. Dehydration is one of the most common causes of fatigue. Though water is not a nutrient in itself, it does play a vital role in your body's absorption of nutrients. The daily requirement is eight, eight-ounce glasses of water per day. If your work is physical or if you exercise frequently, be sure to drink more water on a more frequent basis (every 20 minutes).
6. Caffeine can enhance alertness, but it can also keep you from getting a good night's sleep. Avoid caffeine within five hours of bedtime to ensure this stimulant will not effect your sleep. When on the job, excessive caffeine can cause anxiety attacks in people with panic disorders, and on a stressful day caffeine – like fatigue can make you short-tempered.

Stomach Ailments

Higher rates of stomach ailments (gastrointestinal problems) have been associated with shift work. Shift workers report a higher incidence of constipation, diarrhea, excessive gas, abdominal pain and heart burn than people who are day workers.

There are many factors believed to contribute to the elevated incidence of GI complaints. The main reason is that the human body has difficulty digesting food during the night. The body's circadian rhythm regulates the digestive processes, and the human digestive system is designed to rest or shut down during the night. Therefore, eating too much food and/or the wrong type of food late in the night can result in stomach problems.

Other factors that may contribute include poor eating habits, overeating, excessive coffee, smoking and psychological stress.



Nutrition as a Strategy in managing Sleep and Alertness

The primary factors that affect mental alertness are how long you have been awake and how much sleep you have had in recent days. When deprived of sleep for several days, you build up a "sleep deficit" that will result in suboptimal mental and physical functioning. However, a long spell of sleep acts as a deposit that actually helps you to pay back the sleep debt. The best strategy to enhance alertness is to make sleep a priority –ensuring you consistently achieve quality sleep.

Foods that may enhance alertness OR drowsiness

Sleep is the best way to enhance alertness; however, the food you eat can also effect your mental energy. Nutrition can effect mental energy in two ways:

1. Food can enhance mental alertness
2. Food can promote sleep

Many people who work on the railroad do not give meal time and food selection the importance they deserve. Railroaders typically eat whenever they can spare a few moments. If you do not take enough time to plan meals carefully, you can easily choose the wrong foods to eat at the wrong time. The consequence of poor food selection can be a sharp decline in mental alertness.

Science has not clearly established how much of which dietary components are needed for optimal mental functioning. However, what we do know is that nutrition plays a vital role in memory, thinking and mental alertness. Researchers have discovered that complex brain functions depend on a balance of nutrients. Increasing evidence demonstrates that nutrient deficiencies and chemical imbalances can disrupt both emotional and psychological well-being.

There are hundreds of chemicals (neurotransmitters) that help brain cells (neurons) communicate with each other to process information. The chemicals are required because neurons do not touch one another. In order to transfer information, the chemicals act as messengers between neuron gaps (known as a synapses) to stimulate receptors on adjacent cells. After the transmission, the neurotransmitter (chemical) molecules are either broken down or reabsorbed.

Some neurotransmitters have an excitatory effect on the nervous system while others produce an inhibitory effect that soothes and calms. The three basic chemical neurotransmitters that are manufactured directly from food are serotonin, dopamine and norepinephrine. These chemical neurotransmitters are sensitive to how much and what type of foods you eat. Changes in food consumption can have substantial effects on behavior, sleep and energy levels.

Serotonin

Serotonin is a neurotransmitter that has a calming effect and is known to effect moods and sleep. The amino acid tryptophan is needed to produce serotonin. One possible way to increase your brain's supply of tryptophan is to eat carbohydrate-rich foods. A carbohydrate-rich meal may help promote sleep after your shift. Your best sources of carbohydrates are whole grain breads, cereals, pasta, rice, pretzels and starchy vegetables such as potatoes. Avoid eating these foods during your shift if you are feeling tired. Another good source of tryptophan is is to drink warm milk.

Dopamine and Norepinephrine

To stay alert, shift workers may turn to protein foods. Protein foods have the opposite effects of carbohydrates because protein blocks serotonin. As protein is digested, the amino acid tyrosine, a key building block for "alertness" neurotransmitters, is delivered to the brain. As tyrosine levels rise, so do levels of dopamine and norepinephrine. When your brain produces these chemicals you feel more alert and motivated. Your best sources of protein are low in fat: seafood, skinless chicken, tofu, dried beans, lean beef or pork. The serving size for each meal should be no more than 3 - 4 ounces (the size of a deck of cards).

Information from CSX Transportation, Inc.:

From: Marks, Jim Jr. [mailto:Jim_Marks@csx.com]
Sent: Friday, March 30, 2007 10:55 AM
To: Lydick, Joe <FRA>
Subject: Fatigue Training CSXT

* * *

- Starting in 2006, 7 wellness coordinators across the system to provide information on topics such as nutrition, proper rest, physical fitness, etc
  - Jacksonville Division is piloting a tailored individual health assessments on a voluntary basis that include lifestyle management tailored to the railroad employee
  - Providing tailored weight management which affects rest

* * *

- Information: Videos

* * *

- 2007 Summer Spike Training in April will incorporate
  - Nutrition & diet
  - Proper rest and sleep
  - Physical Activity
- In 2006, Wellness Coordinators performed 6000 health screenings
  - ETNA diabetic counseling increased as a result
- Sleep Apnea screening module being developed for Gateway information and voluntary training

Information from Norfolk Southern:

From: Moore, Jeremy D. [mailto:jeremy.moore@nscorp.com]
Sent: Fri 3/30/2007 2:51 PM
To: Lutton, Ronald <FRA>
Cc: Wehrmeister, Charles J.; MacMahon, Mark R; Wells, Barry L.; Browning, Don R
Subject: NS work/rest education and training initiatives

Ron,

Attached is a list of NS initiatives on work/rest education and training. I believe you may have most of the materials on hand in case you need them for reference. If not, please call Barry Wells or Don Browning—they could assist you.

Jeremy Moore

cc: MRM, CJW, BLW, DRB

Norfolk Southern

Work/Rest Training and Education

- Every new hire employee receives classroom instruction and training on lifestyle adjustment and work-rest.
- 2005 8 hour Transportation Safety Workshops – included module on lifestyle training and discussion on how to balance work/rest demands in the railroad environment. This training is a collaborative effort with labor organizations.
- Distribution of "The Railroader's Lifestyle Training Program" video and handbook to employees' homes developed for NS by SyncroTech.
- Distribution of "Lifestyle Management in Our 21st Century World" to employees produced by NS. Included in train service and dispatcher training programs.
- NS has engaged in initiatives to provide employees with educational material on sleep disorders. NS produced a training video that includes a section on sleep disorders, such as sleep apnea that featured the NS Associate Medical Director.
- In 2005 Transportation Safety Workshop, NS used a training video that addresses benefits of sleep, sleep deprivation, sleep disorders and healthy sleep tips.
- To facilitate education and communication on work/rest issues, NS established its own Work/Rest Committee composed of members from UTU, BLET and NS management.
- NS is an active participant in the FRA NARAP committee that was formed to develop work/rest education and training for the railroad industry, such as the NARAP educational website on fatigue which is under development with the University of Denver.
- NS is an active member of the AAR Work/Rest committee for the industry that addresses fatigue issues including training and education.
- NS has ongoing system level (general chairmen) and division level (local chairmen) communication with labor to address work/rest training, education and operational issues.
- NS has consulted with recognized experts in the area of work/rest in developing ongoing education and training materials.
- 2007 8 hour Transportation Safety Workshops will include a module on work/rest training and education.

NS began concentrating on efforts to educate its employees in the early 1990s of the importance of understanding fatigue and balancing work and rest in the rail environment. NS recognizes the importance of ongoing training in this arena, and includes work/rest education/training every one to two years. Venues for this ongoing education/training may be safety workshops and/or rules classes.

If you need additional information concerning these materials, please contact B. L. Wells or D. R. Browning respectively at (540)981-4865 or (540)981-4068.

Information from Union Pacific Railroad Company:

-----Original Message-----
From: SKENYON@up.com [mailto:SKENYON@up.com]
Sent: Friday, March 30, 2007 10:09 AM
To: Edmondson, Regie <FRA>
Subject: Union Pacific Fatigue Management Video & Brochures

Attached is a listing of Union Pacific's videos and brochures covering alertness, drugs and alcohol, depression, resiliency, and workplace violence that was requested by Rick Kutch.

Please let me know that you received this.

(See attached file: Union Pacific Railroad Videos and Brochures.doc)

(Embedded image moved to file: pic02306.gif) Building America

Steve Kenyon

General Manager Safety

Union Pacific Railroad

1400 Douglas Street,
Mail Stop 1040

Omaha, NE 68179-1040

402.544.3564 |
skenyon@up.com

Union Pacific Railroad Videos and Brochures

Videos

Title/Description	Order Number
Sleep Basics A discussion of the main sleep basics, including, how your sleep habits affect fatigue, the circadian clock, and what happens when you lose sleep.	**HP-043-99**
The Program A general description of the UP Alertness Management Program and how to access information available to employees.	**HP-045-99**
Strategies for Living A discussion of the strategies for managing fatigue, including, good sleep habits and how your lifestyle affects your level of fatigue.	**HP-046-99**
Fatigue and Family Support This video explains the need for sleep and the need to be part of a family, including tips on how families can support shift workers.	**HP-047-99**
Sweet Dreams This video brings a lighter look to fatigue education regarding sleep disorders and what can be done about them.	**HP-068-01**
Sleep Deprivation A discussion about the costs of lack of sleep for the employee and lack of motivation and response. The video also touches on the costs of sleep deprivation for the company in terms of decreased productivity and absenteeism.	**HP-050-00**
History of Drowsy Driving This video brings a lighter look to educating people on symptoms associated with lack of sleep and increased fatigue, in conjunction with getting behind the wheel.	**HP-069-01**
Insomnia This video describes what to do when you are unable to fall asleep or stay asleep.	**HP-077-01**
Z-9 Adolescents and Sleep This video is a guide to a full discussion on adolescent sleep issues.	**HP-078-2**
Planned Nap Program (T&E) This video discusses the development of the planned nap program at Union Pacific for those with erratic schedules and shift work.	**HP-120-08**

Napping This video outlines Union Pacific's Napping Policy and gives guidelines and recommendations for napping.	**HP-084-03**
Sleep Disorders This video was created by the KC Southern and gives signs and symptoms of sleep disorders, as well and treatment options available.	**HP-083-03**
Bouncing Back – Resilience This video gives coping strategies for individuals while dealing with life's difficulties and challenges.	**HP-085-03**
Depression – Think About It This video gives signs and symptoms for depression, as well as many treatment options available.	**HP-088-05**
Drugs and Alcohol Don't Work Here This video explains the Operation RedBlock Program at UPRR and how it works.	**LR-165-05**
Too Dangerous To Work With This video shows how an actual event can affect co-workers and the workplace around you. It is part of our Operation RedBlock Program.	**LR-25-82**
0 – 1 – 2 – 4: How Much Is Too Much This video discusses the National Guidelines for responsible drinking consumption on an hourly, daily and weekly basis.	**HP-087-5**
Help Prevent Workplace Violence This video outlines Union Pacific's official policy on Violence in the Workplace. It also instructs viewers on what to do when an incident occurs.	**HP-086-04**

Brochures

Title/Description	Order Number
Project AM/PM: Alertness Management...People Matter Project AM/PM is a world class alertness management initiative designed to protect the health and well being of Union Pacific Railroad employees. This brochure displays a comprehensive, organization-wide commitment to managing fatigue at UPRR.	**PB-26190**
Lodging Facilities Identifies factors in the sleep environment that can have an affect on the quality and amount of sleep someone can obtain. Includes tips on how to improve that environment. Identifies factors in the sleep environment that can have an affect on the quality and amount of sleep someone can obtain. Includes	**PB-26103**

tips on how to improve that environment.

Drugs, Alcohol, and Fatigue
Long hours and irregular schedules can result in sleep loss and fatigue. Those stressors are significant for workers who are dealing with substance abuse recovery. This brochure will provide information on alertness, fatigue, and relapse prevention. **PB-26109**

Fatigue Concerns and Myths
This brochure addresses some common myths about fatigue and demonstrates why this issue is relevant to all UP employees. **PB-26114**

Planning your Emergency Response
The purpose of this brochure is to provide those managers and employees who must respond to unscheduled, or emergency, work activities, assistance in developing a plan of action for coping with the negative impact of fatigue before, during and after the unscheduled events. **PB-26117**

Managers Alertness Travel Guide
A brief guide that provides facts about the physiology of fatigue and jet lag, in addition to giving a few strategies to improve your performance on the road. **PB-26108**

Alertness Management Guide
A brief guide that provides facts about the physiology of fatigue, in addition to giving a few strategies to improve your everyday performance. **PB-26111**

Alertness Management Reference Guide
A brochure that serves as a reference guide to the Alertness Management Department and briefly describes all of the educational materials available to our employees. **PB-26113**

Guide for Day Sleepers
Provides suggestions for employees and family members that are designed to help employees get the most restful sleep they can during the day, at home, or while away. **PB-26116**

Drowsy Driving
Designed to give an overview of characteristics of drowsy driving accidents and some things to remember before driving and while driving. **PB-26191**

Sleep Disorders
Displays signs, symptoms, risk factors and remedies of sleep apnea. **PB-26192**

Good Sleep Habits **PB-26193**

A variety of sleep habits can promote good sleep quality and quantity, both at home and on the road. These good sleep habits can be useful to everyone in preparing for sleep and in staying asleep.

Strategies for Living — **PB-26194**
A discussion of the general health strategies for managing fatigue, including, diet, exercise and other helpful topics.

Fatigue and the Family — **PB-26195**
This brochure is for all employees who work erratic hours, work long hours, travel, or just plain work hard.

Managing Life's Tensions — **PB-26158**
Recognizing that there are imperfections in the world today, this brochure offers some mindful suggestions on how to deal with daily stressors.

Jetlag — **PB-26201**
Provides symptoms and remedies when dealing with jetlag.

Pocket Guide to Alertness — **PB-26202**
Designed as a quick reference for those noticing possible symptoms of fatigue and decreased alertness.

The Rules of Napping — **PB-26252**
Outlines Union Pacific's Policy on napping, in addition to giving restful tips, definitions, and strategies.

Staying Alert on the Job — **PB-26253**
Everything you always wanted to know about caffeine and its consumption, but were afraid to ask.

Insomnia — **PB-26277**
A guide that gives you tactics for getting back to sleep and getting back to those good sleep habits.

Operation RedBlock: Help a Co-Worker, Protect Yourself — **PB-20927**
Outlines the Operation RedBlock history and applicable program information.

Signs and Symptoms of Substance Abuse — **PB-20926**
A guide for things to look for concerning substance abuse, this brochure also gives statistics related to alcohol and drug use/abuse.

How Much Is Too Much Alcohol? — **PB-26258**
If you have ever wanted to know the National Guidelines for hourly, daily and weekly alcohol consumption, this brochure will tell you that and more.

Resiliency — **PB-26250**
A guide to dealing with life's challenges, while giving suggestions on the development of personal

strategies for building resilience for you.

Frequent "Blues" Should Raise a Red Flag An employee guide to depression that gives symptoms to recognize and where to go to get help.	**PB-26259**
Anger Management Anger is often part of a bigger picture, but can be managed successfully. Anger Management strategies recommended by the APA are outlined in this brochure.	**PB-26262**
Stress Defining stress is very individualistic. This brochure gives some common causes of stress and symptoms that you should look for.	**PB-26264**
Stress Techniques This brochure can be used as a starting point for dealing with stress. It gives tools and techniques that are available to reduce stress and how you are able to make changes for you.	**PB-26268**
Take Control A guide to understanding how you have the power to affect outcomes in your life.	**PB-26275**
Help Prevent Workplace Violence This brochure defines Workplace Violence and gives an overview of Union Pacific's policy on prohibited behavior and its consequences.	**PB-20696**
Help Prevent Workplace Violence: Signs and Responses This pocket brochure outlines the Tiers of Violence and the necessary responses required when an incident occurs. Know what to do.	**PB-20697**

Posters and Other Items

Title/Description	Order Number
Drugs and Alcohol Don't Work Here Poster	**PB-26185**
Drugs and Alcohol Don't Work Here Poster For Non-Ops Crafts	**PB-6185A**
Operation RedBlock Committee Communication Poster	**PB-26278**
Operation RedBlock Mark Off Sticker	**PB-20949**
Resiliency Poster	**PB-6250P**
Help Prevent Workplace Violence Poster	**PB-20695**

Statement of
The Honorable Corrine Brown
Chairwoman
Subcommittee on Railroads, Pipelines, and Hazardous Materials
Hearing on Fatigue in the Rail Industry
Tuesday, February 13, 2007

The Subcommittee will come to order.

The Subcommittee is meeting today to hear testimony on Fatigue in the Rail Industry.

According to the FRA, human factors are responsible for nearly 40 percent of all train accidents, and a new study confirms that fatigue plays a role in approximately one out of four of those accidents.

Researchers analyzed the 30-day work schedules of locomotive crews preceding 1,400 train accidents

and not surprisingly found a strong correlation between the crew's level of alertness and the likelihood that they would be involved in an accident. NTSB investigators have reached similar conclusions.

The hours of service law, which was originally enacted in 1907 and substantially amended in 1969, is outdated. It deals only with acute fatigue, not cumulative fatigue. Since the rail industry is markedly different today compared to 40 or 100 years ago, there are some significant shortcomings in the law.

For example, the law does not properly address "limbo time," which is the time when a crew's working assignment is finished and they are waiting

for transportation back to their homes. During limbo time, crewmembers are required to stay awake, alert, and able to respond to any situation, which means that crews can be on the job for as long as 15 or 20 hours at a time. In the case of the Texas accident, which the NTSB will mention this afternoon, the engineer worked longer than 14 hours on 11 days prior to the accident. On one of the days, he worked a total of 22 hours – 12 hours on-duty and 10 hours of limbo time.

The Texas accident raised some long-standing concerns with the hours-of-service law and railroad operating procedures. Although the NTSB has repeatedly asked the FRA to make improvements to hours-of-service and address fatigue, the FRA

seemingly does not have the regulatory authority to do so. So it is up to Congress to take action!

I understand that the railroads are busier than ever and need all the manpower they can get, and I understand that railroad workers are having to work longer and harder just to make ends meets. But these hearing are about safety, and we have an opportunity to stop a large percent of accidents if we use sound science to determine a safe and productive work schedule.

I want to welcome our distinguished panelists today, and I'm looking forward to working with you and hearing your ideas on reducing fatigue in the rail industry and strengthening the overall safety environment.

Before I recognize Mr. Shuster for his opening statement, I ask unanimous consent to allow 30 days for all Members to revise and extend their remarks and to permit the submission of additional statements and materials by Members and witnesses.

Without objection, so ordered.

Mr. Shuster.

Committee on Transportation and Infrastructure

Subcommittee on Railroads, Pipelines, and Hazardous Materials

Fatigue in the Rail Industry

February 13, 2007

Testimony of

United Transportation Union

Paul C. Thompson, President
James M. Brunkenhoefer, National Legislative Director
304 Pennsylvania Avenue, SE
Washington, DC 20003-1147
(202) 543-7714

February 13, 2007
United States House of Representatives
Committee on Transportation and Infrastructure
Subcommittee on Railroads, Pipelines, and Hazardous Materials

Hearing on Fatigue in the Railroad Industry

Testimony of James M. Brunkenhoefer, National Legislative Director, United Transportation Union

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My name is James M. Brunkenhoefer, and I am the National Legislative Director of the United Transportation Union (UTU). Accompanying me today is Lawrence M. Mann, attorney for the UTU in this matter. As always, the UTU appreciates the opportunity to present our views to your Subcommittee on rail safety issues. We are pleased to associate ourselves with the Brotherhood of Locomotive Engineers and Trainmen (BLET) in this hearing. Today's hearing is the focus of fatigue, which represents one of the railroad industry's worst safety problems.

"My mind clicks on an off...I try letting one eyelid close at a time while I prop the other open with my will. My whole body argues dully that nothing, nothing life can attain, is quite so desirable as sleep. My mind is losing resolution and control." Charles A Lindbergh, The Spirit of St. Louis.

The above could be said for many operating employees working on the nation's rails. One of the most critical railroad safety issues involves the hours of service of rail workers. This covers the maximum number of hours an employee should be

permitted to work each day and each week, amount of undisturbed rest (i.e. calling time), regular scheduling, and being required to remain on trains after the maximum time on duty has been reached. As shown by the studies discussed below, there is an overwhelming body of evidence which demonstrates that fatigue is endemic in the railroad industry. Those who have studied this issue agree that the problem is pervasive, and the industry has not adequately addressed it. Railroad operating crews are typically plagued by chronic fatigue caused primarily by excessive hours of work coupled with inadequate rest time, and by unpredictable and irregular work schedules. The problems experienced by the workers are varied: typically, the employee takes the few free hours he/she has off duty to pay attention to personal and family matters; many experience circadian rhythm problems; employees are forced to work too many successive days without a day off; and others are called to duty sooner than expected. These problems have long been recognized in the industry. Not even the railroads can, with a straight face, dispute the evidence. Safety on the rails depend upon compliance with the safety statutes and regulations and the operating rules of the railroads. We know from the body of evidence that they are often compromised by employees' inability to obtain adequate rest.

The current law is deficient in various ways. It is not limited to the employees' weekly or monthly work hours, restrict the irregularity or unpredictability of on-call work schedules, or restrict commuting distances without compensatory time off.

Extensive night work, irregular work schedules, extended work periods with few or no days off, and the policies and procedures that encompass such practices are permissible within the current law. (*See*, Coplen, M. and D. Sussman, *Fatigue and Alertness in the U.S. Railroad Industry Part II: Fatigue Research in the Office of Research and Development at the Federal Railroad Administration*(March 2000).

We believe the remedy is to give the FRA authority to regulate fatigue, and at the same time, keeping in effect the statutory protections obtained over the years. Also, we strongly recommend that Congress amend the law to require that waiting for deadhead transportation and deadhead transportation be counted as time on duty, require undisturbed rest(calling time), and mandate the removal of the few remaining sleeping quarters from rail yards.

There have been numerous studies and recommendations regarding hours of service. The time for congressional action is long overdue. Hopefully, your Committee will make the needed changes in the law. We will now summarize for the Committee the agencies that have investigated this problem, and demonstrate to you that fatigue is unfortunately a reality working on the railroads.

It is to be noted that in 1994 Congress granted FRA a limited authority to approve pilot projects, including waivers of the statute, proposed jointly by rail labor and management. This has not proven to be very effective.

NTSB

For many years the NTSB has been concerned about the unpredictable nature of train crew work assignments and its attendant effect on crew fatigue. Although there are some exceptions, the majority of train crews are subject to call with little notice. At the recent hearing on January 30, 2007 before the Subcommittee on Railroads, Pipelines, and Hazardous Materials regarding the reauthorization of the Federal railroad safety program,, Robert L. Sumwalt, III, Vice Chairman of the NTSB testified:

> The Safety Board also found that the minimum rest periods prescribed by Federal regulations do not take into account either the rotating work schedules or the accumulated hours spent working and in limbo time. Limbo time, the time when a crew is neither operating the train nor yet released from duty, is most often associated with a crew's travel time to their final release point after the expiration of their 12-hour service limit. The time spent awaiting that transportation can be significant and can lead to very long workdays. For example, in June 2004, over 42 percent of the Union Pacific Railroad train crews in the San Antonio, Texas area spent greater than 12 hours on an assignment, over 24 percent spent greater than 13 hours, and 5 percent (or 760 train crews) spent greater than 15 hours.

Virtually every time the NTSB has testified before Congress in recent years, it has pointed out that fatigue of railroad workers is a major concern in accidents. On February 19, 1991, the Board's Chairman testified:

> In both the August 9 and November 7, 1990, railroad accidents in Sugar Valley, Georgia and Corona, California, work/rest cycles of railroad crewmembers is an issue. Crewmember fatigue has been a Safety Board concern in all modes of transportation, and it has been placed on our "Most Wanted" list of safety issues. Through the Board's safety recommendation

> follow-up process, and discussions with railroad officials, we will continue to push for safety improvements in this area.

Hearings on Department of Transportation and Related Agencies Appropriations for 1992, Before the House Subcommittee on the Department of Transportation and Related Agencies Appropriations, Committee on Appropriations, 102nd Cong., 1st Sess. 35 (1991).

Mr. Kolstad again repeated the NTSB's concerns in testimony June 12, 1991, on *Railroad Safety Programs before the House Subcommittee on Transportation and Hazardous Materials, Committee on Energy and Commerce,* 102nd Cong., 1st Sess.). He stated:

> Human performance is still the most important factor in any accident, in any mode of transportation. An operator who is inattentive, for whatever reason, can expect to find himself in an accident sooner or later. Too often, that inattention is caused by fatigue.
>
> Railroad employees, especially train crews, are confronted by very unpredictable and tiring work schedules — a situation that has not changed since the beginning of railroading. The changing nature of railroad operations and competitive factors have increased the relative numbers of crewmembers and other in safety sensitive positions who must work irregular and unpredictable shifts — often on a long term basis.
>
> We have found in accident after accident that workload and work/rest issues have been critical factors.
> *(Hearings, Id.* at 164).

Upon being asked at that hearing by the Subcommittee Chairman, to prioritize the top safety issues, Mr. Kolstad replied:

> I would say fatigue and hours of service problems is probably the biggest single problem. That is currently being addressed by a study in the Office of the Secretary at DOT. I know that FRA has got a study underway. But that dearly would be the most significant problem.

> I might just mention, Mr. Chairman, that this is not a problem that the railroad industry experiences alone. Fatigue is a problem in all modes of transportation.
>
> Mr. Swift. Is that because of the length of time people will typically have to work?
>
> Mr. Kolstad. It is circadian rhythm problems; it is duty time problems; it is this business of going on duty at 3 a.m. and working until 11 on one day, taking 8 hours of rest, and then going on duty at 7 p.m. the following day and working until 4 in the afternoon, taking 8 hours, and continuing in that process. That simply cannot be sustained with any expectation that human performance is going to continue to be sharp.
>
> Mr. Swift. Yet the schedules of the transportation industry, airlines, railroads, buses, kind of require those kinds of hours.
>
> Mr. Kolstad. In many cases that is true. It seems to be more true in the railroad industry and in the trucking industry.
>
> *(Hearings, Id.* at 171).

Chairman James E. Hall , testifying before your Committee on March 26, 1998 stated "Human fatigue in transportation operations is probably the most widespread safety issue in the transportation industry, and it has been an item on the Safety Board's "Most Wanted" list of transportation safety issues since its inception in 1990."(*Hearings on Reauthorization of the Federal Railroad Administration Before the Subcommittee on Railroads of the Committee on Transportation and Infrastructure,* 105th Cong., 2d Sess. 317). He noted that the Board has been concerned about fatigue in the industry for many years, and needed to be addressed in the hours of service laws. He also stated that "While fatigue remains one of the most perplexing problems to substantiate in accident investigations, the body of scientific evidence collected over the past decade clearly reflect a critical need for adequate rest for those operating the transportation system."(*Id.).*

An important comparison by Mr. Hall of the hours worked among the transportation modes is telling. He pointed out that under current regulations or rules, a commercial airline pilot can fly up to 100 hours per month. Shipboard personnel on large ships over 100 tons cannot operate more than 240 hours per month. A truck driver can be on duty about 260 hours per month. Locomotive engineers, however, can operate a train up to 432 hours per month, which equates to more than 14 hours a day, each of those 30 days.*(Id. at 318)*.(We recognize that in August, 2005 the Federal motor carrier safety regulations were amended for truck drivers to reduce the total hours per month to 240 hours).

It is irrational that operating crews are permitted to work more than four times longer than an airline pilot, and one and-a-half times longer than a truck driver. To allow an operating railroad crew to work over 400 hours per month is unconscionable.

A summary of some of the more notable NTSB reports of accidents relating to fatigue is presented below. One of the NTSB's earlier findings of fatigue in the railroad industry resulted from a collision of the Penn Central Railroad 35 years ago in 1972. The Board found that the engineer and head brakeman had both fallen asleep.(NTSB-RAR-73-3).

Texarkana, TX

In a recent train accident report, the Board on October 17, 2006 issued its findings as to the probable cause of an early morning collision in Texarkana, Arkansas which occurred on October 15, 2005. It said the cause was the failure of the crew of the train to remain attentive and alert and thereby able to stop before striking an observable standing train in front of them.(Acc. No. DCA-06-FR-002).

Macdona, TX

In another decision, on July 6, 2006, the Board determined that crew fatigue caused a train collision near Macdona, Texas. The accident occurred on June 28, 2004, and three persons died from inhalation of chlorine near the surrounding area of a ruptured tank car. The Board said that the unpredictability of the UP's work schedules may have encouraged the crew to delay obtaining rest. It said that during periods of high demand for crews, the additional pressure on crews who have not had full rest can be difficult.

In its Report on the Macdona accident, the Board said:

> Contributing to the crewmembers fatigue was their failure to obtain sufficient restorative rest prior to reporting for duty because of their ineffective use of off-duty time Union Pacific Railroad train crew scheduling practices, which inverted the crewmembers work/rest period.
> (NTSB Report RAR-06-03).

In commenting on the accident, then Acting Chairman Mark Rosenker stated:

> Get enough sleep--it sounds so simple and yet we continue to see accidents caused by fatigue. How many more tragedies have to occur before employers and employees get the message that being well rested is critical to job performance.

We submit that Mr. Rosenker may not recognize how difficult it is for the rail workers to get the necessary rest. The crew scheduling practices are abominable on some railroads. In addition, an employee, through no fault of his own, may not be adequately rested, but most railroads do not allow the employee to mark off duty under those circumstances. Hopefully, Congress will help us correct the problem.

Wiggins, CO and Newcastle,WY.

The Board pointed out over 20 years ago in its 1985 report on Burlington Northern Railroad collisions in Wiggins, Colorado, and Newcastle, Wyoming (Railroad Accident Report-NTSB/RAR-85/04) that railroad crews are confronted by the most unpredictable work/rest cycles in the transportation industry.

Thompsontown, PA

The effect of sleep deprivation and unpredictable and irregular work/rest cycles were succinctly summarized by the NTSB in the *National Transportation Safety Board Railroad Accident Report, Head-End Collision of Consolidated Rail Corporation Freight Trains UBT-506 And TV-61 Near Thompsontown,*

Pennsylvania January 14, 1988, NTSB/RAR-89/02 (1989). One of the causes of the Thompsontown accident was unpredictable work/rest cycles of the crew. *NTSB Report* at 54.

In the Report, it explains that workers do not remedy this hazardous condition by making up for lost sleep on their days off, nor do they "adapt" to the irregular work hours. Chronic sleep deprivation results in fatigue, frequent microsleeps or lapses (periods in which workers fall asleep for a short time then awaken spontaneously, unaware that they had been sleeping at all). *NTSB Report,* at 37. The frequency and duration of such lapses increase as the person becomes more chronically sleep-deprived. *Id.* Although the worker will perform his task perfectly both before and after the lapse, he is asleep during it. As a result, the worker will not respond at all to external stimuli unless they are massively sensory in nature, very unusual, or particularly meaningful. *Id.*

Also, workers subject to non-systemic and unpredictable changes in their work schedules are highly susceptible to variation in alertness and consciousness that are associated with their circadian "body-clock," which is typically at its lowest ebb between roughly 1 a.m. and 7 a.m. Employees suffering from the effects of chronic sleep deprivation are more susceptible to environmental conditions which do not promote sleep. Extensive studies have been conducted on operating crews in which, not only single crew members,

Based upon the NTSB's analysis of the Thompsontown accident and other prior accidents, it concluded:

> 17. The changing nature of railroad operations and competitive factors have materially increased the relative number of train crewmembers who must work irregular and unpredictable shifts on a long-term basis.
> 18. Since train crewmembers lack the requisite training to recognize the condition, they may allow themselves to become chronically sleep-deprived and develop physiological problems that impact adversely on their performance. Conrail and the other railroads need to recognize and deal with this probability by modifying their operations to reduce shift irregularity and by instituting educational and intensified medical examination programs. *NTSB Report* at 53.

Sugar Valley, GA and Corona, CA

In the NTSB's Report of the Corona, California, accident of November 7, 1990, it demonstrates the hazards in the railroad operations resulting from irregularity and unpredictability of a locomotive crew's work schedule. The Board concluded that both of the locomotive crewmembers had fallen asleep because of acute fatigue, partly resulting from the irregularity and unpredictability of the work schedule. *(National Transportation Safety Board Railroad Accident Report, Atchison, Topeka and Santa Fe Railway Company (ATSF) Freight Trains ATSF 818 and ATSF on 891 on the ATSF Railway Corona, California* (November 7, 1990), RAR-91/03 at p. 45 (July 23, 1991).

In its investigation of the Sugar Valley, Georgia, accident on August 9, 1990 the Board determined that the Norfolk Southern engineer who failed to comply with a stop signal resulting in the accident had reverted to a routine of sleeping at night on his

three days off duty before the accident after having been on his normal night-work and day-rest routine for over three weeks.

Willaimsburg Bridge, NY

The Board found that the NYC Transit train operator, who was at the controls of a train involved in the accident on the Williamsburg Bridge on June 5, 1995, had recently changed from a weekend schedule of sleeping at night to his weekday schedule. When there is a change in a person's work/rest cycle, there is a change in the circadian rhythm, which affects fatigue.

Later the same year, in November of 1995, the Safety Board convened the first International Multimodal Symposium on the effects of fatigue on transportation safety. The railroad group concluded that the lack of schedule predictability and regularity were the number one problems for train crews.

Kelso, WA

On November 15, 2003 a UP Railroad train collided with a BN train at Kelso, Washington. The Board determined that the UP crew neglected wayside signal indications because the crew was asleep, and concluded that irregular work schedules contributed to the accident.

We could present many more NTSB investigations into fatigue in the rail industry, but the above adequately demonstrate the extent of the problem.

FEDERAL RAILROAD ADMINISTRATION

At the previously mentioned January 30 hearings before your Subcommittee, FRA Administrator Joseph H. Boardman addressed fatigue. He testified:

> Fatigue has long been a fact of life for many railroad operating employees, given their long and often unpredictable work hours and fluctuating schedules. Train crews may legally work an enormous number of hours in a week, month, or year. While commuter train crews often have some predictability in their work schedules, crews of freight trains rarely do. The long hours, irregular work/rest cycles, and lack of regular days off, combined, have a very deleterious effect on employee alertness. Railroads are necessarily 24-hour businesses, and the effects of "circadian rhythms" challenge the alertness of even well-rested employees, particularly in the early morning hours. The hours of service law, originally enacted in 1907 and last substantially amended in 1969, sets certain maximum on-duty periods (generally 12 hours for operating employees) and minimum off-duty periods (generally 8 hours, or if the employee has worked 12 consecutive hours, a 10-hour off-duty period is required). However, the limitations in that law, although ordinarily observed, do not seem adequate to effectively control fatigue.

The FRA's studies on the effects of work schedules on train operations support the conclusion that something must be done to help eliminate fatigue in the rail industry. Its most recent study issued on November 29, 2006, entitled *Validation and Calibration of a Fatigue Assessment Tool for Railroad Work Schedules,* was an attempt to determine if a fatigue model can accurately predict an increased risk of human error contributing to an accident. The study analyzed the 30-day work schedule histories of locomotive crews preceding 1,400 train accidents and found a strong statistical correlation between the crew's estimated level of alertness and the likelihood that they would be involved in an accident caused by

human factors. It found that the relationship is so strong that the level of fatigue associated with some work schedules was equivalent to being awake 21 hours following an 8-hour sleep period the previous day. The study noted that human factor errors are responsible for nearly 40 percent of all train accidents over the past five years, and that fatigue plays a role in one out of four of those accidents.

At the 1998 Hearings before your Subcommittee, FRA Administrator Jolene Moiltoris, in her testimony gave an example to illustrate the seriousness of the fatigue problem in the railroad industry from a transcript of a recorded telephone conversation between a locomotive engineer on a Class I railroad and a crew caller. The call from the railroad crew caller for her to report to duty was approximately 1 a.m.

> Engineer: I haven't had any sleep. I'm just going to have to lay off. I haven't had a chance to get any sleep.
> Crew caller: So you're telling me that you would probably work unsafe.Engineer: You can lay me off 'personal.' I am tired and `account fatigue.' However you want to call that.
>
> The crew caller said he could not allow her to lay off on that basis.
>
> Engineer: We are not robots, though ....
> Crew caller: I totally agree with you. They are working us 16 hours down here. We're getting . . . we're getting six hours of sleep and coming right back and working 16 more because we're short-handed, too, and I ... I agree with you .... *Hearings on Reauthorization of the Federal Railroad Administration, Before the House Subcommittee on Railroads of the Committee on Transportation and Infrastructure,*105th Cong.2d Sess.792.(Apr.29, 1998).

The crew caller expressed some sympathy for her situation, but he told her that she

would be subject to discipline if she did not accept the call.

At the same Hearing, the Administrator summarized the results of two related examples of FRA's studies to help determine the nature of performance decreases that operating employees may experience. In the first study, FRA observed the performance of locomotive engineers on the Research and Locomotive Evaluator Simulator (RALES) facility at the Illinois Institute of Technology. The final report (DOTIFRA/ORD-97-09) is entitled *The Effects of Work Schedule on Train Handling Performance and Sleep of Locomotive Engineers: A Simulator Study.* This study investigated how work schedules affect engineers' train handling performance and vigilance. The report concluded:

> Current Federal regulations governing Hours of Service for locomotive engineers allow work schedules that have backwards rotating shift start times and do not allow sufficient sleep. Locomotive engineers who work under such schedules can accumulate a progressive sleep debt over a period of days. The present study demonstrates that schedules which have these characteristics are easily composed ad do, indeed, result in sleep durations which are considerably less than those obtained by the general population. The locomotive engineers in this study, while working on such schedules, reported progressive decreases in subjective alertness across the duration of the study. Moreover, several aspects of job performance, including safety sensitive tasks, degraded during the same time period. This suggests that current Federal regulations governing Hours of Service have the potential to allow work which degrade the job performance of locomotive engineers and reduce the safety of railroad operations.

In a limited second study, FRA, with the participation of the Brotherhood of Locomotive Engineers and major railroads, gathered diaries from 200 locomotive engineers employed by six railroads. The diaries consisted of self-reporting with

respect to quantity and quality of sleep, estimates of alertness at various times while on duty, time on duty, commuting time, and the accuracy of information provided to crews about job-start times. The conclusions from that study were:

> On average, engineers participating received almost the same amount of sleep as the general population, which was seven and one-half hours. However, for jobs starting between 10:00 p.m. and 4:00 a.m., sleep averaged less than six hours. This means that the engineers who had had less rest than normal began shifts during a period when lack of alertness would be expected.
>
> Engineers felt they were less alert during the early morning hours, and these periods extended longer than would be expected for scheduled shift work.
>
> Engineers reported that the most important change that could improve their alertness was more accurate information about the time of the next job start (permitting better planning of rest).

The FRA has undertaken a few other studies of the issues related to a railroad worker's irregular work hours, excessive working hours, waiting times etc. *See, e.g.*, J.K. Pollard, *Issues in Locomotive Crew Management and Scheduling*(FRA/RRP-91-06). In another one authored by M. Pollard in 1996, he studied the work/rest diary of 200 locomotive engineers. He found that those who started work between 10 p.m. and 3 a.m. averaged only about 5 hours sleep. In a subsequent study by Thomas, Raslear and Kuehn entitled *The Effects of Work Schedule on Train Handling Performance and Sleep of Locomotive Engineers: A Simulator Study*(DOT/FRA/ORD-97-09), they found that 55 engineers working strictly within the hours of service law accumulated a progressive sleep debt over a period of days. The engineers averaged between 4.6 and 6.1 hours of sleep,

depending upon the amount of time off duty. The engineers reported a progressive decrease in subjective alertness across the duration of the study, and performance of safety sensitive tasks degraded during the same time period. The study concluded that the hours of service law allows work schedules that degrade job performance and reduce the safety of railroad operations. It said that a law that merely allows time for sleep is not sufficient to ensure adequate sleep, prevent fatigue and maintain safe rail operations.

In its 2006 fall edition, the Transportation Law Journal published an article by Sherry, P., Belenky, G. , & Folkark, S, entitled *Hours of Service Regulation in the United States Railroad Industry: Time For a Change*(vol. 33, No. 3, p. 253). In the article Dr. Sherry traces the history of the fatigue problems in the rail industry, including sleep deprivation and fatigue countermeasures. In his conclusions he states:

> Railroad carrier companies should develop Comprehensive Fatigue Counter Measures Plans to holistically address and manage fatigue issues in their operations. Furthermore, the maximum number of on-duty hours should remain at twelve hours in a twenty-four hour period. The maximum number of hours at work (on duty and prerelease) should be limited to sixteen, and should include the amount of time preceding release with a minimum of twelve hours undisturbed rest immediately following. It is further recommended that individuals be limited to a maximum number of four consecutive twelve-hour shifts in a one hundred and forty four hour period. 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. Individuals should be afforded the opportunity to obtain eight hours of sleep in every twenty-four hour period. A minimum of two days off is recommended to recover from extended work

> schedules. In order to recover from regular work shifts, there should be at least ten hours off between shifts in order to ensure eight hours of time in bed. Persons who have worked several consecutive midnight shifts will require at least two days off, and may need as many as twelve to sixteen hours off between shifts to recover. At the away-from-home lodging facilities, railroad employees should be permitted shorter recovery times in order to return to their homes.

For further support of the adverse safety effects of irregular work cycle, *see, Biological Rhythms, Sleep, and Performance,* by Wilse B. Webb at pp. 59-87, 110-141, 175-204 (John Wiley & Sons 1982); and testimony of Dr. Charles Czeisler at the *Hearings on Shift Work Scheduling and Biological Clocks Before the House Subcommittee on Investigations and Oversight of the Committee on Science and Technology,* 98th Cong., 1st Sess. 176 (1983).

TRANSPORTATION RESEARCH BOARD

At its mid-year meeting on January, 2006 the Transportation Research Board issued a Circular entitled Railroad Operational Safety(No.E-CO85) where it analyzed the issues of fatigue in the rail industry. It is a scholarly analysis, and the Committee is urged to review its findings. One of the presentations at the meeting was by Dr. Goran Kecklund, who has been responsible for many research projects related to sleep, fatigue and safety. At the TRB, he provided results from the Swedish TRAIN project. In doing so, he discussed a number of fatigue countermeasures, including introducing at least 12 hours rest between shifts to avoid serious lack of sleep and critical fatigue; Sleep loss and fatigue should be

compensated with rest and recuperation and not with economic compensation; Avoid compressed work hours(i.e., many workdays in succession); Work more toward forward rotation of schedules; Education in sleep and fatigue management; Rehabilitate risk groups; and Use fatigue modeling.

Another presenter at the conference, was Dr. Frederick C. Gamst. He pointed out what many in the industry know, but rarely openly discuss--the fatiguing schedules of employees yield benefits to the employer because it allows a carrier to have highly flexible and maximal use of operating employees. It also maximizes income because more paid time can be worked. Dr. Gamst presented a succinct summary of many fatigue studies conducted over the years, which adds to the necessity for Congress to now act.

ASSOCIATION OF AMERICAN RAILROADS

We would be remiss if we did not acknowledge that some of the nation's railroads have undertaken limited countermeasures to fatigue. Some of these include allowing the crew to take short naps at certain locations(BNSF, UP,CSX,KCS, CN); upon request, allowing up to a maximum of 18 hours rest(Pilot projects--UP, NS); minimum of 10 hours rest(BNSF, UP, NS, CSX, KCS, Amtk, CN, CP); sites with time windows(UP Pilot program). The problem is that without federal enforcement, any countermeasure can be terminated abruptly without any recourse to the employee.

We have another beef with the AAR on fatigue issues. FRA created a Collision Analysis Working Group (CAWG) to analyze 65 main line train collisions, identify commonalities, and recommend changes to prevent future collisions. Rail management, the UTU, BLET, and the FRA were all equal partners in this exercise. This analysis showed a direct link to fatigue as a contributing factor in many of these collisions and the corresponding loss of situational awareness by the crews. The industry participated in the analysis as an equal partner. The industry also participated in drafting and approved the final language contained in the report as an equal partner, and afterwards demanded that their officers' names be stricken from the final report when senior management learned the involvement of fatigue was mentioned in connection with these collisions. We are thankful that FRA had the courage to remove the railroad officers' names from the report and published this significant work. *See, Collision Analysis Working Group,65 Main-Track Collisions 1997 Through 2002: Review, Analysis, Findings and Recommendations, CAWG Final Report, FRA(Aug.2006).*

NECESSARY STATUTORY REMEDIES

1. Granting the Secretary authority to regulate fatigue

We would be agreeable to giving the Secretary regulatory jurisdiction over fatigue in the railroad industry, with a caveat. The existing statutory protections which the railroad workers fought very hard over the years to obtain will not be

repealed. Otherwise, we will be forced to oppose the provision vigorously.

Also, there are a few new provisions which we believe are needed to improve the quality of life for the covered workers, which are discussed below.

2. **Deadhead Transportation.**

Despite what we deem is clear in the hours of service law, the Supreme Court in Brotherhood of Locomotive Engineers, et.al, v. Atchison, Topeka & Santa Fe RR, 516 U.S. 152(1996) held that time waiting for deadhead transportation is limbo time and therefore neither time on duty nor time off duty. While we believe the Court was wrong in its interpretation, an amendment to the law is now needed to clarify that waiting for deadhead transportation is time on duty. Also, time traveling in deadhead transportation should be time on duty.

In our arguments before the Court, we pointed out at least 4 distinct provisions under the current statute which lead to the only valid conclusion ---that all of the time spent on the trains by the employees covered by the HSA is time on duty, except when the employee is actually traveling in deadhead transportation.

a. Title 49 U.S.C. § 21103(b)(1) states " Time on duty begins when the employee reports for duty and ends when the employee is finally released from duty." The employee is not finally released until he/she reaches the designated terminal. We believe that the FRA used a specious distinction in arguing to the Court that the time while the employee is on the engine awaiting another crew to

relieve it is not time on duty because the employee is "relieved" (even though not finally "released"). Such rationale is not accurate by a simple reading of the language in the statute. Also, the employee is not finally released from duty because there are still obligations imposed on the worker--- at the very least he/she must protect the train from vandals and undesired train movement. The employee is not free to leave the train, and is subject to further orders from the railroad. In fact the crew would be disciplined if he/she were to leave the train unprotected. More significantly, an employee is not finally released from duty until he/she reaches the designated terminal. Unless specifically excluded by the statute, all such time is on duty time.

b. Time on duty shall include interim periods available for rest at other than a designated terminal. 49 U.S.C.§ 21103(b)(5). This section makes it clear that such time is still to be counted as time on duty, where the employee is not at a designated terminal. Even if the employee is at a designated terminal, if the relief is less than 4 hours, such time is on duty time. 49 U.S.C.§ 21103(6).

c. The time is not time off duty because the employee is not in deadhead transportation, i.e. traveling from duty to point of final release. *See,* 49 U.S.C.§21103(b)(4).

d. Under 49 U.S.C.§ 21103(b)(3), in determining the number of hours an employee is on duty, there shall be counted, in addition to the time actually

engaged in or connected with the movement of any train, all time on duty in other service performed for the railroad. *See also*, 49 C.F.R. § 228.7(a)(5). Therefore, even if the employee is not engaged in or connected with a train movement, the employee is still not finally released and is on duty in other service, such as protecting the train against vandalism. As long as the employee is subject to orders of the employer, he/she should be considered in "other service " and, therefore, "on duty".

The Court's Interpretation Is Contrary To The Legislative History

The 1969 amendments to the Hours of Service Act demonstrate Congress' concern with exactly what constituted "time off duty" and "time on duty". Originally, all time within the twenty-four-hour period was considered either "on" or "off" duty, with deadheading time both to and from service generally being "off duty" time. This resulted in flagrant abuses which thwarted the entire purpose of the statute.

> "This has resulted in an employee, believe it or not, being assigned to ride 8 hours in deadhead service and not have this time count as time on duty, and then follow it immediately with his official tour of duty, which could run anywhere from 8 to 16 hours, making his total time in railroad service a potential of 24 hours divided between deadheading and nondeadheading time."

116 Cong. Rec. H29,322 (daily ed. Oct. 9, 1969) (Statement of Representative Olsen).

The 1969 amendments changed time on duty (used in computing the maximum 12 hour workday) to include the time that is provided for rest in places

other than the designated terminal, time provided for rest of less than 4 hours at a designated terminal, and time spent by employees going to an assignment or traveling between assignments. Time off duty is also defined, and time spent in deadheading back from a duty assignment is not considered time off duty. Id. at H29,318 (Statement by Representative Staggers). These changes were designed to prevent abuses by ensuring that off duty time is time of "undisturbed rest" and time on duty includes time of deadheading to and between service. Id. at H29,322. (Statement of Representative Olsen). These clarifications were designed to limit the time required in traveling to duty and to get the employees to designated terminals as quickly as possible after duty.

The decision of the Supreme Court promotes just the type of abuses the 1969 and 1978 amendments were designed to remedy.

3. Undisturbed rest

Another unresolved issue under hours of service is the amount of undisturbed rest to which a railroad worker is entitled.

Unless a human being knows in advance what time they must report to work, they can not arrange to be rested and fit for duty. The railroad industry functions on a 24/7 schedule with continuous operations from coast to coast. This is not an excuse for the current position of the railroads holding that their employees do not deserve and are not entitled to advance knowledge of the time

they must appear for their next assignment. Every railroad terminal has an information line commonly referred to as a "lineup" that is intended to advise crews that are subject to call 24/7 regarding their status. Every railroad has "problems" with the accuracy of these "lineups". The employees must have early and reliable information indicating when they will be required to report for duty

UTU and BLET have voluntarily participated in many different forums on Fatigue, Work Rest issues, and pilot projects designed to help stabilize the work schedules for operating crews. There are a few successful Work Rest projects continuing across the country, but these represent no more than 2% of the affected employees. Railroads have adopted unilateral Availability Policies that set arbitrary guidelines for employee work schedules. One railroad Availability Policy states that employees will be available for service 85% of their time. The average American worker that is expected to work 40 hours each week is available for service about 24% of their time. The railroads expect their employees to be available for work more than 3 times the national average. Despite an Availability Policy in effect, at least two railroads are only permitting one weekend day a month and 1-2 days at most of weekdays off. If the employee requests a day off for sleep, exhaustion, etc. and it exceeds the number he/she is required to under the railroad's calculations, employees have been disciplined and dismissed.

We submit that under the existing law an employee is entitled to undisturbed rest for 8 or 10 hours, depending upon how many hours the person worked before the rest period began. However, the practice on the railroads still is that the employee 's rest period is normally interrupted by a telephone call from the railroad at least 2-3 hours before the time he/she is told by the railroad when to report to duty. This obviously interrupts a person's rest. Nevertheless, a court, at the urging of the FRA, has held that calling time is not to be considered time on duty. California State Legislative Board, United Transportation Union v. Mineta, 328 F.3d 605(9th Cir. 2003). Incredibly, the court held that it is o.k. to interrupt the employee once, and that does not interfere with the rest. It said in the opinion that the FRA is not required to accept as controlling a statement in the report of your Committee contained in the legislative history. Therefore, since the FRA disregarded the statement in the report as to the requirement of uninterrupted rest, the court followed FRA's position.

Section 21103(a)(3) states that the employee's off duty time shall be "consecutive". The congressional deliberations clarify the statute's intent that the rest period shall not be interrupted by duty calls [also commonly known as "calling time" in the industry]. S. Rep. No. 91-604, 91st Cong., 1st Sess. 7-8(1969);Cong. Rec. H29321(daily ed. Oct. 9, 1969). To permit the Ninth Circuit's interpretation to stand would undercut the intent of Congress, and continue to contribute to

fatigue for operating railroad workers.

4. **Removal of sleeping quarters in yards**.

In 1976 the Congress, amended the Hours of Service Act and allowed railroads to retain then existing sleeping quarters inside rail yards, but that any new or reconstruction of the sleeping quarter must be safely away from the yards. Congress permitted maintenance on the existing facilities, so that it would not be a significant economic burden on the railroads to all of a sudden be required to move all sleeping quarters from the yards. The intent was that these old sleeping quarters would be removed in a reasonable period of time, and replaced by safer conditions. We have been able to prevent major rehabilitation and keep railroads sleeping quarters away from the yards. *See, e.g.,* United Transportation Union v. Dole, 797 F.2d 823(10th Cir.1986). Nevertheless, there still remain some sleeping quarters in the yards, and should be removed. We have not been able to attain this result, and Congress' involvement is needed.

CONCLUSION

We recognize that this testimony is very detailed. However, we believe that the Committee should have a full understanding of the fatigue issues when deliberating on proposed changes to the hours of service laws. We urge you to give the Secretary only limited authority to regulate hours of service. That is, give the Secretary authority to regulate fatigue, and at the same time retain the existing

statutory protections that rail fought for many years to obtain. In addition we are seeking needed changes to deadhead transportation provisions, undisturbed rest, and removal of existing sleeping quarters from the yards.

Statement by Congressman Jerry F. Costello
Committee on Transportation and Infrastructure
Subcommittee on Railroads, Pipelines, and Hazardous Materials
Hearing on Fatigue in the Rail Industry
February 13, 2007

Thank you, Madame Chairwoman, for calling this hearing. Fatigue is an issue that affects all modes of transportation, including aviation, rail, trucking, and oceangoing and coastwise vessels. This is an important safety issue and I am glad Chairwoman Brown has called this hearing so we can examine fatigue in the rail industry. I would like to welcome today's witnesses.

Work undertaken on our railroads can occur at any time during the day or night, in difficult circumstances and against demanding work schedules. Fatigue is foreseeable in such circumstances and, if not adequately controlled, can lead to human error and accidents as seen in the Macdona accident.

Rail is extremely important to my state of Illinois and our nation and we must place rail safety at the top of our priority list. It should be telling that the National Transportation Safety Board (NTSB) has placed rail fatigue on the NTSB's Most Wanted list of safety improvements since its inception in 1990. We must and can do better. We must continue to push for new rail

precautions and enforce higher safety standards to protect workers, passengers and communities that host rail traffic.

In addition, technological improvements, such as positive train control (PTC), are an advanced train control technology that can prevent collisions with automatic brake applications. I am pleased the PTC technology is currently being testing in my home state of Illinois and is being sponsored by the Illinois Department of Transportation, the FRA and the freight railroads acting through the Association of American Railroads (AAR). PTC is critical to increasing safety and that is why it remains on the NTSB's Most Wanted list of safety improvements.

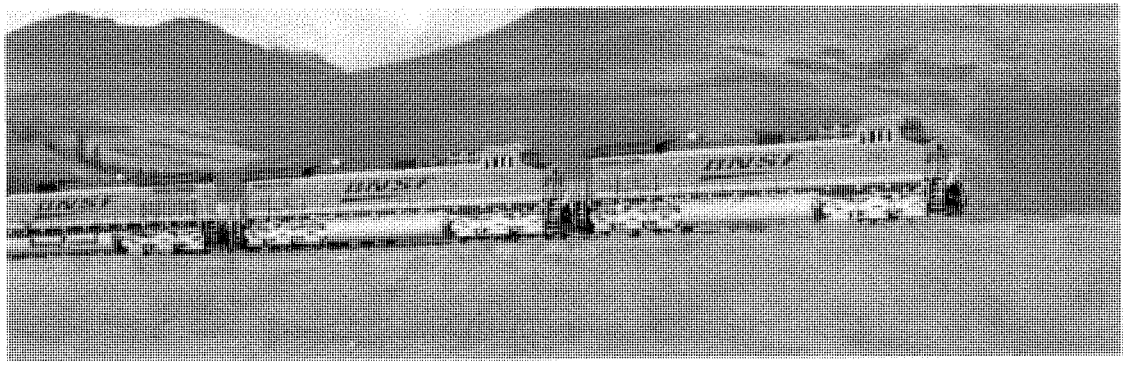
I am interested in learning more about practical changes we can make to our hours of service laws for our rail employees that will dramatically reduce fatigue and improve safety.

Again, I look forward to the testimony of today's witnesses.

BNSF Railway

BNSF Fatigue Strategy
M. David Dealy
Vice President, Transportation
BNSF Railway
Before the
U.S. House of Representatives
House Transportation and Infrastructure Committee
Subcommittee on Railroads, Pipelines, and Hazardous Materials
Hearing on Fatigue in the Rail Industry
February 13, 2007

BNSF RAILWAY



BNSF Fatigue Strategy
Railroad Operations Since 1972

Railroad operations have changed significantly since Hours of Service law last revisited in 1972

- Thirty years ago.... Box car trains... balanced train flows over relatively short distances (100 to 125 miles).
- Today.... Network of long distance trains loaded with double-stacked international shipping containers, unit coal and grain trains moving distances of over 2,000 miles... variability and complexity... assigned crew districts of greater than 260 miles in places.
  - Compared to shorter runs of 30 years ago, many of our employees can make the equivalent of six days' pay in one round trip, allowing them to be at home 2 to 3 days between trips.

BNSF RAILWAY

1

BNSF Fatigue Strategy
Primary Issues

Guiding principles of the BNSF fatigue strategy are primarily centered around the following work and rest issues

- Variability in work schedules
- Variability in working hours
- On-duty hours
- Consecutive days
- Getting employee back to home terminal
- Employees need to rest when off-duty

BNSF RAILWAY

BNSF Fatigue Strategy
Scope of Fatigue

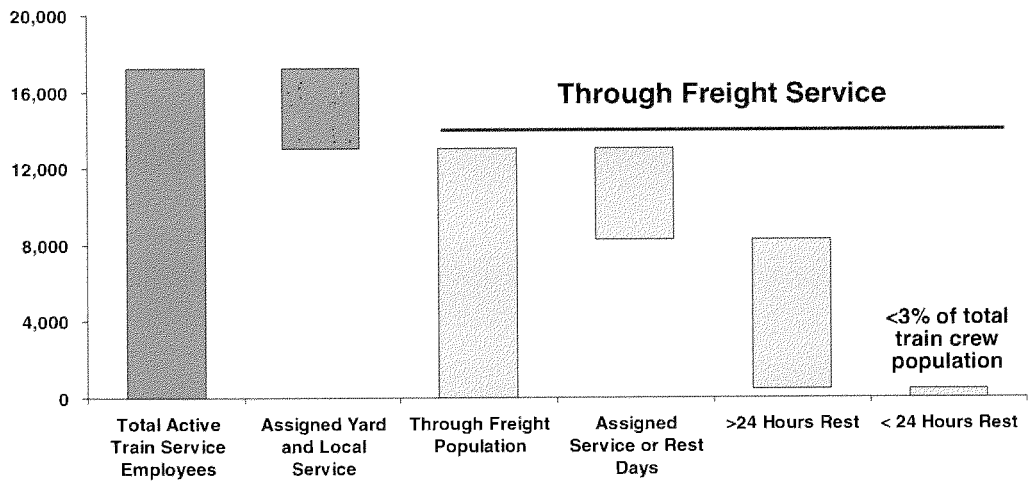
Scope of fatigue due to scheduling is small

- Due to present day BNSF scheduling practices, only a small number – approximate 500, or 3%- who are offered scheduled rest days opt not to accept them. All others have assigned days off or scheduling that allows them 24 hours rest.
- This 3 percent of our employee population work in short crew districts, which means that they seek to take more trips in order to maximize income.
- This small employee population is an important focus of the BNSF fatigue strategy.

BNSF RAILWAY

BNSF Fatigue Strategy
Targeted Population

Primary focus is on crews most impacted; those in non-assigned service with less than 24 hours rest at the home terminal



BNSF RAILWAY

BNSF Fatigue Strategy

BNSF's approach to fatigue is focused in four primary areas:

- **Agreements**
- **Processes**
- **Education**
- **Environment**

BNSF RAILWAY

5

BNSF Fatigue Strategy
Agreements

Over time, BNSF has negotiated many industry leading fatigue agreements with labor

- Agreements have been negotiated to allow employees to have the irrevocable opportunity to rest
- Agreement evolution:
  - Booking 14' rest
  - Work/rest cycle agreement
  - 8' undisturbed rest
  - 5/2 yard agreement
  - 7 a.m. markup
  - No call agreement
  - Foot of the board
- Adoption of agreements has been slow in some geographic areas

BNSF RAILWAY

BNSF Fatigue Strategy
Processes

Processes and policies revolve around improved execution by management

- Improved execution:
  - Increasing number of crews to their tie-up point within their 12 hours
  - Improving line-up accuracy
  - Maintaining adequate manpower supply
- Other:
  - Sleeping on-duty policy in place system-wide since 1997
  - Employees allowed to mark-off fatigue

BNSF RAILWAY

BNSF Fatigue Strategy
Education

BNSF adopted fatigue related educational programs beginning in 1997 and has routinely enhanced the content

- CBT training and recertification process in place
  - Explains science behind fatigue and alertness
  - Applies information to improving sleep and alertness
  - Recommends alertness strategies
- Informational website in creation in association with AAR and labor union Work Rest Task Force
- Sleep disorder communications released in conjunction with National Sleep Week
- Fatigue symposium to be held in conjunction with Intermodal Transportation Institute

BNSF RAILWAY

8

BNSF Fatigue Strategy
Environment

Work and rest environment can play a key role in ensuring adequate alertness

- Lodging standards:
  - Minimum lodging standards are outlined in existing labor agreements
  - BNSF has created additional standards that exceed our agreements
  - Routine audits take place to ensure compliance to those standards
- Cab environment:
  - BNSF has a cross-functional cab committee comprised of labor and management.
  - Cab committee has worked with manufacturers to design and incorporate changes promoting safety and functionality

BNSF RAILWAY

BNSF Fatigue Strategy
Conclusion

- Much has been done in the area of fatigue
- Railroad operations are complex
- Solutions can't be "one size fits all"
- BNSF and its employees represented by the BLET and UTU will continue to fine tune agreements already in place.

BNSF RAILWAY

STATEMENT OF

EDWARD R. HAMBERGER
PRESIDENT & CHIEF EXECUTIVE OFFICER
ASSOCIATION OF AMERICAN RAILROADS

BEFORE THE
U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON TRANSPORTATION AND INFRASTRUCTURE

SUBCOMMITTEE ON RAILROADS, PIPELINES, AND HAZARDOUS MATERIALS

HEARING ON FATIGUE IN THE RAIL INDUSTRY

FEBRUARY 13, 2007

Association of American Railroads
50 F Street NW
Washington, DC 20001
202-639-2100

Introduction

On behalf of the members of the Association of American Railroads (AAR), thank you for the opportunity to discuss issues surrounding rail safety, the Hours of Service Act, and fatigue in the rail industry. AAR members account for the vast majority of freight railroad mileage, employees, and traffic in Canada, Mexico, and the United States.

Railroads want properly rested crews: it is not in a railroad's best interest to have employees who are too tired to perform their duties properly. That's why railroads have long been working diligently to gain a better understanding of fatigue-related issues and find innovative, effective solutions to fatigue-related problems. In the interest of managing fatigue-related railroad issues, railroads have adopted a set of principles (listed later in this testimony) to guide such efforts.

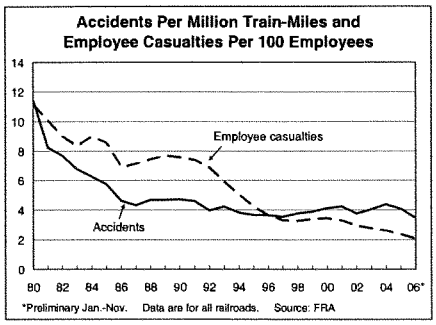
As explained in more detail below, although railroads have made substantial progress in combating fatigue in the rail workplace, it is clear that factors that can result in fatigue are multiple, complex, and frequently intertwined. Consequently, efforts to combat fatigue should be based on sound scientific research — and not on anecdotes or isolated events. There is no single, easy solution to fatigue-related problems.

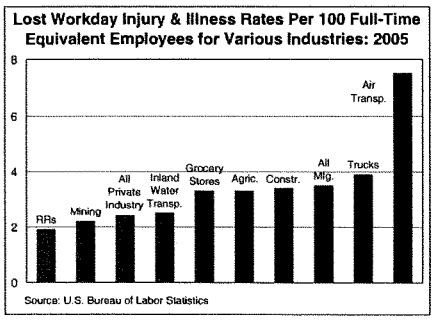
That said, railroads agree that a careful reassessment of the Hours of Service Act (HSA) — the statute that governs the on-duty time of rail employees involved in operating trains — is appropriate in addressing fatigue. Currently, under the HSA, train crews must go off duty after 12 consecutive hours on the job, and then must have at least 10 consecutive hours off duty. If crews go off duty after less than 12 hours on the job, they must have at least 8 consecutive hours off duty. Railroads are willing to provide crews with more off-duty time than these statutory minimums and are willing to require employees to take time off for rest opportunities.

Combating fatigue is a shared responsibility of railroads and individual employees. Railroads are willing to work cooperatively with rail labor and with policymakers to find ways to combat fatigue, while ensuring that U.S. freight railroads continue to provide the cost-effective and efficient freight rail service that is so important to our economic health and standard of living.

Overview of Rail Safety

The overall rail industry safety record is excellent, reflecting the extraordinary importance railroads place on safety. As a Federal Railroad Administration (FRA) official noted in Congressional testimony last week, "The railroads have an outstanding record in moving all goods safely." From 1980-2005, railroads reduced their overall train accident rate by 64 percent and their rate of employee casualties by 79 percent.





And rail safety is continuing to improve. Data for 2006 through November show continued improvements in the three major rail safety measures, with record lows for the train accident rate, the employee casualty rate, and the grade crossing incident rate. Railroads have lower employee injury rates than other modes of transportation and most other major industry groups, including agriculture, construction, manufacturing, and private

industry as a whole. Available data also indicate that U.S. railroads have employee injury rates well below those of most major foreign railroads.

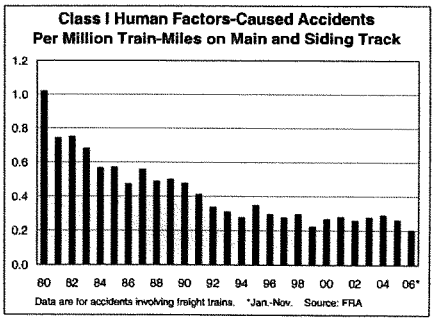
Railroads are also far safer than trucks. Rail freight transportation incurs less than one-fifth the fatalities that intercity motor carriers do per billion ton-miles of freight moved.

Background on Rail Accidents Caused by Human Factors

According to FRA data, human factors (*i.e.*, human errors) constitute the largest category of train accidents, accounting for 38 percent of all train accidents from 2001 to 2005.

Given the extent and complexity of rail operations — the U.S. freight railroad "factory floor" is outdoors and nearly 141,000 miles long — the potential for rail accidents always exists. And while railroads respect and applaud the professionalism and attention to safety that rail employees bring every day to their jobs, people may sometimes make mistakes.

Over the past decade, the rate of rail accidents caused by human factors has stayed relatively constant, and in 2005 was 53 percent lower than it was in 1980. In addition, many human factor-caused accidents are low-speed yard accidents, which incur substantially lower damage and casualties. The rate of human factors-caused accidents involving freight trains on main and siding track in 2006 through November was 80 percent below its 1980 level and 58 percent below its level in 1990. Because of the more standardized work environment in yards and terminals, fatigue issues come into play most predominantly on mainline, long-distance trains. However, safety data indicate that the human factors-related accident rate (which include accidents caused by fatigue) on main lines has greatly improved.



Nevertheless, railroads agree that they, rail labor, and the FRA must continue to try to reduce the frequency of accidents caused by human factors.

Background on the Hours of Service Act

As members of this committee know, the on-duty time of rail employees involved in operating, dispatching, and signaling trains is governed by statute — specifically, the Hours of Service Act (HSA), now codified as 49 U.S.C. 21101-21108.

Under the HSA, rail employees that operate trains (*i.e.*, conductors and engineers) must go off duty after 12 consecutive hours on the job, and then must have at least 10 consecutive hours off duty. If they go off duty after less than 12 hours on the job, they must have at least 8 consecutive hours off duty. On-duty time starts the minute the employee reports for duty and includes any work that involves engaging in the movement of a train and deadhead transportation to a duty assignment. Off-duty time starts when the employee is released from duty, generally at a designated terminal or place of lodging.

For dispatchers, a workday is limited to nine hours in a 24-hour period where two shifts are used, or 12 hours over the same period when there is only one shift.

Finally, signal employees can work a maximum of 12 consecutive hours on duty, followed by at least 10 consecutive hours off duty.

Railroads must keep detailed records specifying when each covered employee is on duty or off duty. Violations of the HSA can result in fines of between $500 and $10,000 per violation, with each employee considered a separate violation.

To comply with the HSA and still operate as a highly-competitive 24-hours per day, 7-days per week industry, freight railroads try to schedule crew assignments with as much precision as possible. Unfortunately, the nature of rail operations makes precision extremely difficult to achieve.

Most people are familiar with passenger modes of transportation, and that familiarity at times slants our thinking about how freight railroads do and should operate. A single flight crew, for example, will typically fly a plane from, say, Los Angeles to Washington. Occasionally, weather or other problems might impact airline schedules, but by and large passenger airlines are able to offer predictable, regularly-scheduled service.

Generally speaking, freight railroads are quite different. Unlike airlines, freight railroads require multiple crew changes to move commodities across the country. Railroads must use multiple local and yard assignments to gather freight at the beginning of a trip, then use multiple crews to move it across the country, and then use more local crews to deliver the freight to its final destination.

Where appropriate and practicable, train scheduling is being implemented and can have positive impacts on fatigue. However, because of the nature of some rail systems, trains in many cases cannot run on a precise schedule.

There are numerous reasons for this. For example, railroads are a derived demand industry: they move traffic that is tendered to them, and the volume of traffic tendered is influenced by a huge variety of factors — *e.g.*, the state of the economy, customer operating and delivery cycles, conditions in specific industries, the time of year, and the time of day. These factors mean that the volume of rail traffic on the U.S. rail network on one day of the year can vary by tens of thousands of carloads and intermodal units compared to another day.

These variances are driven by myriad external market forces over which railroads have no control, such as the arrival (and severity) of summer weather (and increased demand for coal to fuel power plants); the size and timing of grain and other agricultural harvests; the approach of Christmas season when retailers are stocking their inventories; factory ramp-ups and temporary shutdowns; ocean vessel arrivals and departures; the status of export markets

for coal, grain, and other products; and even interest rates, which affect sales volumes of automobiles and home building materials, among many other things.

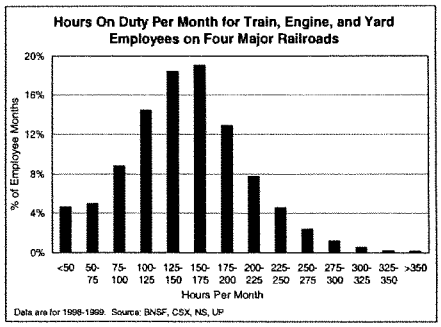
These variances mean that a different number of trains must be operated from one time period to the next, which in turn impacts the number of crews needed.

In addition to carload variances, weather conditions, track maintenance, accidents, track congestion, and dozens of other events or circumstances can delay a particular train's progress, thus impacting the time that other crews will be needed. For example, when a motor vehicle goes around crossing gates and is hit by a train, not only might that train be delayed for several hours, but all trains behind it and other trains approaching from the opposite direction might be delayed as well. Crews at the next terminal are unexpectedly delayed in terms of when they go to work.

Thus, there is considerable volatility in railroad crew needs on a daily, weekly, and monthly basis. Indeed, there is probably no other industry with scheduling volatility as pronounced as freight railroading.

In addition, the existing hours-of-service regime is embedded in many existing collective bargaining agreements, including provisions on crew calling and pay scales.

Crew calling is the procedure by which engineers and conductors are required to be available for duty and are called to report for duty. Railroads try to provide employees as much advance notification as is practical, but, again, the nature of rail operations and the fact that most rail operating employees bid into a seniority-based pool system from which they are drawn in a complex rotating order makes precise scheduling impossible to achieve. This pool system is an integral part of collective bargaining agreements between rail management and rail labor.



Some have pointed out that a rail employee could work 432 hours per month and still be in compliance with the HSA. Theoretically, that's true, but there is a huge difference between theory and practice, and in fact we know of no cases where this has occurred. As the accompanying chart shows, the overwhelming majority of railroad train, engine, and yard employees are on duty each month for periods comparable to most other U.S. workers. Some 83 percent of these rail workers are on duty less than 200 hours per month and more than 95 percent are on duty less than 250 hours per month. Fewer than 1 percent of employees are on duty more than 300 hours per month.[1]

Of course, on-duty time does not equate to time actually operating a train, which is typically much less. For example, under the statute and FRA interpretations, "on duty" time can include activities such as attending a safety briefing before or after leaving a train, being transported to trains, and making computer entries. Time spent on these activities is treated the same as time spent running a train.

Railroads believe that a recent study of crews operating in the busy western U.S. coal fields in 2004-2005 reveals what rail employees typically face in terms of hours worked. The study of more than 11,000 crew starts by 150 employees during a 10-month period found that the average time on duty was 9.5 hours with an average of 25 hours off duty between trips.

[1] The data referenced in this paragraph cover 1998-1999. Recent analysis reveals that the average hours worked per year for train and engine employees have increased only slightly between 1998-1999 and 2005. Thus, the relationships noted above are believed to be valid today.

Combating Fatigue in the Rail Industry

As noted at the beginning of this testimony, it is clearly not in the best interest of railroads to have employees who are too tired to perform their duties properly. That's why railroads have long partnered with their employees to gain a better understanding of fatigue-related issues and combat fatigue-related problems. However, because factors that can result in fatigue are multiple, complex, and frequently intertwined, there is no single solution.

Scientific research to date suggests that flexibility to tailor fatigue management efforts to address local circumstances is key to the success of these programs. Significant variations associated with local operations (*e.g.*, types of trains, traffic balance, and geography), local labor agreements, and other factors require customized measures. Consequently, a one-size-fits-all regulatory or legislative approach is unlikely to succeed as well as cooperative efforts tailored to individual railroads.

Railroads recognize that combating fatigue is a shared responsibility. Employers need to provide an environment that allows the employee to obtain necessary rest during off-duty hours, and employees must set aside time when off duty to obtain the rest they need.

Since 1992, the AAR, the Brotherhood of Locomotive Engineers, and the United Transportation Union have addressed fatigue through the Work/Rest Task Force. The Task Force members share information about fatigue countermeasures. Periodically, the Task Force publishes a compendium of railroad initiatives. A revised compendium has recently been completed.

Different railroads employ different fatigue countermeasures, or the same counter-measures in different ways, based on what they've found to be most effective. Not every countermeasure is appropriate for every railroad, or even for different parts of the same railroad, because the effectiveness of various fatigue countermeasures is critically dependent

on the circumstances unique to each railroad. A list of countermeasures that are used by one or more railroads includes:

- Increasing the *minimum number of hours of rest* at both home and away from home terminals.
- Implementing a *morning return* to work time if off work more than 72 hours.
- Evaluation of a system to *identify relative levels of fatigue* in different locations using a work schedule model.
- Evaluation and adoption of a sophisticated *fatigue modeling computer program* that allows users to vary shift lengths, duration of off-duty time, and the like to determine which set of variables is likely to induce the least amount of fatigue at a particular location. Employees and their labor representatives at several locations have been given a copy of the model and training in its use in order to test prospective countermeasures from the perspective of fatigue and lifestyle.
- Fatigue identification and avoidance *training information* for employees and families.
- Permitting *napping* by train crew members under limited circumstances (*e.g.*, when a train is expected to remain motionless for a minimum period of time)
- *Sleep disorder screening.* Recognizing that some employees with sleep disorders may be reluctant to come forward for treatment for fear of their livelihood, in 2005 railroads and labor produced and circulated a statement saying that a sleep disorder will be addressed no differently than any other medical condition that might affect job performance — namely, individual evaluation by medical professionals for diagnosis and treatment.
- *Improved standards* for lodging at away-from-home facilities that provide black out curtains, white noise, and increased soundproofing.
- Railroads have devised a number of systems, including web sites and automated telephone systems, to *improve communication* between crew callers and employees. Union Pacific, for example, has developed a customized notification process allowing employees to specify how (cell phone, text message, e-mail) they want to be notified. They can also specify "when" to be notified — *i.e.*, when the number of employees ahead of them drops to a level that the employee specifies.

Railroads and unions have agreed in some cases to additional scheduling tools where such tools are feasible and will provide for an improved opportunity for rest. They include:

- Enhanced emphasis on *returning crews home* rather than lodging them away from home. CN, for example, uses this practice for many of its road train

crews as a result of its scheduled turn around service and the hourly collective bargaining agreements it has in place.

- Providing more predictable *calling windows* and rest opportunities between shifts. For example, a significant number of Norfolk Southern crews know within a narrow window when their next assignment will begin.
- Providing for a *set number of days off* after being available for a given number of days. For example, at some 200 crew locations covering thousands of employees, BNSF has implemented a scheduling policy that provides three set days off after seven days of work. These provisions required local union agreements at the various locations and were implemented with union agreement and participation.
- Allowing employees to request an *extra rest period* when they report off duty.

Again, these various countermeasures may be appropriate and practical in some situations for some railroads, but not for others. Each railroad works carefully to craft particular fatigue countermeasures to match the particular circumstances it faces.

In addition, AAR member railroads offer fatigue education programs for employees and their families, including individualized coaching to assist employees in improving their sleep habits.

The importance of education in this area cannot be overstated, since the value of fatigue-related initiatives is highly dependent upon the actions of employees while off duty. Many employee actions while off duty (for example, working second jobs) can contribute to fatigue, and railroads have little control over these actions. The most important time frame that affects fatigue on the job are the hours prior to going on duty. Employees must make proper choices regarding how they utilize their off-duty time, and education of the entire family is important in encouraging sound decision making.

An educational web site designed solely for railroads and rail employees is under development by the Class I railroads in partnership with the American Short Line and Regional Railroad Association and the American Public Transportation Association. The

purpose of this tool is to provide general information to employees about alertness and to identify possible sleep disorders. The site will include a self-assessment tool and an explanatory letter about sleep disorders that employees can take to their physicians.

Another part of the web site will include existing educational programs (videos, pamphlets, etc.) that subscribers can exchange. An expert scientific panel has been formed to review content. The panel includes Dr. Greg Belenky, Director of the Sleep and Performance Research Center at Washington State University Spokane; Dr. Simon Folkard, Emeritus Professor, Department of Psychology, University of Wales Swansea; and Dr. Ann M. Williamson, Associate Professor and Deputy Director, NSW Injury Risk Management Research Center, University of New South Wales.

It is important to remember that there is no single solution to the issue of fatigue. It must be, and is being, attacked on multiple fronts. Railroads agree with the National Transportation Safety Board that it is a "...shared responsibility of the carrier to provide an employee the opportunity for adequate sleep and of the employee to acquire sleep sufficient to work at a safe level of alertness..."

What Should (and Should Not) Be Done

As detailed above, railroads are heavily involved in efforts to better understand and combat fatigue in the workplace, and have made many advances within the current framework of the HSA. They favor continued research on the subject and will continue to work with rail labor to find and implement new ways to combat fatigue.

Railroads agree that changes in the HSA might help reduce fatigue in the rail workplace. However, railroads urge extreme caution in amending the HSA. If not carefully thought out, new fatigue-related regulatory or statutory mandates may not achieve the goals they are designed to achieve.

This is so for a variety of reasons. First, a single set of mandates cannot take into account the widely-varying circumstances found on individual railroads. For example, operating characteristics vary widely between freight, intercity passenger, and commuter railroads, and within railroads in each of these categories.

Second, collectively-bargained labor agreements must be taken into account when addressing fatigue. Labor agreements commonly include provisions governing seniority, income, methods of calling crews to duty, and many other matters that impact how often particular employees work. These agreements differ from one locale to another.

Moreover, rail operating crew pay scales typically reflect pay premiums for work beyond specified thresholds. This is why rail unions have traditionally resisted modifications to the HSA that would limit the freedom of their members, if they so choose, to maximize hours worked (within the limits of the HSA) and thereby maximize earnings.

The conflict between collectively-bargained agreements and government regulation is exemplified by the case of railroad signal employees, who install and maintain signal systems that direct the movement of trains. To enable signal employees to finish their work at far-away sites without having to commute multiple times, railroads and signal employees historically have agreed to work schedules of eight consecutive work days (ten hours each day, not including extended work days in emergency situations) followed by six consecutive days off. Although these work schedules are permitted under the HSA and would result in much less total off-duty travel time for employees working a substantial distance from home, they are not permitted by Federal Motor Carrier Safety Administration (FMCSA) hours-of-service regulations, which apply to the many railroad signal employees who drive commercial vehicles to perform their duties.

For several years, railroads and rail labor (through the Brotherhood of Railroad Signalmen) have petitioned FMCSA to allow the Congressionally-imposed requirements of the HSA to take precedence over FMCSA's hours of service requirements. To date, FMCSA has refused. Railroads respectfully urge members of this committee to encourage FMCSA to accede to this reasonable request.[2]

Third, regulations could stifle needed innovation. Rail labor and management are constantly gaining knowledge in the area of fatigue, especially practical experience from projects they have begun. Flexibility is needed to facilitate new projects and changes in existing ones, but regulations could "lock in" procedures and preclude innovations.

Fourth, nonproductive work/rest rules could impair the railroads' ability to provide efficient, cost-effective service to their customers. Unproductive regulations could hinder rail service without improving safety.

These important caveats notwithstanding, railroads are amenable to a careful reexamination of the HSA's statutory limitations. Several key principles should be kept in mind:

- Railroads want fully rested crews.
- After 12 hours of service, crews in limbo time should receive additional rest after limbo time.
- To the extent practicable, fatigue management policies should be based upon scientific research.
- Railroads are willing to provide more than the statutorily-required rest time at both home and away terminals to assure that crews are fully rested.
- Railroads are willing to require employees to take time off for rest opportunities.
- Fatigue management issues are a joint responsibility of the railroad and individual employees.

[2] I testified on this issue to this committee on June 22, 2000. On August 21, 2001, several members of this committee wrote to then-DOT Secretary Norman Mineta asking him to require that the FMCSA's hours of service requirements not apply to railroad signal employees.

"Limbo Time"

As noted earlier, the Hours of Service Act limits the number of hours that train crew employees can remain on duty. At times, though, a train may be unable to reach its scheduled (or even a convenient) crew change point within its crew's allotted 12 hours. When this happens, the crew becomes "outlawed" and must immediately stop the train and wait for a new crew to replace it. Transportation of the replacement crew to the train, and of the outlawed crew from the train to a designated location where it is released from duty[3], is called "deadhead" transportation. Deadhead transportation is typically provided by other rail personnel or by private contractors hired by railroads for this purpose.

For purposes of the Hours of Service Act, once a replacement crew reports for duty, the time it spends waiting to be taken to a duty assignment, and the time it spends being transported, count as time on duty. However, time that outlawed crews spend waiting for deadhead transportation, and the time they spend being transported to where they are released from duty, count as neither time on duty nor time off duty. Instead, this time is considered "limbo time." Employees' off-duty rest time begins only after they are released from duty.

The concept of limbo time was created in an amendment to the HSA passed by Congress in 1969. Prior to then, time spent deadheading from a duty site to a terminal counted as off-duty time. As a result, employees often spent some of their off-duty time not resting, but deadheading. When the 1969 legislation was being debated, rail unions claimed that all time spent deadheading should be classified as time on duty. Railroads disagreed with respect to time spent deadheading from a duty site, on the grounds that counting this as limbo time (rather than off-duty time) eliminated the chance that deadheading would contribute to

[3] For example, to a terminal or a place of lodging.

greater fatigue. Moreover, it was recognized that if time spent deadheading from a duty site were counted as on-duty time, railroads would have to calculate the approximate deadheading time and stop the train early enough to take account of that interval. Any miscalculation would lead to a violation of the HSA. This would create significant operating difficulties for railroads, substantially increase railroad costs (that rail shippers would have to cover), and reduce the efficiency of freight transportation.

The enacted statute — on duty at a shift's beginning, limbo time at its end — is consistent with the FRA's position since 1969, except for a brief period in the 1990s.[4]

Rail employees are paid for limbo time. Nevertheless, rail labor has long tried to convince railroads, regulators, legislators, and, in 1995, the U.S. Supreme Court, that limbo time should be abolished altogether, or at least for the time an outlaw crew spends waiting for deadhead transportation. According to this argument, whenever more than 12 hours elapses from the time a crew reports for duty to the time it is formally released from duty at a designated location, it is a violation of the HSA.

Railroads strongly disagree with this view. As the Supreme Court noted in its 1996 decision[5], on-duty time typically includes those hours that contribute to an employee's fatigue during his or her shift. Thus, time spent waiting for deadhead transportation to a duty site is properly classified as on-duty time because, along with the time spent in transportation itself, it contributes to employee fatigue during the work assignment. But time spent waiting for

[4] In 1990, rail labor filed suit in California and Oregon claiming that time spent waiting for deadhead transportation from a duty site is time on duty under the HSA. The Court of Appeals for the Ninth Circuit agreed. For the sake of national uniformity, the FRA then decided to apply the Ninth Circuit's interpretation of the HSA nationwide. In response, several major railroads sought review, in the Court of Appeals for the Seventh Circuit, of the FRA's order changing its interpretation. The Seventh Circuit rejected the Ninth Circuit's interpretation. The FRA then switched back to its original position that time spent waiting for deadhead transportation from a duty site is limbo time. Rail labor then appealed to the U.S. Supreme Court, which, in a unanimous 1996 decision, affirmed the Seventh District ruling.

[5] Brotherhood of Locomotive Engineers v. Atchison, Topeka & Santa Fe R. Co, 516 U.S. 152 (1996).

deadhead transportation away from a duty site and time spent in deadhead transport do not cause fatigue that implicates safety concerns. This is so because no matter how much time employees must spend deadheading from a duty site, they still must receive the requisite off-duty time once they are released from duty and before beginning a new shift. Consequently, as long as crew members are not engaged in or connected with the movement of a train, time spent waiting for deadhead transportation from a duty site and time in the deadhead transportation itself should not count as on-duty time.

Moreover, classification of limbo time as on-duty time would impose on railroads the very scheduling problems that Congress sought to avoid when it created limbo time in 1969. As noted earlier, if time spent deadheading from a duty site were counted as on-duty time, railroads would have to calculate the approximate deadheading time and stop the train early enough to take account of that interval. The creation of limbo time solved the problem of the employee who was forced to spend some of his or her off-duty rest time in deadhead transportation, but it did so without imposing intractable scheduling burdens on railroads that would do nothing to improve safety but would lead to significant inefficiencies and higher costs for rail customers and the economy at large.

Conclusion

Railroads' commitment to safety is absolute. Indeed, through massive investments in safety-enhancing infrastructure and technology; employee training; cooperative efforts with labor, suppliers, customers, communities, and the FRA; cutting-edge research and development; and steadfast commitment to applicable laws and regulations, railroads are at the forefront of advancing safety.

Combating fatigue is a shared responsibility. Railroads recognize that they must ensure that employees have sufficient opportunity to rest, and they are open to reasonable

changes to the HSA to help assure this outcome. For their part, employees are responsible for using a sufficient amount of the time made available to them for rest. No legislative, regulatory, or corporate measure can make employees devote their time to any particular activity.

Railroads and their employees are best able to design tailored fatigue countermeasures to match particular situations. Ill-considered blanket statutory or regulatory requirements under the guise of fatigue management could undercut the cooperative efforts of rail labor and management by eliminating the flexibility necessary to test and implement custom-tailored, effective fatigue management programs.

PREPARED STATEMENT OF STEVEN R. HURSH, PH.D., PRESIDENT, INSTITUTES FOR BEHAVIOR RESOURCES, BEFORE THE COMMITTEE ON TRANSPORTATION AND INFRASTRUCTURE'S SUBCOMMITTEE ON RAILROADS, PIPELINES, AND HAZARDOUS MATERIALS FEBRUARY 13, 2007

Good afternoon, Madame Chairwoman and Ranking Member Shuster, and other members of the Subcommittee. Thank you for inviting me to testify before you on the important subject of fatigue in the rail industry. My remarks can be divided into two distinct sections. The first section will summarize for the subcommittee the important findings of a study just completed on using a biomathematical model to predict fatigue related accidents in freight rail operations. This study was funded by the Federal Railroad Administration (FRA) and the official report was coauthored with two members of the FRA staff. My summary today should be considered my personal reporting, summary, and interpretation and not the official report of the FRA. The second section of my remarks outlines some general concepts for an evidence-based fatigue management approach that may be applied in the rail industry. I offer these concepts for the Subcommittee's consideration as it deliberates on actions that Congress might take to address this problem. Again, these remarks are entirely my own and do not necessarily represent the opinion of anyone within the FRA or the official position of the FRA.

Fatigue as I shall be using the term is a complex physiological state characterized by a lack of alertness and reduced mental performance, often accompanied by drowsiness. Fatigue is clearly more than "falling asleep at the switch"; fatigue causes a range of performance changes:

- Operator inefficiencies and performance errors
- Lapses in attention and vigilance
- Delayed reactions
- Impaired logical reasoning and decision-making
- Reduced "situational awareness"
- Low motivation to perform "optional" activities, such as check-lists
- Poor assessment of risk or failure to appreciate consequences of action

Many of these changes in performance can occur before a person is aware that changes have taken place; people are notoriously poor judges of the adequacy of their own performance. Yet, the factors that cause fatigue have been extensively studied and the scientific community has identified two main factors that cause fatigue: a) the amount and pattern of sleep, and b) time of day, the "body clock" or circadian rhythm. However, there is no blood test for fatigue; we do not know yet how to determine a person's state of fatigue from a physiological marker, like a "breathalyzer" for alcohol.

In the absence of a physiological marker, there are several ways to assess a person's level of fatigue: a) conduct a performance test to see if performance capacity has deteriorated, b) test to see how long it takes the person to go to sleep – a short sleep latency is indicative of a fatigued state, or c) do an assessment of the person's likely level of performance and fatigue using a biomathematical model based on the person's history of sleep and the time of day. Approaches

like the first two are most accurate for individual assessment but impractical for the work environment because they require a series of laboratory-type tests; the modeling approach is less accurate for any specific individual but can be applied without requiring tests of each person in the work place. The modeling approach is ideal for rapid and unobtrusive group level assessment of fatigue and gives the manager an objective and comprehensive fatigue risk assessment based on readily available work schedule information.

The FRA has recognized the potential of fatigue modeling as a way to provide industry a practical and objective metric for assessing fatigue based on work/rest schedules. As a consequence, the FRA has sponsored a study to test the validity of a fatigue model as a predictor of railroad accident risk. If such a tool could be shown to effectively assess the fatigue factor in human factors accidents, then the model could be used to guide operational decisions to reduce fatigue. A validated model can be applied with the confidence that operational changes that reduce predicted fatigue will improve safety by reducing a proven factor in accidents. The FRA considers the validation and calibration of a fatigue model to be a key component of the National Rail Safety Action Plan because it would provide industry a much needed objective tool to assess and manage fatigue.

Summary of the Study to Validate and Calibrate a Fatigue Assessment Tool

In this section, I will summarize the findings of a recently completed study to validate and calibrate a fatigue model as a tool for fatigue assessment and management. The following brief summary is based on the "Validation and Calibration of a Fatigue Assessment Tool for Railroad Work Schedules, Summary Report" published by the FRA dated October 31, 2006 and available from the FRA website. I am the lead author of the report and it is co-authored by two members of the FRA staff, Dr. Thomas Raslear and Mr. Scott Kaye, aided by a statistical analyst, Mr. Joseph Fanzone. This summary is my personal interpretation of those findings and not the approved position of the FRA.

Biomathematical fatigue models allow the objective assessment of fatigue so that employees and employers can schedule work and rest to minimize the degradation of operator performance by fatigue. To be useful, a fatigue model must be validated. Validation means that the model must be a predictor of fatigue-related performance errors. Moreover, a model should be calibrated. Calibration means that the predictions from a model can be related to the level of risk of failures of human performance. One method of validating and calibrating a biomathematical fatigue model is to demonstrate that the model can predict an increased likelihood of human factors accidents relative to nonhuman factors accidents under conditions of fatigue. A valid fatigue model should predict higher levels of fatigue (based on opportunities to sleep and an accident's time of day) when there is an increased risk of accidents and this relationship should be especially strong for human factors accidents, as opposed to accidents caused by equipment or track failures. The Federal Railroad Administration (FRA) Office of Research and Development and the Office of Safety have partnered with the railroad industry to demonstrate a method to validate and calibrate fatigue models. This study collected 30-day work histories of locomotive crews prior to 400 human factors and 1000 nonhuman factors accidents to demonstrate this validation method. A total of over 1 million 30-minute work intervals before the accidents, covering over 57,000 work starts, were evaluated for effectiveness (the inverse of

fatigue) predicted by the Sleep, Activity, Fatigue, and Task Effectiveness (SAFTE) model using the Fatigue Avoidance Scheduling Tool (FAST). The model analyzed effectiveness during all work intervals to serve as the baseline of exposure to various levels of effectiveness and estimated effectiveness at the time of each accident. These calculations were the basis for calculation of accident risk as a function of effectiveness scores. Effectiveness is a predictor of speed of reactions and vigilance based on laboratory tests and is inversely related to fatigue. The following chart, Figure 1, gives examples of typical effectiveness scores and relates them to another measure of fatigue, the likelihood of having a lapse in attention.

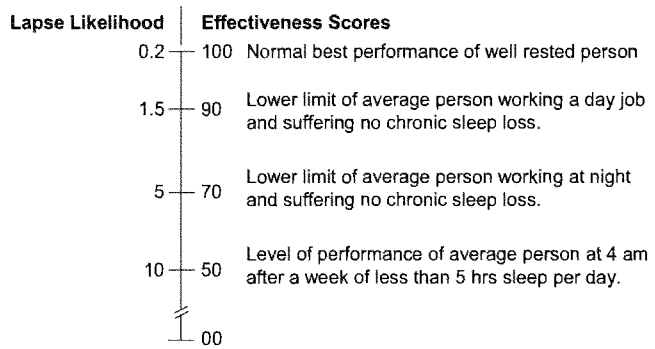


Figure 1: Effectiveness and lapse likelihood scores

Risk was defined as the proportion of human factors accidents that occur at a particular level of effectiveness divided by the proportion of time working at that level of effectiveness (exposure level). For example, if 5% of work times occur with effectiveness below 60 but 10% of human factors accidents occur with effectiveness below 60, then that would represent a doubling of risk when effectiveness is predicted to be below 60. A fatigue model is deemed to be valid if reductions in effectiveness scores (or increases in predicted fatigue) are reliably related to consistent increases in human factors accident risk, without similar consistent changes in nonhuman factors accident risk.

The results of the study indicated that the biomathematical fatigue model met the criteria for validation and the results were statistically reliable. The following chart (Figure 2) indicates that as effectiveness scores decreased, the risk of having a human factors accident increased. The relationship was statistically reliable and indicated a maximum increase in risk of 65% at the lowest levels of effectiveness or greatest fatigue.

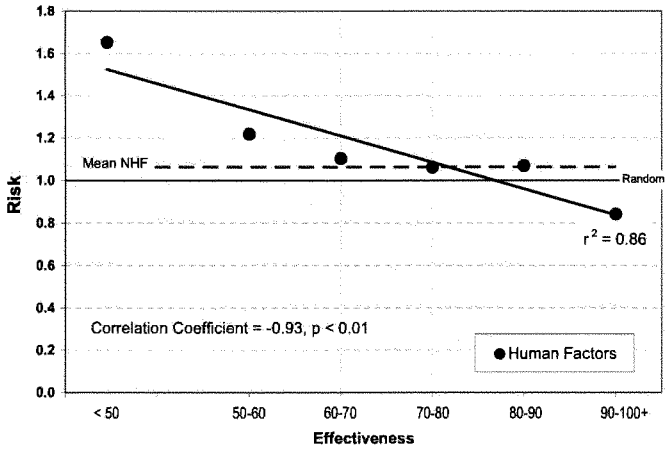


Figure 2: Human factors accident risk increases with decreases in predicted effectiveness.

The biomathematical fatigue model distinguished between human factors and nonhuman factors accidents. Nonhuman factors accident risk was not correlated with estimated effectiveness and at low estimated effectiveness the relative risk of human factors and nonhuman factors accidents were significantly different.

This study found that an elevated risk of human factors accidents occurs at any effectiveness score below 90, and accident risk increased as effectiveness decreased. A reliable increase in human factors accident risk occurred when effectiveness scores were below 70 but nonhuman factors accident risk was not consistently elevated. From the chart in Figure 1, a score of 70 is correlated with a five-fold increase in the chances of having a lapse in attention.

An analysis of the cause codes associated with accidents that occurred at or below an effectiveness score of 70 showed an overrepresentation of the type of human factors accidents that might be expected of a fatigued crew (e.g., failure to comply with a stop signal). This is consistent with the interpretation that there is a causative relationship between reduced effectiveness and elevated human factors accident risk.

The study also indicated that work in the rail industry is fairly evenly distributed around the clock with 22% of work hours occurring between midnight and 6 a.m., indicated in Figure 3. When the distribution of human factors accidents are tabulated in relation to time of day, the risk of such an accident follows a circadian pattern that is consistent with the circadian rhythm of fatigue, shown in Figure 4. The fatigue rhythm is not correlated with nonhuman factors accident risk.

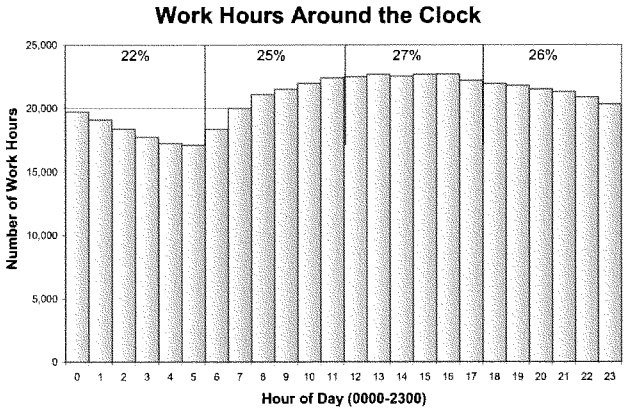


Figure 3: Railroad work hours around the clock.

The maximum human factors accident risk was increased by less than 20 percent due to time of day alone, while the maximum accident risk due to reduced effectiveness (fatigue) was increased by 65 percent, reflecting the combined effects of time of day and sleep opportunities.

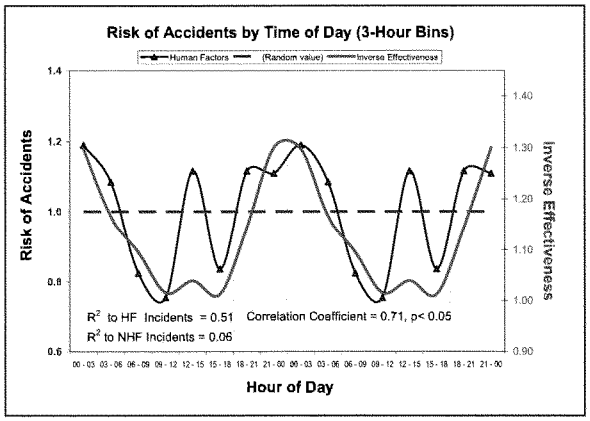


Figure 4: Human factors accident risk by time of day.

This study was designed to demonstrate a method to test the validity of fatigue models. The workers involved in these accidents and the 30-day work histories that preceded the accidents were not a random sample from freight rail operation. Hence, the levels of effectiveness calculated by the SAFTE model should not be interpreted as representative of the freight railroad work force in general. The study was not designed to determine the extent of fatigue in the freight rail industry. Furthermore, given the well-known variations in individual sleep requirements and absence of specific information on individual sleep habits, health, and circumstances, this study was not designed to validate fatigue models as tools for determining the fatigue of particular individuals.

Rather, this study provides the first evidence that a biomathematical fatigue model can be used to predict elevated risk of railroad accidents based on work schedules. These results provide a strong scientific basis for more broadly evaluating work schedules with valid mathematical models to reduce worker fatigue. A mathematical model for detecting elevated fatigue risk could be part of a performance-based fatigue management plan that would supplement current regulations. Although fatigue models do not identify all sources of fatigue and will require a cooperative partnership among management, labor, and government regulators, they are an important tool in the identification of one of the causes of fatigue in the railroad industry.

The Limitations of Simple Rules and the Power of an Evidence-based Approach

The validation study has established that fatigue exists in the rail industry and that this fatigue, as measured by a fatigue model, increases the risk of rail accidents. How are we to respond to this information? I shall offer some concepts for consideration.

Fatigue Cannot Be Eliminated: Some fatigue, as defined here, is inherent in rail operations; indeed it is inherent in any industrial operation that works around the clock. Approximately 22% of over-the-road rail operations occur between the hours of midnight and 6 a.m. – times when the human biological system is inherently less energized and alert. Most people will have slower reaction times during these hours than at any other time in the day and generally be more prone to mistakes. Working at night can elevate accident risk by 10 to 20%. This is a risk that is inherent in an industry that must operate around the clock to meet the demands of commerce and to serve the needs of the public. So the goal of fatigue management cannot be to eliminate fatigue risk, but rather to minimize unnecessary fatigue and manage the consequences of the fatigue risk that cannot be avoided.

Simple Rules Can Lead to Unintended Consequences: Simple, uniform work rules intended to reduce or eliminate fatigue, under certain circumstances, can have unintended and undesirable consequences. While it is true that science can enumerate the conditions that lead to excessive fatigue, those conditions are generally not directly under the control of the railroad operator. The rail operator can and should provide adequate opportunities for employees to get sleep, but ultimately, getting adequate sleep is the responsibility of the employee. Hence, maintaining alertness is a shared responsibility. There are no simple rules of thumb guaranteed to minimize fatigue in the complex railroad operating environment because it is not always possible to predict the ramifications of the rules for rest opportunities and work demands placed

on employees. In fact, some rules intended to improve opportunities to get sleep can fail in practice because of unanticipated impact on other aspects of operations that then backfire to inhibit adequate sleep. The following example illustrates this problem.

In this case study, I have de-identified the names of the engineer and the rail employer; let's call the employee Engineer Sam and the rail operator Superior Railroad. For years Superior operated in a certain way but wanted to make some changes to decrease risk of fatigue. Superior contacted a fatigue expert and asked how they might reduce fatigue and the expert advised them to cut work shifts down to about 6 hrs in length. After a period of adjustment, Engineer Sam complained that the new schedule actually made him much more fatigued and he submitted to me actual work schedules for analysis with my fatigue model, one from prior to the change and a log of work and sleep following the change by Superior Railroad. I analyzed the old and new schedules with my fatigue model and verified his subjective impression. Table I illustrates what I found, based on Engineer Sam's actual experience. Note that current hours-of-service rules were followed throughout.

Table 1: Engineer Sam work schedule characteristics before and after change in shift lengths.

Year	Total Calendar Days	Average Shift Length (hrs)	Total Work Hours	Total Work Shifts	Average Effectiveness	Percent Time < 70
2000	32	10.6	180	17	90	0
2002	32	6.3	163	26	77	13

For comparable 32 day samples from year 2000 prior to the change and year 2002 after the change, I found that prior to the change shifts averaged over 10½ hrs and that the employee actually spent 180 hrs on duty during 17 work starts. After the change the average shift length was less than 6½ hrs and the time spent at work was 163 hrs during 26 work starts. Fatigue analysis indicated that prior to the change average on-the-job effectiveness was about 90 with no duty time spent below 70. After the change, average on-duty effectiveness was down to 77 and 13% of the work time was spent below 70. So prior to the change in operating practices to reduce fatigue, Employee Sam worked longer hours and more hours but was generally more effective and spent less time at risk. This coincided with Engineer Sam's subjective report that he felt much less fatigued prior to the change. So, how can a change that would appear to be an obvious improvement in work practice lead to such a dramatic "reversal of fortune" for Engineer Sam?

The answer is pretty simple. The suggestion to shorten work shifts was certainly made with the best of intentions and probably was based on an implicit assumption that, all else being constant, short work shifts should be less fatiguing than longer ones. Unfortunately, all else was not constant and, in retrospect, could not remain constant. An engineer's pay is based on the number of miles driven – generally – and the production requirement of the railroad is also miles driven. If work shifts are reduced in length from over 10½ hrs to less than 6½ hrs, but the total miles or hours to be driven remains the same, then the engineer will have to work more shifts to accomplish the same amount of driving. This necessitates what is called "quick turns", i.e. back to back runs with the minimal amount of rest between them. In a typical turn, the employee

awakened at 3 a.m. for a 4:30 a.m. start that lasted until 11 a.m. He then had the required 8 hrs off duty (rest) until 7 p.m. and was on duty until 1:30 a.m. returning home at around 2:30 a.m. Since the 8 hrs rest occurred in the middle of the day when sleep was difficult, he may have obtained only 2 hrs of poor sleep in the entire 23.5 hr interval from 3 a.m. on one day until 2:30 a.m. the next day. Typically, this employee did three of these circuits in a row before getting a day or two off. This schedule led to progressive sleep debt and serious erosion of expected performance across the schedule. From time to time, the employee was so fatigued that he had to refuse assignments to get recovery sleep. This disastrous unintended consequence of the fatigue mitigation strategy was the result of a failure to predict all the ramifications of the new strategy in the context of the operating environment. While I don't know this to be the case, it is possible that the new duty limits benefited most employees of Superior Railroad working under different conditions – unfortunately, the practice conspired against Engineer Sam.

This case is emblematic of the limitations of simple formulas for fatigue risk management. The point here is NOT that all rules are bad. The challenge is how to tell a bad rule from a good rule. Hours of service rules, for example, provide a necessary set of boundary conditions, and refinement of the rules that apply to the rail industry may warrant consideration, but those rules alone will not eliminate fatigue. Within hours-of-service boundaries – whatever they are, evidence-based fatigue management programs, explained next, offer the greatest promise for further limiting fatigue. Such a system at Superior Railroad might have rescued Engineer Sam.

Evidenced Based Approaches Offer the Greatest Promise: The most effective approaches to managing fatigue are those based on empirical evidence used to shape operating practices and individual life-style decisions toward reduced levels of fatigue. In contrast, work/rest formulas and other work rules introduced in the absence of an evidenced based adaptive program assume that we can accurately predict uniform reductions of employee fatigue without confirming that benefit with empirical monitoring. The case cited above is merely an example of how that assumption can fail. Hence, as a scientist, I am skeptical of our ability to accurately predict all the consequences of well intended work rules for all employees. I have invented a reasonably accurate model for predicting the effects of sleep patterns on performance at various times of the day. However, that model accounts for only one part of the equation – the physiology and performance of the employee. It does not predict changes in the operating environment of the employee. Models may be developed to anticipate operating conditions for employees, but those models, too, will only account for a subset of all possible operating cases since available resources and demands on such systems are constantly changing. Ultimately, the best model of the system is the system itself studied in real-time. Because of this, I suggest that the most promising approach is a strategy based on Four M's: measurement of working conditions, modeling of operator fatigue and system behavior, modification of practices based on modeling, and monitoring of results to provide corrective feedback for further performance improvement (the Four-M approach, see Figure 5).

The fatigue risk management process in Figure 5 starts with measurement of the current situation based on a comprehensive work schedule analysis. Schedule measurement feeds to an automated system to model the level of fatigue across the system for each location, work group and situation. This defines the problem and sets the stage for commitment to find solutions

tailored to each situation. The stakeholders cooperate to design solutions that involve modifications, as appropriate, including operating practices, labor agreements, and training for individual life-style decisions. The success of these modifications is confirmed by monitoring relevant outcome measures, such as close calls, reports of fatigue, and accidents/incidents. Inherent in this system is *feedback*. The feedback element means that modifications that do not lead to improvements are abandoned and replaced by practices that have positive impact. The approach is continuous and self-correcting; there is no final solution; the problem is constantly changing - resources and demands are continually in flux; and novel solutions often emerge when new information leads to insights for improvement.

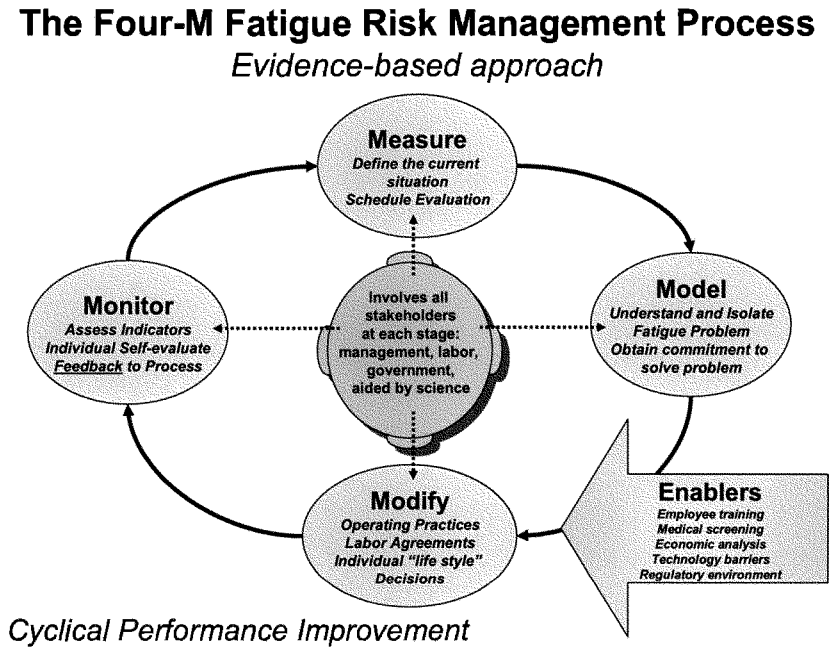


Figure 5: An Evidence-based Fatigue Risk Management Process.

In short, evidence-based fatigue risk management systems offer the greatest promise for solving the problem of fatigue in the rail industry. There are four essential features of the Four-M process: 1) all the stakeholders collaborate on solutions, 2) solutions are tailored to the situation, 3) the results of the process are monitored for beneficial reductions in fatigue, and 4) procedures are modified to adapt to changing conditions or new information. I would encourage the adoption of such systems as a complement to hours of service regulation. Inherent in this initiative is a flexible approach by the regulator to recognize and endorse fatigue management practices that emerge from the Four-M process. This implies that the FRA must be empowered to encourage creative and evidence-based solutions.

Enablers of the Fatigue Risk Management Process

There are a number of enabling technologies that can facilitate the fatigue risk management process, indicated in Figure 5. I will describe them briefly. Each topic could be the subject of a book so this statement merely serves as the occasion for further consideration. In some cases, the FRA and other modes within the Department of Transportation have undertaken initiatives that advance these enabling technologies and tools.

Employee Training: Employee training has always been an important element of any safety program; employees need to know the nature of the problem, the causes of the problem, and steps that they can take to solve the problem. Fatigue is no exception and it may be even more important here because everyone is a personal expert – we all know what it is like to be too tired to function effectively. Yet, our subjective impressions are often misleading and the importance of simple solutions is often under-appreciated. Training is an important corrective.

Medical Screening: Sleep is a physiological process and can be degraded by certain medical conditions, such as sleep apnea, restless leg syndrome, and insomnia. While detrimental to restful sleep and consequently destructive to effective performance, the conditions can often be effectively treated. Corporate sponsored medical screening could detect these conditions and provide employee assistance to obtain treatment. In addition, certain medications for other conditions can cause drowsiness and medical screening can identify those situations and prescribe solutions. Medical screening is also an important adjunct to fatigue modeling because predictions usually assume average, healthy workers unimpaired by medications or sleep disorders.

Economic Analysis: Economic factors play an important part in maintaining the status quo. Management is required to control costs to support a healthy business; employees are entitled to fair compensation for their labor and solutions that interfere with opportunities to work can create an economic hardship. Yet, fatigue management can bring economic benefits: improved operator efficiency, reduced operating errors, improved safety, reduced injury claims, better employee health and wellbeing, reduced absenteeism, greater retention, and easier recruiting. Furthermore, effective fatigue management does not necessarily reduce productivity; as demonstrated in the example of Engineer Sam, fatigue management means working smarter, not necessarily working less. Economic analysis can shape solutions that minimize undesirable costs to the operator and employees, and document compensatory savings that result from improved fatigue management. There are now business cases that illustrate the "good news" associated with effective fatigue management. In rail operations, economic analysis can be coupled with fatigue modeling to estimate the ultimate cost of fatigue related accidents and the potential savings from reduced fatigue and improved safety.

Technology Barriers: As indicated earlier, some degree of fatigue, especially at night, is inherent in operations around the clock. While not a total solution, technology can be applied for improvements in control systems to serve as a secondary barrier to the detrimental effects of fatigue. Smart systems could detect performance changes indicative of fatigue, trigger changes in system operating characteristics to compensate for fatigue, warn the operator to take corrective

action, and ultimately, take control of the system when the operator is "out of the loop" because of fatigue. While such solutions may not be available now for the rail industry, investment to develop such systems seems warranted by the nature of the operating environment and the normal physiological limitations of operators.

Regulatory Environment: In the heat of discussion of fatigue in the rail industry, the public may become impatient for immediate solutions. It may seem like foot dragging to wait for corrective actions based on what appears to be a slow evidence-based process. Clearly, it will take time to develop fatigue management plans, and more time still to implement those plans and enjoy the success of those plans in the form of reduced fatigue. So how can the public be assured that this process will be undertaken expeditiously and aggressively for the sake of public safety? The answer is that we are not starting from scratch. The FRA has already undertaken a set of creative and proactive programs that will serve as enabling resources for effective evidence-based fatigue risk management. I will let the FRA speak for itself on these matters, but as an outsider, I am impressed by the leadership shown by the FRA on the fatigue issue. Indeed, some of the fatigue management tools and approaches developed by the FRA could be expanded fruitfully to other modes of transportation. In addition, the rail industry itself has not been idle regarding this approach. At least one major Class I railroad has initiated a comprehensive fatigue risk management program that promises to serve as one model for how this might be accomplished.

Beyond these current initiatives, the implementation of fatigue management plans across the rail industry will require encouragement from the FRA. Evidence-based approaches to fatigue management may require that the FRA has the authority to establish hours of service controls that apply to the rail industry, in a manner equivalent to the other modes of transportation. Under such authority, the FRA could play a key role in advancing the development of fatigue risk management plans, setting standards for acceptable plans, and, most importantly, exercising an essential regulatory function to examine the evidence of performance improvement that demonstrates the effectiveness of those plans. It is beyond my expertise to suggest how this FRA responsibility might be established and exercised but a constructive and supportive regulatory environment is a key to energizing solutions.

Conclusion

Fatigue is an issue for the rail industry, as it is for all modes of transportation and any industry that conducts safety sensitive business around the clock. Fortunately, we now have tools to aid in the measurement of fatigue and methods to implement effective fatigue risk management systems. The government can play a key role in encouraging the adoption of fatigue measurement tools and evidence-based methods as part of a cooperative initiative with the rail industry and labor organizations. As a scientist, I endorse that approach as the best prospect to minimize fatigue and improve rail safety.

Thank you for this opportunity to address this important topic. I would be happy to respond to any questions from the Subcommittee.

Statement of
Ranking Republican Member John L. Mica
Committee on Transportation & Infrastructure

Subcommittee on Railroads,
Hazardous Materials & Pipelines

Hearing On
Fatigue in the Rail Industry

2-13-07

Thank you, Madam Chairwoman.

Historically, the railroad was always a dangerous place to work. In the early days, it was all too common for a worker to be killed while coupling freight cars or seriously injured while working on a hot steam boiler.

Thankfully, times have changed. Through the efforts of railroad management, labor, and the federal government, railroads are now one of the safest places to work.

In fact, statistics show that it is more dangerous to work in your corner grocery store than on a major railroad.

During the last thirty years, we have seen a 71 percent decline in train accidents. Total employee deaths have dropped by 80 percent. And last year was one of the safest years on record for our nation's railroads.

Today's hearing is on the subject of rail worker fatigue with an eye toward the Hours of Service Act. According to the latest research by DOT, a fatigued worker has a greater risk of having an accident. This only confirms past reports by the NTSB, which identified fatigue as a factor in several major rail accidents.

We need to take a close look at the issue of fatigue in light of the new research done by DOT. At the same time, we must consider this research within the proper context.

The rail industry is fundamentally different from other Industries where fatigue has been studied, such as the aviation industry and the military.

Changing the Hours of Service law, if we decide to do it, will not be simple. The law is woven into union labor agreements, railroad crew management practices and worker expectations.

Our existing rail laws have produced an enviable safety record. We need to keep improving safety, but in a way which will produce solid, measurable results.

Thank you, Madam Chairwoman.

STATEMENT OF
THE HONORABLE JAMES L. OBERSTAR
SUBCOMMITTEE ON RAILROADS, PIPELINES, AND HAZARDOUS MATERIALS
HEARING ON
"FATIGUE IN THE RAIL INDUSTRY"
February 12, 2007

- Good afternoon. I am pleased that Chairwoman Brown scheduled this hearing today; it is long overdue. Fatigue is a serious concern in the rail industry. The Federal Railroad Administration (FRA) reports that 40 percent of all train accidents are caused by human factors, and one in four of those accidents is caused by fatigue. I suspect that figure is underestimated.

- The National Transportation Safety Board (NTSB) has noted in many of its accident investigation reports that fatigue is difficult to detect, particularly when the victims are deceased. The NTSB reviews the statements of other workers and witnesses, the hours worked and slept in the days leading up to the accident, and the time at which the accident occurred, but there is no chemical test for identifying the presence of fatigue as there is for identifying the presence of drugs or alcohol; hence, I believe – and I believe the NTSB would agree – that fatigue is a factor in far more accidents than has been reported.

- I also believe that the laws and regulations governing fatigue for railroad workers are outdated. The Hours of Service Act was enacted 100 years ago, and it has not been substantially amended for 40 years. The law does not reflect growth and changes in the rail industry since 1907. It does not address cumulative fatigue, and just barely addresses acute fatigue. It is not based on science, and most importantly it does not address the demands and needs of working families. In 1907, there weren't many single parent households or situations where both parents had to work to survive. Today, divorce rates are much higher, and as a result there are more single-parent homes. In homes where there are two parents, both of them often have to work to meet the family's basic needs of food, shelter, and clothing. Yet somehow railroad workers are expected to miraculously figure out how to get adequate rest and time for commuting, personal, and family activities in eight or 10 hours.

- **Growth and changes in the rail industry.** I was reviewing Mr. Dealy's (BNSF) testimony for this afternoon's hearing. He pointed out that just 30 years ago, rail shipments were transported mainly by boxcar trains for relatively short distances. Today, he reports, trains are loaded with double-stacked international shipping

containers and unit coal and grain trains moving distances of over 2,000 miles. Those changes have an impact on safety and fatigue.

There has also been substantial growth in the industry. According to the U.S. Department of Transportation's Freight Analysis Framework, rail traffic is expected to rise more than 50 percent, from 1.8 billion tons to 2.9 billion tons by 2020. Add that to the fact that current growth predictions indicate that container cargo at U.S. ports will quadruple in the next 20 years, and you have got a tremendous amount of pressure bearing down on our Nation's rail system and the rail workers who are responsible for moving that freight.

When you look at changes in the industry, you also have to look at the reductions in crew size over the past several decades; for example, maintenance-of-way staffing has decreased 66 percent in just the past 25 years. Some of this decrease can be attributed to new technologies and greater work productivity, but the fact remains that existing workforce levels are insufficient for the task at hand. I know that the industry is hiring more workers, but I also know that those workers are being trained at a faster rate than workers have been in the past, and that they are moving up through the ranks faster, having less time for apprenticeships, all of which can have a significant impact on fatigue.

- **The law does not address cumulative fatigue, and it is insufficient to meet the current needs of working families.** Under current law, train operating crews and railroad signalmen are permitted to work 12 consecutive hours with 10 hours of rest. If they work less than 12 hours by even one minute, then they get eight hours of rest-time. This means that an individual can begin a shift on Monday at 8:00 p.m., and be called for a shift on Tuesday at 4:00 a.m. and a shift on Wednesday at midnight. According to the FRA, this kind of "backward-rotating shift" may continue for weeks, and can wreak havoc on an employee's circadian rhythm, the biological cycle that governs sleeping patterns.

  During emergencies, rail workers may be required to work an additional 4 hours, for a total of 16 hours for train operating crews and railroads signalmen, and a total of 13 to 16 hours for train dispatchers. Then there is "limbo time," which is the time train operating crews are waiting for transportation back to their home or away terminals. During limbo time, crewmembers are required to stay awake, alert, and able to respond to any situation and follow the railroad's operating rules. Although time spent in limbo is classified under current law as neither on-duty nor off-duty time, limbo time can and has kept railroad operating crews effectively on-duty for well over 12 hours and, in the case of the Union Pacific engineer

involved in the 2004 Macdona, Texas accident, 22 hours (12 hours on-duty and 10 hours of limbo time).

When it comes to time available for rest, train crewmembers are generally called for service approximately 2 to 3 hours before their report for duty time. So, if a train crewmember is called to return to duty at the completion of his or her statutory off-duty period, then the duration of uninterrupted off-duty time available for sleep could be as little as 5 or 6 hours. However, since the required 8 or 10 hours of off-duty time includes commuting, leisure, and personal time, the duration of any period available for sleep could be even less than that.

- **The law is not based on science.** Various DOT modal administrations, including the FRA, and the NTSB have conducted a number of studies on fatigue since the Hours of Service law was enacted in 1907. Most recently, the FRA released a study on a Fatigue Avoidance Scheduling Tool, a biomathematical model that can be used to reduce the risk of fatigue in work schedules. FRA researchers used two and one-half years of accident data from five Class I freight railroads and the 30-day work schedule histories of locomotive crews preceding about 1,400 train accidents to determine the relationship between accident risk and crew effectiveness. Data from the research showed a strong statistical correlation between the crew's estimated level of alertness and the likelihood that they would be involved in an accident caused by human factors. The level of fatigue associated with some work schedules was found to be equivalent to a 0.08 blood alcohol level or being awake for 21 hours following an 8-hour sleep period the previous night. At this level, train accidents consistent with fatigue, such as failing to stop for red signals, are more likely to occur.

- All of these issues must be considered in looking at the adequacy of the hours of service law. In the last several Congresses, I have introduced legislation to strengthen hours of service. The railroads fought against it, stating that hours of service should be dealt with at the collective bargaining table. I believe that the safety of railroad workers and the safety of the general public, which all too often are the victims in these train accidents, should not be relegated to a negotiation between management and labor. This Congress has a responsibility to prevent fatigue, and I intend to address that in any reauthorization bill that is considered by this Committee.

Submitted by
Leonard Parker

February 13, 2007

U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON TRANSPORTATION and INFRASTRUCTURE
SUBCOMMITTEE ON RAILROADS, PIPELINES, AND HAZARDOUS MATERIALS

HEARING ON
FATIGUE IN THE RAIL INDUSTRY

TESTIMONY OF W. DAN PICKETT
INTERNATIONAL PRESIDENT
BROTHERHOOD OF RAILROAD SIGNALMEN

Good Morning. I would like to thank Madame Chair Corrine Brown and the members of the Committee. It is an honor for me to testify today on fatigue in the rail industry, a subject of great concern to this country and to all employees of the nation's railroads.

My name is Dan Pickett, and I am the International President of the Brotherhood of Railroad Signalmen. The Brotherhood of Railroad Signalmen (BRS), a labor organization with headquarters at 917 Shenandoah Shores Road, Front Royal, Virginia, 22630-6418, submits the following comments concerning fatigue in the rail industry.

BRS, founded in 1901, represents approximately 10,000 members working for railroads across the United States and Canada. Signalmen install, maintain and repair the signal systems that railroads utilize to direct train movements. Signalmen also install and

maintain the grade crossing signal systems used at highway-railroad intersections, which play a vital role in ensuring the safety of highway travelers. Throughout our entire existence, the BRS has dedicated itself to making the railroad workplace safer, not only for the railroads and rail workers, but also for the public at large.

The rail industry is moving more freight today than ever before and with fewer employees. This is a critical point that must be acknowledged. Through mergers and the railroad's never ending quest to eliminate workers, railroad staffing levels are at an all-time low. In the past year, those numbers have increased as the railroads' need to train new people to fill the increased vacancies as a result of baby-boomers retiring. This trend of retirees outnumbering new hires is expected to continue for the next 10 years. Those railroad workers that are left are working longer hours for many days at a stretch. A 12 to 16 hour day is not unusual for a railroad worker, and in many cases it is the norm. Railroads are abusing the very asset that is their most important resource.

The BRS seeks to amend the Hours of Service Act for signalmen. Currently, the Hours of Service Act (HOS) allows individuals performing signal work to work 12 hours in a 24-hour period with an emergency clause provision that allows for an additional 4 hours of service in a 24-hour period. The BRS seeks to eliminate the 4-hour emergency provision due to its abuse by the railroad industry.

When the HOS Act was expanded to include signalmen in 1976, it was envisioned and intended to be a 12-hour law. It should be noted that this is how the railroads originally applied the law. If a signal employee needed additional time to correct a signal problem he would inform his lower lever supervisor that he is approaching the 12-hour

limit of the HOS Act. The supervisor would make a decision based on their experience if the employee could finish the work within 12 hours, or if another signal employee would be called to finish the repair work. When the law was new, it worked well, and for years the railroads limited signal workers to 12 hours of work in a 24-hour period. However, through gradual "creep" the railroads have mutated the act into a 16-hour law. Many railroads have official or unofficial policies that state that any signal problem is an "emergency" and workers need not contact their supervisors for an interpretation.

Signal employees are routinely instructed to work up until the 16-hour limit before they call for any relief personnel. In some cases, the railroads authorize outright violations of the HOS Act, and order signal employees to continue working until they are finished with the repair work. Many times employees are pressured by supervisors to falsify FRA reporting documents to cover up violations. That is why it is up to Congress to remove the 4-hour emergency provision in its entirety. This discretion combined with the railroads tendency to push the limits of the law has morphed the HOS Act and is contrary to the intentions of the 1976 Congress.

Of even greater concern is when a BRS member can work 20 hours in a 24-hour period without adequate rest. For example: On Day 1 a signalmen goes to sleep at 21:00 and awakens at 05:00 to arrive for his regular shift on Day 2 at 07:00 to 15:00. Under the current law, his "rest" period starts at 15:00. At 23:00 he is considered fully rested and a new 24-hour clock begins. In many cases it is highly likely that he may have just gone to sleep at 22:00. After less than two hours of sleep he then receives a call to work at 00:00 on Day 3. He works four additional hours and is finished with the trouble call at 04:00.

He then travels home and then has to return to work for his regular shift of 07:00 to 15:00. The cumulative effect of the law on the individual is that he is allowed to work a total of 20 hours of service within a 32-hour period. While the employee has had 12 hours off, he has gotten virtually no sleep.

This situation is exasperated further when railroads then require signal personnel to work an additional 4 hours under the emergency provision. Additionally, if an "emergency" occurs at the end of his shift, the railroad could require him to work an additional 4 hours from 15:00 until 19:00. The cumulative effect of the law on the individual would now be that he is allowed to work a total of 24 hours of service within a 40-hour period with virtually no sleep. This type of work schedule is a recipe for disaster. This is especially true when you consider that after being off duty for a period of 10 hours, 2 hours of which are spent traveling to and from work, the signal employee has to return to work for his regular shift at 07:00 and can then work another 16 hours before he is entitled to another rest period. It is possible that after waking at 05:00 on Day 2, a signal employee may get only 8 hours of actual sleep in a 66-hour period. See "Appendix A" for further explanation of this scenario.

The BRS asks that the Hours of Service Act be amended to require that employees performing signal work receive at least 8 hours of actual rest during a 24 hour period. What drives our request is the fact that many, if not all, of the railroads willfully abuse the HOS Act. For example, when the railroad receives emergency calls (prior to the end of the 8 hours of required rest) they will delay calling signal personnel until 8 hours have passed since the end of their scheduled shift, or their last additional duty so that they

can start a new 24-hour clock. This is unacceptable. The railroads are aware that the signal personnel have probably not received adequate rest. All that the railroads care about is resetting the 24-hour clock so that they can work the individual 12 to 16 additional hours.

Chairman Oberstar has gone on the record saying, "In previous Congresses, I have introduced legislation to strengthen hours of service. The railroads fought against it, stating that hours of service should be dealt with at the collective bargaining table. I believe that the safety of railroad workers and the safety of the general public, which all too often are the victims in these train accidents, should not be relegated to a negotiation between management and labor. This Congress has a responsibility to prevent fatigue."

Madame Chair, I could not agree more with Chairman Oberstar. As explained in my earlier testimony, the railroads have manipulated a 12-hour Congressional Hours of Service Act into a 16-hour law. In fact, the situation is even worse in the industry than what I have explained so far. The Brotherhood of Railroad Signalmen is currently engaged in National Negotiations with the railroads to reach a new agreement over wages, benefits and work rules. The railroads have targeted the employees I represent during these negotiations. The railroads want work rule provisions that allow them to subcontract our safety-sensitive signal work to the lowest bidder. While I will not go into the inherent degradation of safety by having untrained and unskilled contractors performing signal work, I will explain one of the main reasons that the railroads want to subcontract this work. Contractors are not covered by the Hours of Service Act. I will repeat this. Contractors are <u>not</u> covered by the Hours of Service Act. If the railroads

persevere in this pursuit, they will have found a way to supercede the intent of Congress by employing individuals to perform safety-sensitive signal work who do not have to comply with the provisions of the Hours of Service Act.

The railroads would be able to hire contractors who can work an unlimited number of continuous hours performing safety sensitive signal work. While the railroads say that they are trying to find ways to combat fatigue in the railroad industry, the reality is that they are trying to find ways to supercede the safety provisions contained in the Hours of Service Act.

The inability to perform adequate testing and the failure to comply with minimum federal regulations have contributed, if not caused, many recent railroad accidents. In their never ending zeal to focus on the financial bottom line, railroads have allowed staffing levels to fall below the minimum needed to perform basic safety functions. Additionally, the railroads are not through with their desire to further reduce manpower levels. The railroads are currently pushing very hard to reduce train crew size to a single person, and the implementation of Remote-Control-Locomotives (RCL) is proliferating as I speak here today.

Training and Education:

Training and education is another key preventive measure that needs to be considered. Rail labor considers it equally important to provide Advanced Training to improve the skills of the professional men and women that install and maintain safety systems for the rail industry. This is an area that will increase productivity, improve safety

and reduce fatigue. A signal employee that receives advanced and recurrent training is a more productive employee who can solve the emergency problems that he encounters in less time than one who is lacking the necessary skills.

Often, signal problems are caused by a signal appliance indicating that a rail is broken, a switch is not properly lined, a track is flooded, or other unsafe condition. A signalman must know the action to take to provide safety for the public and the rail carrier even before considering how to repair the problem.

By being more efficient, the trained signal employee spends less time in the field and therefore encounters less fatigue, while increasing the capacity, efficiency and safety of our rail network. Rail labor will continue to work to implement training provisions which were agreed to by the industry — but to date have not been implemented on many of our nation's railroads.

Conclusion

There is little question that more must be done to eliminate fatigue in the rail industry in general and to signal employees specifically. Signalmen install, maintain and repair the signal systems that railroads utilize to direct train movements. Signalmen also install and maintain the grade crossing signal systems used at highway-railroad intersections. As such, it is in the best interest of the traveling public and the employees that work for the railroad that Congress act to solve the problem of fatigue for signalmen in the rail industry.

An adequately staffed signal department of well-trained, well-rested signalmen is needed to make the critical safety-sensitive decisions that are a routine part of their daily duties. Signal employees often work alone in the worst weather conditions in some of the most demanding terrain, and it is imperative that these workers have the opportunity to perform their duties after receiving adequate rest.

There is much to accomplish to eliminate fatigue for signalmen and the rail industry as a whole in order to make the nation's railroads safer for communities across the country, and rail workers. Experience teaches us that it is Congress that must provide the leadership to make safety a reality. I hope we can work together to see that improved safety practices become a reality.

On behalf of rail labor and the Brotherhood of Railroad Signalmen I appreciate this opportunity to testify before the Committee. At this time I would be more than pleased to answer any questions.

Respectfully submitted,

W. Dan Pickett

W. Dan Pickett
International President

APPENDIX A

Day 1		Day 2		Day 3		Day 4	
00:00		00:00	sleep	00:00	emergency call	00:00	sleep
01:00		01:00	sleep	01:00	emergency call	01:00	sleep
02:00		02:00	sleep	02:00	emergency call	02:00	sleep
03:00		03:00	sleep	03:00	emergency call	03:00	sleep
04:00		04:00	sleep	04:00	travel home	04:00	sleep
05:00		05:00	wake for work	05:00	off duty	05:00	wake for work
06:00		06:00	travel to work	06:00	travel to work	06:00	travel to work
07:00		07:00	regular work	07:00	regular work	07:00	regular work
08:00		08:00	regular work	08:00	regular work	08:00	regular work
09:00		09:00	regular work	09:00	regular work	09:00	regular work
10:00		10:00	regular work	10:00	regular work	10:00	regular work
11:00		11:00	regular work	11:00	regular work	11:00	regular work
12:00		12:00	regular work	12:00	regular work	12:00	regular work
13:00		13:00	regular work	13:00	regular work	13:00	regular work
14:00		14:00	regular work	14:00	regular work	14:00	regular work
15:00		15:00	regular work	15:00	regular work	15:00	regular work
16:00		16:00	off duty	16:00	emergency call	16:00	emergency call
17:00		17:00	off duty	17:00	emergency call	17:00	emergency call
18:00		18:00	off duty	18:00	emergency call	18:00	emergency call
19:00		19:00	off duty	19:00	emergency call	19:00	emergency call
20:00		20:00	off duty	20:00	off duty/travel	20:00	emergency call
21:00	sleep	21:00	off duty	21:00	sleep	21:00	emergency call
22:00	sleep	22:00	off duty	22:00	sleep	22:00	emergency call
23:00	sleep	23:00	off duty	23:00	sleep	23:00	emergency call

Legend

Sleep | Work | **Off Duty**

In the above scenario, after waking at 05:00 on day two, a signal employee can be awake for 40 continuous hours; traveling to, or working 30 of those 40 hours, then after "receiving" 10 hours of rest (of which the actual sleep may only be 8 hours), the signal employee could then work an additional 16 hours. It is possible that after waking at 05:00 on day two, a signal employee may receive only 8 hours of actual sleep in a 66-hour period. The above scenario would be in total compliance with the Hours of Service Act, as currently written, pertaining to employees who perform signal service.

BEFORE THE

UNITED STATES HOUSE OF REPRESENTATIVES

COMMITTEE ON TRANSPORTATION AND INFRASTRUCTURE

SUBCOMMITTEE ON RAILROADS, PIPELINES,
AND HAZARDOUS MATERIALS

HEARING ON

FATIGUE IN THE RAILROAD INDUSTRY

FEBRUARY 13, 2007

TESTIMONY OF

THOMAS A. PONTOLILLO, DIRECTOR OF REGULATORY AFFAIRS
BROTHERHOOD OF LOCOMOTIVE ENGINEERS AND TRAINMEN
A DIVISION OF THE TEAMSTERS RAIL CONFERENCE

United States House of Representatives
Committee on Transportation and Infrastructure
Subcommittee on Railroads, Pipelines, and Hazardous Materials
Hearing on Fatigue in the Railroad Industry
Testimony of Thomas A. Pontolillo
Director of Regulatory Affairs, Brotherhood of Locomotive Engineers and Trainmen

Thank you and good afternoon Chairwoman Brown, Ranking Member Shuster, and Members of the Subcommittee. My name is Tom Pontolillo, and I am Director of Regulatory Affairs for the Brotherhood of Locomotive Engineers and Trainmen Division of the Teamsters Rail Conference. On behalf of the Conference — and the more than 70,000 men and women we represent — I want to thank the Subcommittee for holding today's hearing and for providing us with the opportunity to present you with our views concerning fatigue in the railroad industry.

I also want the Subcommittee to know that we have coordinated our work on this subject with my good Brother Brunkenhoefer from the United Transportation Union, and that the Conference fully supports and endorses his testimony before you today. I hope that our joint work has eliminated much unnecessary duplication of information and of the positions that we share. Further, we want you to know that we support and endorse the testimony of the Brotherhood of Railroad Signalmen.

There is no question in our minds that safety degradation because of fatigue is a ticking time bomb in the railroad industry. The National Transportation Safety Board has, on numerous occasions, pointed to crew fatigue as a potential contributing factor in an accident. Indeed, just last year the NTSB adopted a report determining that the 2004 Macdona, Texas, collision and toxic chlorine release, which killed three people, was caused by a fatigued crew's failure to respond to wayside signals. The crew was criticized for failing to effectively use off-duty time, thereby not obtaining sufficient restorative rest prior to reporting for duty, and Union Pacific was criticized for train crew scheduling practices that created inverted crew members' work/rest patterns.

This hearing will provide you with significant scientific research and opinion, some of it going back many years, that establishes beyond any reasonable doubt that fatigue in the industry poses a significant safety risk. One factor that aggravates fatigue is the industry's manipulation of the Hours of Service Act by leaving crews stranded for unconscionable lengths of time under the Supreme Court's 1996 "limbo time" decision.

I could not hope to improve on the legal and statutory analysis concerning limbo time that Brother Brunkenhoefer provides today. However, I do want to provide the Subcommittee with some shocking facts that expose the depth of the limbo time crisis.

For the past year and one-half, we have been collecting data from BLET field officers concerning excessively long work tours. The data provided to us has been gathered from railroad records, and is stunning.

We have data from one Class I railroad — which I will refer to as Railroad "A" — showing that nearly 335,000 crews had work tours in excess of 14 hours during the years 2001 through 2006. This is an average of over 150 crews exceeding the Hours of Service by two hours every day for six years. However, during the past three years, the average is over 205 crews per day. During that same period, an average of about 94 crews per day had work tours longer than 15 hours.[1]

The breakdown by length of work tour for last year on this railroad is as follows:[2]

Length of Work Tour	Number of Crews
over 14 hrs.	76,268
over 15 hrs.	34,854
over 16 hrs.	15,815
over 17 hrs.	7,251
over 18 hrs.	3,529
over 20 hrs.	1,003

We also have two full years of data covering a single terminal on another Class I railroad — which I will refer to as Railroad "B" — where approximately 110–115 BLET members work in two pools and on one extra board. The breakdown by length of work tour for these engineers is as follows:[3]

Length	2005	2006
over 13 hrs.	1,189	1,928
over 14 hrs.	331	593
over 15 hrs.	141	231
over 16 hrs.	39	73
over 17 hrs.	13	29
over 18 hrs.	7	8
over 19 hrs.	2	4
over 20 hrs.	1	2

Lastly, we have data for the entire Railroad "B" system, covering two days in mid-September of last year. The breakdown by length of work tour for Railroad "B" for these two days is as follows:

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[1] A graph showing the increase in limbo time on Railroad "A" is attached to this testimony as Exhibit BLET-1.

[2] A graphical representation of this breakdown is attached as Exhibit BLET-2.

[3] A graphical representation of a portion of these data is attached as Exhibit BLET-3.

Length	Day #1	Day #2	Total
over 12 hrs.	1,249	1,381	2,630
over 13 hrs.	443	559	1,002
over 14 hrs.	144	177	321
over 15 hrs.	61	66	127
over 16 hrs.	18	21	39
over 17 hrs.	9	5	14
over 18 hrs.	8	2	10
over 20 hrs.	6	1	7

Of the six work tours in excess of 20 hours on Day #1, three were an incredible 32 hours long. The work tour in excess of 20 hours on Day #2 totaled 23 hours and 15 minutes.

The decade since the Supreme Court's decision has seen both the number of crews stranded waiting for transportation and the length of limbo time increase. Indeed, the problem has become so prevalent in recent years that the December 16, 2003 BLE National Agreement included language committing that participating carriers would "make reasonable efforts to relieve and expeditiously transport [outlawed crews] to the tie-up point." Unfortunately, things have only deteriorated since that commitment was made, as the data from Railroad "A" clearly demonstrate.

The industry makes two responses to its self-created limbo time crisis. One is that crews are not disadvantaged because they are paid for their excessively long work tours. Very frequently that is not the case. Under existing national agreements, road freight crews are not entitled to overtime until they have "run off" the mileage for their trip. The table below shows when a crew will be entitled to overtime under current national agreements, based on the length of their run:

Length	Time
195	12:00:00
200	12:18:28
225	13:50:46
250	15:23:05
275	16:55:23
300	18:27:42
325	20:00:00
350	21:32:18

Thus, a crew in a 325-mile pool must accrue more than 8 hours of limbo time before they would be entitled to overtime. Some system and local agreements provide for overtime at a point prior to when the miles have been "run off," but many do not. The undisputable fact is that crews do not receive any compensation for this time in a large percentage of cases.

The other industry response is that safety is not diminished because the crews are not performing service while in limbo. This claim is misleading, at best. Many times, a crew will be instructed to not secure their train when the railroad plans to not remove that crew until its relief

has arrived. This is done so that the train can be further advanced toward its destination during the period when the crew would otherwise be securing the train.

Furthermore, whether the train has been secured or not, the crew continues to be governed by operating rules requiring that they remain alert and observant, and that they take any action necessary to protect the train against unanticipated mechanical problems or vandalism. In a November 21, 2001 Opinion Letter, FRA's Assistant Chief Counsel for Safety stated that requiring a crew to attend to its train in this manner will be considered limbo time provided that the crew is permitted to leave the train when its relief arrives. Significantly, it was after the issuance of this Opinion Letter that the frequency of excessive limbo time skyrocketed.

There is but one lesson to learn from the industry's abuse of limbo time: If you give the industry a carrot, the railroads will chomp it down without a second thought. Nothing short of legislatively correcting the Supreme Court's 1996 error will resolve this problem and I cannot urge the Subcommittee strongly enough to include a limbo time fix in the rail safety package you send to the House floor.

The NTSB's determination in the Macdona accident also illustrates a problem that has increased in severity in recent years. For many decades, industry practices worked to minimize or camouflage potential fatigue problems. Much larger crew sizes greatly reduced the likelihood that an entire crew would be working while fatigued. Moreover, collective bargaining agreements contained maximum mileage regulations — that were strictly enforced — under which a worker would be marked off for the remainder of the month when the maximum was exceeded.

Over the past 50 years, technology has reduced crew size from five or six to two or three. Notwithstanding this fact, the supply of locomotive engineers, conductors and brakeman has not kept up with demand, creating enormous pressure on the industry to work crews above agreement-based mileage levels. The desire of railroad workers to improve, and not just maintain, their standards of living created similar pressure on unions to permit crews to continue working when those mileage levels were exceeded. As a result of these factors, today's smaller crews work far more trips and miles than their historical predecessors.

This leads to a question posed by Representative LaTourette last week. Namely, how much fatigue is caused by so-called "mileage hogs" who deliberately place themselves, their crews, and the communities through which they traverse at risk by working too much?

The fictitious "mileage hog" is nothing more than the creation of an industry that cannot stoop low enough to camouflage its own responsibility for causing fatigue. Beginning in the latter part of the 1800s, most operating crews were paid on the basis of miles run, with 100 miles comprising the basic day, and slightly lower rate — about 91½% of the daily rate — for each additional mile.[4] The typical operating division also was roughly 100 miles in length.

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[4] Prior to 1964 the mileage rate was identical to the daily rate. However, in the aftermath of the Presidential Railroad Commission and Arbitration Board No. 282, the June 25, 1964 National Agreement involving all operating crafts froze the mileage rate for a 3-year period, creating the 8½% difference.

Part of the industry's response to the deregulation created by the Staggers Act was to intensify its pressure for an end to the 100-mile day. This directly led to a strike by the Brotherhood of Locomotive Engineers in 1982, which was ended when Congress passed — and President Reagan signed — Public Law 97-262, imposing the recommendations of Presidential Emergency Board No. 194 as the basis for settlement.

Included among those recommendations was adoption of the industry's proposal to establish a Study Commission to investigate and consider a number of collective bargaining matters, including the basis of pay for locomotive engineers. A similar Study Commission — pursuant to a recommendation made by Presidential Emergency Board No. 195 — was empanelled pursuant to the UTU National Agreement that was reached shortly after the BLE strike ended.

The Study Commissions, both chaired by Arthur T. Van Wart, issued their reports in late 1983. Of particular interest to this Subcommittee are recommendations that (1) the mileage comprising the basic day be increased, (2) that pay rates for overmiles, special allowances and arbitraries be frozen, (3) that special allowances and arbitraries be eliminated for future hires, and (4) that the waiting time for final terminal delay payments to begin be extended from 30 minutes to 75 minutes.

These proposed changes began impacting locomotive engineers less than 2½ years later, when Arbitration Board No. 458 issued its award. The mileage comprising the basic day was increased, the rate paid for miles in excess of the basic day was frozen, special allowances and arbitraries were eliminated for future hires and frozen for current employees, and the final terminal delay waiting time was doubled from 30 to 60 minutes. As a result of the 1991 legislative imposition of the recommendations of Presidential Emergency Board No. 219 — via Public Law 102-29 — the mileage comprising the basic day was further increased to 130, where it stands today. In mid-1996 the rate for overmiles was unfrozen; however, special allowances and arbitraries continue to be paid at the rate in effect in May of 1986.

The impact of these changes on earnings of operating crews has been staggering. The change from a 100-mile basic day to a 130-mile basic day devalued the basic day by over 23%. Moreover, while the rate of pay of the basic day has increased by nearly 75% over the past 24½ years, the overmile rate has increased only 58%, because of the decade-long freeze in the rate from the mid-1980s until the mid-1990s. Thus, whereas the overmile rate was 91.5% of the daily rate in 1982, it less than 83.2% of the daily rate today.

For a crew on a 130-mile run, replacement of the 100-mile day with the 130-mile day has caused a pay cut in excess of 21½%. Crews on a 150-mile run saw a 20% reduction, and even a crew on a 350-mile run makes nearly 14% less because of the 130-mile day and the freeze in the overmiles. An engineer on a 150-mile run makes over $100 less per round trip, and must work six trips to equal what he or she used to make in five trips. An engineer on a 325-mile run makes over $150 less per round trip, and must work seven trips to equal what he or she used to make in six.

These losses do not include the impact of freezing duplicate time payments at 1982 rates, doubling the waiting time for final terminal delay, and even more draconian cuts for post-1985 hires, which only recently have begun to be ameliorated. For a quarter of a century, operating crews have had to run faster and faster just to remain in place. To us, the "hogs" are not the men and women who must work extra trips to maintain their standard of living, they are those at the top who have skimmed the savings from these changes and stuffed that money into their own pockets.

In addition to forging permanent and fundamental changes to pay scales that forced locomotive engineers to work more and more just to remain in the same place, Arbitration Board No. 458 also placed control of work allocation even more firmly in the industry's hands. Existing agreement provisions were overridden to give railroads broad latitude to establish and abolish extra boards at will. Instead of regulating these extra boards consistent with historic mileage minima and maxima, the Award decreed that these boards would be guaranteed the equivalent of 3,000 miles per month in earnings, and that the railroad would have the sole and absolute right to determine the number of extra engineers.

This shift in control of extra board staffing combined with austere hiring practices over the past 20 years to produce consistent shortages of operating crews throughout the industry. Thus, not only did we lose the ability to regulate extra boards to mitigate fatigue, deliberate understaffing by railroads bled over into pool regulation because it was impossible to add pool turns at locations where there was insufficient manpower.

These problems were exacerbated by the manner in which mergers were carried out during the 1990s. First the Interstate Commerce Commission and, later, the Surface Transportation Board reversed decades of precedent by legalizing and permitting the practice of "cram down," whereby merged carriers were granted almost absolute rights in consolidating work essentially on any terms they chose. As a result of "cram down," the BNSF and UP mergers produced a large number of pools that were created by estimating how far a crew could operate in 12 hours, and some pools now operate nearly the entire length of three "divisions" of yesteryear. In many of these pools, crews will only have two opportunities to work a trip out of their home terminal in a given week.

Then, within the past decade, one railroad after another imposed attendance policies. Typically, these policies require an operating employee to work or be available for work 85% of the time or face discipline — up to and including dismissal — for a failure to do so. Even worse, I was recently informed that one Class I railroad has increased its availability requirements to 95%. The 85% standard is more than reasonable when applied to a five day, 40-hour work week, because it equates to availability for just over 20% of the total number of hours in a week. However, it is absurd in a 24/7 setting like the railroad industry, where, for example, our divorced members are regularly forced to choose between seeing their children within the limits imposed by divorce custody orders and facing discipline for poor attendance.

We believe that another contributor to fatigue is the railroad industry's failure to accommodate cultural changes over the past 30 years. Dual earners in a family has become an absolute necessity for the large majority of Americans; this is no less true for BLET members

and other railroad workers as it is for people in other occupations. This reality, combined with historically high divorce rates, means that railroad workers have far more direct domestic responsibility than their predecessors. However, the industry has not only failed to meet its workers halfway in responding to these cultural changes, railroads demand more work from today's workforce than in the past.

Fatigue is not a function of "mileage hogs" running rampant throughout the industry. Rather, it is a result of men and women who (1) must operate the nation's freight trains for more trips and over longer distances just to stay even with their predecessors from a quarter century ago, (2) cannot mark off work from a guaranteed extra board or guaranteed pool when maximum mileage is reached, (3) have fewer work opportunities in those areas where "super pools" operate, and (4) essentially must work every time the telephone rings in order avoid discipline.

You will no doubt hear the industry repeat past promises to make significant headway in the battle against fatigue, and you may even hear that the Hours of Service Act is an impediment to a solution. However, the real problem is the industry's continuing denial of any responsibility towards its workers in mitigating or preventing fatigue. In fact, the Act was amended over a dozen years ago to include a process whereby labor and management could jointly petition FRA for a waiver of the Act's requirements, for up to two years, for purposes of implementing a pilot program to achieve the Act's goals by alternative measures. No railroad has made any proposal to us that would justify such a petition for waiver during this period.

Indeed, although AAR regularly appears before this Subcommittee touting the sincerity of its member railroads in combating fatigue, the reality is far different. As just one example, Railroad "A" — whose limbo time data I cited before — is currently attempting to use a merger implementing agreement it obtained under "cram down" to actually reduce our members' ability to combat fatigue. This railroad is attempting to use the implementing agreement to eliminate pools and replace them with identical pools operating between the same points that this railroad claims are "new," and, thereby, not subject to 25-year old agreements allowing locomotive engineers to take extra rest beyond that required by the Hours of Service Act at their home terminal.

It bears repeating: of all the various factors that can cause and contribute to fatigue among operating crews, the one that can be resolved today — and simply by better management — is excessive limbo time. To the extent that some crews in some areas are receiving additional pay for this time, curbing limbo time abuse also contributes to the industry's bottom line. We believe the industry's position concerning this subject is indefensible, and it has become clear that the only effective remedy at this point is legislative.

Like operating crafts, maintenance of way (MW) forces are also affected by fatigue. However, the causes of maintenance of way employee fatigue — or MW fatigue — and the solution to the problem for MW employees is very different than the causes and solutions for operating craft employees. In the Maintenance of Way craft, fatigue is most often caused by long commutes, inadequate overnight lodging and lack of manpower.

The extremely long commutes for MW employees are a direct result of rules sought by the railroads before Presidential Emergency Board No. 219 in 1991. PEB-219 essentially removed contractual territorial limits for many MW employees engaged in programmed production maintenance work such as rail and tie replacement. As a result, approximately 25-30 percent of MW employees are required to travel the entire railroad system to work and an additional 20-25 percent are working away from home in other traveling gangs that cover smaller distances.

For example, a MW worker employed on a BNSF System Production Crew is required to report for assignments anywhere on the 32,000+ route mile system covering two-thirds of the territory of the United States from New Orleans to Los Angeles and from Los Angeles to Seattle or Chicago. The same holds true for all the other major freight railroads. System Production Crews must travel the entire railroad system to work.

As a result, at the beginning of the work period, these workers are forced to travel on their scheduled days off, their "rest days, " in order to reach a job location which is usually hundreds, and often times over 1,000, miles from home. These excessive commutes have been independently documented in a December 2006 FRA-sponsored report (DOT/FRA/ORD-06/25) conducted by Foster-Miller.

The methodology for this study was a survey of a random sample of working MW employees who completed a background survey and kept a daily log over a two-week period. The published report includes employee comments on fatigue related matters such as travel, sleep location, etc. Small samplings of these published comments are reproduced below:

Travel

"It was a typical Monday after traveling. It was 9 hours to the motel and between that and getting up between 2-3 a.m. I am very tired. On this job we are working early Monday hours because that is the only time that we can get the track."

"It seems Monday's I am usually more tired than any other day of the week. It takes me 8 hours to drive from home to my lodging motel."

"I left home at 0400. How do you expect me to keep my family together? My mother is also in the hospital. Drove 900 miles just to get to work."

"My drive home was 1,000 miles which is a 14 hour drive."

Sleep Location

"I have difficulty sleeping at times due to noise in the motel."

"Did not sleep good at camp (car). There were passing trains that woke me up 2 times. And a co-worker woke up and opened the door and it woke me up."

"Employees opening and closing the camp (car) door as they come in. Employees snoring very loudly after being out late."

The Teamsters Rail Conference believes that the solution to these excessive fatigue-inducing conditions is to reinstate some reasonable limits on the size of the territory these workers have to cover. It is simply unreasonable to expect people to commute in excess of 8-14 hours and be alert and attentive upon arrival. Couple the long commutes with noisy double occupancy lodging, or even worse, 8-10 persons lodged together in a decrepit and unclean camp car, it is little wonder why we have fatigue-related safety issues in the MW craft. Smaller territories, better overnight lodging with single occupancy, and the elimination of camp cars are the keys to reducing fatigue and improving safety for MW employees and railroad operations.

Camp cars exacerbate fatigue by forcing up to eight individuals to share cramped quarters for days at a time. Norfolk Southern Railroad is the only Class I Railroad in the country that still houses MW employees in camp cars. All other Class I rail carriers abandoned the camp cars years ago because lodging employees in hotels or providing them with a cash per diem payment was both economical and the "right thing to do" to treat their workers better than before. However, Norfolk Southern has not followed this trend and continues to use camp cars.

The Norfolk Southern camp cars the workers return to at the end of an exhausting and punishing day are small, cramped facilities — measuring ten feet by forty feet — that must be shared by up to eight grown men. The men sleep in small bunk beds (measuring 2'8" x 6'), smaller than a twin sized mattress, much like one would find today in a summer camp for children. The men generally sleep four on each end of the camp car, , with sinks and showers in the middle. The water in most camps cars is non-potable, meaning it is not fit for drinking, but it is the only water available for brushing their teeth, washing their face and showering.

The NS camp cars provide the eight men with 400 square feet of living space — 50 square feet each — but given most of the room is taken up with the bunk beds, showers, sinks, hot water heater and lockers, there is essentially less than 20 square feet per person. This is less space than in a death row prison cell in Florida, where each death row inmate has 54 square feet of living space and an indoor toilet. MW workers living in NS camp cars have to walk outside, through the elements — whether it be rain, snow, sleet, or hail — to use an often dark and dirty outhouse or porta-john.

After a grueling day's work, a worker has to compete with seven other workers for shower time, eat in the camp's often unsanitary dinning car and then attempt to get a restful night's sleep in a crowded camp car with seven other workers, next to an operating train track where mile-long freight trains roar by regularly throughout the night, sounding their horn and shaking the camp car as it passes. It makes for fitful night's rest under the best of circumstances.

In 1988, the FRA issued "Guidelines for Clean, Safe, and Sanitary Railroad Provided Camp Cars" as Appendix C to 49 CFR Part 228. These guidelines are not enforceable regulations and, therefore, have no teeth. While FRA will respond to complaints, their enforcement is basically reduced to making recommendations and facilitating quick fixes. Furthermore, the FRA guidelines do not provide FRA with authority to require such essentials as potable water for bathing, cleaning eating surfaces and washing utensils. The discharge of "gray water" from sinks and showers onto the ground is also not prohibited by FRA Guidelines.

To address these health issues, the union must often try to find a sympathetic city, county or state health department to conduct an inspection and force compliance with city, county or state public health ordinances. Many times these agencies are denied access and jurisdiction. And in the rare instances where jurisdiction is rightfully claimed by a local agency, NS simply moves the cars to another location outside the jurisdiction in order to evade local health authorities and enforcement of local ordinances and law.

Camp cars are a health hazard and a blight which must be once and for all eliminated. The union has repeatedly requested NS to abandon camp cars and place workers in hotels like every other rail carrier in the U.S. However, they have refused to do so and expect the union to give one of the most profitable railroads in the country concessions in exchange for treating their workers humanely when every other railroad that has abandoned camp cars actually has saved money by doing so. We have reached the conclusion that an Act of Congress may be the only means of compelling NS to abandon this inhuman practice once and for all.

We further believe that MW fatigue also is — to some degree — a function of staffing levels. Railroads are not hiring and retaining a sufficient number of employees to adequately maintain the nation's rail infrastructure. There has been a precipitous drop in BMWED staffing levels over the past 25 years. For example, BMWED's average monthly active (i.e., working at the craft) membership in 1981 was 90,610 members. Average monthly active membership fell to 50,795 by 1991 and stands at 30,579 today. This represents a manpower decrease of approximately 66% in just 25 years. While some of this decrease can be attributed to improved technology and greater worker productivity, the fact remains that existing track force levels are insufficient for the task at hand.

There is, of course, a safety aspect to chronic understaffing. It takes appropriate staffing levels and quality training to keep the nation's rail infrastructure properly inspected and maintained, especially in light of the record ton-miles of freight being transported on the railroads. The BMWED has lost a significant number of members over the past several decades due to retirements, injuries, and other natural attrition. As a result, BMWED members are working longer hours, shorthanded, and their complaints about insufficient manpower continue to fall on deaf ears.

This lack of manpower causes the nation's rail infrastructure to be maintained in a reactive, rather than a proactive fashion. Track caused derailments account for approximately one-third of all rail accidents, and this trend will continue to increase until manpower in the maintenance of way department is brought into line with the track miles employees are expected

to inspect and repair. Railroad safety is largely dependent on proper track maintenance, and today's high volume, heavy tonnage trains require increased, rather than decreased, track maintenance. Thus, rail safety requires sufficient manpower in maintenance of way track forces to properly and proactively address current track deficiencies and reduce derailments on our nation's rail infrastructure.

Rail labor believes that the evidence clearly supports our position that fatigue is seriously degrading the level of safety in the rail industry among all crafts. There is no question that fatigue is a ticking time bomb in the railroad industry and real solutions to this problem need to be formulated and implemented, most likely by legislation. I implore you to pass common sense legislation enabling the FRA to affirmatively and aggressively regulate fatigue in our industry.

Once again, I thank the Subcommittee for hearing us today, and I'm happy to try to answer any questions you may have.

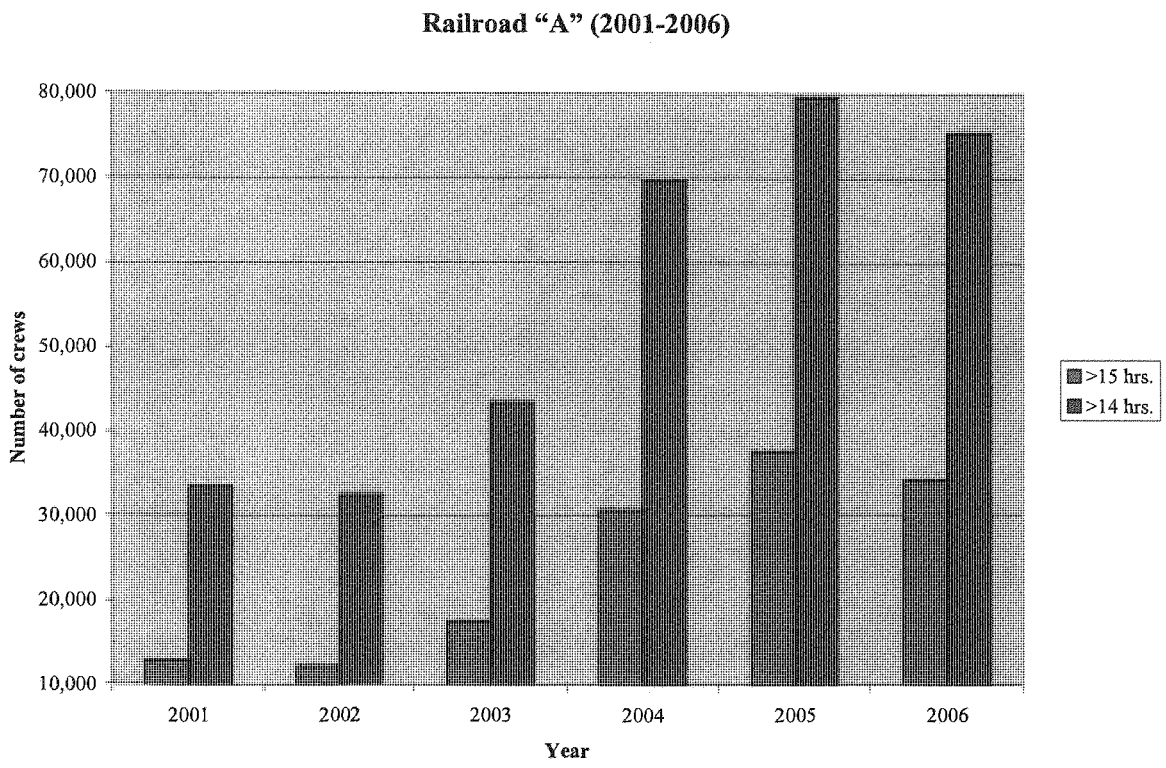

Exhibit BLET-1

Railroad "A" (2006)

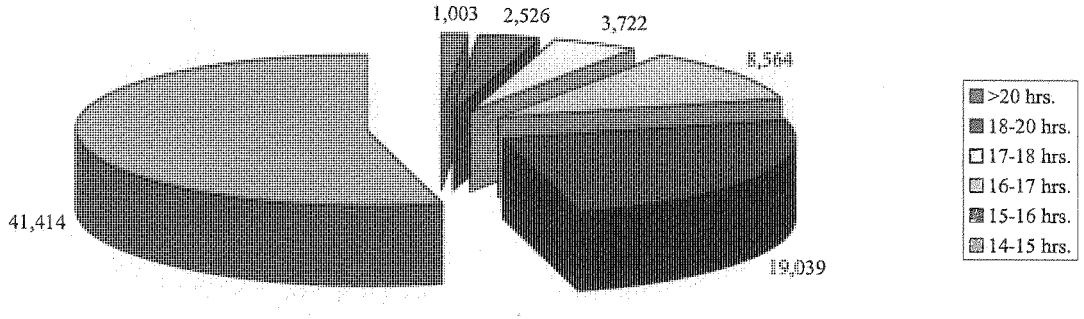

Exhibit BLET-2

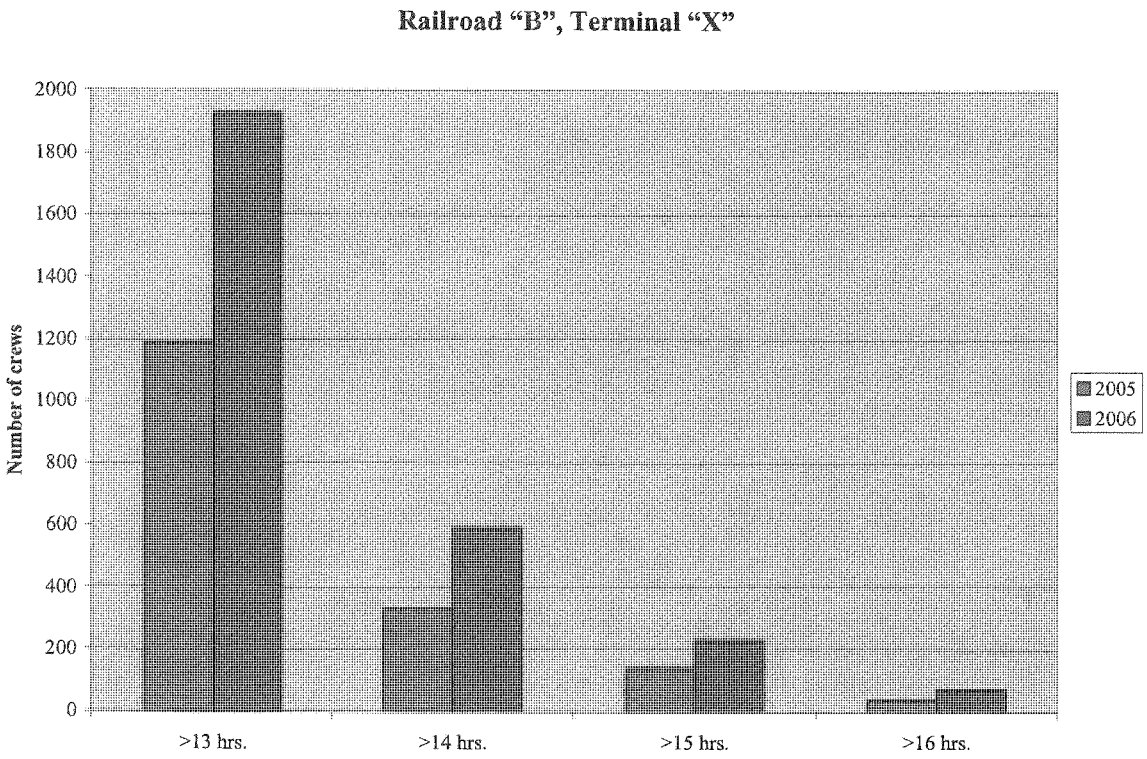

Exhibit BLET-3

National Transportation Safety Board

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Testimony of Mark V. Rosenker, Chairman
National Transportation Safety Board
Before the
U.S. House of Representatives
Committee on Transportation and Infrastructure
Subcommittee on Railroads, Pipelines and Hazardous Materials
Fatigue in the Rail Industry
February 13, 2007

Good afternoon Chairwoman Brown, Ranking Member Shuster and Members of the Subcommittee. My name is Mark Rosenker, Chairman of the National Transportation Safety Board. Madame Chairwoman, I would like to take this opportunity to thank you, the Members of the Subcommittee and staff for inviting the Safety Board to testify today on the topic of Fatigue in the Rail Industry and for your continued interest in furthering the safety of our Nation's railways.

The Safety Board has long been concerned with the sources and consequences of human fatigue in the rail industry. I would like to discuss three areas related to that concern: the decades-long history of fatigue-caused railroad accidents that the Safety Board has investigated, the equally long history of safety recommendations that we have made to address the problem, and the frustration we share with the Federal Railroad Administration (FRA) regarding its lack of legislative authority to address the root causes of fatigue through scientifically based principles of workload and fatigue management.

Fatigue-caused Railroad Accidents

Over the past 23 years, the Safety Board has investigated 16 major railroad accidents in which we established that the probable cause was crewmember fatigue. We have investigated numerous other railroad accidents in which we believe fatigue played a contributing role. The earliest railroad accident investigation in which the Board attributed the probable cause to fatigue was a collision between two freight trains at Wiggins, Colorado, on April 13, 1984. About a week later, on April 22, 1984, two more freight trains collided near Newcastle, Wyoming. The Board found that the probable cause of that accident was that the crew of the striking train had fallen asleep and so had failed to comply with restrictive signals.

Since 1984, fatigue-related train accidents have continued until the most recent collision between two freight trains at Macdona, Texas, on June 28, 2004. I know that Vice Chairman Sumwalt appeared before this Subcommittee just two weeks ago and related the details of the Macdona investigation so I will not elaborate on that particular accident. However, the Safety Board did find that both the crewmembers' failure to obtain sufficient restorative rest before reporting for duty, because of their ineffective use of off-duty time and the Union Pacific Railroad's train crew scheduling practices, which inverted the crewmembers' work/rest periods, contributed to the accident. Work as a train crewmember

entails an unpredictable job schedule that can make it difficult for employees to effectively balance their personal and work lives. We found that the unpredictability of the Union Pacific train crewmembers' work schedules may have encouraged this crew to delay obtaining rest in the hope that they would not be called to work until later on the day of the accident.

Fatigue related accidents have occurred across all regions of the country, and most every major railroad has had at least one fatigue-caused accident. Moreover, no type of railroad operation is immune from the effects of fatigue. Although the majority of the 16 accidents cited above involve freight operations, our investigation case files contain fatigue accidents involving long-distance passenger trains, commuter trains, light rail operations, and even subway trains.

The work schedules of rail crewmembers permit repetitive 12-hour days that we know lead to cumulative fatigue, and when the workers' commute, limbo time, and family responsibilities are factored into their daily schedules, the conditions for exceedingly long days leading to acute fatigue are evident. Limbo time refers to a crew's time spent awaiting transportation and travel time to their final release point after the expiration of their service time (which can be substantial, adding additional hours to the work day). The relatively short mandatory periods of time off currently in place do not afford the opportunity for fully restorative sleep.

Safety Recommendations Addressing Fatigue

In the past two decades, the Safety Board has issued 33 recommendations specific to railroad employee fatigue. The FRA received 8 and the others have gone to rail carriers and operating unions.

Just as our accident history traces the problem of fatigue in railroad accidents, the Safety Board's recommendation history defines the actions that we think could address the problem. Beginning with the Burlington Northern accident that occurred in Colorado in 1984, we recommended enhanced nighttime supervision and crew alerters. In 1989, after the investigation of a Consolidated Rail Corporation accident in Pennsylvania, we recommended that train dispatchers have qualified backup relief and mandatory breaks. We also asked for the railroad company to reduce the irregularity and unpredictability of crewmember's work/rest schedules and provide education and counseling to help them avoid sleep deprivation. Two years later, we recommended to another operator that it develop education and counseling to help crewmembers avoid sleep deficits and sleep deprivation. We then expanded the scope of that recommendation, sending it to the Association of American Railroads, member carriers, and the operating unions. We went further and asked all rail carriers to develop policies that would allow an employee to report off duty when they are impaired by lack of sleep. In 1991, as a result of a Norfolk Southern accident in Georgia, we asked FRA to study fatigue and explore parameters of an optimum alerter system for locomotives. Recommendations concerning the distribution of fatigue awareness materials and fatigue training were also made to Union Pacific Railroad (1999) and to the Canadian National Railway (2002).

Recommendations to address the issue of operator fatigue were placed on the Board's Most Wanted List in 1990. In 1999, the Safety Board conducted an evaluation of the Department of Transportation's (DOT) efforts during the 1990s to address operator fatigue and, despite DOT supported research and educational programs targeting fatigue management, we found that the problem continued to be widespread and presented an unnecessary risk to the traveling public. Recommendation R-99-2 arose from this 1999 evaluation of DOT efforts. It asked the FRA to establish, within 2 years, scientifically based hours-of-service regulations that set limits on hours of service, provided predictable work and rest schedules, and considered circadian rhythms and human sleep and rest requirements. A companion recommendation (Safety Recommendation I-99-1) asked that the DOT seek Congressional authority, if necessary, for the modal administrations to establish these regulations.

The laws, rules, and regulations governing this aspect of transportation safety are archaic in the railroad industry and not adequate to address the problem. The Railroad Hours of Service Act was first enacted 100 years ago. It permits railroad operating employees to work 11 hours 59 minutes, and return to work after only 8 hours off duty. However, under this statutory framework, an employee who works the full 12 hours, only one more minute, would get 10 hours off duty before being permitted to return to work. And, under the law these employees are permitted to repeat that arduous work-rest cycle an unlimited number of times. Thus, the Railroad Hours of Service Act does not take into account either rotating work schedules or the accumulated hours spent working and in limbo time.

Regulatory Authority to Address Hours of Service

The FRA's response to the Board concerning R-99-2 acknowledged the seriousness of the effects of fatigue on safety, but stated that FRA does not possess the authority to change Federal hours of service. The FRA is the only modal administration within the DOT whose constituents' hours of service are mandated by set statutory hours of service limitations (49 *United States Code* 21101 et seq). FRA's response letter further stated that DOT attempted to seek congressional authority in 1991 to bring about modernization of the Federal hours of service laws in a bill submitted to Congress. Under the provisions of that bill, the existing hours of service laws would have been repealed and immediately adopted as regulations. FRA would have had the authority to begin a process of consultation and rulemaking to address the important safety issues identified by both the Safety Board and FRA. According to the FRA, the bill was not supported by rail labor and rail management, and, unfortunately, it was not enacted by the 102nd Congress.

During the Board's 2003 meeting to consider its Most Wanted List of Federal Recommendations, R-99-2, the hours of service recommendation, to the FRA was classified "Closed-Reconsidered" in recognition of FRA's lack of authority to be responsive to the recommendation. However, in the year following the 2003 Board meeting, the Safety Board considered two railroad accidents attributed to fatigue (a collision of two Union Pacific freight trains at Pacific, Missouri, and the collision and derailment of two Union Pacific freight trains at Des Plaines, Illinois); launched on the Woodley Park Metro accident here in DC; and held a public hearing on a third fatigue-related rail accident (Macdona, Texas). This

prompted the Safety Board to issue two new recommendations to FRA: R-06-14 to require railroads to use scientifically based principles when assigning work schedules, and R-06-15 to establish requirements that limit train crewmembers limbo time. Recommendations were also issued to Union Pacific Railroad, the Brotherhood of Locomotive Engineers and Trainmen, and United Transportation Union to use the Macdona accident as a fatigue case study.

The FRA's October 24, 2006, response to the Board on these recent recommendations again stated that FRA lacks rulemaking authority over duty hours, which the FRA said precludes it from making use of almost a century of scientific learning on the issue of sleep-wake cycles and fatigue-induced performance failures. The FRA lacks the statutory authority to adopt the requirements contemplated by either of these recommendations. Any requirement that the railroads use scientifically based principles in assigning work schedules to reduce the effects of fatigue would most certainly require that they not comply with the periods established by the hours of service law, which are not based on science related to fatigue. The FRA's response letter further stated that " the FRA supports efforts to address the fatigue experienced by railroad operating employees, and acknowledges that the existing hours of service is not designed to address the causes of fatigue."

The Board applauds the FRA's recent efforts to study the effects of fatigue in railroad operations, including the recently released Summary Report of a Validation and Calibration of a Fatigue Assessment Tool for Railroad Work Schedules. Safety Board staff have reviewed the summary report and await receipt of the full study. While this effort to apply lessons from studies of schedule-induced fatigue in the military and aviation to the practice of railroad work schedules is important, the bottom line is that the FRA apparently lacks an ability to actually regulate work schedules. The FRA needs authority to regulate crewmember work scheduling practices and work limits and the Safety Board continues to support the need for change that would provide the FRA that authority.

Madame Chairwoman, this completes my statement, and I will be happy to respond to any questions you may have.

Questions for the Record
The Honorable Mark Rosenker

QUESTION 1: Mr. Rosenker, your written testimony documents many instances in which the NTSB has followed up accident investigations with specific recommendations to the FRA, industry, and labor to combat fatigue. What was the FRA's response to these recommendations? Was the FRA's response acceptable? Do you follow-up on the recommendations made to industry and labor? Have they adopted your recommendations?

RESPONSE: The FRA's response to the Board's recommendations to modify hours of service has uniformly insisted that the FRA did not have authority to establish hours of service regulations due to the provisions of the railroad hours of service law. The Board acceded to that interpretation and closed the hours of service recommendation, reconsidered in 2003. The response of the FRA and industry to other fatigue related recommendations has been mixed, with some positive efforts in the development of fatigue awareness materials and fatigue training.

QUESTION 2: Mr. Rosenker, the railroads infer that fatigue-related rail accidents are an isolated and increasingly rare occurrence. For example, Mr. Hamberger of the AAR states in his written testimony that the railroads "have made substantial progress in combating fatigue in the rail workplace." How many accidents has the NTSB investigated involving rail worker fatigue? Fatigue is difficult to detect; there is no chemical test to detect fatigue, like there is for use of alcohol and drugs. Do you believe that fatigue as a causal or contributing factor to accidents is under-reported?

RESPONSE: Unfortunately, it is the Safety Board's experience that fatigue-related rail accidents are far from isolated and rare. As I indicated in my written testimony, the Safety Board has investigated 16 major railroad accidents in the past 23 years in which the probable cause was crewmember fatigue. While the industry has increased awareness of fatigue issues through information and training programs, relatively little has been done to alter the fundamental hours of service and scheduling issues that give rise to fatigue in the first place.

Granted, there is no simple chemical test to detect fatigue, but the circumstances that produce fatigue are well known and well documented in many rail accidents. Work-rest schedules hold the key to this threat to rail safety. Hours of service limits play an important role in managing fatigue, as do company scheduling practices, crew member responsibility to obtain sufficient rest, and effective oversight by the regulator.

In major rail accidents investigated by the Safety Board, we believe that we are usually able to gather sufficient information to evaluate crewmembers' fitness for duty, including fatigue. Absent voice or video recorders we cannot always account for crewmember lapses of attention and other behaviors that may be influenced by fatigue, however.

QUESTION 3: Mr. Rosenker, can a railroad worker develop a sleep disorder due to the unpredictable hours associated with the job? Has the NTSB made any recommendations to this?

RESPONSE: While it is well established that sleep disorders will aggravate and amplify the effects of sleep loss, and thus fatigue, we do not have any information on the role of unpredictable hours in the development of sleep disorders. The NTSB has not made recommendations in this area.

QUESTION 4: Mr. Rosenker, what are the maximum possible hours of service for an employee across the different transportation modes? Who (among transportation workers) works the longest hours?

RESPONSE: If we were to calculate the maximum possible hours of service simply by applying existing hours of service law or regulation, we obtain the following result: Rail - 432 hours of work per month (30 days); Air Transport Operations - 100 hours per month; Air Taxi Service - 120 hours per month; Commercial Truck Drivers - 350 hours per month; and Ocean going marine vessels - 360 hours per month. It must be recognized that these estimates are maximums permitted under regulation/law and not typical work schedules.

QUESTION 5: Mr. Rosenker, how does the unpredictability of a rail worker's job schedule impact fatigue?

RESPONSE: The unpredictability of rail worker schedules is one of the biggest contributors to crew fatigue. Our investigations have repeatedly shown that failure to obtain sufficient recuperative rest is perhaps the most important determinant of fatigue. That failure (to obtain sufficient rest) is, in turn, closely associated with unpredictability of the crewmember's schedule.

QUESTION 6: Mr. Rosenker, what is the legislative authority of the other DOT modal administrations to address fatigue?

RESPONSE: Most DOT modal administrations have rulemaking authority to develop hours of service limits. The Federal Transit Administration is one modal administration that does not have authority to establish hours of service requirements for transit trains. The most recent exercise of this authority was the Federal Motor Vehicle Safety Administration's revision of highway hours of service rules (49 CFR Part 395) in August of 2005.

QUESTION 7: Mr. Rosenker, if the FRA was granted authority to change railroad hours of service, what changes should be made?

RESPONSE: While we would not presume to prejudge the rulemaking process, one of the most important aspects of effective hours of service limits is the provision of sufficient opportunity for crewmembers to obtain sufficient uninterrupted and recuperative rest between workdays. An eight-hour per day sleep requirement has solid support from decades of fatigue research. It absolutely must be recognized that off-duty periods must be sufficiently long to allow for commuting, eating, personal hygiene, and other personal functions **in addition to** eight hours of sleep. Other considerations, such as schedule predictability, operation on a 24-hour clock, and circadian variations in alertness should also be considered during the rulemaking process.

QUESTION 8: Mr. Rosenker, does the NTSB believe that the voluntary efforts of management and labor to reduce fatigue are sufficient?

RESPONSE: No, these voluntary efforts have not solved the problem.

QUESTION 9: Mr. Rosenker, what should the FRA do to address limbo time (if they had the legislative authority)?

RESPONSE: It is the Board's position that limbo time should be considered to be on-duty time.

Additional Questions for the Record
Submitted on behalf of Congresswoman Grace Napolitano

QUESTION 1: Mr. Rosenker, on October 16, 2004, a Union Pacific freight train derailed 3 locomotives and 11 cars near Pico Rivera, California releasing a small amount of hazardous material. The National Transportation Safety Board (NTSB) noted that the cause of the Pico Rivera accident was a failed pair of insulated joint bars due to fatigue cracking. NTSB and FRA informed me that they would be testing the cracked joint bar from this accident to better understand how it happened and how we can prevent it. What were the results of the NTSB and FRA tests?

RESPONSE: NTSB laboratory examination of the 2 joint pieces found that there were slowly growing fatigue cracks in both the joint bars and that at least part of each fatigue crack had been visible on the lower outer portion of the bar for some time before failure. The initial cracking in the south joint bar was between the first and second bolt holes from the center of the joint and was associated with an indentation in the bottom outside corner of the bar. The epoxy bead along the top of the joint bars was missing from the center sections of the bars, indicating that the joint was older and was experiencing relative movement between the rail head and bars. The joint bars were still securely bonded at the ends, indicating that the joint bars were not moving laterally, but were bending cyclically in the middle under the weight of passing trains.

The NTSB recommended on March 15, 2004, that FRA require all railroads with continuous welded rail track to include procedures (in programs that are filed with the FRA) that prescribe on-the-ground visual inspections and nondestructive techniques for identifying cracks in rail joint bars before they grow to critical size. The NTSB also recommended that the FRA establish a program to periodically review continuous welded rail joint bar inspection data from railroads and FRA track inspectors and when determined necessary require railroads to increase the frequency or improve the methods of inspection of joint bars in continuous welded rail.

QUESTION 2: States can play an important role in assisting FRA with ensuring safety along the rail lines. Unfortunately, FRA has been reluctant to allow states to regulate the railroads in order to provide a safe environment for their residents.

RESPONSE: The NTSB agrees that states can play an important role to improve rail safety. (Please see the Safety Board's response to Question 3.)

QUESTION 3: What role do you feel states should play in assisting with railroad safety and regulation?

RESPONSE: It is our understanding the FRA offers states the opportunity to be actively involved in rail safety through its State Participation Program and that it offers funding to pay for training and travel for its rail inspectors. In this program, state inspectors can enforce Federal safety regulations, including track safety requirements. We believe that states can help identify through inspections railroad non-compliance with safety requirements for enforcement, and also identify areas where railroad safety standards need improvement and then work with the FRA to strengthen those requirements for all railroads.

Testimony

Delivered to the

House Committee on Transportation and Infrastructure
Subcommittee on
Railroads, Pipelines, and Hazardous Materials

Fatigue in the Railroad Industry

Professor Patrick Sherry

University of Denver
Intermodal Transportation Institute
National Center for Intermodal Transportation

February 13, 2007

Fatigue in the U.S. Railroad Industry

Professor Patrick Sherry, Ph.D.
Professor, Intermodal Transportation Institute
Co-Director, National Center for Intermodal Transportation
University of Denver
&
Mississippi State University

February 13, 2007

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.

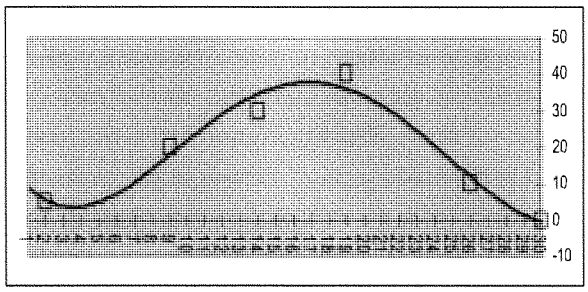

Figure 1. Alertness over time.

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.

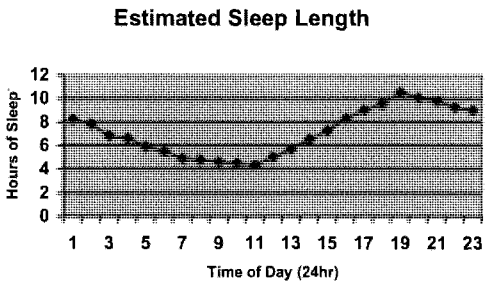

Figure 2. Estimated Sleep Lengths.

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.

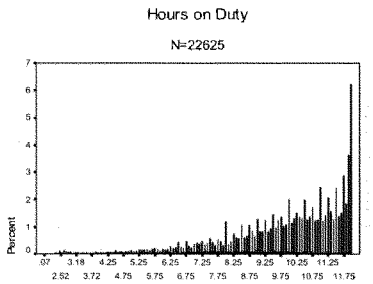

Figure 3. Hours on Duty.

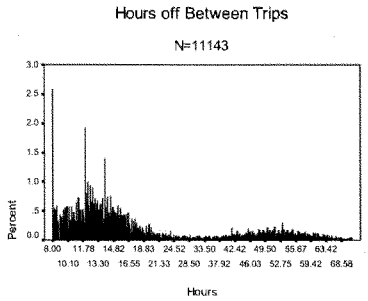

Figure 4. Hours off-duty between trips.

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.

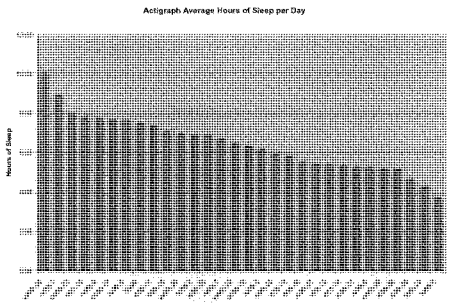

Figure 5. Average Hours of Sleep Obtained in a Sample of Engineers and Conductors.

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.

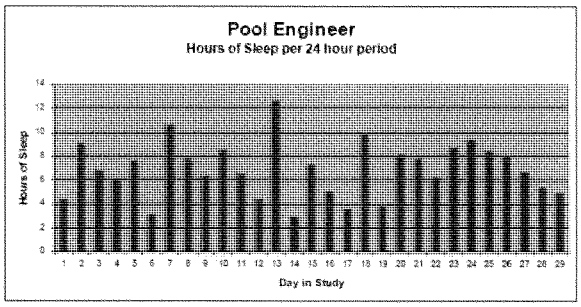

Figure 6. Daily Hours of Sleep for Pool Engineer.

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.