



A BLET Reference Manual of Railroad Worker Fatigue

ABRIDGED

Brotherhood of Locomotive Engineers & Trainmen

A Division of the Railway Conference of the

International Brotherhood of Teamsters

By

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Executive Summary

This abridged reference manual was produced for presentation at the 2005 Fatigue Countermeasures in the Transportation Industry workshop held in Denver, CO, in conjunction with the winter NARAP meeting. In its entirety, the Reference Manual of Railroad Worker Fatigue provides background information for fatigue mitigation policies and strategies.

This document provides a short discussion of recent BLET efforts to mitigate railroad worker fatigue. It goes on to discuss fatigue management plans around the world. A BLET fatigue management plan is outlined with five major elements that include Education, Medical Aspects of Fatigue, Critical Aspects of Fatigue, Chronic Aspects of Fatigue, and Evaluation. This paper concludes with a BLET perspective on computer models of railroad worker fatigue.

INTRODUCTION

This paper was abridged from a guide prepared for leaders of the Brotherhood of Locomotive Engineers & Trainmen. The goal of that guide was to provide updated research and discuss issues effecting railroad worker fatigue.

Efforts to resolve fatigue are reported here with a focus on non-prescriptive solutions intended to resolve the fatigue issue without intervention by government, either by regulation or statute. The fatigue plans envisioned here would include all railroads, all rail operations, and all railroad workers associated with safety critical jobs. This non-prescriptive effort involves cooperation between labor and management to forge effective fatigue management plans for each railroad in the US.

While non-prescriptive efforts may arguably be advantageous, at some point in time, the BLET must determine if a non-prescriptive approach to resolving railroad worker fatigue is feasible based on:

- effectiveness---do they work to reduce worker fatigue
- comprehensiveness---do they address all aspects of railroad worker fatigue
- inclusiveness---are all railroads in the US participating in the solution

While this process of evaluation is an iterative process for the BLET, there is a definite limit to the iterations that the BLET has determined are appropriate before deciding that a non-prescriptive effort is futile in the US railroad industry. This abridged guide concludes by acknowledging, but does not elaborate on, two prescriptive strategies: a regulatory effort through the FRA and a Federal statute passed by the US Congress.

Background: The 2002 BLE Proposal – E.I.E.

In September 2002, the BLET, formerly the Brotherhood of Locomotive Engineers, proposed a solution to fatigue in the railroad industry. The proposed solution was based on a belief that if the railroads, government, and labor would come together in good faith, the problem of railroad worker fatigue could be resolved.

More than just a Pollyanna suggestion, the proposal entitled Education, Information, and Empowerment (E.I.E.), envisioned using a “systems” approach to mitigate serious fatigue plaguing the railroad industry. Generally, the 2002 BLE fatigue proposal suggested that if:

- 1) railroad workers were educated about fatigue and how to avoid it, and
- 2) if Management and Labor would work together exchanging information about improving schedules and other work practices that contributed to fatigue, and
- 3) if railroad workers were permitted to absent themselves from duty if their individual fatigue interfered with their ability to safely perform their duties;

then fatigue in the railroad industry could be resolved for the good of management and labor. In this suggested proposal, government was seen as an arbiter and a facilitator to ensure success of the overall process, but the solution would be non-prescriptive.

The E.I.E. initiative was not embraced by the railroad industry. Throughout 2003 and 2004, no systemic solutions have been adopted by any single railroad or the industry generally.

On September 21, 2004, the FRA issued an advisory to the railroad industry based upon NTSB recommendations that attempts to encourage the industry to adopt fatigue countermeasures for “sleep apnea.” The BLET experienced the advisory as a very narrow response to the NTSB recommendations. The BLET outlines concerns with fatigue here that go beyond the NTSB recommendations and the FRA advisory.

The railroad industry has made moves toward mitigating the problem of railroad worker fatigue. However, the BLET believes that railroad industry efforts can be described as tentative, uneven, and at times intended to delay a solution to serious railroad worker fatigue issues as experienced by BLET members.

The Fatigue Problem in the Railroad Industry

Railroad worker fatigue has plagued the industry from the founding of railroads. The scientific community identifies numerous symptoms that can be extrapolated to suggest a possible hazard in safety critical positions in the railroad industry. However, there is no scientific definition of fatigue accepted by US railroad management and labor.

Beginning in the late 1980’s, the NTSB identified railroad worker fatigue in several severe railroad accidents. By the early 1990’s, the NTSB focused on fatigue as one of its top concerns to improve safety in the railroad industry.

Since that time, several proposals from labor and management have resulted in minor changes, some successful pilot projects that were never expanded, and considerable resistance from government, management, and even some labor to resolve railroad worker fatigue. Attempting to overcome this resistance and resolve railroad worker fatigue are concerned families, some safety experts, and some government officials.

Understanding the resistance to change in the most oversimplified terms means addressing the tensions each group is experiencing. For labor, a tension exists between earning potential and fatigue from overworking. This tension exists with a host of qualifications given the individual’s personal experience, but generally includes family commitments, personal commitments, and social needs. However, in a recent survey by the BLET, 89.1% of BLET members responding said work/rest cycles were important or extremely important. Also, 88.3% of BLET members responding identified layoff provisions as important or extremely important. BLET members are asking with gusto for a solution to the fatigue problem.

Both management and government experience tensions and considerations as basic as labor that they can enunciate themselves. However, the railroad industry must consider societies expectations. For example, New Jersey is the first state to define fatigue as failing to sleep in the previous 24 hour period. This law imposes legal liability to the fatigued individual; however, the Insurance Journal (7) reports that industries that mandate irregular and excessive work schedules may soon face new liability issues from fatigued workers.

Within this shrinking acceptance of railroad worker fatigue, there exists a small window of opportunity to comprehensively address railroad worker fatigue from a scientific formulation without government intervention. Labor and Management are

pursuing this non-prescriptive effort in order to avoid the mandates of federal regulation. Some labor and management representatives believe that federal mandates will entirely eliminate options enjoyed by railroad workers and railroads alike. For example, mandated 7 days available for work followed by 3 days of rest (7 & 3) might be acceptable to workers on one railroad while at the same time entirely unacceptable to railroad workers on another railroad. This is one prescriptive solution advocated by some interests in the railroad industry. Therefore, in order to provide a framework that comprehensively addresses railroad worker fatigue in the US, while at the same time retaining as many options for a diverse worker population, some labor and management representatives are considering the concept of “Fatigue Management Plans.”

FATIGUE MANAGEMENT PLANS

Around the World

In Europe, a social compact has resulted in a work ethic that prescribes a certain maximum expectation on the number of hours and days worked by industrial workers. Processes have been introduced that define the acceptable or society norm for work and rest in many European countries. These processes have led to a foundation or definition of acceptable and unsafe levels of fatigue in the work place.

Australia on the other hand, has attempted to incorporate scientific research of worker fatigue as a basis for prescribing a process that is designed to mitigate fatigue resulting in railroad operations. This “outcome” orientation suggests that the process is variable within the confines of the Australian legal system; however the outcome must be to eliminate unsafe levels of railroad worker fatigue. The Australian model mandates individual responsibility by railroad workers for their fatigue and prescribes penalties for the failure of railroad workers to be rested while performing railroad service.

Canada has employed a hybrid model of scientific and social processes in order to develop “Fatigue Management Plans” that mandate fatigue mitigation for every railroad schedule within a railroad operation. Using a process model involving labor, government and management working together to resolve complex fatigue issues that is distinct to the Canadian political/legal system, Canadian railroads operate with individually fashioned written fatigue management plans that are designed to address the unsafe levels of railroad worker fatigue.

Fatigue Management Plans in the US

Several US Class 1 and short-line railroads with operations in Canada are required to submit fatigue management plans conforming to Canadian law for those operations within Canada. These railroads have successfully implemented fatigue management plans, though the efficacies of these plans are still in question. A common failure of these plans, though mandated in the Canadian process, is an effective and complete evaluation process.

Translating the Canadian “process model” into the US culture is somewhat problematic however. Canadian law incorporates mandates that require cooperation between labor, management, and government. There exists no similar US mandate.

In order to progress a non-prescriptive solution to fatigue that will effectively resolve engineer and trainmen issues, a framework must be designed and a collaborative process invoked to achieve the results other countries have achieved recognizing that

both labor and/or management may choose to sabotage this non-prescriptive effort. Sabotage from any quarter might demonstrate a need for government intervention in order to address unsafe levels of railroad worker fatigue.

A BLET Fatigue Management Plan

From the perspective of the BLET, an effective fatigue management plan in the US railroad industry will require a plan that incorporates education, addresses medical aspects of fatigue, critical aspects of fatigue, chronic aspects of fatigue, and establishes a method of evaluation that feeds-back into the process to determine if fatigue in the work place has been reduced. The corrective intervention resulting from the evaluation requires ongoing collaborative efforts by labor and management to ensure that the desired goal of mitigating unsafe levels of railroad worker fatigue is accomplished. Further, effective fatigue management as described here is an iterative process that in the railroad industry can become quite tiresome for labor and management representatives.

Success using fatigue management plans might be measured and incremental, not revolutionary, as many workers, managers and government agencies may desire. Yet, successful mitigation of fatigue may produce a process born from trust that could be advantageous in future management/labor negotiations. An outline of fatigue management that addresses the scientific, social, and organizational concerns of the BLET is described below.

Education Aspects of a Fatigue Management Plan

Education to resolve fatigue is necessary for successful mitigation of engineer and trainmen concerns. However, education needs to be focused for three different strata of railroad workers. For example, the sort of education necessary to successfully mitigate personal levels of fatigue in an engineer or trainmen is different from the education necessary to convince a railroad chief executive or chief operating officer of the necessity of incorporating a fatigue mitigation plan in that executive's railroad work place.

Senior Management Educating Senior Management for effective fatigue management in the railroad industry requires a focus on the options that a fatigue management plan provides for a US railroad operation.

Railroad management is suggesting a need for as many as 80,000 railroad workers in the next five years. In addition, new workers tend not to accept the fatiguing schedules the railroad industry has relied upon for decades.

Bringing the necessary ideas into a single education piece that will convince railroad executives to support the application of fatigue management plans will be necessary before these plans can be implemented in the industry. At present, this education piece has not been designed, produced or implemented in the railroad industry.

Railroad Supervisors While it is necessary to educate senior managers of the need and efficacy of a successful fatigue management plan, middle and first line supervisors need to be educated about the importance of supporting and incorporating the iterative process of managing railroad worker fatigue into the daily regimen of railroad operations.

In addition some supervisors of engineers and trainmen themselves are experiencing unsafe levels of fatigue. The symptoms of fatigue such as irritability,

inability to concentrate, and impaired judgment can lead to unsafe levels of stress in the supervisor/labor working relationship.

It is not the responsibility of labor to advocate for management working conditions. Yet, in order to address unsafe levels of fatigue in the railroad industry, fatigue management planners must pay attention to this group experiencing fatigue in the railroad's system. Creating a culture that encourages fatigue management planning is both daunting and necessary in order for a non-prescriptive effort to succeed.

At present, this educational piece of the fatigue management plan has not been fully discussed, let alone designed, produced, or implemented.

Railroad Workers For railroad workers, education has occurred for many years about the hazards of fatigue in the industry and how to mitigate fatigue to reduce those hazards. At the same time, new workers need to be educated about the effects of fatigue, how to mitigate fatigue in a busy railroad life, and what to do if mitigation efforts fail. In addition, existing railroad workers must be kept informed about advances in mitigating fatigue in the work place for shift workers and unconventional work schedules.

An effective educational tool would necessarily include recent research around fatigue mitigation, important lessons from recent sleep research, as well as health and fitness information designed to mitigate unsafe levels of fatigue. Further, any education tool must be multifaceted in order to achieve both goals of easy accessibility and frequently updated information. It does no good to provide Internet access as a tool to a working population that may be Internet illiterate or too fatigued to access the information. Yet, pamphlets, booklets, and posters cannot be relied solely upon to meet the educational needs of adult railroad workers.

Current adult education techniques should be employed, as well as, multi-faceted tools integrated into the culture in order for education to be maximally effective in mitigating railroad worker fatigue.

At present, a proposal for a web based education process accessible to railroad labor and management is under consideration. However, it should be noted that this exact effort has been tried previously without a resolution to the fatigue experienced by many railroad workers. Education by itself will not address the concerns of the BLET.

Individual Responsibility Mitigating unsafe levels of railroad worker fatigue ultimately relies heavily on individual railroad workers taking responsibility for their personal work and sleep habits. However, in order for individuals to exercise personal responsibility for managing fatigue, those individuals must be provided with the tools necessary to implement personal fatigue mitigation efforts. These tools include education, information, but most importantly *the time to sleep and recuperate from fatiguing schedules*. Once all of these tools are made available to the railroad worker, it is necessary to rely on all existing cultural tools possessed by labor and management to ensure that fatigued workers are absent from the work place.

Resolving worker fatigue is not just an effort by unions to get railroads to address the numerous issues contributing to the problem, railroad workers themselves must be accountable for using the tools available to become properly rested to perform railroad service. A safer railroad environment requires an effort by all parties to participate as they are able, to ensure a rested railroad work force.

Currently, successful efforts by operation red block/operation stop have been employed by railroad workers to assist each other in the process of eradicating drugs and alcohol from the work place. The E.I.E. proposal offered by the BLET envisioned a peer oversight process to discourage fatigued workers from performing railroad service. History suggests that as part of an effective nationwide “systems” solution to railroad worker fatigue, individual responsibility and peer support may well emerge as integrated aspects supporting the goal of reducing unsafe levels of railroad worker fatigue.

It is not logical to suggest that this element can be incorporated as a stand alone process without the accompanying tools necessary for individual railroad workers to use to mitigate their personal fatigue. Toward that end, a toolbox of available options to help mitigate unsafe levels of railroad worker fatigue is necessary. Ideally, each railroad’s management and on property labor representatives might draw from this toolbox to create an effective fatigue management plan for individual railroad workers to use on that property.

Medical Aspects of a Fatigue Management Plan

The NTSB asserted medical problems resulting in fatigue as a contributing cause in the November 15, 2001, Clarkston, Michigan accident, with both the engineer and conductor suffering from either diagnosed or undiagnosed sleep apnea. When the medical treatments are observed, research indicates that unsafe levels of fatigue can be removed from the workplace.

With proper diagnoses and treatment, it is believed that greater than 90% of all fatigue resulting from medical issues can be effectively resolved without interfering with an employee’s ability to work as a railroad engineer or trainmen. Getting the railroad industry to act upon this information in a sensitive and supportive manner that will serve to reduce the medical aspects of fatigue in the railroad industry is the overall goal of this section.

Railroad Policies on Medical Aspects of Fatigue Instituting a policy or collective bargaining agreement that acknowledges and treats fatigue from medical problems just as it would any other medical issue is necessary for effective implementation and resolution of fatigue resulting from medical problems.

Succinctly, a policy is needed that is worded to protect the rights and livelihoods of railroad workers and also effectively addresses the medical aspects of fatigue as experienced in railroads today in order to satisfy the concerns voiced by the NTSB and the FRA.

Each railroad and on property labor representative will need to determine if it is necessary to turn the railroad’s medical aspects of fatigue policy into a collective bargaining agreement. Once the policies are in place on the nation’s railroads, it will be necessary to address logistical issues.

Medical Provider Education Not all medical doctors are properly trained to diagnose fatigue related illnesses. Specialists, particularly in outlying railroad communities that are distant from specialty practitioners, must be identified and a list of these specialists must be provided as a necessary tool to the railroad worker.

Individual Responsibility Once the policy is in place, labor and management working together might forge education and/or peer intervention efforts to encourage railroad workers to receive medical evaluations for possible fatigue related problems before they result in an accident. With the reassurance that railroads will not use a fatigue medical condition to punitively interfere with employees efforts to support their families, individuals will have the tools necessary to resolve personally with their private physician a medical intervention that will ensure their ability to work properly rested and free from medical problems resulting in fatigue.

As discussed above, ultimate responsibility for addressing fatigue from medical problems reside within the individual. The BLET believes the railroads have the responsibility to provide the tools to the employee, as discussed above, in order to ensure “a safe working environment.”

Various class one railroads report they are in the process of developing these policies and developing strategies to address the logistics of implementing these policies. To date, there is no evidence in the day to day experience of locomotive engineers and trainmen that this effort to address medical aspects of fatigue is progressing in the railroad industry.

Critical Fatigue Aspects of a Fatigue Management Plan

Critical aspects of fatigue result from the unique demands of working in the railroad industry. For example, working on call 24 hours a day seven days a week often without reasonable forecasting of schedules or lineups may result in a severe short term loss of sleep. These situations can occur immediately following extended rest periods such as vacation, days off or long layovers. Often times, they result from the vagaries of the system that fails to forecast with any effectiveness the movement of trains in the US. Some railroads have mitigated these vagaries by attempting to schedule railroad operations. Other roads have attempted to use lineups to forecast the need for workers. Both of these efforts have shown success and failure.

When attempts to mitigate critical aspects of fatigue fail and a railroad worker is identified as experiencing a lack of sleep, what is provided by the railroads to mitigate this safety hazard?

Short Term Sleep Loss Short term sleep loss research spanning many years and originating in Australia has identified a correlation between the amount of sleep an individual gets and his/her fitness to perform certain safety related transportation duties. Dawson (2) argues that a “Prior Sleep and Wake Model (PSWM)” provides a better determinate of fitness for duty than a prescriptive model that relies on the traditional hours of service. In Dawson’s original formulation, implemented on one class one railroad, a person minimally needed five hours of sleep in the previous 24 hour period. Additionally, Dawson suggested that in the previous 48 hours, a person required a minimum of 12 hours of sleep. Barring this, mitigation efforts were necessary from caffeine use to not performing service, depending on the severity of sleep loss beyond the identified parameters.

In 2004, Dawson (3) reported on a study of 61 NTSB “fatigue-related” heavy vehicle accidents that were single-vehicle accidents with no evidence of corrective action by the operator to avoid the accident and no other obvious cause for the accident. These

data were compared with 44 NTSB control accidents that involved multiple-vehicles, demonstrated attempts at corrective action and/or identified other known causes rather than fatigue. This research suggested a common determinate in over 2/3 of the fatigue-related accidents resulted from operators receiving less than 6.5 hours of sleep in the previous 24 hour period.

Sleep researchers have often advocated eight hours of sleep each night for individuals. Dinges (4) suggests that individuals require a minimum of 7.5 hours of sleep per day. Today Americans average 6.9 hours of sleep on weeknights and 7.5 hours per night on weekends according to the 2003 poll of the National Sleep Foundation (NSF). From Dawson's research, 6.5 hours of sleep correlates to a threshold that may result in accidents. Under the Hours of Service law in the US, railroad workers are minimally required to have 8 hours off duty. However, these 8 hours off duty do not translate into 6.5 hours of sleep. With personal hygiene, transportation to and from work, eating and other disruptions, railroad workers are reporting 4 hours or less of sleep during an 8 hour off duty time period.

These calculations contribute to part of the experience of critical fatigue in the railroad industry.

Circadian Rhythms Short term sleep loss does not entirely explain the experience of critical fatigue in the railroad industry. Research dating back decades have identified biological cycles conforming generally to the 24 hour day. Between 3-5 am and to a lesser degree between 3-5 pm, the human body experiences "down cycles" when our bodies physically demand sleep. These circadian rhythms exist as unalterable difficulties in ever changing railroad operations.

During these periods, shift workers often experience a debilitating need to sleep. Mitigating these biological needs may be complimentary to mitigating short term sleep loss, or the solutions may involve separate fatigue mitigation efforts. However, short term sleep loss coupled with biological down cycles either individually or together creates a critical fatigue concern in the railroad industry.

Possible practical solutions to critical fatigue The National Sleep Foundation has identified the following possible solutions for mitigating circadian sleep loss:

- Short breaks throughout the shift.
- Working in groups.
- Try to exercise during breaks.
- Try to eat three normal meals per day.
- Drink a caffeinated beverage early in the shift, e.g. before 3 a.m. for the night worker.
- Don't leave the most tedious or boring tasks to the end of the shift.

While the National Sleep Foundation provides ideas based on traditional shift worker research, railroad worker experiences, particularly from short term sleep loss may require making additional opportunities or mitigation efforts possible for railroad workers. Thus in addition to NSF recommendations to make opportunities available for the

recommended stop gap measures above, other successful solutions to critical fatigue include:

- Opportunity naps lasting 20-40 minutes
- Allowing the worker to absent themselves from duty when they have not gotten the minimal amount of sleep necessary to safely perform a shift.
- Creating rest periods that exceed the minimum eight hours rest provided by federal law and allowing workers to optionally book these extend rest periods as needed.

Combinations of these tools may effectively mitigate critical fatigue in the railroad work place.

At present, various Class One railroads are experimenting with various combinations of the above mitigation efforts for critical aspects of fatigue. However, no railroad in the US has adopted a comprehensive plan on their entire system that addresses the critical aspects of fatigue by all engineers and trainmen working for that railroad. Many of these efforts have developed with cooperation and leadership from the General Committees of Adjustment of the BLET. Future non-prescriptive solutions to critical fatigue may develop with additional leadership from the General Committees of Adjustment working with Management on the individual railroads.

Chronic Fatigue Aspects of a Fatigue Management Plan

Sleep Debt Research While addressing critical fatigue is necessary, it does not necessarily relieve railroad workers from chronic aspects of fatigue. Chronic fatigue describes accumulated fatiguing factors that build over the course of a work week. For example, researchers have found that if an individual sleeps extensively on his/her first rest day, the individual's body may be recovering from sleep debt that has accumulated during the work week. Dinges (4) argues persuasively that sleep debt research is relevant to addressing chronic worker fatigue.

According to the National Sleep Foundation, working more than 60 hours a week increases your risk of driving drowsy by 40%. Kraus, at one time researching for the Association of American Railroads (AAR), reported that engineers "working more than 50 hours a week have a significantly higher rate of accidents than those working fewer hours." This research raised additional concerns about yard service engineers working the overnight time frames.

According to the US Department of Transportation (DOT)(5), fatigue results from "the combination of long work periods and other non-duty factors that contribute to on-the-job fatigue, by limiting the available time for recreation, rest, and sleep. Over extended working periods, repeated inadequate sleep periods can result in accumulated sleep debt and associated operator fatigue." All waking hours contribute to the accumulation of sleep debt, since there are only 24 hours in any day. Therefore, railroaders working 12-23 hours in a 24 hour period necessarily must respond to accumulated sleep loss. While the federal "Hours of Service" limits work to 12 hours, one railroad territory reported over 900 times railroad workers were on duty in excess of 15 hours in a single month in 2004. It is not clear that opportunity napping was employed in any of the 900 cases to mitigate fatigue.

Health Aspects contributing to fatigue In addition to acquired sleep debt from working extended hours, health aspects may contribute to fatigue. Several health issues are associated with chronic fatigue in the general population. Weight issues have been related to interrupted sleep. Exercise, properly scheduled with work and sleep has been identified as mitigating chronic fatigue, though incorrectly scheduled can actually contribute to critical fatigue.

For railroad workers, unpredictable schedules can result in the best efforts by an individual to address health aspects of fatigue resulting in higher levels of fatigue. For example, exercise too close to sleep can disturb normal sleep patterns. Eating too close to sleep is counter productive. Yet, with eight hours rest mandated by law, addressing health aspects of fatigue is virtually impossible without mitigation during work hours.

Possible practical solutions to chronic fatigue Research indicates that in order to overcome a sleep debt, workers need time of extended undisturbed rest. In addition, a single sleep episode fails to restore an accumulated sleep deficit. Often, a minimum of 48 hours of rest or more is necessary in order for the individual to experience more than one sleep period that will satisfactorily restore an accumulated sleep deficit.

Examples used in the industry include work / rest cycles such as 7 & 3, 8 & 3, or 10 & 5. In other words, a worker on a 7 & 3 schedule is available for duty to the railroad for 7 days and then is provided the option of up to 3 days of undisturbed rest.

Reports from railroad workers suggest that initially there is resistance to work / rest scheduling, particularly if the rest periods are mandatory. However, over time optional work / rest cycles are accepted and individuals often report significant relief from fatigue.

Negative reports from railroad workers suggest that the 7-10 day work availability can be excessive for many workers from a fatigue standpoint. For these, a 4 days available, 2 days off, 3 days available, 1 day off schedule (4 & 2, 3 & 1) might relieve fatigue concerns and provide another option for railroads and workers alike.

Other options to address chronic aspects of fatigue may include:

- Scheduled meal periods during work shifts
- Exercise options in the work place
- Scheduling trains and using assigned crews rather than using extra, pool service, or irregular service

At present, several Class One railroads are experimenting with various combinations of the above mitigation efforts for chronic aspects of fatigue. However, no railroad in the US has adopted a comprehensive plan on their entire system that addresses the chronic aspects of fatigue experienced by all engineers and trainmen working for that railroad. Many of these efforts have developed with cooperation and leadership from the General Committees of Adjustment of the BLET. Future non-prescriptive solutions to chronic fatigue may develop with additional leadership from the General Committees of Adjustment in cooperation with railroad management on the individual railroads.

Evaluation of a Fatigue Management Plan

Once labor and management have agreed to a fatigue plan on an individual railroad, how will railroad workers know if the efforts are successful beyond their individual experience? Railroad workers realize that not just personal or “my” level of fatigue is hazardous to my safety, but my coworker’s level of fatigue can be even more hazardous to my safety. Evaluating each railroad’s fatigue management plan is necessary to move the fatigue issue from talk into action.

Methods of evaluation can take two forms: direct measures and proxy measures. At present no single measuring tool can be relied upon to effectively determine if fatigue has been reduced in the work place. Further, the measuring tool will necessarily respond to the solutions implemented by the various railroads. However, in all cases, management and labor will be determining whether medical, critical, and chronic aspects of fatigue have been reduced in the railroad workplace.

Direct Measures of Railroad Worker Fatigue Direct measures of fatigue describe tools that directly report a variable that has been theoretically related to fatigue. For example, actigraphs are a “wristwatch” type of device that measures an individual’s activity or inactivity based on the person’s movement. Extremely reduced periods of activity are *assumed* to indicate the person is sleeping. Measuring the total sleep accumulated in 24 hours, and using a standard assumption that a minimum of 5-8 hours of sleep is necessary in that 24-hour period provide a direct measure of fatigue to the user.

Other direct measures of fatigue include Electro Encephalogram, Multiple Sleep Latency Test, Stanford Sleepiness Scale, and sleep diaries. It should be noted that all of the direct measures of fatigue are fallible. Actigraphs must be constantly worn to be effective; if removed in any 24 hour period the report is not accurate. Tests that have been developed for the individual to report their personal level of fatigue have been shown to “under-report” the true level of the worker’s fatigue. In other words, we are often more fatigued than we are prepared to admit. Finally, many direct measures require expert analysis, resulting in a cumbersome or complicated process that is not suitable for railroad operations.

It should be noted that the trucking industry recently reported on a methodology that was shown to measure driver fatigue, was minimally intrusive, and did not require expert interpretation. (see Dinges)

Proxy Measures of Railroad worker Fatigue Proxy measures of railroad worker fatigue measure variables that are assumed to directly correlate with fatigue. For example, a measurement of engineer’s operating skills over the course of a work day might be gauged to fatigue. However, proxy measures tend to exist as a second order or intermediate variable that can be affected by other issues. In this example, personal issues unrelated to fatigue, such as attitude, can affect operator efficiency. Also, environmental variables such as wind, snow or rain can effect efficient operation of trains. Finally, mechanical issues such as engine failure on-line, continuous wheel slip or inaccurate train tonnage can affect an operator’s efficiency.

Proxy measures can be made with effort to approximate a level of fatigue experienced by railroad workers. Generally, direct measures tend to more accurately address the BLET's concerns of reducing railroad worker fatigue.

How to Use Measures of Railroad Worker Fatigue Either direct or proxy, the measures chosen by management and labor on the individual railroads provide a tool to initiate a "continuous improvement process." Ideally, each iteration of the improvement process might contribute to an eventual "best practice" for consideration or even adoption by other railroad operations.

Finally, a solution to fatigue can also be a measure of fatigue in the workplace. For example, if railroad workers are allowed to absence themselves from railroad service when they are fatigued without interference from management, the tracking of these requests becomes a valuable tool for measuring fatigue in the workplace. In addition, the absence of these requests also is a measure of a work place not suffering from debilitating fatigue.

At present, no railroad has implemented a systemic program in cooperation with labor that measures railroad worker fatigue. Without this effort, it is not convincing for the railroad industry in the US to scientifically argue that they are addressing railroad worker fatigue.

Where does the Fatigue Plan Apply?

For the fatigue plans to effectively resolve railroad worker fatigue in the US, they need to be adopted for each railroad that is part of the general rail system. In other words, all railroads in the US.

Further, the plans must be applicable to all railroad operations. Figure 1 below provides an outline of the BLET proposed fatigue management plan as it would apply on any single railroad in the US. The plan identifies assigned service and unassigned service. This outline takes into account jobs that may work 5, 6, or 7 days in a week. The plan also addresses 8 hour days or 8-12 hour days as well as the time of day the assignment goes to work. With each of these considerations, the medical, critical, and chronic aspects of fatigue are analyzed to provide the relevant concerns from a scientific standpoint for each assignment utilized by a railroad operation. An "X" indicates a need for concern by both the railroad and the individual railroad worker.

Figure 1

Scientific Concerns of Fatigue in the Railroad Industry

		Assigned Service		
		5 Day / 8 hour day		
		7:00 AM	3:00 PM	11:00 PM
	Start Time			
Education		X	X	X
Medical		X	X	X
Critical Fatigue	<i>Short Term Sleep Loss</i>			X
	<i>Circadian Rhythm</i>			X
Chronic Fatigue	<i>Sleep Debt</i>			X
	<i>Health Aspect</i>			X
Evaluation	<i>Aspects of Plan</i>	X	X	X
		Assigned Service		
		5, 6, or 7 days / 8-12 hour day		
		7:00 AM	3:00 PM	7:00 PM
	Start Time			
Education		X	X	X
Medical		X	X	X
Critical Fatigue	<i>Short Term Sleep Loss</i>		X	X
	<i>Circadian Rhythm</i>			X
Chronic Fatigue	<i>Sleep Debt</i>	X	X	X
	<i>Health Aspect</i>	X	X	X
Evaluation	<i>Aspects of Plan</i>	X	X	X

		Unassigned Service		
		Work Train Any Time	Extr Brd Any Time	Pool Sevice Any Time
	Start Time			
Education		X	X	X
Medical		X	X	X
Critical Fatigue	<i>Short Term Sleep Loss</i>	X	X	X
	<i>Circadian Rhythm</i>	X	X	X
Chronic Fatigue	<i>Sleep Debt</i>	X	X	X
	<i>Health Aspect</i>	X	X	X
Evaluation	<i>Aspects of Plan</i>	X	X	X

		Management		
		Senior Any Time	Middle Any Time	Front Line Any Time
	Start Time			
Education		X	X	X
Medical				X
Critical Fatigue	<i>Short Term Sleep Loss</i>			X
	<i>Circadian Rhythm</i>			X
Chronic Fatigue	<i>Sleep Debt</i>			X
	<i>Health Aspect</i>			X
Evaluation	<i>Aspects of Plan</i>			X

COMPUTER MODELING OF FATIGUE

Finally, it is worth noting that several researchers are attempting to provide the railroad industry with a computer-generated model that arguably identifies fatiguing schedules in the railroad workplace. At last report, *these models are not a scientifically reliable indicator of railroad worker fatigue*. None of the models have demonstrated a level of accuracy necessary to impose restrictions on a railroad worker due to fatigue. Further, to date, none of the models are accurate enough to capture all experiences of railroad worker fatigue. These models are nearly as likely to report a fatigue incident

when one did not exist as they are to ignore fatigue as a contributing factor when it is applicable.

Further, railroad management, railroad labor, and government agencies do not share a common vision for possible use of computer models.

What use are models

Certain railroads have utilized models to provide workers with a tool to create work schedules that address fatigue within the constraints of railroad operations. These railroads intend for the models to provide new ideas to mitigate railroad worker fatigue. These models have been met with mixed results from railroad workers. However, on occasion these models have proven successful education tools for work groups to develop effective mitigation in local work environments.

Predictive Ability

For any tool, such as a computer model, to be effective it must be able to reliably predict worker fatigue. In this regard, reliability requires direct measures of fatigue from the individual worker and a scientifically validated computer model. In this manner, a predictive model can be implemented to address fatigue predictions for railroad workers as well as post accident analysis and testing.

Application Suitability based on reliability

In the BLET's estimation, based on the current level of research, computer models of fatigue are not ready for wide use in the railroad industry for mitigating worker fatigue. These models can provide a basis for users to understand the complexity of railroad worker fatigue. Notably however, *the models at present are not a significant threat to BLET member's interests*. They may actually evolve into a valuable tool at some future date to progress the concerns of BLET members.

STRATEGIES AND TIMELINES FOR RESOLVING FATIGUE IN THE RAILROAD INDUSTRY

The BLET has participated in ongoing efforts to resolve railroad worker fatigue using non-prescriptive cooperative efforts for nearly a decade. At some point, the BLET must determine if these efforts have adequately met the safety interests of BLET members. Toward that end, an arbitrary date might accomplish the goals of the BLET. It must be remembered, that under the current BLET leadership at least two major nation wide efforts to forge a fatigue solution in the railroad industry have been attempted.

Failing a successful non-prescriptive solution of fatigue, as discussed above, there are two possible avenues for government-imposed solutions to railroad worker fatigue: a Congressional mandate and/or a regulatory mandate from the FRA. The BLET has identified and prepared a process for each of these possibilities. Finally, all solutions evaluated by the BLET as seriously addressing fatigue assume no change to the existing federal hours of service in the US.

Bibliography:

- 1) Senge, P. (1990) *The Fifth Discipline. The art and practice of the learning organization.* Currency, New York.
- 2) Dawson, D. (January, 2004) *Fatigue Risk Management Handout.* Director Centre for Sleep Research University of South Australia
- 3) Dawson, D. (June, 2004) *Simulating fatigue management.* Power point presentation. Director Centre for Sleep Research University of South Australia
- 4) Dinges, D. (2004) *Sleep debt and scientific evidence.* Editorial in *Sleep* Vol. 27, No. 6.
- 5) McCallum, M, etal. (July, 2003) *Commercial Transportation Operator Fatigue Management Reference.* US Department of Transportation.
- 6) Sherry, P. (June, 2002) *Fatigue Countermeasures in the Railroad Industry: Past and Current Developments.* University of Denver, Association of American Railroads.
- 7) *Insurance Journal* (August, 2003) *Maggies law underscoring importance of corporate fatigue management.* Wells Publishing.