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Work Schedules and Sleep Patterns of Railroad Dispatchers

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13. ABSTRACT (Maximum 200 words)

This report presents the results of a study designed to characterize the work/rest schedules and sleep patterns of U.S. railroad dispatchers and to examine the relationship between these schedules and levels of alertness of the individuals working the schedules. The study methodology was a survey of a random sample of currently working U.S. railroad dispatchers who completed a background survey and kept a daily log for 2 weeks. Railroad dispatchers are a predominantly healthy middle-aged male population, but 14 percent are women. Dispatchers work as either a trick dispatcher, subject to the limitations of the Hours of Service Law, or an assistant chief dispatcher who oversees the trick dispatchers. All dispatching jobs have a 40-hour nominal workweek, but assistant chief dispatchers average more than 40 hours per week. Dispatchers are a shiftwork population. Many are subject to working nights and a variable work schedule, making it difficult to get adequate quality sleep. Overall, 39 percent of dispatchers get 6 or fewer hours of sleep while 29 percent of U.S. adults get this amount of sleep. Across all three shifts, dispatcher alertness on workdays peaked after arrival at work and then declined through the workday. The decline was greatest for those working third shift.

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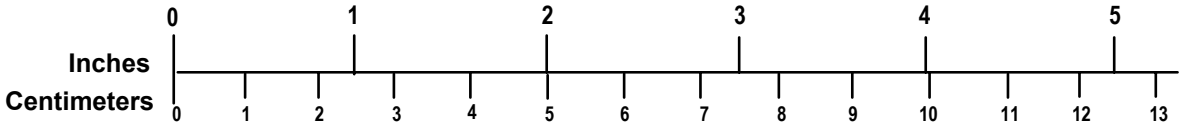

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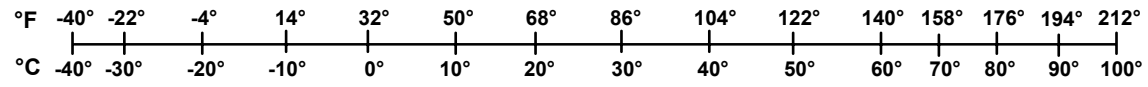

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Executive Summary

In a continuing effort to improve railroad safety and to reduce the number of injuries and fatalities to railroad workers, the Federal Railroad Administration (FRA) and the railroad industry, through the North American Rail Alertness Partnership (NARAP), have focused on the issue of fatigue among train and engine crew personnel. Because railroading is an around-the-clock, 7-days-a-week operation, and because a wide array of workers are needed both to operate and maintain the Nation's railroads, other crafts besides train and engine crews can also be subject to fatigue. The non-operating crafts, which include right-of-way construction and maintenance, signal system construction and maintenance, and dispatchers, fall into this category. With all of the non-operating craft groups, staff shortages, expanding territories, call schedules, and working conditions may contribute to employee fatigue. In 2001, FRA decided to begin exploring non-operating craft workers' fatigue by initially focusing on signalmen. A subsequent study addressed maintenance of way (MOW) workers. This study, similar in methodology to the two earlier studies, investigated the fatigue issues of railroad dispatchers.

This study had two primary objectives:

- To design and conduct a survey to collect work schedules and sleep data from railroad dispatchers.
- To analyze data to characterize work/sleep patterns and to identify work schedule-related fatigue issues.

The goal was to characterize U.S. railroad dispatchers as a group, not to characterize dispatchers on a specific railroad.

The railroad dispatcher is responsible for the safe, efficient, and economical movement of trains and other railway vehicles over the railroad, as well as for the protection of those who work on the railroad. Dispatcher jobs fall into two categories, trick dispatcher and assistant chief dispatcher. Trick dispatchers manage and control access to a specific territory or track. The assistant chief dispatcher oversees several trick dispatchers and assists them as necessary. Because an assistant chief dispatcher does not directly control train movements, this position is not subject to the limitations of the Hours of Service Law.

The work schedules for both types of dispatcher jobs are similar, with shifts that cover 24 hours (h) of each day, 7 days (d) a week. Three types of work schedules exist for dispatchers: regular daily shift (first or day, second or evening, third or night), relief, and extra board. Regular jobs work 5 consecutive d on the same shift followed by 2 consecutive d off. Relief jobs work 5 consecutive d by rotating through the shifts in a pattern such as 2 days, 2 evenings, and 1 night. While the regular and relief jobs work the same days each week, the extra board jobs do not have a fixed schedule. The extra board dispatchers fill in for regular and relief dispatchers as necessary.

The research described in this report had three phases: preparation, field data collection, and data analysis. Since no existing data source would provide answers to the study's research questions, a survey of railroad dispatchers was the only means to obtain the necessary data. The preparation phase included securing approval from the Office of Management and Budget

(OMB) for the survey. Representatives from the American Train Dispatchers Association (ATDA) worked closely with the researchers throughout the study.

Survey Design

The study used two survey instruments–a background survey and a daily log. Survey participants used the background survey to provide demographic information, descriptive data for their job type and work schedule, and a self-assessment of overall health. The daily log provided a place for recording work periods and sleep on workdays and non-work or rest days. Dispatchers recorded not only the starting and ending times for each sleep and work period but also a subjective assessment of their alertness at different times during their workday. Capturing the week-to-week variability in the work schedules of extra board dispatchers required a 2-week data collection period.

Researchers drew a random sample of 963 dispatchers from the ATDA database of actively working U.S. dispatchers. Retirees, full-time union officials, and anyone currently holding a railroad management position were specifically excluded from the sampling frame. Determination of the sample size assumed a 95 percent confidence interval on the estimates for mean sleep time, an error tolerance of 20 percent, and a 40 percent response rate. The method for sizing the sample assured that the sample could include an adequate number of extra board dispatchers.

Mailing of the survey materials occurred on April 18, 2006. One month (mo) later, every dispatcher in the random sample received a reminder postcard encouraging him/her to participate and to call the researchers if he/she needed additional materials.

Survey Response Rate

The overall response rate for the survey was 46 percent. Table 1 provides a breakdown of the survey responses.

Table 1. Breakdown of survey responses

	Number	Percent
Returned both background survey and daily log	445	46.2
Returned only one survey instrument	5	.5
Materials undeliverable due to invalid address	20	2.1
No response	493	51.2
Total number of surveys mailed	963	

Of the 445 complete responses, 2 could not be a part of the analysis because those individuals were currently working as a chief dispatcher, which is a management job.

The non-response bias study based on age found no difference between survey respondents and non-respondents.

Dispatcher Demographics

The majority of survey respondents (87 percent) held trick dispatcher jobs. Ten percent held an assistant chief position, and the remaining 3 percent reported their job type as other. Fourteen percent of the survey respondents were female. Average dispatcher experience was 14 years (yr), but the average for women was 11 yr while that of their male counterparts was 15 yr. Nearly half of all dispatchers are 50 yr and older, with male dispatchers being, on average, 3 yr older than the female dispatchers.

The majority of dispatchers (76 percent) are married, but few have children under the age of 2 yr. In contrast, 55 percent of U.S. adults age 18 and older are married. Since many railroaders report that their work schedule strains marital relationships, finding such a high proportion of married dispatchers was surprising. The survey did not, however, ask how many times the dispatcher had been married. The lack of young children is consistent with the average age of this population.

Nearly 85 percent of dispatchers rated themselves in good or excellent health. This self-assessment did vary by work schedule with third shift dispatchers having a lower overall health self-rating than extra board dispatchers. While the majority of dispatchers rated their health as good or excellent, this group averaged 5.6 workdays lost due to illness annually. In comparison, U.S. employed adults with paid sick time average 3.6 d. The higher rate of use of sick time may be due to the stressful nature of the job or, for those working an irregular schedule, the need to catch up on sleep.

Approximately 9 percent of the dispatchers reported having a diagnosed sleep disorder, and 7 percent reported having sleep apnea. One-third of these dispatchers have gone without treatment. The dispatcher rate for sleep apnea is higher than the estimated norm of 4 percent for U.S. middle-aged working men. Two possible explanations exist for the higher rate among dispatchers: the sedentary nature of their job which may lead to weight gain which exacerbates sleep apnea, and an awareness of the symptoms of sleep apnea which led them to seek diagnosis and treatment.

Job Characteristics

The around-the-clock nature of railroading requires railroads to staff dispatching centers with three 8-h shifts. Dispatchers working permanent first, second, or third shifts rarely work outside their typical schedules. The most common relief rotation was to work two first shifts, followed by two second shifts, and a third shift. Since extra board dispatchers fill in for dispatchers who cannot work their regular shifts, the expectation was that this group of dispatchers would be split evenly among the three shifts. This did not occur. Forty-two percent of the shifts worked by an extra board dispatcher during the study were on first shift. First shift dispatchers are the most experienced and therefore accrue the largest number of vacation and sick days. Due to the seniority of first shift dispatchers, vacancies are most likely to occur on first shift and require assignment to an extra board dispatcher. A third of the extra board dispatchers experienced no shift variability during the study because they filled in for a regular dispatcher on vacation or other extended leave.

Both trick dispatchers and assistant chiefs have a nominal 40-h workweek. While trick dispatchers averaged close to 40 h of work during the study, assistant chiefs averaged approximately 45 h of work per week. In addition, one-quarter of the assistant chiefs worked a

day per week of overtime. Actual work, as reported in the daily logs, was similar to reported typical workweeks for both groups, suggesting that the time period for this study was a typical one with respect to dispatcher work schedules.

Railroad dispatchers have no contractual provisions for breaks. Nearly a third of the time, both groups of dispatchers took no breaks during their shift. Trick dispatchers averaged 2 breaks per day with the longest break averaging 8 minutes (min). Assistant chiefs averaged 1½ breaks per shift with the longest break averaging 10 min. Despite the lack of breaks, this was not a primary source of stress for dispatchers.

Trick dispatchers and assistant chiefs had similar sources of stress. In general, trick dispatchers had higher stress ratings than assistant chiefs, with ratings on sleep loss, lack of time off, ambiguous rules, and lack of breaks being significantly higher.

Sleep Characteristics

The study examined primary and total daily sleep, which includes naps. Dispatchers working permanent first shift jobs get considerably less total sleep on workdays than those with other work schedules, but these dispatchers appear to make up for their loss of sleep on non-workdays. In comparison with shiftwork norms, railroad dispatchers get less sleep than other shiftwork populations. First shift for a railroad dispatcher may begin as early as 6 a.m. This early start time appears to limit the nighttime sleep for those who work first shift. For total and primary sleep, all shifts are statistically different from each other.

Because many dispatchers on a permanent third shift use a split sleep strategy on workdays, the napping rate was highest for this group. The majority of workday naps for all dispatchers combined began between 4 and 8 p.m. In contrast, naps on non-workdays tended to start between 12 and 4 p.m., a time that coincides with the afternoon nadir in the circadian cycle.

Comparison of dispatcher sleep with normative data for U.S. adults indicates that, in terms of average daily sleep in 24 h, railroad dispatchers are getting less sleep than U.S. adults. While 29 percent of U.S. adults get 6 or fewer h of sleep daily, 39 percent of dispatchers get this amount of sleep.

Overall, dispatchers gave higher ratings to their non-workday sleep than their workday sleep. Dispatchers' qualitative ratings of their sleep differed based on the shift actually worked. In particular, sleep ratings for dispatchers working second shift were statistically different for all ratings except ease of arising. Correlations between each of the four sleep quality ratings and length of the primary sleep period were all significant but did not show a strong relationship.

Dispatchers with diagnosed but untreated sleep disorders rated their sleep of lower quality than those with treated sleep disorders or no sleep disorders, but these differences were not statistically significant.

Alertness

Data from dispatchers' daily logs revealed some differences in alertness levels based on the shift worked. For all shifts, alertness peaked after the commute to work but then declined throughout the day. The decline in alertness was greatest on third shift.

Dispatchers with diagnosed but untreated sleep disorders had lower alertness ratings throughout the day than those with treated or no sleep disorders, but these differences were not statistically significant.

Textual Analysis of Log Book Comments

A systematic qualitative analysis of the textual comments in the daily logs provided greater insight into the concerns of dispatchers and, in many cases, added further insight to the quantitative survey results. The most frequently mentioned topics were sleep, workload, alertness/fatigue, and naps. Sleep was in three times as many comments as workload, which was the second most frequently mentioned topic in the comments.

Findings and Recommendations

The following lists the key findings with respect to the dispatcher's health, work periods, sleep patterns, and alertness:

- Dispatchers average 5.6 workdays lost annually due to illness. In contrast, U.S. employed adults with paid sick time average 3.6 d per year. The need of this shiftwork population to catch up on lost sleep and the stressful nature of dispatching may be responsible for this difference.
- The 8-h workday of a dispatcher plus commute time allow adequate time for sleep and personal activities, but varying and unpredictable schedules for some dispatchers and the need to sleep at times that run counter to human physiology may prevent the dispatcher from getting adequate rest. For assistant chief dispatchers, the situation has the added complication that no limitation exists on the number of hours that they may work in a day, thus allowing 2 shifts in 1 d and backward shift rotation.
- Although dispatchers do not have any planned or guaranteed breaks during their 8-h shift, this was not a major source of stress to either trick dispatchers or assistant chiefs, perhaps because they have become accustomed to their few short breaks and the need to eat meals at their desk.
- Overall, dispatchers are a sleep-deprived group. They sleep less than other shiftwork populations and less than the norm for U.S. adults. Research has shown that sleep deprivation leads to performance degradation and may also have health consequences. Many dispatchers, who perform a safety-critical function on the railroad, may be unaware of their degraded performance.
- The incidence of sleep apnea among U.S. dispatchers exceeds the U.S. adult norm. Only two-thirds of those with sleep apnea or another sleep disorder reported being treated. To encourage these individuals to accept treatment, railroads and unions should continue their sleep education programs, pointing out the possible performance and health consequences of untreated sleep disorders. Initial dispatcher training and periodic rules training provide the opportunity for fatigue education that includes discussion of sleep disorders, as well as strategies for coping with shiftwork.

Based on the experience of this study, several methodological changes should be a part of any future studies of this nature. Two of the four recommendations below focus on issues unique to a shiftwork population. The following lists the recommended changes:

- *Design and test instructions for third shift workers to use in recording their primary sleep period.* Despite instructions specifically directed at third shift dispatchers, some third shift dispatchers failed to record their primary sleep on the correct day. Improved

instructions, inclusion of a hypothetical example in a pilot test, and participation of more third shift dispatchers in the pilot test for a future study should correct this problem.

- *Separate the question on job type (e.g., trick dispatcher, assistant chief, other) from the one covering work schedule.* A poorly worded question on the background survey covered both job type and work schedule. Despite this, researchers were able to effectively categorize each survey respondent's job type and work schedule. Two questions, one for each characteristic, will avoid confusion and the need to manually code these two job characteristics.
- *Include a definition of a work break and guidance on recording break information.* The lack of a definition for a work break led to some ambiguity among survey participants as to how to respond to this entry in the daily log book.
- *Include a question on the background survey that asks, "How many times have you been married?*" Both shiftwork and railroad careers can lead to marital and family difficulties. For this reason, an additional question on the number of marriages would be helpful.

The researchers have developed an effective procedure and methodology for characterizing the work schedules and sleep patterns of railroad workers. Additional studies of other populations using this methodology would provide a more complete picture of work schedule and fatigue issues in the industry. Yardmasters, locomotive engineers, and conductors are candidate groups for study.

A number of biomathematical models exist for predicting human fatigue and alertness. Model developers could use the data from the dispatcher survey, as well as the data from the two earlier studies, to further refine their models and predict how the typical railroad worker schedule may be affecting on-the-job alertness.

Further analysis of the dispatcher survey data is possible. Additional analyses might examine the relative likelihood (i.e., odds ratio) of getting less than a minimum amount of sleep as a function of shift worked or work period start time. A similar analysis could estimate the likelihood of a workday nap as a function of shift worked. Comparisons across the different railroad craft groups are possible to determine if differences in work schedules and sleep patterns occur when a group is subject to the work limitations of the Hours of Service Law.

1. Introduction

In a continuing effort to improve railroad safety and to reduce the number of injuries and fatalities to railroad workers, FRA and the railroad industry, through NARAP, have focused on the issue of fatigue among train and engine crew personnel. Because railroading is a round-the-clock, 7-days-a-week operation, and because a wide array of workers are needed to operate and maintain the Nation's railroads, other crafts besides train and engine crews can also be subject to fatigue. The non-operating crafts, which include right-of-way construction and maintenance, signal system construction and maintenance, and dispatchers, fall into this category. With all of the non-operating craft groups, staff shortages, expanding territories, call schedules, and working conditions may contribute to employee fatigue.

In 2001, FRA decided to begin exploring fatigue of the non-operating craft workers by initially focusing on signalmen. A separate report presents the results of the signalmen study (Gertler & Viale, 2006a). Subsequent to the signalmen study, FRA sponsored a similar study of MOW workers (Gertler & Viale, 2006b). The study described in this report, which is similar in scope and methodology to the two earlier studies, concerns railroad dispatchers. Previous studies of dispatcher fatigue (e.g., Popkin, Gertler, & Reinach, 2001) used convenience samples of dispatchers rather than a random or stratified sample based on estimates of accuracy and target error rate, as was the case for the surveys of signalmen and MOW workers. Unlike the earlier dispatcher work, this study provides defensible and definitive data on work/rest cycle parameters and fatigue among dispatchers.

1.1 Nature of the Dispatcher's Job

The railroad dispatcher is responsible for the safe, efficient, and economical movement of trains and other railway vehicles over the railroad, as well as for the protection of those who work on the railroad. The dispatcher's principle duties include:

- Monitoring radio and telephone and communicating with other railroad personnel regarding train and track information.
- Scheduling the routing and movement of trains to provide for safe meets and passes.
- Arranging for track use by engineering forces for maintenance activities.
- Managing unplanned events to protect the safety of the public, railroad employees, and railroad property.
- Maintaining records of train movements, track assignments, maintenance activities, and other events.

The job requires the dispatcher to issue, monitor, and cancel track usage authorizations in accordance with the railroad's operating rules and procedures. The dispatcher also operates signals, switches, and bridges; communicates with train and MOW crews; responds to emergency events; and performs administrative and clerical duties. The dispatcher spends a significant portion of his/her day communicating on the radio or telephone.

Every dispatcher is responsible for a predefined territory or portion of the railroad's network. One of the dispatcher's first tasks at the beginning of the shift is to plan the known track moves

on the territory for the duration of the shift. This strategy takes into account current traffic, expected traffic, the physical characteristics of the territory, train priorities (e.g., passenger versus freight), track and signal maintenance requirements, characteristics of train performance, and the presence of hazardous materials. Information from MOW crews, yard personnel, and dispatchers on adjoining territories also contributes to the dispatcher's action.

Once this plan is in place, dispatchers spend the remainder of the shift trying to keep the trains moving while adjusting for the inevitable occurrence of delays and unforeseen events. Even short delays may necessitate the reformulation of the entire plan. Indeed, the dispatcher may have to reformulate the plan multiple times during the course of the shift as unplanned events transpire. The dispatcher is also responsible for monitoring train crew hours to ensure compliance with the Hours of Service Law. Finally, the dispatcher must also assume responsibility for railroad and non-railroad problems that are phoned in by railroad personnel, as well as the general public, and must be knowledgeable about proper procedure for notifying the appropriate authorities in the event of an emergency, such as a hazardous materials spill.

With few exceptions, today's dispatchers work with computer-based dispatching and communications technology. Dispatchers for the larger Class I railroads work in shifts around the clock in large centralized operations. Upwards of 100 dispatchers may work the same shift in a large centralized operations center. Some may control territories that are located over 1000 miles away. As the cost of computer systems decreases, even the smaller railroads are abandoning paper forms and radio directives in favor of the computer-based dispatching technology.

To meet the need for 24-h operation, railroads staff their dispatching center with three 8-h shifts. Typical shifts are 7 a.m. to 3 p.m. (day), 3 p.m. to 11 p.m. (evening), and 11 p.m. to 7 a.m. (night). Three categories of jobs exist in all dispatching centers: regular jobs, relief jobs, and extra board jobs. Regular jobs work 5 consecutive d on the same shift followed by 2 consecutive d off. Relief jobs work 5 consecutive d by rotating through the shifts, in a pattern such as 2 days, 2 evenings, and 1 night. Occasionally, a relief job will work the same shift each day but will not be responsible for the same territory each day. While the regular and relief jobs work the same days each week, the extra board jobs do not have a fixed schedule. The extra board dispatchers fill in for regular and relief dispatchers during vacations, training, and road days, as well as when an unplanned absence occurs. On occasion, a regular dispatcher on a rest day may fill a vacancy if an extra board dispatcher is not available. Most dispatching centers have a guaranteed extra board. This means that the extra board dispatchers are guaranteed 5 d of work per week, but the days and shifts that they work may change weekly. In addition, extra board dispatchers usually do not have 2 consecutive rest days.

All dispatching centers have a chief dispatcher who oversees the entire dispatching operation. In larger centers, assistant chief dispatchers supervise groups of trick dispatchers. (A trick dispatcher works as described above. The term dispatcher may refer to an assistant chief or a trick dispatcher.) The chief and/or the assistant chief provide backup support to the trick dispatchers as required. Like the majority of trick dispatchers, the chief and assistant chief positions have an assigned shift. Some assistant chiefs work a relief schedule that involves a rotating shift pattern. No extra board exists specifically for assistant chief positions. When a vacancy occurs in an assistant chief position, a trick dispatcher or other assistant chief who is qualified to work the open position will fill in.

As is the case with train and engine crews and signalmen, the Hours of Service Law limits the length of the dispatcher's workday. The Hours of Service Law stipulates that the dispatcher may not remain on duty for more than 9 h, whether consecutive or in the aggregate, in any 24-h period, in operations that employ 2 or more shifts. This means that once the dispatcher has worked for 9 h, he/she must have 15 h of rest. Where only 1 shift is employed, the dispatcher may remain on duty up to 12 h in any 24-h period. During an emergency situation, the law allows the dispatcher to remain on duty for an additional 4 h in any 24-h period for a maximum of 3 d over the course of 7 d. This law limits the length of the dispatcher's shift and provides for guaranteed time off, but it does not address the number of consecutive days that the dispatcher may work. Because chiefs and assistant chiefs are typically not directly responsible for overseeing train movements, the Hours of Service Law does not apply to these positions. As a result, individuals in these positions may sometimes work for 12 or 16 h to cover a vacancy.

The majority of U.S. dispatchers earn vacation days, sick leave, and personal days, all in proportion to their years of service with their respective railroad. This is true for dispatcher jobs covered by a labor agreement, as well as those considered a management position and thus covered by company policies.

The nature of the dispatcher's job has remained the same for at least the last 30 yr, but changes in the technology of dispatching and restructuring of the industry have resulted in a significantly different work environment. Today's dispatcher is likely to work in an office environment with suitable lighting and temperature controls. The dispatcher's work area consists of several computer screens, a keyboard, and a mouse. An overhead schematic display of multiple territories may also be present, as Figure 1 illustrates.

Figure 1. Modern dispatching center

The introduction of computer-aided dispatching has made it possible to control larger territories from much farther away. Changes in signal technology have reduced the need for tower operators and other field operations personnel, resulting in more direct dispatcher control over train movements, an increase in responsibilities, and an increase in the number of individual tasks involved in carrying out the same responsibilities. While some believe that these changes in technology have made the dispatcher's job easier, others argue that they have increased the dispatcher's workload and associated job stress and fatigue. Regardless, the dispatcher performs a safety critical job with many responsibilities. Alertness is key to his/her ability to carry out

those responsibilities safely and effectively. Staff shortages, causing dispatchers to work on rest days, can compromise the dispatcher's alertness.

1.2 Objectives

This study had two primary objectives:

- To design and conduct a survey to collect work schedules and sleep data from railroad dispatchers.
- To analyze data to characterize work/sleep patterns and to identify work schedule-related fatigue issues.

The goal was to characterize U.S. railroad dispatchers as a group, not to characterize dispatchers on a specific railroad.

Specific research issues that the study sought to answer included the following:

- What is the distribution of dispatchers among different work schedules?
- What is average number of hours worked per day? Per week?
- How does average number of hours worked vary based on type of job?
- How frequently are dispatchers able to take a break?
- What are the levels of alertness of dispatchers as a function of work schedule?
- To what extent is sleep quality a function of age?
- What is the average number of hours of sleep on workdays? Non-workdays? How does this compare with U.S. adult norms and other shiftwork populations?
- Does quality and amount of sleep vary by shift or work schedule?
- What is the relationship between number of breaks and end of day fatigue?
- What is the average number of hours that the dispatcher spends commuting to and from work? Is commute time related to level of alertness?

1.3 Overall Approach

Since no existing data sources could provide answers to the above issues, a survey of dispatchers was the only means to obtain the necessary work schedule and sleep data. The research project consisted of three phases: preparation, field data collection, and data analysis (see Figure 2). The preparation phase involved designing the survey methodology and procedures, conducting a pilot survey to refine the survey instruments and data collection procedure, securing approval from OMB, and preparing the final survey instruments. (Because this survey involved more than nine participants, Federal regulations required that OMB approve the overall study design.) Activities during this phase included discussions with ATDA to assure that the survey instruments had suitable wording and would collect the data necessary to address the research issues. A pilot survey, conducted in parallel with the OMB review process, assured that the survey would capture the data needed to meet the survey objectives.

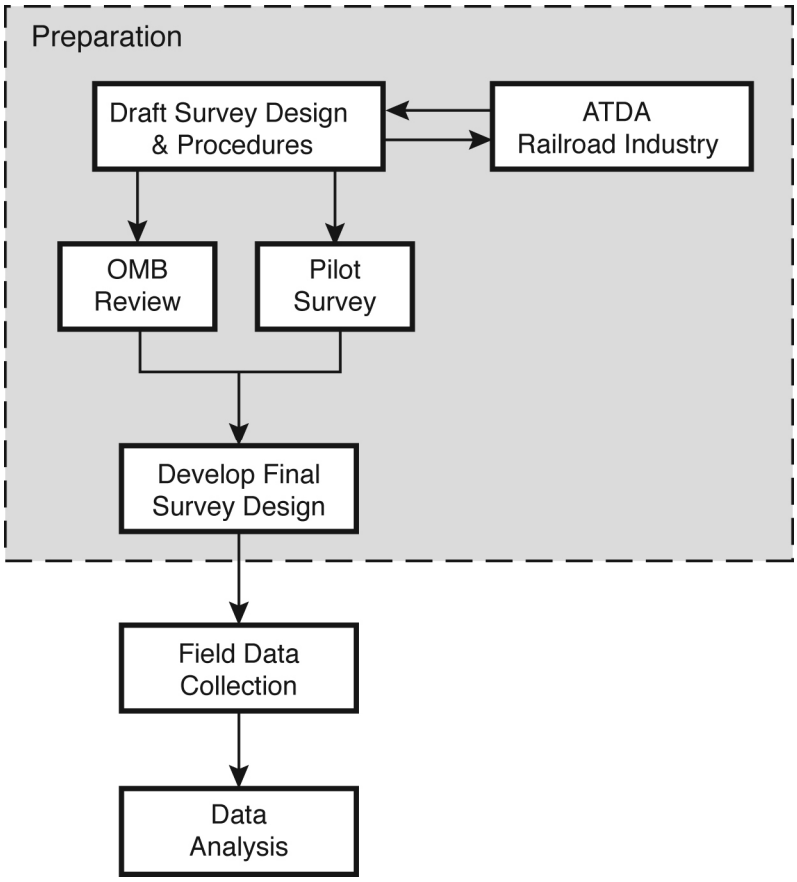


Figure 2. Overall approach

The second phase of the research consisted of distributing the survey materials and collecting the survey data. Analysis of the survey data was the final phase. A non-response bias study validated that no difference existed between the survey participants and the non-respondents. The data analysis methods for the survey data included descriptive statistics, analysis of variance (ANOVA), correlation analysis, and textual analysis of the log book comments.

1.4 Scope

This research involved railroad dispatchers working in the United States. The study characterized these workers as a group. It did not attempt to characterize dispatchers working for specific railroads. Making recommendations regarding fatigue countermeasures was beyond the scope of the study.

1.5 Organization of the Report

Section 2 describes the overall survey design and procedures. Section 3 provides analysis of the survey results, and Section 4 contains the findings and recommendations. Appendix A contains copies of the survey materials. Appendix B contains detailed summaries that support the statistical analyses of Section 3, and Appendix C describes adjustments to the data that were part of the analysis process. A list of abbreviations and acronyms used in the report follows the appendices.

2. Survey Design

One of the objectives of this study was to characterize the work schedules and sleep patterns of U.S. railroad dispatchers. Achieving this objective required a nationwide survey. The only practical means of reaching these individuals was through either their union or, in the case of non-union dispatchers, their employing railroad. This section describes the potential respondent universe, the survey instruments, sampling plan, and procedures that the researchers developed to survey this population. This methodology is similar to that used in the earlier studies of railroad signalmen and MOW workers.

2.1 Potential Respondent Universe

The potential respondent universe is the 3000 actively working railroad dispatchers in the United States. The majority of the dispatchers, two-thirds, are members of ATDA. Nearly 30 percent are non-union, and the Transportation Communications International Union (TCU) and the Association of Commuter Rail Employees (ACRE) represent the remainder. Table 2 shows how the potential respondent universe is split among these organizations.

Table 2. Estimate of number of actively working U.S. dispatchers by labor organization

Labor Organization	Number of Members
ATDA	2000
TCU–Norfolk Southern Railway	60
TCU–Long Island Railroad	33
ACRE–Metro-North Railroad	61
Union Pacific Railroad (Non-Union)	375
Other Non-Union	471
Total U.S. Dispatchers	**3000**

Ideally, the survey should have drawn from all of these subgroups, but several factors prevented this. First, no way existed to identify and contact the non-union dispatchers. Privacy concerns prevent an employer from providing the names and addresses of their employees to researchers. The researchers attempted to secure participation of multiple unions in the study; however, this was not possible. Since each union's participants must receive a cover letter from their union official, the administrative cost to do this with multiple unions prevented the inclusion of TCU and ACRE in the sampling frame. The final respondent universe was the 2000 actively working ATDA dispatchers.

2.2 Survey Instruments

This study used two survey instruments, a background survey and a daily log. (Copies of both instruments appear in Appendix A.) The background survey gathered demographic information, descriptive data for the dispatcher's job type and work schedule, and a self-assessment of overall health. The purpose for collecting this data was twofold. First, it provided data for characterizing the U.S. dispatcher population. Second, it provided identifying data that researchers used in conjunction with the daily log to characterize the work/sleep patterns of the two major categories of dispatcher jobs: trick dispatcher and chief/assistant chief. This instrument also asked participants to rate, using a Likert scale of 1 to 4, potential sources of stress at work. The background survey also included a list of life stress events. In the event that a participant's daily log indicated frequent nighttime awakenings or excessive fatigue, the researchers could use the individual's response to this section of the background survey to assure that no non-work circumstances were confounding the survey data. Completion of the background survey required less than 15 min.

The daily log provided the means for survey participants to record sleep and work periods on both workdays and non-workdays. Dispatchers recorded not only the starting and ending times for each sleep and work period but also a self-assessment of alertness at different times during the day. These subjective assessments used a five-point Likert scale. The daily log included space to record "Comments on today's sleep experience" and "Comments on today's work experience." The instructions for the log encouraged participants to use this space to explain anything unusual about the day's sleep or work. These comments proved useful in understanding an irregular work or sleep pattern and, in general, complemented the study's quantitative findings. Completion of the daily log required less than a total of 10 min daily.

2.3 Data Collection Period

Examination of the relationship between work schedules and fatigue requires data from each person that encompasses at least a full work cycle. Fatigue is cumulative, and its effects on the individual are not readily identified from 1 or 2 d of data. In addition, adequate data must be available to compare sleep periods from both workdays and non-workdays. The typical dispatcher work cycle is 7 d. The study used a 2-week data collection period in order to capture the week-to-week variability in the work schedules of extra board dispatchers.

2.4 Sampling Plan

ATDA maintains a database with the names, mailing addresses, and date of birth for all of its members. This database does not include the type of job that the dispatcher is currently working or his/her work schedule. Only actively working ATDA members living in the United States could be in the sampling frame. Retirees, full-time union officials, and anyone currently holding a railroad management position were not eligible for the study. The effective sampling frame was 1,963 after these exclusions. The researchers drew a simple random sample without replacement from these individuals.

One of the most important issues in conducting this study was determining how large a sample was necessary for the estimates obtained in the sample survey to be reliable enough to meet the objectives of the study. In general, the larger the sample, the greater the reliability of the

resulting estimates, but this must be traded off against the expense of a larger sample. The first step in this process was to specify the level of reliability needed for the resulting estimates.

Since the study design includes examining characteristics of subgroups of dispatchers working different work schedules (regular shift, relief schedule, extra board), the study design must assure that the subgroups have adequate numbers within the overall sample to support reliable estimates of their characteristics. One statistic of interest is mean number of hours of sleep per day for each subgroup. Using the ATDA estimate of the workforce breakdown by type of work schedule, then approximately 1,080 dispatchers work jobs with regular shifts (55 percent), 393 dispatchers work relief jobs (20 percent), and 491 dispatchers work extra board jobs (25 percent). The appropriate sample size, n, for estimating the mean daily sleep time can be computed from the following (Levy and Lemeshow, 1999):

$$n \geq \frac{(z^2 N V_x^2)}{z^2 V_x^2 + (N-1)\varepsilon^2}$$

where z = reliability coefficient (1.96 for 95 percent confidence level)

N = population size (regular = 1,080; relief = 393; extra board = 491)

V_x = unknown population variance (1)

ε = error tolerance (.20)

This estimation for sample size also applies to other mean values, such as work and commute time, that the study seeks to estimate.

Webb (1992) estimates that the standard deviation for daily sleep for the general population is 1 h (Webb, p. 72). Applying this estimate of standard deviation (and hence V_x, variance) to the dispatcher population (N) and using an error tolerance of ± 10 percent (ε = .20), the sample must include 88 dispatchers working regular jobs, 77 working relief jobs, and 80 working extra board jobs. Since relief dispatchers are estimated to be 20 percent of the dispatcher population, using the assumptions above, the sample size must be 77/.2 or 385 to be reasonably certain of including enough relief job dispatchers in the study. This sample size will include more than enough dispatchers working regular jobs and extra board jobs to meet the target error tolerance of ± 10 percent. Because it was not possible to know *a priori* the type of job that each ATDA member works, a stratified sample was not possible.

Since not every dispatcher who is selected to participate in the study would choose to do so, over sampling was necessary. The extent of over sampling was a function of the anticipated response rate. Since the signalmen and MOW surveys achieved response rates of 50 percent and 30 percent, respectively, planning for the dispatcher survey assumed a 40 percent response rate, which was the average of the 2 prior surveys of this type. If 40 percent of the random sample chose to participate, then the random sample had to be 963 (385/.4) to yield 385 participants.

2.5 Procedure

In accordance with government regulation, FRA sought approval for the proposed survey from OMB. OMB approved this collection of information under OMB control number 2130-0570 on February 23, 2006.

Concurrent with submittal of the OMB application, the researchers conducted a 1-week pilot survey with 8 participants to refine the data collection procedures and survey instruments. ATDA assisted the researchers in identifying suitable participants for this pilot survey. Since reporting of third shift work and sleep periods might prove problematic, three third shift dispatchers participated in the pilot. In addition, two participants worked first and second shifts, two worked relief jobs, and one worked an extra board job. Pilot study participants completed the Railroad Dispatcher Background Survey and Dispatcher's Daily Log, as well as a brief Post-Survey Form to provide feedback on the survey instruments and procedures. Similar to the full survey, pilot participants received a $75 gift certificate to a national retail establishment. Based on the experience with the pilot survey, the researchers made several changes in the background survey. The changes were the following:

- To allow for comparison of survey results with national data on annual use of sick days, the question on use of sick days was reworded.
- The question concerning the Hours of Service Law was re-worded.
- Two sources of stress at work were added, "Lack of break time" and "Inadequate time off."

Because some confusion existed among the third shift dispatchers in the pilot as to where to record morning sleep after a work period, the final instruction sheet that accompanied the survey materials contained additional instructions that specifically addressed third shift dispatchers.

Following the pilot survey and before mailing of the survey materials, an article in the March 2006 issue of the ATDA publication, *Train Dispatcher Journal*, publicized the upcoming survey.

The researchers drew a simple random sample of 963 ATDA members, without replacement, from the sampling frame derived from the ATDA membership list. The package mailed to each participant on April 18, 2006, consisted of the following items:

- *Railroad Dispatcher Background Survey* in booklet form. Each page was 5.5 x 8.5 in, printed on white paper with no questions on the cover page.
- *Railroad Dispatcher's Daily Log* in spiral notebook form. Each page was 5.0 x 3.25 in. The log included 14 sections, one for each day of the data collection period. One of the introductory pages contained brief instructions on completing the log.
- *Cover letter* signed by the President, ATDA. This letter explained the purpose of the study and encouraged ATDA members to participate.
- *Instructions* explaining the survey procedures and how to complete the daily log.
- *Return envelope,* postage paid.
- *$5 bill.*

Copies of the cover letter and instructions appear in Appendix A along with the survey instruments.

All materials were printed on high quality paper, and each letter was individually addressed to the recipient. The instruction sheet was printed on yellow paper to increase the likelihood that recipients would read it. The mailing label for the survey packet used the ATDA return address, rather than Foster-Miller, because it would be familiar to recipients. The purpose of the $5 was

to encourage participation. Those who returned both the background survey and daily log also received a $75 gift certificate to a national retail establishment.

The instructions emphasized that (a) a total of 14 consecutive d of data should be provided, (b) data collection should begin on the first day of the next work cycle, and (c) data should not be reported during vacation periods. Both the instructions and the log included contact information for two Foster-Miller research staff members who were available to answer questions regarding the survey instruments and procedures.

Approximately 6 weeks after mailing of the materials, every survey recipient who had not returned the survey materials received a reminder postcard encouraging him/her to participate and to call Foster-Miller if he/she needed additional materials.

3. Analysis of Survey Data

This chapter presents the survey findings based on data provided in respondent background surveys and daily logs. The results are organized into six subtopic headings:

- Survey response rate
- Non-response bias study
- Dispatcher demographic characteristics
- Job characteristics
- Sleep characteristics
- Alertness

A separate section presents the results of the textual analysis of the log book comments.

This study used a confidence interval of 95 percent. The researchers used SPSS 15.0 to analyze the survey data and ATLAS ti V5.2.8 for textual analysis.

3.1 Survey Response Rate

The survey materials were mailed to 963 actively working dispatchers. A total of 445 people returned both the background survey and the daily log. Five individuals returned only one of the survey items, and 20 mailings failed to reach the addressees due to bad addresses. Two respondents were chief dispatchers. Since chief dispatcher is a management job, the responses from these two people could not be a part of the analysis. (ATDA was unaware of the change in status for these people so they were a part of the sampling frame.) The overall response rate was 46 percent. The final analysis used data from 443 dispatchers who returned both data collection instruments.

3.2 Non-Response Bias Study

OMB requires that a non-response bias study be conducted if the survey response rate is below 75 percent. The purpose of the non-response bias study is to assure that no difference exists in the characteristics of the survey respondents versus the non-respondents.

Information about non-respondents was limited to information available from the ATDA membership database. In addition to each member's address, this database includes birthdate. Birthdate (or age) is an appropriate variable to use for determining non-response bias. For a number of reasons, age is an important characteristic for assessing potential bias in this study. First, human sleep patterns change with age (Van Cauter, Leproult, & Plat, 2000). In addition, age is highly correlated with years of work experience and seniority. Seniority allows a dispatcher more opportunity to select work schedules that meet his/her personal needs.

All 445 individuals who returned both the background survey and the daily log were respondents, and the remaining 518 were non-respondents. Of the 518 non-respondents, ATDA membership records included birthdates for 470. Analysis of mean age for each of the groups

found no significant difference between the respondents and the non-respondents, $t(913) = 1.93$, $p = .054$.

3.3 Dispatcher Demographic Characteristics

This section provides demographics, as well as basic job-, family-, and health-related information based on responses in the background survey. Where appropriate, the study includes comparisons of the study results with national norms.

Characterization of dispatchers considered a number of factors. These factors are job type, work experience, sex and age, marital and family status, overall health, workdays lost due to illness, incidence of sleep disorders, and consumption of caffeinated beverages. The sections below discuss each of these elements. A brief summary of this information follows.

3.3.1 Job Type

Respondents reported their job type as trick dispatcher, assistant chief, or other. The majority (87 percent) was trick dispatchers, 10 percent held assistant chief positions, and the remaining 3 percent reported their job type as other. Review of the other responses to the job type question allowed classification of these respondents into one of the other two groups based on whether or not the position was covered by the Hours of Service Law. Those positions covered by this law became part of the trick dispatcher group, and those not covered were combined with the assistant chief group.

3.3.2 Sex and Age

Railroad dispatchers are a predominantly male population. ATDA membership in May 2006 was 14.5 percent female. Fourteen percent of the survey participants were female.

The average age for all dispatchers is 46.9 yr, and the median age is 49 yr. Figure 3 displays the age distribution for dispatchers overall and by sex, based on the survey results. As is typical for other railroad crafts, this is an aging work force. Nearly half of all dispatchers are 50 yr and older, and over three-quarters are 40 yr and older. Approximately two-thirds of the female dispatchers are under 50 yr, but 49 percent of the male dispatchers are in this age group.

Table 3 presents the overall age data by sex. The mean age for male dispatchers was 47.3 yr and for female dispatchers, 43.9 yr. The average female dispatcher is 3.4 yr younger than the average male dispatcher, but the median ages for the two groups differ by 6 yr. A statistically significant difference exists in the age of the two groups, $t(441) = 2.68$, $p < .05$.

In the early 1980s, railroads did not hire many dispatchers. By the end of this decade when railroads began hiring again, an effort to include women and minorities in all crafts, including dispatchers, occurred. At the same time, changes in communications technology made the position of tower operator obsolete. Traditionally, a tower operator position was on a career path to becoming a dispatcher. It was at this time that women began to enter dispatching in larger numbers than previously. This hiring pattern is likely responsible for the current difference in both age and experience levels between male and female dispatchers. With retirement of the senior male dispatchers in the coming years, this difference by sex should become smaller and perhaps disappear.

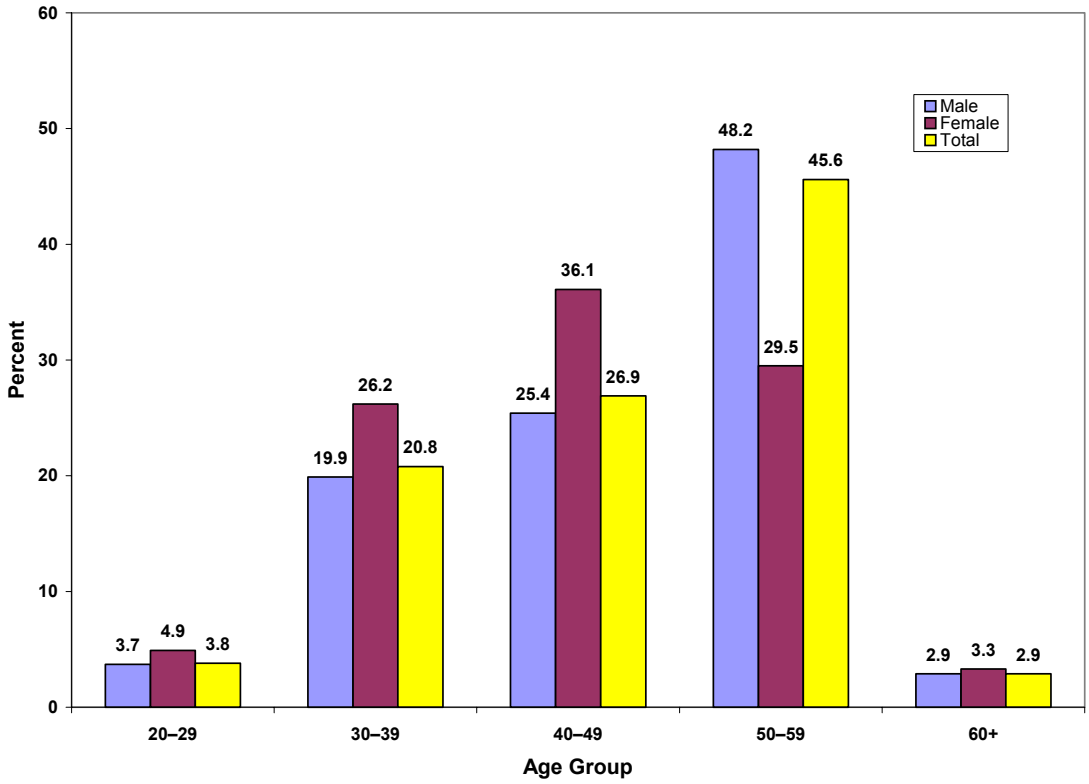


Figure 3. Distribution of dispatchers by age group and sex

Table 3. Dispatcher age by sex (yr)

Group	Mean	Median	Standard Deviation
Male	47.3	50	9.3
Female	43.9	44	8.7
All	46.9	49	9.3

Research has found that a higher perceived age, relative to chronological age, can be an indicator of chronic stress and poor psychological well-being (Barnes-Farrell & Petrowski, 1989, 1991). Overall dispatchers reported a lower perceived age (43.2 yr) in comparison with their average chronological age (46.9 yr). As shown in Table 4, the dispatcher population tends to feel younger as they age. This is the same pattern that Barnes-Farrell and Petrowski found with permanent day shift workers in a manufacturing plant. Barnes-Farrell and Petrowski point out that younger people tend to report feeling older to reflect perceived maturity. The dispatchers' perceived age follows the pattern reported by Barnes-Farrell and Petrowski and, as such, is not indicative of poor psychological well-being.

Table 4. Discrepancies between chronological and perceived age by age group (percent)

Age Perception	Worker Age (yr)				
	20–29	30–39	40–49	50–59	60+
Younger	17.6	39.1	54.6	62.4	69.2
Same Age	35.3	19.6	19.3	15.8	15.4
Older	41.2	41.3	18.5	15.3	7.7

3.3.3 Experience

The average dispatcher in the survey had 14.2 yr of experience as a dispatcher. The median level of experience was 11.4 yr. The lower median value indicates that individuals with years of experience below the mean dominate the group (see Table 5). Assistant chiefs had more experience than the trick dispatchers, which is not surprising, since a dispatcher cannot become an assistant chief without desk dispatching experience.

Table 5. Years of experience as a dispatcher by job type (yr)

Job type	Mean	Median	Standard Deviation
Trick Dispatcher	13.8	11.4	9.5
Assistant Chief	17.8	14.7	11.8
Other	16.0	12.9	12.5
All	14.2	11.8	9.9

As Table 6 indicates, dispatchers have had nearly all of their dispatching experience with their current employer. This is true regardless of job type. On average, dispatchers have been with their current employer for 12 yr of their 14-yr career as a dispatcher. It also appears that, based on the age of this group of railroad employees, most dispatchers came to dispatching after working in another job. The average age of a dispatcher is 47 yr, and he/she has been working in this craft an average of 14 yr. (The survey did not collect information concerning whether or not the prior job was in the railroad industry.)

Table 6. Years of experience as a dispatcher with current employer by job type (yr)

Job type	Mean	Median	Standard Deviation
Trick Dispatcher	11.9	9.5	8.7
Assistant Chief	14.0	12.7	8.9
Other	13.6	7.0	12.2
All	12.2	10.0	8.9

Males have historically dominated all railroad crafts. In recent years, however, the dispatching profession has seen an increase in the number of women in its ranks. Table 7 presents years of dispatching experience by sex. On average, female dispatchers have 4 yr less experience than their male counterparts. The level of experience by sex is consistent with the difference in age between the two groups.

Table 7. Years of experience as a dispatcher by sex (yr)

Sex	Mean	Median	Standard Deviation
Male	14.8	12.3	10.1
Female	10.6	9.2	7.3
All	14.2	11.8	9.9

3.3.4 Marital and Family Status

Most recent statistical data from the U.S. Census indicates that 54.7 percent of the U.S. population age 18 and older and 56.6 percent of the U.S. male population 18 and older are married (U.S. Census Bureau, 2005). At the time of the study, 75.6 percent of participants were married, 12.2 single, 10.4 divorced, 0.5 widowed, and 1.4 categorized themselves as other (these people were likely separated or living with a partner). Since many railroaders report that their work schedule strains marital relationships, finding such a high proportion of dispatchers who are married was surprising. This data, however, does not indicate whether or not the married individuals were in an initial marriage or one subsequent to a divorce.

The survey asked participants whether or not their family included young children, a factor that can lead to disrupted sleep. While a large percentage of dispatchers are married, very few have children under the age of 2 yr (6.1 percent). This finding is not surprising given the average age of a dispatcher.

3.3.5 Health

Participants rated their health as excellent, good, fair, or poor. Nearly 85 percent of dispatchers rated themselves in good (65.5 percent) or excellent (19 percent) health (see Figure 4). Analysis of these self-assessments of health by work schedule revealed that a statistically significant difference existed based on work schedule, $F(4, 437) = 2.65$, $p < .05$. Post hoc tests identified a difference between third shift and extra board dispatchers with third shift dispatchers having a lower overall health self-rating (see Table B-1 in Appendix B).

Figure 5 contains the frequency distribution for dispatcher sick days. While the majority of dispatchers rated their health as good or excellent, this group averaged 5.6 workdays lost due to illness annually. In comparison, U.S. employed adults with paid sick time averaged 3.6 d of sick time (U.S. Department of Health and Human Services, 2006, p. 49). One possible explanation for the higher rate of sick days among dispatchers is the stressful nature of the job that may lead to stress-related medical conditions. Popkin, Gertler, and Reinach (2001) found a higher rate of stress-related medical conditions among dispatchers than U.S. population norms. Another

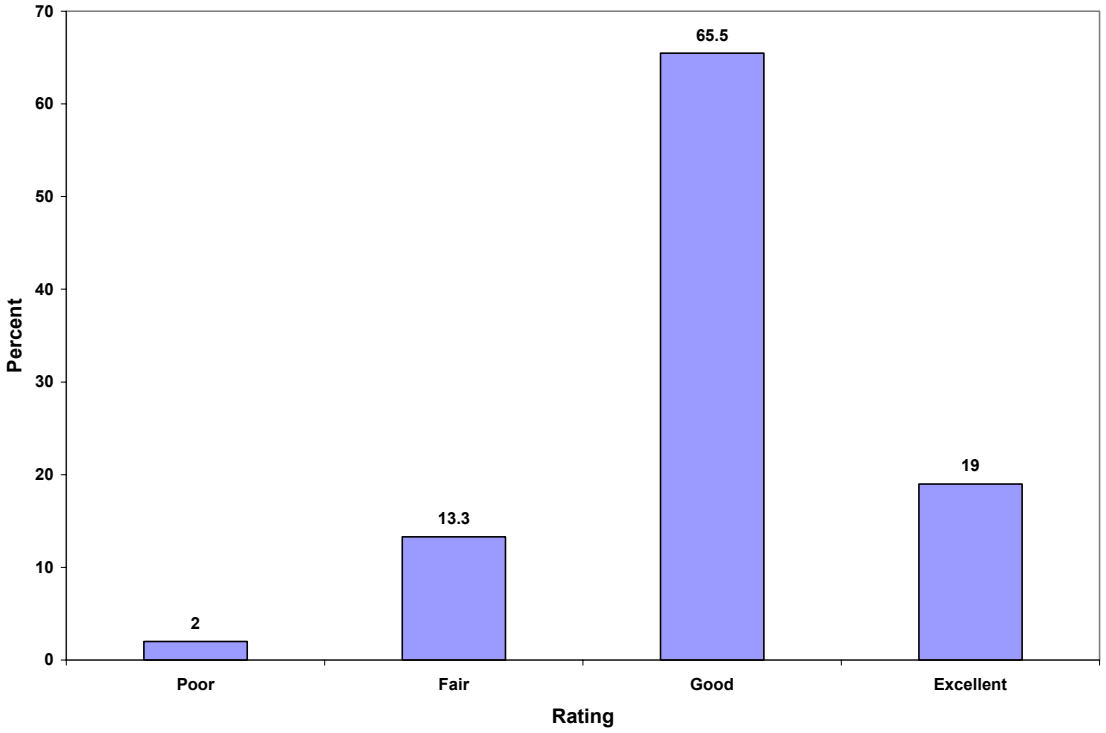


Figure 4. Self-assessment of overall health

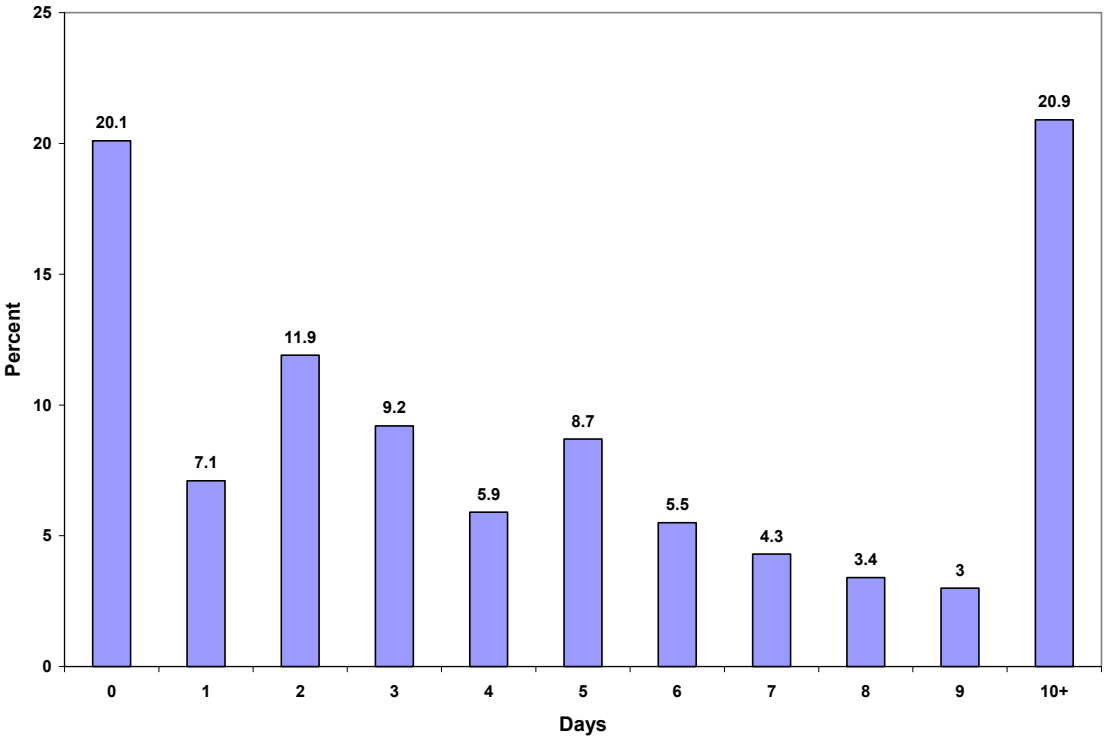


Figure 5. Workdays lost due to illness in past year

possible explanation is that some dispatchers, particularly those working an irregular schedule, may mark off sick to catch up on sleep.

3.3.6 Incidence of Sleep Disorders

The Wisconsin Sleep Cohort Study, a longitudinal study of cardiopulmonary sleep disorders among middle-aged working adults, estimated that 2 percent of women and 4 percent of men have sleep apnea (Young, et al., 1993). (The definition of sleep apnea for this study was an apnea-hypopnea score of 5 or higher and daytime hypersomnolence.) The National Sleep Foundation (NSF) and the National Institutes of Health report the numbers from the Wisconsin study as an estimate of the prevalence of sleep apnea among U.S. adults. Some sleep researchers hypothesize that the prevalence of sleep apnea may in fact be higher because many remain to be diagnosed. According to the Wisconsin study, 9 percent of women and 24 percent of men have undiagnosed sleep-disordered breathing, a condition that in some people results in excessive daytime sleepiness.

Of the 443 participants in this study, 41 or 9.3 percent reported having a diagnosed sleep disorder. Of those with a diagnosed disorder, 63.4 percent reported receiving treatment. A separate question inquired about sleep apnea. Of the total group, 7.4 percent reported having sleep apnea. (This implies that 1.9 percent have a sleep disorder other than sleep apnea.) Two-thirds of those with sleep apnea are receiving treatment. Two possible reasons exist as to why the dispatchers' incidence of sleep apnea is higher than the reported norm for U.S. middle-aged working adults. Railroad and labor educational programs, as well as media publicity, in recent years may have made this group of railroad employees more cognizant of the symptoms of sleep apnea and its consequences and caused them to seek medical evaluation. In addition, dispatching is a sedentary job that requires sitting in one place for an 8-h period. Sedentary jobs may lead to weight gain, which exacerbates sleep apnea.

3.3.7 Consumption of Caffeinated Beverages

NSF reports that 250 mg of caffeine a day, the equivalent of a soda and a couple of coffees, generally poses no harm. Almost all participants reported consuming caffeinated beverages on a daily basis (90.7 percent), and those who did averaged 3.5 beverages a day. Based on this level of caffeine consumption, dispatchers are within normal healthy limits, and their sleep, in general, is not likely disrupted due to caffeine unless caffeine consumption occurs close to bedtime (NSF, 2002a).

3.3.8 Summary of Dispatcher Demographic Characteristics

At the time of the survey, 87 percent of the dispatchers held trick dispatcher jobs, and the remainder worked as either an assistant chief or other non-Hours of Service position. The average dispatcher is 47 yr old and has worked as a dispatcher for 14 yr. Nearly half of all dispatchers are 50 yr or older, and 14 percent are female. Female dispatchers have, on average, 4 yr less experience and are 3.5 yr younger. Seventy-six percent are married, but very few have children under the age of 2 yr. Nearly 85 percent rate their health as good or excellent, but dispatchers' use of company-paid sick days exceeds that of U.S. working adults with paid sick days. Over 7 percent of dispatchers report having sleep apnea, and another 2 percent have sleep

disorders other than sleep apnea. A third of those dispatchers with a sleep disorder remain untreated.

3.4 Job Characteristics

This section explores several aspects of the dispatcher's job, including work schedule, hours worked, workday breaks, commute time, and sources of workplace stress.

3.4.1 Work Schedule

Work schedules fell into five basic categories: permanent first, second, and third shifts; relief; and extra board. Researchers defined shifts based on the starting time of the workday as follows: first shift–workdays starting between 4:30 a.m. and 10 a.m., second shift–starting after 10 a.m. and extending less than 4 h after 12 a.m., and third shift–any shift running at least 4 h after 12 a.m. Relief schedules are those that forward rotate through shifts but work the same days each week. Finally, extra board jobs are those positions requiring filling in for regular and relief dispatchers, and hence the schedule is irregular.

Nearly 70 percent of dispatchers worked the same shift each day. The remainder was split between relief (19 percent) and extra board (12 percent). Table 8 compares the work schedules of trick dispatchers (i.e., those covered by Hours of Service) and assistant chiefs (i.e., those not covered by Hours of Service). Both trick dispatchers and assistant chiefs worked across each schedule type. One notable difference between the schedules of the two groups is that 14 percent of trick dispatchers worked the extra board, whereas only one assistant chief reported working the extra board. Railroads usually have trick dispatchers who are qualified to work their assistant chief positions. When they have a need to fill in for an absent assistant chief, a trick dispatcher fills the vacancy rather than having an extra board for assistant chief jobs. This is why it is rare to find someone holding an assistant chief position with an extra board schedule.

Table 8. Work schedule by type of job and overall (percent)

	Job Type		
Work Schedule*	**Trick Dispatcher (n = 385)**	**Assistant Chief (n = 58)**	**Total (n = 443)**
1	26.2	19.0	25.3
2	19.5	31.0	21.0
3	22.3	25.9	22.8
Relief	18.2	22.4	18.7
Extra Board	13.8	1.7	12.2

*1 = first or day shift, 2 = second or evening shift, 3 = third or night shift

Table 9 presents age and experience data by work schedule. Dispatchers working first shift are older than those working other schedules, $F(4, 438) = 8.87$, $p < .05$. (See post hoc test for age in Appendix B, Table B-2.) Likewise, first shift dispatchers have more years of experience than

those working other schedules, and extra board dispatchers have the least experience, $F(4, 433) = 33.80$, $p < .05$. (See post hoc test for experience in Appendix B, Table B-3.)

Table 9. Work schedule by age and experience (yr)

	Age		Experience	
Work Schedule	**Mean**	**Median**	**Mean**	**Median**
1	50.5	52.0	21.5	21.9
2	46.6	50.0	13.7	11.8
3	45.7	47.0	13.1	10.3
Relief	46.0	49.0	12.5	11.8
Extra Board	42.7	43.5	5.6	3.1

A variety of shift rotation combinations for relief jobs exists, but by far the most common is two first shifts, followed by two second shifts, and a third shift. The Hours of Service Law precludes backward shift rotation for dispatchers. Figure 6 provides a breakdown of the shift patterns of relief dispatchers.

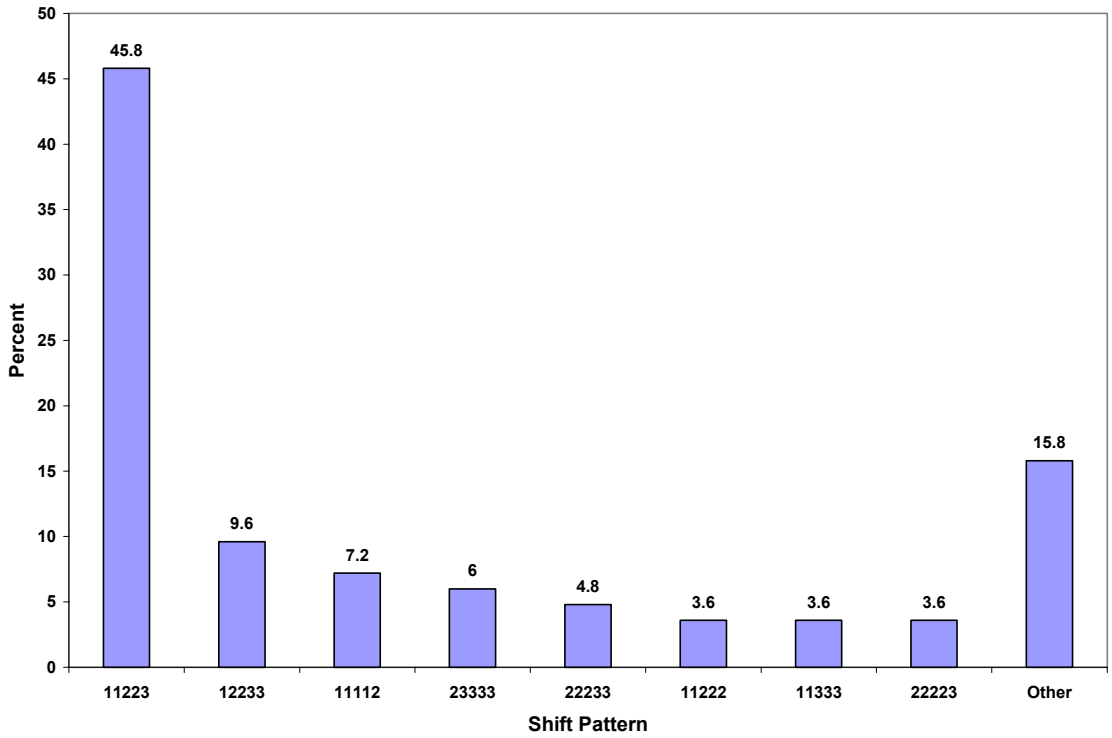


Figure 6. Relief schedules

Because relief jobs rotate through various shifts during the workweek, and because extra board jobs work irregular shift patterns, researchers were interested in the actual shifts worked as a function of schedule type. Table 10 presents the actual shifts worked by work schedule. Results indicate that those working permanent shifts rarely work outside their typical schedules, but due to staff shortages, vacations, sickness, and other absences, this can occur. Relief jobs worked primarily second shift (40 percent), followed by first shift (33 percent), and third shift (27 percent).

Table 10. Actual shifts worked by job schedule (percent)

	Work Schedule				
Shift Worked	**1 (n = 112)**	**2 (n = 93)**	**3 (n = 101)**	**Relief (n = 83)**	**Extra Board (n = 54)**
1	96.5	1.6	1.9	32.9	42.1
2	3.0	97.9	3.4	39.7	34.7
3	0.5	0.6	94.7	27.0	22.9

It was surprising to find such a large percentage of extra board dispatchers working first shift. The expectation was that extra board dispatchers would be split evenly among the three shifts with perhaps a slightly smaller proportion on third shift. (Passenger railroads and some freight railroads combine desks at night and on weekends so fewer opportunities exist to work third shift.) A possible explanation for the survey results is that these dispatchers were filling in for experienced dispatchers who take vacation during periods of good weather. (The majority of survey respondents completed the survey from the end of April through the end of June.) In addition, since regular first shift dispatchers are the most experienced and therefore accrue the largest number of vacation and sick days, this is likely the shift that most frequently uses an extra board dispatcher, regardless of the time of year.

Shift variability can lead to fatigue if it disrupts a worker's normal sleep pattern. Investigation of shift variation provided a means to estimate work schedule variability. The study defined a variation in shift as a change in shift (e.g., from first to second) from the previous day. If the previous day was a non-workday, then no shift variation occurred. The start of the workday determined the shift categorization, as previously stated. Table 11 presents the number of shift variations for relief and extra board dispatchers throughout the 2-week study period.

Another surprise was the large percentage of extra board dispatchers who had no shift variation through the study period. As stated above, however, this may be explained by extra board dispatchers who fill in for more experienced permanent shift dispatchers when they take vacation during periods of good weather. If the dispatcher did not have 2 consecutive rest d, then the definition of shift variability may also result in underestimation of extra board dispatcher shift variability.

Even though one would expect all relief dispatchers to have some shift variations due to the nature of this work schedule, two dispatchers in the survey reported working the same shift throughout the study period, therefore having no shift variation.

Table 11. Shift variability for relief and extra board work schedules (percent)

Number of Shift Variations (in 2-week period)	Work Schedule	
	Relief	Extra Board
0	2.4	35.2
1	9.6	22.2
2	32.5	27.8
3	19.3	13.0
4	33.7	1.9
5+	2.4	.0

3.4.2 Hours Worked

The study collected data on a nominal workweek, a typical workweek, and actual hours worked. In the background survey instrument, both trick dispatchers and assistant chiefs reported a nominal workweek of 40 h. During the study period, trick dispatchers worked only slightly more than this. In contrast, assistant chiefs averaged approximately 45 h of work per week. In fact, one-quarter of assistant chiefs worked 48 h or more per week, which is 8 h more than their nominal schedules require. The 75th percentile for trick dispatchers' workweek was 43 h, which is only 3 h more than their nominal schedules.

Actual work was similar to reported typical values for both groups. This suggests that the time period for this study was a typical one with respect to dispatcher work schedules. In addition, assistant chiefs, who are not covered by the Hours of Service Law, do indeed work substantially more than their nominal 40-h workweek. Table 12 presents typical and actual work for trick dispatchers and assistant chiefs.

Table 12. Typical and actual work for 2-week period by job type (h:min)

	Trick Dispatcher					Assistant Chief				
	Mean	Median	Std. Dev.	25th %	75th %	Mean	Median	Std. Dev.	25th %	75th %
Typical Work	82:22	80:00	6:06	80:00	80:00	90:01	80:00	12:54	80:00	96:00
Actual Work	81:09	80:25	9:49	77:52	86:06	89:19	85:33	13:34	80:11	96:56
Number of Work-days	10.1	10	1.1	10	11	10.6	10	1.6	10	12

3.4.3 Breaks

Unlike railroad crafts such as signalmen and MOW workers, who have contractual provisions for a meal break after 4 h on the job, railroad dispatchers have no such contractual provisions. As

such, a trick dispatcher could potentially sit at his/her desk monitoring communications and controlling track movements without a break for up to 9 h, or even 13 h in the case of an emergency. Assistant chiefs, because they are not covered by the daily limitations of the Hours of Service Law, can potentially work 12 to 16 consecutive h without a break. This is somewhat concerning knowing that mental fatigue can accumulate as a result of time on task (Popkin, Reinach, & Gertler, 2001).

Dispatchers occasionally leave their desk to use the bathroom or to bring food back to the desk, but this is not always possible, however, due to the nature of the job and the workload that a dispatcher handles. Leaving the desk means potentially missing important communication from train crews, MOW, or others that may require immediate response.

Each day of the study period, participants recorded the number of breaks they took and the duration of their longest break of the day. Trick dispatchers averaged 2 breaks per day, with the longest break averaging 8 min. Assistant chiefs averaged 1½ break per day, with the longest break averaging 10 min (see Table 13).

Table 13. Number and length of longest break per day by job type

	Number of Breaks		Length of Longest Break (min)	
Job	**Mean**	**Median**	**Mean**	**Median**
Trick Dispatcher	2.06	2	8	7
Assistant Chief	1.53	1	10	10

Figure 7 presents the number of breaks per day by job type. Almost one-third of the time, both trick dispatchers and assistant chiefs took no breaks during their shift. Researchers treated blank fields in the diary as missing data rather than zero; therefore, it is likely that the percentage of shifts when dispatchers did not have a break was even greater than the survey results indicate.

Although median values for break length on third shift were higher than those on first and second shift, researchers found no differences in the average number of breaks by shift (see Table 14).

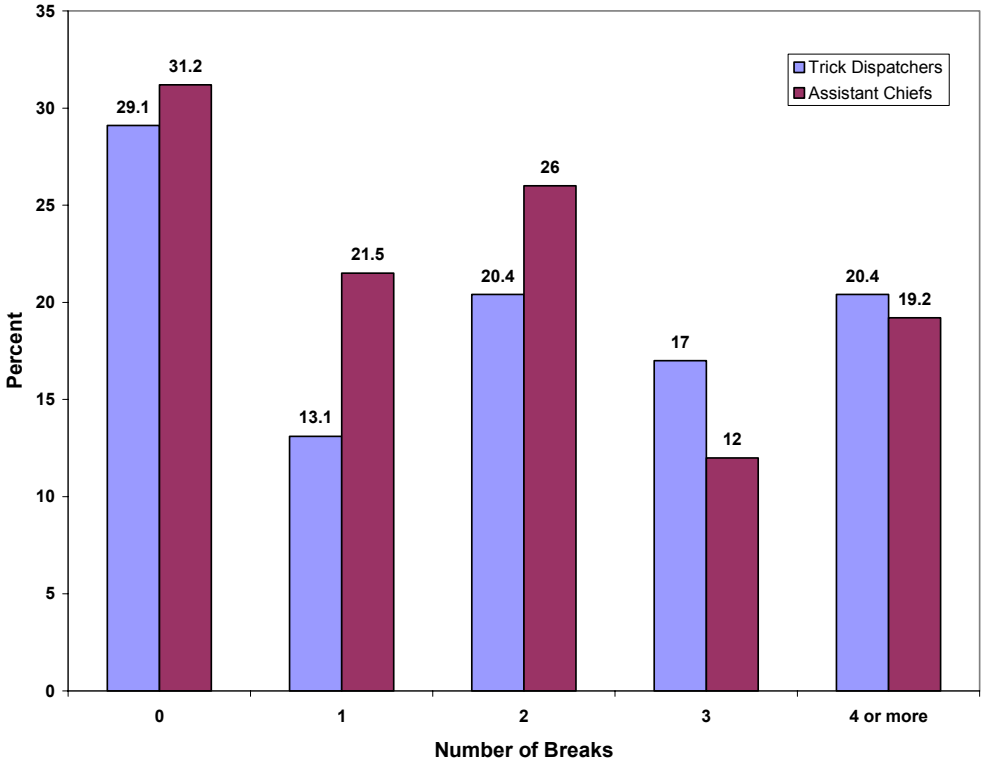


Figure 7. Number of breaks per day by job type

Table 14. Breaks by shift worked

	Number of Breaks		Length of Longest Break (min)	
Shift	**Mean**	**Median**	**Mean**	**Median**
1	2.05	2	8	7
2	1.95	2	8	6
3	1.99	2	8	10

Assistant chiefs, despite averaging fewer breaks than trick dispatchers, took longer breaks. Approximately one-quarter of breaks taken by assistant chiefs were 10 min or more in length, compared to only 13 percent of breaks taken by trick dispatchers. Figure 8 presents a more detailed breakdown of longest break length by job type.

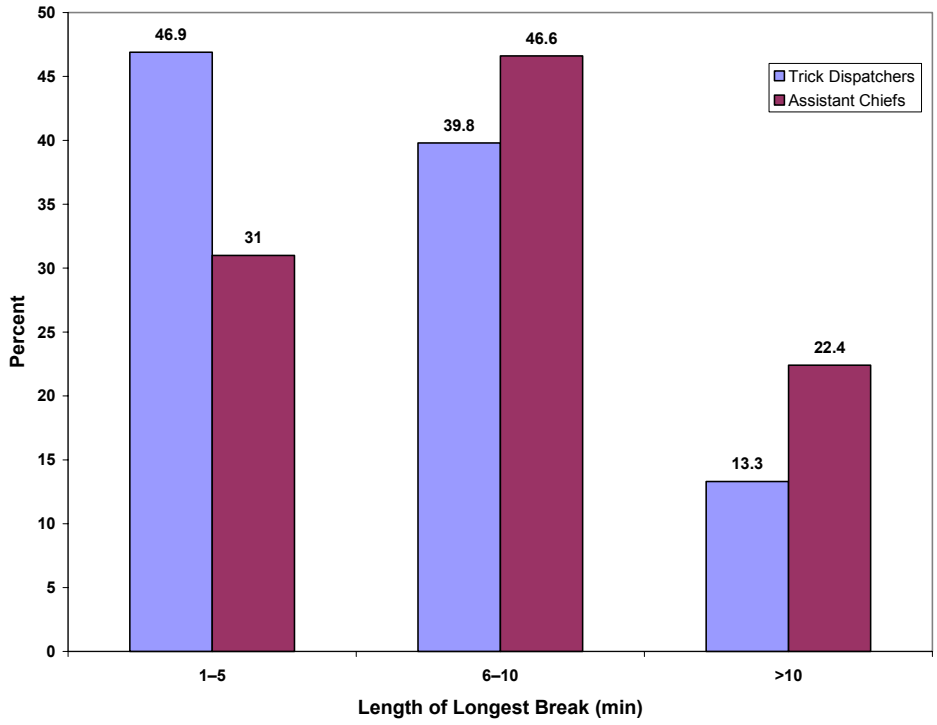


Figure 8. Length of day's longest break by job type

3.4.4 Commute Time

For the purpose of this study, commute time refers to travel between the dispatcher's home and his/her work site. Figure 9 depicts the average dispatcher workday, including commute times, for trick dispatchers and assistant chiefs. Both groups of dispatchers travel over 35 min to work. This commute is longer than the U.S. Census Bureau (2004) estimate of 25.5 min for U.S. workers, excluding those who work at home. The commute home tends to be longer because, according to notes in the log books, many dispatchers do errands or other activities on the way home. The primary difference in the length of the workday for the two types of dispatcher jobs is in the length of the work period. On average, assistant chiefs work 40 min longer each day than trick dispatchers. Both trick dispatchers and assistant chiefs arrive 10 to 15 min before the start of their shift to begin the transition from the dispatcher working the position on the previous shift.

Figure 10 shows the distribution of commute start times for dispatchers. The tri-modal distribution reflects commutes for first, second, and third shifts. Although most first shift positions began at 6:30 a.m., some began as early as 4:30 a.m., and hence some of the commutes began as early as 4 a.m.

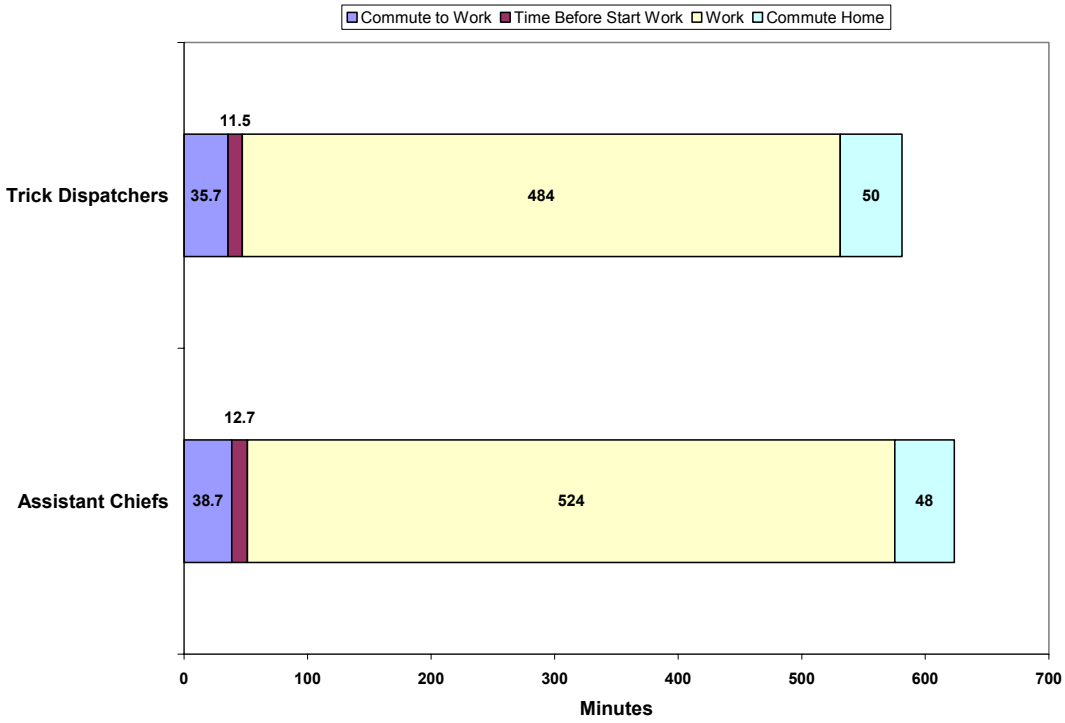


Figure 9. Commute time and workday by job type

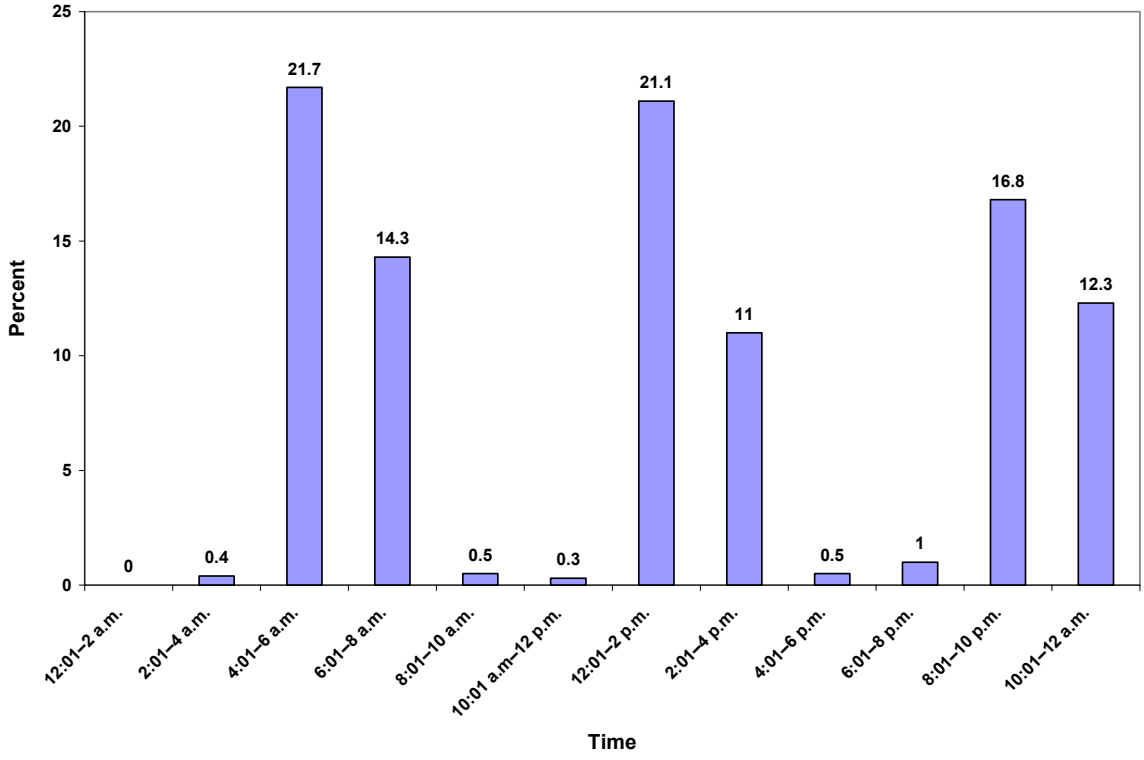


Figure 10. Start of commute to work

3.4.5 Sources of Stress

In the background survey, dispatchers rated job-related sources of stress. They rated stress using a Likert scale with values from 1 to 4 with 1–no stress, 2–a little stress, 3–stressful, and 4–very stressful. The top four sources of stress for both trick dispatchers and assistant chiefs were management policies, surges in workload, ambiguous rules or procedures, and responding to emergencies (see Figure 11). While many of the comments in the trick dispatchers' daily logs bemoaned the lack of regular breaks, lack of break time was in the middle of the list of stressors for trick dispatchers. As shown in Table 15, in 4 of the 14 sources of stress, statistically different ratings existed between the 2 groups of dispatchers. Trick dispatchers assigned significantly higher ratings of stress than assistant chiefs to the following categories: loss of sleep, inadequate time off, ambiguous rules or procedures, and lack of break time. The difference in the ratings for loss of sleep is likely due to a difference in job schedule. A substantial percentage of trick dispatchers work the extra board and must constantly adjust their sleep patterns to obtain proper rest. A higher stress rating for lack of break time by trick dispatchers supports the finding that assistant chiefs are getting longer breaks. With regard to inadequate time off, trick dispatchers typically have less seniority than assistant chiefs and therefore do not have as much vacation time. Finally, the difference in stress rating with respect to ambiguous rules may result from the fact that assistant chiefs do not necessarily apply or exercise the rules as frequently as trick dispatchers.

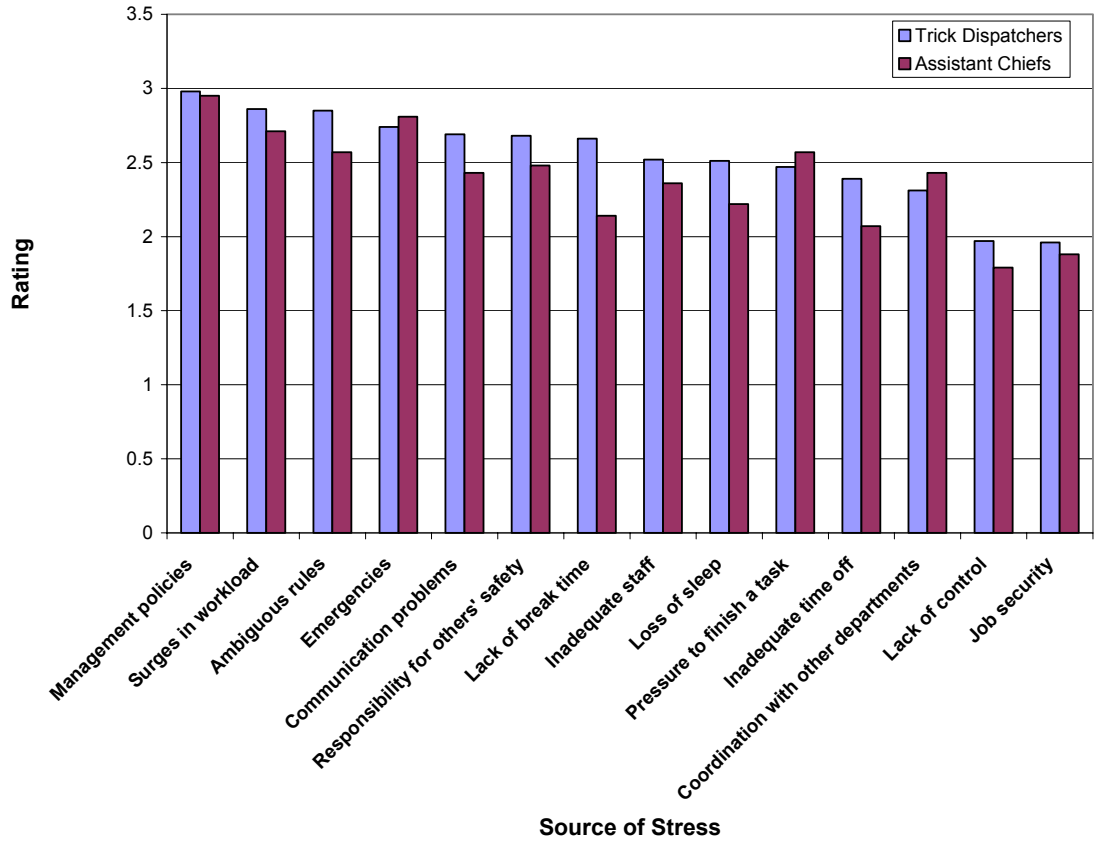


Figure 11. Sources and levels of stress by job type

Dispatchers had different sources of stress based on their work schedule. Appendix B, Table B-4 provides ANOVA results for sources of stress by work. The statistically significant differences were the following:

- Permanent first shift dispatchers were less troubled by job security than permanent third shift and extra board dispatchers.
- Permanent third shift, relief, and extra board dispatchers rated inadequate time off as a greater source of stress than did permanent first shift dispatchers.
- Dispatchers working permanent third shift rated sleep loss a greater stressor than those working permanent first or second shift.
- Extra board dispatchers were more concerned about lack of control over their work schedule than all other schedule groups.
- Extra board dispatchers were less concerned about coordination with other departments than dispatchers working permanent first, second, or third shifts.
- Extra board dispatchers felt less pressure to finish a task than those working permanent first and second shifts.
- Ambiguous operating rules or procedures were less a source of stress for extra board dispatchers than for permanent first and second shift dispatchers.
- Extra board dispatchers rated communication problems as less of a source of stress than all other schedule groups except permanent third shift.

3.4.6 Job Characteristics Summary

The around-the-clock nature of railroading requires railroads to staff dispatching centers with three 8-h shifts. Dispatchers working permanent first, second, or third shifts rarely work outside their typical schedules. The most common relief rotation is working two first shifts, followed by two second shifts, and a third shift.

Surprisingly, a large percentage of extra board dispatchers worked first shift. This is most likely because first shift dispatchers are the oldest and most experienced, therefore likely to have and use the most vacation and sick time. This may also explain why more than one-third of extra board dispatchers had no shift variation through the study period.

Both trick dispatchers and assistant chiefs reported a nominal workweek of 40 h. Trick dispatchers worked just slightly over their nominal amount, while assistant chiefs worked approximately 45 h per week. One-quarter of assistant chiefs worked 48 h or more per week, 8 h more than their nominal schedules require. Because the Hours of Service Law does not apply to assistant chiefs, the additional work hours could be either an extra day of work or more than 8 h in a single day. Actual work was similar to reported typical values for both groups, suggesting that the time period for this study was a typical one with respect to dispatcher work schedules.

Railroad dispatchers have no contractual provisions for breaks. Almost one-third of the time, both trick dispatchers and assistant chiefs took no breaks during their shift. Assistant chiefs take fewer but longer breaks than trick dispatchers.

Table 15. Stress ratings by job type

Source of Stress	Trick Dispatcher	Assistant Chief	Significance Test
Management policies	2.98	2.95	t (440) = .29, p = .776
Surges in workload	2.86	2.71	t (439) = 1.25, p = .211
Ambiguous rules or procedures	2.85	2.57	t (440) = 2.13, p < .05*
Responding to emergencies	2.74	2.81	t (440) = -.56, p = .573
Communication problems	2.69	2.43	t (440) = 1.93, p = .054
Responsibility for safety of others	2.68	2.48	t (440) = 1.44, p = .152
Lack of break time	2.66	2.14	t (439) = 3.57, p < .05*
Inadequate staffing	2.52	2.36	t (440) = 1.13, p = .261
Loss of sleep	2.51	2.22	t (440) = 2.34, p < .05*
Pressure to finish a task	2.47	2.57	t (440) = -.83, p = .407
Inadequate time off	2.39	2.07	t (440) = 2.14, p < .05*
Coordination with other departments	2.31	2.43	t (439) = -.96, p = .337
Lack of control over work schedule	1.97	1.79	t (438) = 1.27, p = .207
Job security	1.96	1.88	t (440) = .57, p = .570

Note: 1 = no stress, 2 = a little stress, 3 = stressful, 4 = very stressful
*statistically significant at α = .05

Trick dispatchers and assistant chiefs had similar sources of stress. In general, trick dispatchers had higher stress ratings than assistant chiefs, with ratings on sleep loss, lack of time off, ambiguous rules, and lack of breaks being significantly higher. Some differences existed in stress ratings by work schedule.

3.5 Sleep Characteristics

This study examined primary sleep, as well as naps. For first and second shift dispatchers, primary sleep refers to nighttime sleep. For third shift dispatchers, this study defined primary sleep as the first sleep period following the end of the individual dispatcher's work period. An alternative way to define primary sleep for third shift dispatchers would have been to select the longest sleep period of the day, but this would have complicated the design of the log book. Designing a log book that dispatchers working all shifts could use presented a challenge in terms of where to record the primary sleep period and the related sleep quality ratings. To facilitate

design and use of the log book for all study participants, the daily log book contained only one sleep period for each day that had sleep quality ratings. The log book sleep section was chronological with the first entry being the nighttime or primary sleep period. First and second shift dispatchers recorded their nighttime sleep in this section upon arising in the morning. When a dispatcher worked third shift, he/she recorded his/her morning sleep period in this section. The next page of the log's sleep section provided space to record sleep periods or naps that occurred later in the day.

Some adjustment of the nap data was necessary to accurately identify naps versus split primary sleep periods. The diary instructions asked dispatchers to record split nighttime sleep as a primary sleep period plus a nap. (This scheme permitted a more accurate computation of nighttime sleep.) For nap entries on non-workdays, if the nap began between 12 a.m. and 7 a.m., then the researchers added nap duration to primary sleep duration. For first shift dispatchers' workday entries, if the nap began after the person went to sleep, but before he/she began the commute to work, then the nap was considered split primary or nighttime sleep and was added to the primary sleep duration. For second and third shift dispatchers, if the nap began less than 1 h after the recorded wake-up time or before 6 a.m., then the nap time was added to primary sleep time and was not a part of the nap analysis.

The ending time of the sleep period determined its assignment to a calendar day. The categorization of each calendar day as a workday or a non-workday depended upon whether or not a work period began on that day. In other words, if a sleep period ended on a day on which the individual began a work shift, then the sleep period was in the category workday sleep. Understanding the method for categorizing sleep as workday versus non-workday is important when reviewing the sleep results.

The following sections discuss primary and total daily sleep, sleep quality, sleep latency, and naps or supplementary sleep periods.

3.5.1 Primary and Total Daily Sleep

The study considered both total daily sleep and the primary sleep period. Table 16 contains the sleep data for total daily sleep by type of day and work schedule. These data indicate that dispatchers working first shift jobs get considerably less sleep on workdays than those with other work schedules, but first shift dispatchers appear to make up for their loss of sleep on non-workdays. When interpreting these data, it is important to keep in mind that on the last day of the work cycle, a dispatcher working third shift may choose to take only a short morning nap after work or to not sleep at all until that night. This means that his/her non-workday sleep for the first non-workday could be 0 h or merely a nap for a few hours. Similarly, the night before the dispatcher's first third shift, he/she usually gets a full night's sleep. For this reason, the workday sleep for the third, relief, and extra board jobs is higher than what might be expected for dispatchers who work third shift, and the non-workday sleep appears understated. For example, the workday sleep for permanent third shift dispatchers is 6:52 (h:min), and their non-workday sleep is 6:16.

Results from a meta-analytic review of shiftworker sleep provide data that can be compared with the results from the present study. Pilcher, Lambert, and Huffcutt (2000) examined 168 primary studies of shiftworkers and selected 36 for their meta analysis. These 36 studies met the following criteria: the study had to report on actual shiftwork, not laboratory-based shiftwork;

the shift length had to be 8 h in duration and had to be either permanent evening, permanent night, or rotating; and the study had to include data on self-report of sleep length. Sleep length for their control group, non-shiftwork day workers, came from a 1998 NSF report. The article does not specify the data collection instrument (log book versus questionnaire) for these studies. Further, it is not clear from the article if sleep refers to the primary sleep period or total daily sleep.

Table 16. Total sleep by type of day and work schedule (h:min)

Type of Day	Work Schedule	Mean	Median	Standard Deviation	25th Percentile	75th Percentile
Workday	1	6:23	6:26	0:46	5:50	6:55
	2	7:05	7:05	0:49	6:25	7:42
	3	6:52	6:58	1:11	5:58	7:40
	Relief	7:00	7:08	0:56	6:22	7:39
	Extra Board	6:57	6:49	1:05	6:13	7:54
Non-Workday	1	7:53	7:58	1:13	7:04	8:47
	2	7:22	7:14	0:55	6:45	8:02
	3	6:05	6:00	1:35	5:18	7:03
	Relief	6:16	6:23	1:34	5:29	7:14
	Extra Board	7:21	7:15	1:48	5:57	8:29

Table 17 compares the total workday sleep of dispatchers, by type of work schedule, with the data from the Pilcher, Lambert, and Huffcutt (2000) study. In comparison with the shiftwork norms, first and second shift railroad dispatchers get less sleep than other shiftwork populations, and first shift dispatchers get the least sleep. The reason that the third shift and relief dispatchers appear to get more sleep is most likely because of how this study assigned sleep to workdays versus non-workdays. The researchers also surmise that the other shiftwork studies used a questionnaire that inquired about usual sleep duration on workdays. This type of questionnaire would lead to a shorter sleep duration for third shift than a daily log book study, such as the one used for this study, that includes the nighttime sleep before the first workday in the average workday sleep.

Table 17. Total sleep by work schedule versus shiftwork norms for workdays (h:min)

Work Schedule	Mean	Median	Standard Deviation	25th Percentile	75th Percentile	Shiftwork Norm*
1	6:23	6:26	0:46	5:50	6:55	7:00
2	7:05	7:05	0:49	6:25	7:42	7:34
3	6:52	6:58	1:11	5:58	7:40	6:36
Relief	7:00	7:08	0:56	6:22	7:39	6:39
Extra Board	6:57	6:49	1:05	6:13	7:54	n/a

*Source: Pilcher et al., 2000.
n/a = not available

Since relief and extra board dispatchers work different shifts over the course of their workweek, it is appropriate to examine the dispatcher sleep patterns by shift actually worked. Table 18 presents total and primary sleep by shift actually worked. The difference between the primary and total sleep for dispatchers working third shift reflects that the majority of dispatchers working this shift employ a split sleep strategy on workdays. Among shiftworkers, second shift workers typically get the most sleep because they do not have to get up early to go to work. First shift workers get less sleep than second, and third shift people get the least sleep. This is the case with the dispatcher results for primary sleep. Once again, the primary sleep for third shift includes the nighttime sleep that occurred the night before the first third shift workday. For both total and primary sleep, all shifts are statistically different from each other, $F(2, 4398) = 137.49$, $p < .05$ and $F(2, 4398) = 243.13$, $p < .05$.

Table 18. Total and primary sleep on workdays by shift worked versus shiftwork norms (h:min)

	Dispatchers		
Shift Worked	Total Sleep	Primary Sleep	Shiftwork Norm*
1	6:19	6:08	7:00
2	7:14	7:06	7:34
3	6:59	5:54	6:36

*Source: Pilcher et al., 2000.

Effect size is a measure of the degree to which a relationship exists between two factors. By computing the effect size for the relationship between total sleep and shift worked, and primary sleep and shift worked, it is possible to compare the relative effect of shift worked on the two sleep metrics. The effect size for total sleep is .24, and for primary sleep it is .32. According to Cohen (1988), an effect size of .25 is a medium effect size. Using Cohen's criteria, the effect size for total sleep is small, and that for primary sleep is medium. This means that shift worked has more of an effect on primary sleep than total daily sleep.

Table 19 provides additional descriptive statistics for primary sleep by shift worked. Both the total and primary sleep results for first shift appear low in comparison with the shiftwork norms. More than 75 percent of those working a first shift get less than the shiftwork norm of 7 h of nighttime sleep. The reason may be that 91 percent of first shift dispatchers begin work by 7 a.m., and 43 percent start by 6:30 a.m. As Figure 10 illustrates, over 20 percent of the dispatcher commute trips to work begin before 6 a.m. This early start of the commute to work requires arising between 5 and 5:30 a.m. Getting 7 h of sleep requires the first shift dispatcher to go to sleep by 10 p.m., a bedtime which most find difficult to accommodate.

Table 19. Primary sleep by shift worked (h:min)

Shift Worked	Mean	Median	Standard Deviation	25th Percentile	75th Percentile	Shiftwork Norm*
1	6:08	6:15	1:07	5:29	6:55	7:00
2	7:06	7:10	1:30	6:10	8:05	7:34
3	5:54	5:55	2:00	4:30	7:15	6:36

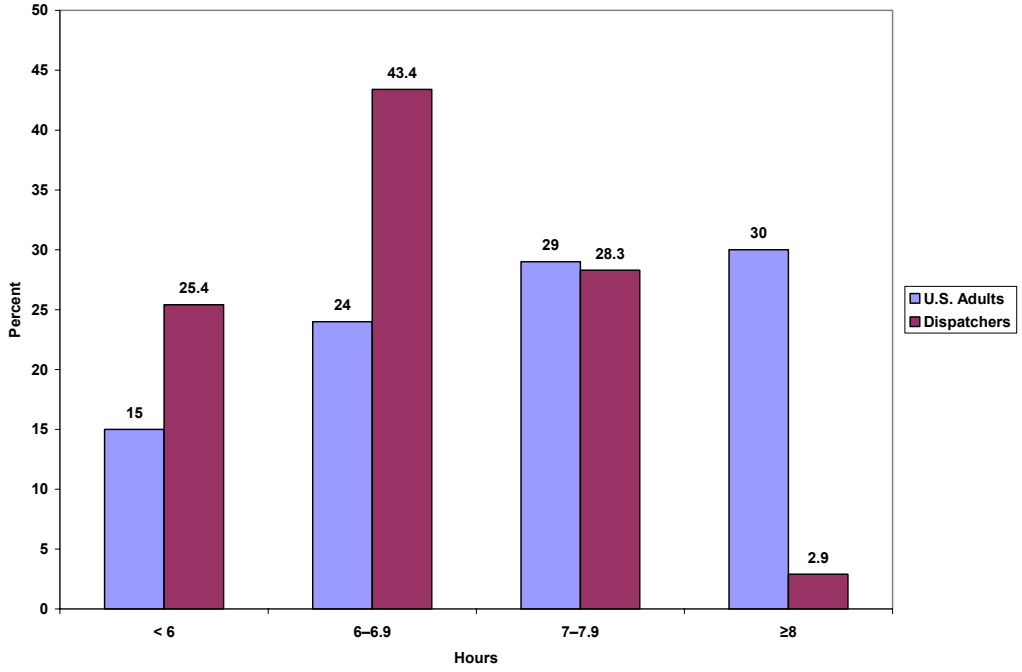
*Source: Pilcher et al., 2000.

Analysis of primary sleep on workdays by age group did not reveal any differences, $F(4, 438) = .14$. This analysis used the 10-yr age groupings of Figure 3 (e.g., 20-29, 30-39).

Comparison of dispatcher sleep with results from surveys of other adult groups is difficult because the dispatchers are a shiftwork population. The *NSF 2002 Sleep in America Poll* provides data on nighttime sleep on workdays for U.S. adults. Because third shift dispatchers do not have nighttime sleep, their sleep data is not comparable to the NSF data. Permanent first and second shift dispatchers, however, sleep at night so their sleep data is comparable to the NSF data. Figure 12 presents a frequency distribution of workday sleep for this group of dispatchers in comparison with the results from the NSF survey. Approximately 59 percent of U.S. permanent first and second shift dispatchers are getting less than 7 h sleep on work nights in contrast with 39 percent of U.S. adults. The proportion getting less than 6 h sleep (25.4 percent) is considerably larger than that for U.S. adults.

A total of 11 dispatchers averaged less than 5 h of sleep on workdays. For nine of these, non-work reasons may have contributed to the lack of sleep. Seven reported multiple personal and family factors or an illness, and two people reported a change in sleeping habits. For the remaining two, no information existed in either the background survey or the daily log to explain the lack of sleep.

The National Health Interview Survey (NHIS) provides another set of normative sleep data for comparison with dispatchers. The Centers for Disease Control, U.S. Department of Health and Human Services, conducts this annual survey to obtain information on a number of health-related issues. It includes the question, "On average, how much sleep do you get in a 24-hour period?" This data is slightly different than that from the *NSF 2000 Sleep in America Poll*. NSF differentiates between work nights and weekends while the NHIS data do not. In addition, NHIS employs a rounding scheme to convert all responses to a whole number of hours. The interview protocol rounded responses of half-hours or more to the next whole hour so, for example, 6½ h



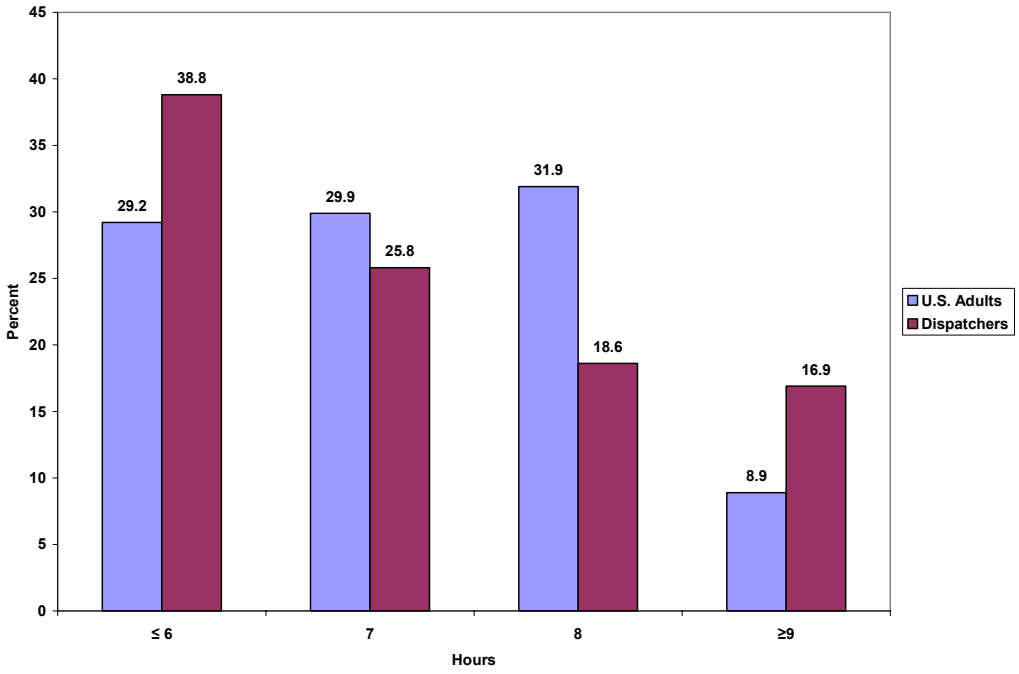
Source: U.S. adult data from NSF, 2002b.

Figure 12. Nighttime sleep on workdays for permanent first and second shift dispatchers versus U.S. adults

was entered as 7 h. Applying the same rounding scheme to the dispatcher data made comparison with the NHIS results possible (see Figure 13). The categories in this comparison differ from those in Figure 12 due to the NHIS rounding. In addition, the dispatcher data in Figure 13 use average total daily sleep across both workdays and non-workdays for the dispatcher population. This comparison, similar to the comparison in Figure 12, shows that dispatchers are getting less sleep than U.S. adults, but the difference is not as great as the comparison with NSF data.

Adults getting less than an average of 7 to 8 h of sleep per night are chronically sleep-deprived. The primary manifestation of sleep loss is excessive daytime sleepiness, but depressed mood and poor memory or concentration may also result. Chronic sleep loss has serious consequences for job performance and health. Performance effects of sleep loss can affect the dispatcher's ability to work safety and efficiently. Belenky et al. (2003) have shown that performance declines initially with mild to moderate sleep restriction of 7 and 5 h, and after a few days it stabilizes at a less than fully rested level. The relevant performance effects include the following (Institute of Medicine, 2006):

- Involuntary microsleeps occur.
- Attention to intensive performance is unstable, with increased errors of omission and commission.
- Cognitive slowing occurs in subject-paced tasks, while time pressure increases cognitive errors.
- Response time slows.



Source: U.S. adult data from National Health Interview Survey, 2005.

Figure 13. Sleep in 24 h for dispatchers versus U.S. adults

- Performance declines in short-term recall of working memory.
- Performance requiring divergent thinking deteriorates.

The job performance of those dispatchers getting less than 7 h of sleep on workdays is likely compromised. Recent research has revealed that sleep loss has neurobehavioral effects, such as those listed above, that often go unrecognized by the affected individuals (Van Dongen, Mullington, & Dinges, 2003). These sleep-deprived dispatchers are probably unaware of the extent of their performance degradation and the increased risk of error.

3.5.2 Sleep Ratings

Dispatchers recorded subjective ratings for primary sleep on both workdays and non-workdays. They rated their ease of falling asleep, ease of arising, length of sleep, quality of sleep, and alertness upon arising. The ratings shown in Table 20 used a Likert scale ranging from 1 to 5, with 1 being the lowest or worst rating, while 5 indicated the highest or best.

Overall, dispatchers gave higher ratings to their non-workday sleep than their workday sleep (see lower right-hand section of Table 20). While all of the work schedule groups rated their non-workday sleep of higher quality than their workday sleep, only the first shift dispatchers' ratings were statistically different for workdays and non-workdays.

Table 20. Ratings of primary sleep (mean of means) by work schedule and type of day

	First Shift			Second Shift		
	Workday	**Non-Workday**	**Significance Test**	**Workday**	**Non-Workday**	**Significance Test**
Ease of Falling Asleep	3.67	4.09	$t(215) = -4.60$, $p < .05$	3.98	4.01	$t(179) = -0.20$, $p = .85$
Ease of Arising	3.18	3.61	$t(215) = -4.12$, $p < .05$	3.18	3.40	$t(179) = -1.81$, $p = .07$
Length of Sleep	3.06	3.75	$t(215) = -7.36$, $p < .05$	3.30	3.45	$t(179) = -1.36$, $p = .18$
Quality of Sleep	3.31	3.80	$t(215) = -5.51$, $p < .05$	3.42	3.58	$t(179) = -1.24$, $p = .22$
Alertness Upon Arising	3.25	3.71	$t(215) = -4.64$, $p < .05$	3.31	3.46	$t(179) = -1.23$, $p = .22$
	Third Shift			**Relief**		
	Workday	**Non-Workday**	**Significance Test**	**Workday**	**Non-Workday**	**Significance Test**
Ease of Falling Asleep	4.04	4.14	$t(197) = -0.99$, $p = .32$	3.86	4.14	$t(161) = -2.51$, $p < .05$
Ease of Arising	3.16	3.30	$t(196) = -1.25$, $p = .21$	3.19	3.08	$t(161) = 0.83$, $p = .41$
Length of Sleep	3.07	3.20	$t(197) = -1.18$, $p = .24$	3.23	3.05	$t(161) = 1.52$, $p = .13$
Quality of Sleep	3.35	3.63	$t(197) = -2.49$, $p < .05$	3.46	3.42	$t(161) = 0.30$, $p = .76$
Alertness Upon Arising	3.28	3.45	$t(197) = -1.53$, $p = .13$	3.27	3.24	$t(161) = 0.26$, $p = .79$
	Extra Board			**All**		
	Workday	**Non-Workday**	**Significance Test**	**Workday**	**Non-Workday**	**Significance Test**
Ease of Falling Asleep	3.62	3.80	$t(105) = -1.18$, $p = .24$	3.85	4.06	$t(865) = -4.15$, $p < .05$
Ease of Arising	2.97	3.11	$t(105) = -0.90$, $p = .37$	3.15	3.33	$t(864) = -3.17$, $p < .05$
Length of Sleep	3.14	3.41	$t(105) = -1.83$, $p = .07$	3.15	3.38	$t(865) = -4.42$, $p < .05$
Quality of Sleep	3.32	3.30	$t(105) = 0.15$, $p = .88$	3.37	3.58	$t(865) = -4.02$, $p < .05$
Alertness Upon Arising	3.21	3.38	$t(105) = -1.33$, $p = .19$	3.27	3.47	$t(865) = -3.76$, $p < .05$

Dispatchers' qualitative ratings of their sleep differed based on the shift actually worked. Table 21 contains these ratings. Second shift ratings were statistically different for all categories except ease of arising. The results for length and quality of sleep and alertness upon arising are consistent with the fact that second shift dispatchers have the longest primary sleep period. With the exception of ease of falling asleep, ratings from first and third shift dispatchers are similar. Correlations between length of primary sleep period and the four sleep period ratings were all significant. The largest correlation (.53) was between the length of the primary sleep period and the rating for adequacy of the length of the sleep period.

Table 21. Workday primary sleep period ratings by shift worked

Sleep Characteristic	Shift Worked 1	2	3	Correlation with Primary Sleep (*r*)
Ease of Falling Asleep	3.67	3.90	4.01	.05*
Ease of Arising	3.14	3.20	3.10	.25**
Length of Sleep	3.05	3.37	3.04	.53**
Quality of Sleep	3.32	3.46	3.34	.28**
Primary Sleep (h:min)	6:08	7:06	5:54	--

*Significant at $p < .05$, **Significant at $p < .01$

3.5.3 Sleep Quality and Sleep Disorders

A total of 41 dispatchers (9.3 percent) reported having a diagnosed sleep disorder. Twenty-six of those dispatchers (63.4 percent) reported receiving treatment for their disorder. The remainder with a diagnosed sleep disorder reported that their problem was untreated. (Two survey participants did not answer the questions regarding sleep disorders.)

Analysis of the sleep ratings included a comparison across three groups: (1) the untreated sleep disorder group (n = 15), (2) the treated sleep disorder group (n = 26), and (3) those with no diagnosed sleep disorder or the normal group (n = 400). Table 22 contains the average sleep ratings for the three groups. While the average ratings indicate that those in the untreated sleep disorder group had lower ratings and a shorter primary sleep period, no statistically significant differences by sleep disorder status existed (see Appendix B, Table B-5).

An analysis of sleep ratings for workdays and non-workdays combined produced similar results with no statistically significant differences by sleep disorder status (see Appendix B, Table B-6). The small number of dispatchers in the two sleep disorder categories makes achieving statistical significance difficult.

Table 22. Sleep ratings and duration by sleep disorder status (workdays only)

Sleep Characteristic	Untreated Sleep Disorder (n = 15)	Treated Sleep Disorder (n = 26)	Normal (n = 400)
Ease of Falling Asleep	3.81	3.84	3.85
Ease of Arising	2.80	3.21	3.17
Length of Sleep	2.78	3.21	3.17
Quality of Sleep	2.99	3.39	3.39
Primary Sleep (h:min)	6:12	6:27	6:24

3.5.4 Sleep Latency

Sleep latency is the time from lights out until the beginning of sleep. Sleep experts consider the adult norm to be 20 min or less. Table 23 displays the sleep latency results based on the dispatchers' sleep log entries. These results refer to the primary sleep period, not supplementary sleep periods or naps.

Table 24 contains similar sleep latency data by shift actually worked.

Table 23. Sleep latency by type of day and job type (min)

	Workdays			Non-Workdays		
Job Type	**Mean**	**Median**	**> 20 min**	**Mean**	**Median**	**> 20 min**
Trick Dispatcher	23	15	35%	20	15	29%
Assistant Chief	23	15	34%	19	15	26%

Table 24. Sleep latency by shift worked (min)

Shift	Mean	Median	> 20 min
1	26	15	40%
2	24	15	35%
3	19	15	26%

Sleep latency does not differ based on job type. On workdays and non-workdays, mean and median sleep latency for both groups is nearly the same. In addition, the majority of trick dispatchers and assistant chiefs are falling asleep within the 20-min adult norm. On non-workdays, both groups fall asleep slightly more quickly than on workdays. This is likely due to the lack of work-related stress on non-workdays and the cumulative fatigue of the workweek.

Examination of the sleep latency data by shift actually worked reveals that those working third shift fall asleep most rapidly. This is a statistically significant difference, $F(2, 4385) = 27.99$, $p < .05$. Individuals are typically not accurate judges of how long it takes them to fall asleep, so drawing conclusions from the dispatchers' self-report data requires caution. Some dispatchers who read in bed or watched TV may not have reported their true lights out time, so their sleep latency would be overstated if this were the case.

3.5.5 Naps

Data from participants' daily logs indicate that the frequency of napping is a function of the individual's work schedule (see Table 25). Those working permanent third shift napped most frequently. This group averaged 4.9 naps in the study's 2-week period. Second shift dispatchers were the least likely to nap and averaged 1.6 naps during this period. Over half of second shift dispatchers reported taking no naps during the study period while nearly a third of the third shift dispatchers reported 8 or more naps in 2 weeks. Many third shift dispatchers employ a split sleep strategy on workdays, which accounts for the high number of naps for this group. Similarly, relief and extra board dispatchers will use this sleep strategy when they work third shift. During the study, as reported in Table 10, relief dispatchers worked third shift on 27 percent of the reported relief work periods, and extra board dispatchers worked third shift 23 percent of the time.

Table 25. Number of naps in 2-week period by work schedule

	Number of Naps	
Work Schedule	**Mean**	**Median**
1	2.4	1
2	1.6	0
3	4.9	4
Relief	3.7	3
Extra Board	2.5	2

Dispatcher nap length varies by work schedule and type of day (see Table 26). First and second shift dispatchers take longer naps on non-workdays than on workdays. They are most likely compensating for loss of sleep during the workweek. Those working third, relief, and extra board schedules most likely take longer naps on workdays because they employ a split sleep strategy when working third shift. The differences in nap length by work schedule on non-workdays were not statistically significant, $F(4,135) = .68$, $p = .604$. For workdays, however, the differences were significant, $F(4,283) = 16.39$, $p < .05$. (Appendix B, Table B-7 contains the Tukey honestly significant difference (HSD) post hoc test results.)

Table 26. Mean nap length by work schedule and type of day (h:min)

	Type of Day	
Work Schedule	**Workday**	**Non-Workday**
1	1:02	1:35
2	1:12	1:26
3	2:12	1:51
Relief	1:57	1:41
Extra Board	1:46	1:48

Nap length differed by shift worked, $F(2, 1048) = 143.90$, $p < .05$. Dispatchers working third shift tended to nap twice as long as those working the other two shifts (see Table 27). These differences are statistically significant (see post hoc test results in Appendix B, Table B-8). Again, this is likely because of a split sleep strategy when working third shift.

Table 27. Nap length on workdays by shift worked (h:min)

Shift Worked	Mean	Median	25th Percentile	75th Percentile
1	1:05	0:58	0:30	1:20
2	1:10	1:00	0:35	1:30
3	2:13	2:00	1:20	3:00

Start time of naps differs depending upon the type of day. As shown in Figure 14, nearly half (49 percent) of all first naps on workdays began between 4 and 8 p.m. First shift dispatchers returning from work and third shift dispatchers taking a pre-work nap account for these naps. The second most popular nap start time was 2 to 4 p.m., a time when first shift dispatchers were likely to nap after returning home from work. Individuals napping during their commute to or from work account for the limited number of early morning naps. (Some dispatchers reported sleeping during their train ride or carpool trip.)

Naps on non-workdays occur at different times of the day than those taken on workdays. Naps on non-workdays tend to start between 12 and 4 p.m. (see Figure 15). This is a time that coincides with the afternoon nadir in the circadian cycle.

3.5.6 Sleep Characteristics Summary

Dispatchers working permanent first shift jobs get considerably less sleep on workdays than those with other work schedules, but first shift dispatchers appear to make up for their loss of sleep on non-workdays. In comparison with sleep norms for other shiftwork populations, dispatchers averaged less primary daily sleep than the shiftwork norms for comparable groups.

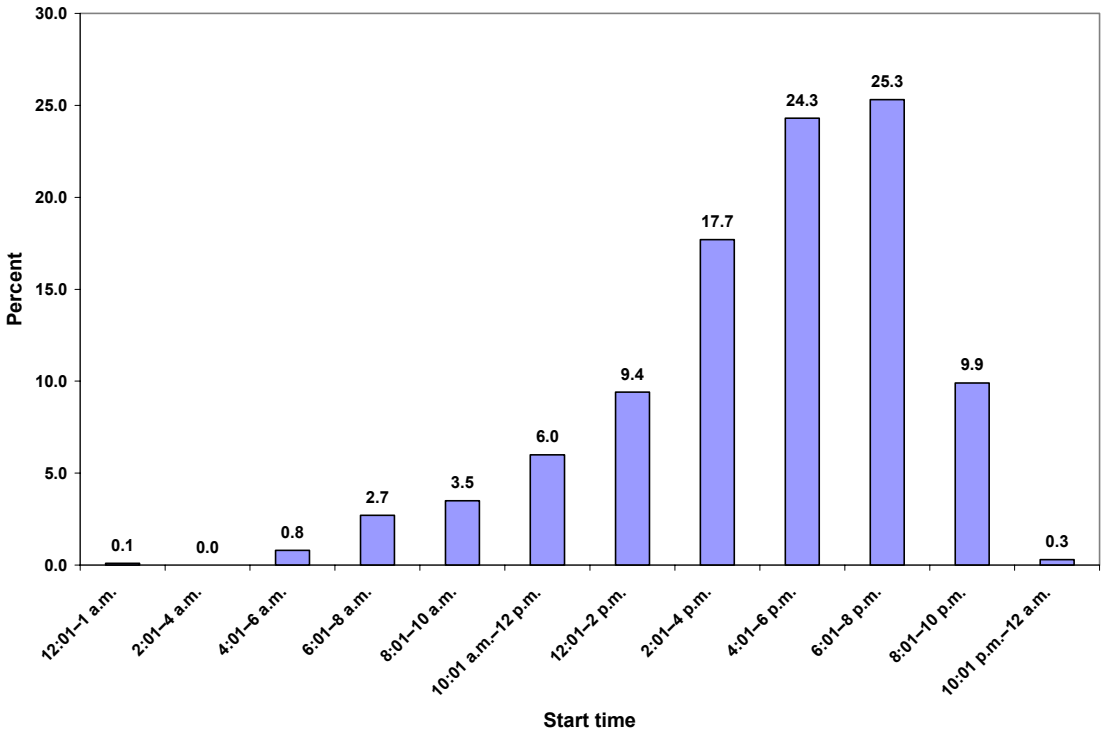


Figure 14. Nap start times for workdays

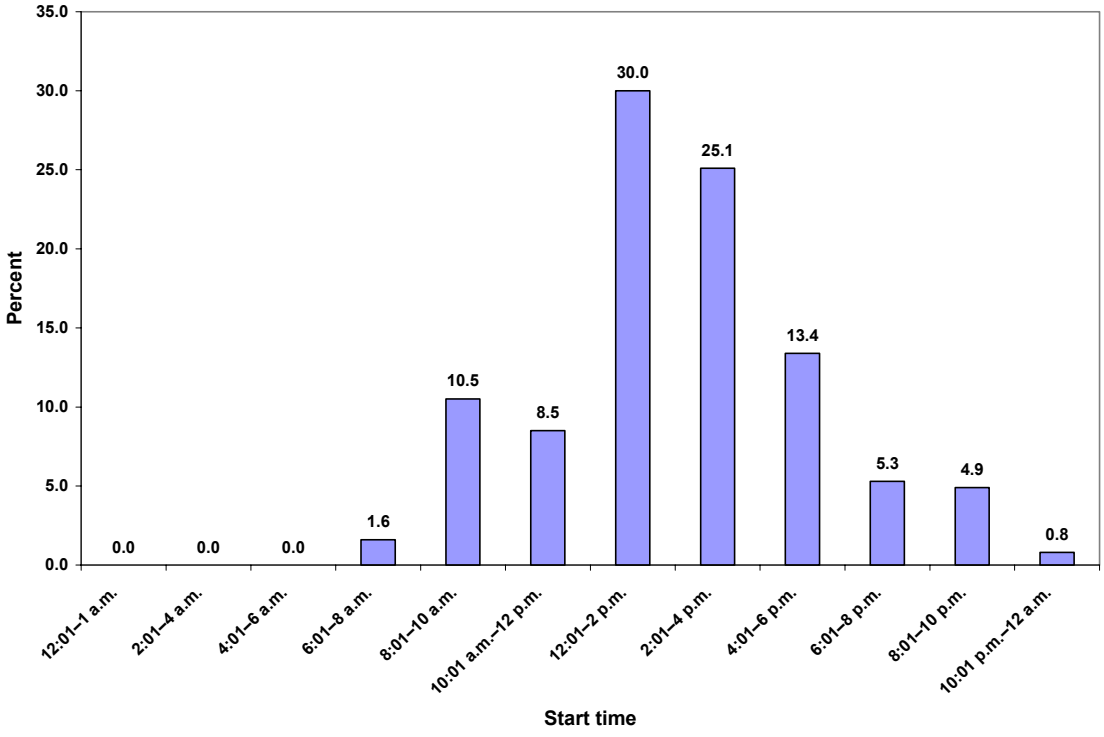


Figure 15. Nap start times for non-workdays

The nighttime sleep of permanent first and second shift dispatchers is less than that of U.S. adults. One quarter of these dispatchers get less than 6 h of nighttime sleep in contrast with 15 percent of U.S. adults. The majority of first shift dispatchers begin work by 7 a.m., making it difficult to get adequate nighttime sleep.

Nap frequency is a function of the individual's work schedule. Dispatchers working permanent third shift averaged 4.9 naps during the 2-week period of the survey, while more than half of the second shift dispatchers took no naps. Nap length also varied by shift worked, with third shift dispatchers taking naps that were on average 2:13, nearly twice that of those who worked first or second shift.

Sleep quality ratings were higher for non-workdays versus workdays. These differences were statistically significant for only the permanent first shift dispatchers. Sleep quality ratings were lower for those with untreated sleep disorders, but no statistically significant differences existed, most likely due to the small number in the untreated sleep disorder category.

3.6 Alertness

This section presents the survey results with respect to self-assessments of alertness. The study collected self-assessments of alertness in two ways. The background survey had questions about overall alertness, and dispatchers recorded their self-assessments of alertness at different points during the workday in their daily log. One section discusses alertness relative to job type, another relative to work schedule, and the third relative to sleep disorders.

3.6.1 Job Type

Through questions on the background survey, dispatchers rated their overall alertness at work and after work. Assistant chiefs generally reported being alert at work more often than trick dispatchers and were less likely to be mentally drained after work (see Tables 28 and 29). These, however, are not statistically significant differences, $\chi^2(2, n = 443) = 1.89$, $p = .39$ and $\chi^2(2, n = 443) = 3.31$, $p = .19$.

Table 28. Alertness at work by job type (percent)

Alert at Work?	Trick Dispatcher	Assistant Chief
Always	7.8	6.9
Frequently	47.3	56.9
Occasionally	41.3	34.5
Never	3.6	1.7

Table 29. Mentally drained after work by job type (percent)

Drained After Work?	Trick Dispatcher	Assistant Chief
Always	17.1	8.6
Frequently	46.8	46.6
Occasionally	34.8	41.4
Never	1.3	3.4

3.6.2 Work Schedule

Examination of these responses by job schedule did, however, result in statistically significant differences overall, $\chi^2(8, n = 443) = 16.26$, $p < .05$. Table 30 contains the responses to the background survey questions regarding alertness at work by work schedule. Pairwise comparison of the work schedule groups revealed that first and second shifts were statistically different from third, and second differed from relief (see Appendix B, Table B-9, for the statistical test results). Those dispatchers working a permanent first or second shift reported that they were more frequently alert at work than those working third shift. Similarly, second shift dispatchers reported that they were more frequently alert at work than those working a relief schedule. Although the data in Table 30 indicate that the dispatchers working the extra board report being alert at work less frequently than those working other work schedules, the small size of this group relative to the other work schedule groups was most likely responsible for the lack of statistical significance in comparisons with this group.

Table 30. Alertness at work by work schedule (percent)

	Work Schedule				
Alert at Work?	1	2	3	Relief	Extra Board
Always	8.9	9.7	5.9	8.4	3.7
Frequently	55.4	58.1	39.6	41.0	46.3
Occasionally	33.0	30.1	47.5	47.0	50.0
Never	2.4	2.2	6.9	3.6	0.0

Table 31 summarizes the responses to the question, "How often do you feel mentally drained at the end of your work period?" The responses from the five work schedule groups were not statistically different, $\chi^2(2, n = 442) = 9.42$, $p = .31$.

Table 31. Mentally drained after work by work schedule (percent)

Drained After Work?	Work Schedule 1	2	3	Relief	Extra Board
Always	7.1	9.7	5.9	3.6	1.9
Frequently	38.4	30.1	40.6	33.7	38.9
Occasionally	47.3	43.0	42.6	48.2	53.7
Never	7.1	17.2	10.9	14.5	5.6

Data from dispatchers' daily logs revealed some differences in alertness levels based on shift worked. For all shifts, alertness peaked after the commute to work but then declined throughout the day, as shown in Table 32. The decline was greatest for third shift and least for first shift. These results are consistent with the time of day when the dispatcher from each shift arrives home and how long the dispatcher has been awake. The first shift dispatcher arrives home mid-afternoon while the second shift dispatcher arrives home around midnight, a time when most adults are ready for nighttime sleep. The third shift dispatcher arrives home after being awake through the night and trying to counteract the body's need for sleep.

Table 32. Alertness throughout the day by shift worked

Time of Rating	Shift Worked 1	2	3
Upon Awakening	3.20	3.36	3.24
After Commute to Work	3.59	3.80	3.65
Mid-Shift	3.51	3.43	2.97
After Arriving Home	3.05	2.69	2.26

Table 33 contains the results of a linear regression analysis to explain alertness as a function of time on shift using the data in Table 32 . The β coefficients indicate the more rapid decline of alertness over the work period on second and third shifts relative to first shift. An alternative formulation for this model that incorporated shift worked as an independent category variable did not have better predictive power than the three separate models.

Table 33. Linear regression results by shift for alertness and time on shift

Shift	β	Constant	R^2
1	-.14	3.79	.86
2	-.28	4.14	.96
3	-.35	4.00	.99

3.6.3 Sleep Disorders

Dispatchers with untreated sleep disorders had lower alertness ratings throughout the workday than those with treated or no sleep disorders (see Table 34). These results do not reveal a statistically significant difference due to the small number with untreated sleep disorders (see Appendix B, Table B-10). The sleep literature contains numerous studies documenting the performance risks of untreated sleep disorders, in particular sleep apnea. A fatigue education program for dispatchers should caution all dispatchers about these risks.

Table 34. Alertness and sleep disorders (workdays only)

Time of Rating	Untreated Sleep Disorder (n = 15)	Treated Sleep Disorder (n = 26)	Normal (n = 400)
Upon Awakening	3.03	3.25	3.28
After Commute to Work	3.48	3.51	3.70
Mid-Shift	2.95	3.31	3.33
After Arriving Home	2.35	2.64	2.70

3.7 Textual Data

The daily log included two separate spaces for participants to record any comments regarding their sleep and work periods each day. This section presents an overview of participants' comments on their sleep and work experiences throughout the 2 weeks of the study.

Commenting on sleep or work experiences in the daily log book was not a requirement of participation. Rather, the diaries provided an opportunity for dispatchers to qualify part of their day. As such, some participants chose not to comment, while others commented frequently. For this reason, a statistical analysis of these comments was not possible. Researchers, however, scanned a number of participant log books to determine common themes presented in the comments and performed a simple tabulation of the frequency of topics mentioned. The following themes emerged from this review:

1. Sleep
2. Workload
3. Alertness/Fatigue
4. Naps
5. Work Schedule
6. Stress
7. Personal Issues (family, leisure activities)
8. Weather
9. Territory
10. Communication

11. Safety
12. Management
13. Responsibility

Researchers used ATLAS.ti® software V5.2.8 to autocode comments based on keyword searches and tally the number of comments made under each topic area. Table 35 lists the keywords that were the basis for each topic area search.

These categories were not mutually exclusive. As a result, many of the comments fell into more than one category. For example, a comment on work schedule may also be counted in the stress category, or a sleep comment may be in both the alertness/fatigue and naps categories. The most frequently mentioned topics in the section for sleep comments were sleep, naps, personal issues, and work schedule. Comments on workload, alertness/fatigue, stress, and sleep dominated the work experience section. The comments complement the quantitative survey results by providing personal examples of the effect of work or sleep patterns present in the survey data. In this way, the comments provide a more complete picture of dispatchers' fatigue-related concerns.

Table 36 presents more detailed results of keyword searches.

The selected comments that appear following Table 36 illustrate the consequences of the work and sleep patterns in the survey data. For example:

- Many of the comments related to *Sleep* touch upon the difficulty of sleeping during the day for those working third shift, the challenge in adjusting or maintaining one's sleep schedule when working a variable schedule, and the general deficiency or poor quality of sleep due to work schedules.
- Comments on *Workload* related to heavy traffic volume and the large variety of responsibilities a dispatcher must handle. Many of these comments linked workload to the lack of breaks.
- A number of participants commented on the difficulty of staying *Alert* on third shift. Others (assistant chiefs) mention *Fatigue* due to long workdays. Many dispatchers commented that being busy at work made it easier to stay alert.
- The comments with regard to *Naps* illustrate how some survey participants, primarily those working third shift, have split sleep patterns. Those individuals typically sleep in the morning after work and then nap in the evening in preparation for their next night shift.
- Comments on *Work Schedule* concern primarily the difficulty in working relief or extra board jobs and how those jobs affect one's personal schedule, including sleep, as mentioned above.
- Dispatchers mentioned *Stress* in relation to a variety of issues, such as traffic volume, workload, communication difficulty, weather issues, train delays, and dealing with train and engine crews and track crews.
- Some survey participants described *Personal Issues* that affected their sleep.

Table 35. Keywords used for each topic area search

Topic	Keywords
Alertness (mental)/Fatigue (physical)	Alert*, aware*, awake, attentive*, watchful, vigilant, prepared, fatigue*, tired, sleepy, exhaust*, weary, energy, weak*
Communication	Communicat*, dispatcher, track gang, track crew, track department, signal department, yardmaster, radio, communication equipment
Management	Manage*, boss, supervis*, company, policy, organization, administration, control, chief, rule*, staff, inadequate
Naps	Nap*
Personal Issues (family, etc)	Personal, private, family, domestic, son, daughter, wife, kid*, baby, father, mother, grand*, relative*, child*, husband
Responsibility	Responsib*, duty, blame, reliab*, accountab*
Safety	Safe*, accident, incident, injury, casualty, error, protect*
Sleep	Sleep*, rest, bed
Stress	Stress*, pressure, strain, anx*, worr*, tense
Territory	Desk, territory, coverage, area, region
Weather	Weather, heat, hot, degrees, temperature, cold, freezing, wet, rain, snow, sleet, light*, dark, sun, ice, climate, condition*
Work Schedule	Schedule, overtime, unscheduled, shift, 3rd, third, extra*, night shift, relief, break, hours, lunch, double
Workload	Busy, work load, workload

Note: ATLAS.ti search logic uses the symbol "*" as a wildcard. For example searching for "stress*," would result in all words starting with s-t-r-e-s-s and would include any ending (such as stressful, stressor, etc.).

Table 36. Frequency of comments by topic area and source

Topic	Source of Comments		
	Sleep Log	Work Log	Total
Sleep	1877	298	**2175**
Workload	17	678	**695**
Alertness/Fatigue	109	393	**502**
Naps	432	36	**468**
Work Schedule	169	178	**347**
Stress	33	308	**341**
Personal Issues	258	47	**305**
Territory	2	55	**57**
Communication	3	38	**41**
Safety	0	28	**28**
Weather	0	28	**28**
Management	9	8	**17**
Responsibility	2	9	**11**
Total	**2911**	**2104**	**5015**

The limited comments relating to *Management* and *Responsibility* were not meaningful and are therefore not presented below.

Selected comments by topic follow:

Sleep

- "Sleeping during the day is not the same as sleeping at night. I've been on third shift for 8 years and I have never gotten used to it."
- "Being on a relief job you never have enough time to catch up on your rest because you only have one and a half days off each week, and how much of that is really a day off?"
- "Did not get enough sleep because worked second shift on Friday and first shift on Saturday." (assistant chief)
- "Was not good sleep due to job called me at 0600 to be at work at 0630. I was scheduled to work at 1430, so my sleep was planned on that schedule." (extra board dispatcher)
- "Woke up from 1200-1215. Even on off days I try to stay on same sleep schedule. If I keep trying to change my schedule around, I will be more tired, grumpy, and have less energy. Feel groggy all day."

- "My change of assignments also meant going from third shift to afternoons so my sleep is now much better! It took about 4 months to get 6 straight hours."
- "It's a day off and I slept more. The extra nap helped a lot. I went to bed at 2200 hours. I use my days off to catch up on lost sleep so I don't get much else done on my days off except SLEEP."

Workload

- "Sunday was a little lighter workload, but trains, duties, responsibilities, rules increase regularly. Eating, taking a break is next to impossible because the workload increases continuously! We are also responsible for numerous weather alerts, warnings, and have to constantly devote excess time to notifying every train and document data–feel like a weather reporter."
- "Extremely busy. Multi-tasking non-stop for full shift. Very stressful. Had to rest in parking lot before feeling fit to drive home."
- "Very busy day today–barely had a chance to eat or go to the bathroom. By 6 p.m. I was really tired, physically and mentally. Each phone call began to be overwhelming halfway through the shift. Days like this would be so much easier if you would get a 30 minute break away from the desk."
- "Sunday night–Did not sleep very soundly. I think the anticipation of the coming day's events (workload) makes sleeping difficult."
- "Very busy. Break long enough to go to the restroom and get coffee. No time for lunch. Signal trouble late in shift."
- "Because of enormous increase in traffic volumes, every day is extremely busy and intense. Opportunities for breaks are few, if any, due to the constant demand for my attention. The long, intense mental workout leaves me mentally drained and tired by end of day. This usually leaves me needing a nap in the afternoon, which disturbs a normal sleep at night and unrested in the morning."
- "Regarding 'breaks' during the work day: we do not have 'break' time built into the work schedule. The only break I ever take is to use the restroom or get my lunch from the refrigerator and return to my work site. I eat lunch while continuing my work. Time passes really fast during the work day. Most days I'm mentally exhausted at the end of the day."

Alertness/Fatigue

- "Typical day for the night shift. It's like a pattern of not enough sleep and always tired."
- "I work days, sleep nights, get good rest. Things were different when I worked nights. I was tired all the time."
- "Work was slow. When it's that way, it's hard to stay awake sometimes. Busier is better."
- "Very good work day. A steady day where time went by quickly and felt rested and alert all day."

- "Another very long night… Fighting to stay awake, drank 7 cups of coffee and took 3 'NoDoz' pills to keep going. So tired I started to invert numbers and forgot what I was going to say to people."
- "Did not sleep. Marked off work for third shift starting tonight at 2230. Due to being dangerously exhausted."
- "It seems that I just reached the point of total exhaustion. I need to try to go to bed at the same time every night, but being on the extra board makes it hard to. The last 2 weeks have been the exception as I had somewhat of a normal shift. Not always true!!!"
- "I feel very alert when leaving work, but after 10 minutes in the car 'winding down' the fatigue envelopes me."
- "I did not feel very alert all day, nodding off frequently at my desk. No matter how many breaks I took, I couldn't seem to fully concentrate on my work because I was so tired. I'm looking forward to tomorrow, a rest day, to catch up on some much needed sleep. At this point of the week, I'm burned out."
- "3rd day to work 12 hour shifts and very tired!"

Naps

- "Generally when my shift changes from evening shift to night shift, I split my sleep. So I will mostly take a nap for abut 3 or 4 more hours of sleep."
- "Took a short nap. Didn't want to waste any of my day and a half off."
- "Had to take nap before work, may have to double."
- "Short nap to relieve stress–felt better after nap."
- "Took a nap–trying to stay rested in case called for third shift. Did not get the call for third until 11:40 p.m. for an 11 p.m. shift. Had just gone to bed and dozed off."
- "Decent night's sleep but will spend the remainder of the day dreading third shift tonight. Short nap prior to work I find to be very helpful, makes the night at least tolerable."
- "Slept extra today–coming off rest day and going to work third–extra sleep so I don't have to take a nap."

Work Schedule

- "Had to work a double shift last night. By the time I got home had only one thing on my mind. Go to bed. Was worried about getting into a car accident on way home I was so tired."
- "The hardest part of the job–working this swing shift–is staying alert on third shift. The workload is OK, but I'm never able to get enough rest to work effectively."
- "Was told I was working third shift. Went to bed and was called to take a rest day and come first shift on the 5th. Yo-yo sleeping messes me up. 'Circadian rhythm out of whack.'"
- "Making the transition to third shift one night a week is very difficult. The next day, 'my so called day off,' I am pretty much exhausted because if I sleep too long when I get

home, I won't sleep that night. Have to get back on a regular schedule. Overall work day OK but I feel like I gradually go downhill."

- "Always seem to have trouble falling asleep after day off. Originally supposed to work second trick today, but when we got home yesterday evening found a message saying I'm working first trick, which required me to rush and get all my stuff ready and my lunch, so instead of winding down before sleep time, I go to sleep all keyed up. I really believe when they call you and change your schedule on your rest day, extra compensation should be given."
- "On call–don't know if I'll work. Sleeping in case they call me for third shift. They did not call."
- "Very tired all night. Tough to go from day schedule to night schedule. Also slow night for trains, doesn't help at all."
- "Going from second to third shift is tough. I don't always get a chance to take a nap so I am usually very tired by the end of my shift."
- "People on third shift should be allowed short naps if needed. I get very tired at night for no reason."

Stress

- "Busy day. Student present today, adding to stress. Lots of impatient T&E and MOW employees making comments about their delays for lack of being able to get in contact with the dispatcher. This in turn causes more stress on the dispatch. Stayed over 45 minutes to help smooth the operation for the shift transfer."
- "Many problems at work due to weather problems. Being tired and having a busy work shift makes for a very long night. Fatigue intensifies on rough work shift. Stress makes things worse."
- "More stress today than usual. Trains close to Hours of Service Law. Plans made by trainmasters, and dispatcher not made aware of plans."
- "Lately work has been really stressful. You have people constantly giving you a hard time. They call and call on the radio despite the fact that they can hear that you are talking to someone else. THEY mess up on something and you somehow get dragged into it...It is like babysitting 60 people all at once who should know how to act like adults but don't."
- "Total chaos. Train traffic heavy and late, MOW people anxious to get time on track. Too much to be done by one dispatcher safely and efficiently by the rules and instructions. I chose the safe route."
- "Medium traffic. Steady work. Many communication and computer issues. Crew in emergency did not notify me, had trains going by–unprotected. I was stressed…"

Personal Issues

- "Wanted to sleep more but have to work this afternoon and I'll take time away from family if I do."

- "On every other Saturday and Sunday I have only a 2-hour (plus or minus) window to sleep. I'm divorced and have split custody of my two children. The kids are brought here around 10:00 and I bring them to their mother's at 20:20."
- "Difficult falling asleep–daughter has strep and worried about her–wife with difficulties at her work."
- "Mother's Day–spent time with grandchildren and cut back on sleep. I'm used to being tired."
- "Due to having worked third shift the night before, I only sleep a few hours so I will be able to fall asleep at a normal time tonight and spend time with my children during the day."

Territory

- "I work a very busy desk that keeps me alert throughout the shift."
- "Another stressful day. Rank 4 out of 5. Too much territory to control safely by one dispatcher."
- "I was shifted off my regular desk. I worked a much busier desk. By 12:30 p.m. I was bushed. By 1:30 p.m. I was completely tired and ready for a nap. 1½ hours still left."

Communication

- "Trains in emergency. Ongoing radio and CADS problems. Crossing failures–one radio tower has been down for weeks. It makes communicating with certain areas nearly impossible. Intermittent radio outages randomly occur on all other towers and constant repeating. The transmissions do not seem to be going out, as well as the fact the radio quality [is poor]."
- "The radio problems are ridiculous. In my opinion, they are unsafe. It's not just the radios. It's the noise, speakers, air box, etc… When I try to talk to another dispatcher on the intercom system there is a lot of feedback, same with my open lines to yards. The computer system has so many glitches that it is causing more work than it saves."

Safety

- "0825–rear end collision between two loaded coal trains. Total chaos. Crewmembers injured. Millions of dollars damage. Main lines blocked. The kind of shift no dispatcher ever wants, but must be ready for."
- "Full throttle. Many trains and the trauma of a crossing incident. I am so fatigued mentally and physically."

Weather

- "Another hard day. Lots of weather-related problems and account maintenance work lots of trains went dead due to hours of service and our responsibilities, including lining up transportation as well. Life of a dispatcher is constantly changing."
- "Stress with weather conditions to protect. Wind in excess of 50 mph and flash floods until 0200."

- “Blizzard conditions–stressful, switches, etc. Won’t lock up. Vans delayed. Trains dead on hours of service, etc.”
- “Tornado warnings. Heavy rain. Signal problems. Very stressful.”

4. Findings and Recommendations

Analysis of the data from this study provides some insights into the demographics of the U.S. dispatcher population, as well as how their work schedules and sleep patterns affect their alertness on the job. The data came from a random sample of U.S. dispatchers who are members of ATDA. Nevertheless, the results are representative of the Nation's dispatcher population at the time of the survey for two reasons. First, approximately two-thirds of the Nation's dispatchers are ATDA members. In addition, it is a reasonable assumption that the work schedules and sleep patterns of dispatchers in non-union dispatching jobs and at railroads with different labor representation are similar to those of the ATDA dispatchers because of the work hour limitations of the Hours of Service Law.

This section presents the key findings of the study, as well as some recommendations for methodological changes for future field studies of this nature. The section concludes with some suggestions for additional research using the survey data from this study.

4.1 Key Study Findings

The following subsections highlight the study's key findings with respect to dispatcher demographics, work periods, and sleep patterns and alertness.

4.1.1 Dispatcher Health

Dispatchers average 5.6 workdays lost annually due to illness. In contrast, U.S. employed adults with paid sick time average 3.6 d of sick time. Several possible explanations exist for the more frequent usage of sick days among dispatchers. First, this is a shiftwork population, and shiftworkers tend to have a higher rate of medical conditions, such as gastrointestinal problems and headaches. The stressful nature of the job may also lead to medical problems. Finally, some dispatchers, especially those working third shift or irregular schedules, may find it necessary to mark off sick to catch up on sleep.

Due to the around-the-clock nature of railroading, dispatchers will always be shiftworkers. If dispatchers understand how the body responds to irregular work schedules and working at night, and if they have strategies for coping with shiftwork, they will be better able to manage this work arrangement and to minimize its health consequences. An initial dispatcher training program should include education on shiftwork, as well as the potential health consequences of inadequate sleep. For dispatchers who have had no shiftwork or fatigue training, annual rules training might provide the opportunity to cover this information.

4.1.2 Work Periods

Both trick dispatchers and assistant chief dispatchers have a nominal workweek of 40 h, but assistant chiefs, on average, work more hours per week. Since the Hours of Service Law does not apply to assistant chiefs, on occasion they will work 12 or even 16 h in 1 d. Based on the survey data, the primary reason that the assistant chiefs worked more hours than the trick dispatchers was that they worked an extra workday. A quarter of the assistant chiefs averaged

1 d or more of overtime per week during the study. A regular work pattern like this with only 1 rest day does not allow adequate time for rest and recovery from the workweek.

The 8-h workday of a dispatcher plus commute time should provide adequate time for sleep and personal activities, but many aspects of their work schedules may prevent this. First shift for over 90 percent of the dispatchers begins by 7 a.m., necessitating an early wake-up time that compromises nighttime sleep. Third shift, relief, and extra board dispatchers must contend with varying and unpredictable work schedules, as well as sleeping at times when their bodies say they should be awake. For assistant chiefs, the situation has the added complication that no limitation exists on the number of hours that they may work in a day; thus two shifts in 1 d and backward shift rotation may occur.

Dispatchers working relief and extra board jobs experience variability in their shift start times. Although the survey indicated that relief dispatchers have more shift variability than extra board dispatchers, relief dispatchers work the same schedule each week so at least the variability is predictable. In contrast, an extra board dispatcher who is not filling in for a regular dispatcher on vacation or other extended leave has no predictability in his/her schedule from week to week. Because of the way that this analysis computed shift variability, the extra board dispatcher's variability may be underestimated.

Since dispatchers do not have any planned or guaranteed breaks during their 8-h shift, the researchers were surprised to find that lack of breaks was not a major source of stress to either trick dispatchers or assistant chiefs. Perhaps dispatchers have become accustomed to their few short breaks and the need to eat meals at their desks.

4.1.3 Sleep Patterns and Alertness

Overall, dispatchers are a sleep-deprived group. They get less sleep than other shiftwork populations and less sleep than the norm for U.S. adults. Only dispatchers working first shift appear to be making up for their poor workday sleep on rest days. When working a third shift, many dispatchers employ a split sleep strategy, which is common in other shiftwork populations as well. The dispatchers' overall lack of sleep is a concern since research has shown that performance decrements occur with less than 7 h sleep, particularly if it is consistently at this level. Even more disconcerting is that nearly 40 percent of dispatchers averaged 6 h or less sleep overall (for both workdays and non-workdays), and these individuals, who perform safety critical jobs, are probably unaware of the extent of their performance degradation and the potential health consequences of lack of sleep.

One of the dispatcher daily log books included the comment that participating in the survey made this dispatcher aware of the extent of the dispatcher's lack of sleep. The same entry included the comment that as a result of the survey, this dispatcher planned to make an effort to get more sleep. This one experience illustrates that fatigue education would likely make dispatchers aware of their inadequate sleep, hopefully leading to some changes in sleep patterns.

The incidence of sleep apnea among U.S. dispatchers exceeds the U.S. adult norm. This may reflect an awareness of the symptoms of sleep apnea and its consequences. A third of those with sleep apnea have gone without treatment. Railroads and unions should continue their education programs pointing out the possible performance and health consequences of untreated sleep apnea and encouraging those with sleep apnea to accept treatment. Initial dispatcher training and

periodic rules training provide the opportunity for fatigue education that includes discussion of sleep disorders.

Dispatchers' self-ratings of alertness throughout the workday increased after the commute to work and then declined from mid-shift. This pattern was the same regardless of shift worked, but the greatest decline occurred with those working third shift.

4.2 Recommendations for Improvements in Study Procedures

This was the third FRA-sponsored study of work schedules and sleep patterns of railroad workers. The experiences of each successive study have resulted in improvements in the subsequent one. Based on the experience of this study, several methodological improvements should be a part of any future studies to collect work schedule and sleep pattern data. Because this was the first survey of a railroad shiftwork population, the first two of the four recommendations below focus on issues unique to a shiftwork population. The recommended changes are the following:

- *Design and test instructions for third shift workers to use in recording their primary sleep period.* Despite having instructions specifically for third shift dispatchers, some third shift dispatchers did not record their sleep on the correct day. Several things can potentially solve this problem. First, the instructions require re-evaluation. In addition, the pilot test of the survey instruments for another shiftwork population could include a hypothetical third-shift day to record. Examination of the pilot test participants' responses to this hypothetical example is a means to evaluate whether or not the revised instructions are effective. Finally, if at least half of the participants in a future pilot test are third shift workers or workers on a relief schedule that includes third shift, then adequate evaluation of these instructions will occur. (OMB regulations limit the pilot test to a total of nine participants.)
- *Separate the question on job type (e.g., trick dispatcher, assistant chief, other) from the one covering work schedule.* Question 5 on the background survey asked "What type of dispatcher job do you currently work?" Possible responses were the following: regular, relief, extra board, assistant chief, other. These categories are not mutually exclusive. For example, a dispatcher could work a regular schedule as an assistant chief. This question should have had the following three responses: trick dispatcher, assistant chief, other. A separate question, under "Your Work Schedule" should have asked, "What type of work schedule do you work?" with the following possible responses: regular first shift, regular second shift, regular third shift, relief, extra board. In spite of this poorly worded question, the researchers were able to effectively categorize each survey respondent's job type and work schedule using the information in the background survey.
- *Include a definition of break and guidance on recording break information*. The survey instructions did not define a break and did not provide any guidance on recording breaks. Based on log book comments, some dispatchers did not record any breaks because they do not get official planned breaks. The intent was to capture any opportunity for the dispatcher to leave his/her desk. The instructions should also specify to record 0 if the dispatcher took no breaks during the shift.

- *Include a question on the background survey that asks, "How many times have you been married?"* Both shiftwork and railroad careers can lead to marital and family difficulties. Railroaders frequently report instances of divorce due to the life style of a railroader. For this reason, an additional question on the number of marriages would be helpful.

4.3 Recommendations for Additional Research

The researchers have developed an effective procedure and methodology for characterizing the work schedules and sleep patterns of railroad workers. Each of the three populations surveyed to date have had some differences, but the researchers used the same basic approach with the signalmen, MOW workers, and dispatchers. Additional studies of other railroad populations using this methodology would provide a more complete picture of work schedule and fatigue issues in the industry. Yardmasters, a group not subject to the limitations of the Hours of Service Law, have job responsibilities similar to a dispatcher and would be a candidate group for such a survey. Pollard (1996) collected data on sleep and work patterns of locomotive engineers using a sample of convenience rather than a random sample. Another survey of engineers would provide a more systematic assessment of these groups. Conductors, who have work schedules similar to those of locomotive engineers, might be surveyed concurrently.

A number of biomathematical models exist for predicting human fatigue and alertness. FRA has sponsored a number of studies to improve and apply the Sleep, Activity, Fatigue, and Task Effectiveness model (SAFTE) to locomotive engineers (Hursh et al., 2004). SAFTE model developers could use the data from the dispatcher survey, as well as the data from the two earlier studies, to further refine this model and predict how the typical railroad worker schedule may be affecting on-the-job alertness. SAFTE also provide a means to examine the potential of alternative work schedules to reduce fatigue and risk of an error.

Further analysis of the dispatcher survey data, as well as that from the signalmen and MOW workers, is possible. Additional analyses might examine the relative likelihood (i.e., odds ratio) of getting less than a minimum amount of sleep, such as 6 h, as a function of shift worked or work period start time and length of the work period. A similar analysis could estimate the likelihood of a workday nap as a function of shift worked. Comparisons across the different craft groups are possible to determine if differences exist between groups covered by the Hours of Service Law and those that are not.

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Appendix A.
Survey Materials

This appendix contains copies of the following survey materials:

- Cover letter to ADTA members from ADTA President
- Instructions to participants on making entries in the Daily Log
- Dispatcher Background Survey
- Dispatcher Daily Log (1 day)

<<Enter date here>>

«Whole_Name»
«Address_1»
«Address_2»
«Location»

Subject: FRA Sponsored Fatigue Study

Dear Sister or Brother:

Fatigue is a major concern in our industry. Staff shortages in many dispatching centers result in working rest days which compromises the dispatcher's quality of life. Rest days are important to recover from the regular work week. The schedule variability of extra-board dispatchers further compromises the dispatcher's opportunity for necessary rest and relaxation.

As you may have read in **The Train Dispatcher,** the Federal Railroad Administration (FRA), along with the cooperation of the American Train Dispatchers Association, is conducting a fatigue study that focuses on dispatchers. You have been randomly selected to participate in this very important scientific study. The results of the study will provide the FRA and the ATDA with a clearer picture of work schedules and sleep patterns of dispatchers. The study will also provide the statistical basis necessary to identify areas for improvements.

You are among a small group of randomly selected ATDA union members nationwide that are being asked to fill out work/sleep diaries for a two-week period.

Your participation in this study involves:

1) completing a brief background survey; and
2) keeping a daily log for 14 consecutive days of your sleep and work times along with self-assessments of your level of alertness five times per day.

To insure that your personal information is completely confidential, the FRA has engaged the services of Foster-Miller for executing the study. The names and personal information of the participants from the sample group will be completely confidential, and the data gathered will only be used to compile the information as a group. After the study's conclusion, all the personal data gathered will be destroyed and only the compiled information will be distributed.

Completing the background survey should take less than 15 minutes; making entries in the daily log should require no more than a total of 10 minutes per day. As a reward for your participation in this study, you will receive a $75 gift certificate to either Home Depot or Sears. *You must provide 14 consecutive days of data and a completed background survey to receive the gift certificate.*

The overall purpose of the study is to develop a better understanding of the work/rest schedules and sleep patterns of dispatchers and to evaluate the relationship between these schedules and fatigue. Your participation is critical to the success of this study. The data will allow us to identify any fatigue-related problems specific to our craft. Once we have the data, we will be able to work toward reducing the risk of fatigue-related accidents and incidents and improving the quality of life for our members. A report concerning this study will be published next year in **The Train Dispatcher.**

Please read the enclosed instructions carefully before beginning your data collection. Thank you for your participation in this important research study.

In Solidarity,

F. L. McCann, President

American Train Dispatchers Association, 1370 Ontario St. , Suite 1040, Cleveland, OH 44113-1736

Survey of Work Schedules and Sleep Patterns of Railroad Dispatchers

Important: Please Read Before Making Entries in Daily Log

Using the Daily Log

The log is divided into 14 sections. Each section contains both a Sleep and Nap Log, and a Work Log.

Start a new section for each new day. On the section divider page, write the date and indicate whether or not you worked this day. Please start with Day 1. Begin your log on the **first day of your next work cycle**. It is important that you provide data for **14 consecutive** days. Do not record data during a vacation period. If you are planning a vacation during this 14-day period, do not begin the log until after the vacation.

Complete the Sleep and Nap Log for every day of the study, not just your workdays. **We need a record of your sleep for all 14 days.** Complete the Work Log for those days that you work.

If for any reason you do not record data at the appointed time, fill out your log as soon as possible to the best of your ability. The study results will not be meaningful without complete diary entries from you.

Record times in the log using the 2400 clock system. For example, 4:30 p.m. is 1630.

Sleep and Nap Log (complete daily)

Make entries on this log **upon awakening** every day. Record the sleep period in the section of the log for the calendar day that you awoke. In addition, if you took any naps, enter this information in the log. If your nighttime sleep is interrupted due to family or other circumstance, record the first segment of your sleep in the "Upon Awakening" section of the Sleep and Nap Log. Use the "Nap 1" section to record subsequent sleep.

If you work third shift, record morning sleep after a work period on the day that the sleep occurs. For example, if you work third shift on Monday and sleep when you return home Tuesday morning, record this sleep period on the Tuesday section of the log.

Explain anything unusual about your sleep in the Comments section.

Please turn over→

Work Log (complete only for workdays)	Make entries on the work log **at the start of your workday when you arrive at your workplace, midway through your shift, and at the end of the workday when you arrive home.** Complete the Work Log for every day that you work. Use the comments section to explain anything unusual about your workday. If you work third shift, enter information about your work period on the calendar day that you *begin* the shift. For example, if you work third shift on Monday, record your work period on the Monday section of the log.
Study Compensation	**You must return a completed background survey and 14 days of sleep and work schedule information to receive the compensation.** You will receive a $75 gift certificate to a retail establishment as compensation for your participation in this study. Complete the last page of the log book to indicate your preference for the study compensation. You should receive your gift certificate within 4 weeks of returning your materials.
Returning Study Materials	Return your Background Survey and Daily Log in the postage paid envelope. If you cannot locate the return envelope, please contact Susan McDonough, smcdonough@foster-miller.com or 781-684-3966, for a replacement.
Questions or Problems?	If you have questions on any aspect of these instructions, are not sure how to report specific work or sleep information, or need additional survey materials, please contact us: Alex Viale 781-684-8444 aviale@foster-miller.com Susan McDonough 781-684-3966 smcdonough@foster-miller.com

ID Number:_____

Railroad Dispatcher Background Survey

The Federal Railroad Administration (FRA) is conducting a study of the work schedules and sleep patterns of railroad dispatchers. The purpose of the study is to develop an understanding of the issue of work schedule-related fatigue of railroad dispatchers. The study results will inform possible future FRA policy and regulatory actions, will assist the railroad industry in addressing any work-schedule related fatigue issues of railroad dispatchers, and, in general, will contribute to overall railroad operational safety.

The data collected from this study will be used primarily for statistical purposes, and is authorized by law (49 U.S.C. 20901). Your participation in this study is completely voluntary. Your personal information will be kept strictly confidential, and will not be disclosed to anyone other than employees and contractors who work on this study.

Public reporting burden for this information collection is estimated to average 15 minutes per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Please note that an agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a valid OMB control number. The OMB control number for this information collection is 2130-0570.

Form FRA 6180.122 (07/05)

About Yourself

1. Age: ____ years
2. Sex: ____ male ____ female
3. How long have you been a dispatcher?
   _____ years and ____ months
4. How long have you been a dispatcher at your current railroad?
   _____ years and ____ months
5. What type of dispatcher job do you currently work?
   ____ regular
   ____ relief
   ____ extraboard
   ____ assistant chief
   ____ other (please explain) _____
   _____
6. What is your marital status?
   ____ single ____ divorced ____ other
   ____ married ____ widowed
7. How many children or other dependents do you have (not including your spouse)? _____
8. How many of your dependents are under the age of 2 years?_____
9. a) Do you drink caffeinated beverages?
   _____ yes _____ no
   b) On average, how many cups and cans of these beverages do you drink per day?_____

Your Health

1. How many times have you marked off sick in the last year? ___ days

2. In general, how would you rate your health? Circle one:

   Excellent Good Fair Poor

3. Some people feel younger or older than their biological age. How old do you feel? ____ years

4. Have you been diagnosed as having a sleep disorder?

   ____ yes ____ no (skip questions 5 and 6)

5. Do you have sleep apnea?

   ____ yes ____ no

6. Are you receiving medical treatment for your condition?

   ____ yes ____ no

Your Work Schedule

1. Please describe your job characteristics using this table. Leave rest days blank. If you work a job that varies from week to week, just write "extraboard" across the table.

	S	M	T	W	Th	F	S
Start time							
End time							

2. On average, how many hours do you work per week? ____

3. Is your position covered by the Hours of Service Law?

   ____ yes ____ no

4. How often do you feel well rested and alert over the course of your work period? Circle one:

   Never Occasionally Frequently Always

5. How often do you feel *mentally* drained at the end of your work period? Circle one:

   Never Occasionally Frequently Always

6. How often do you feel *physically* drained at the end of your work period? Circle one:

   Never Occasionally Frequently Always

Stress at Work

Use the following scale to rate how much each factor below contributes to your stress at work:

No Stress	A Little Stress	Stressful	Very Stressful
1	2	3	4

Please assign a rating to *each* of the following items:

___Responding to emergencies

___Lack of control over work schedule

___Loss of sleep

___Coordination with other departments

___Pressure to finish a task

___Ambiguous operating rules or procedures

___Management policies and decisions

___Job security

___Surges in workload

___Communication problems

___Inadequate staffing

___Responsibility for safety of others

___Lack of break time

___Inadequate time off

___Other (please specify) _____

_____

_____

_____

4

Life Events

Please indicate with a ✓ whether any of the events listed below has occurred to you in the last 6 months:

___Personal illness or injury

___Marital difficulties

___Birth of a child

___Death of a spouse

___Change in sleeping habits

___Difficulty with the law

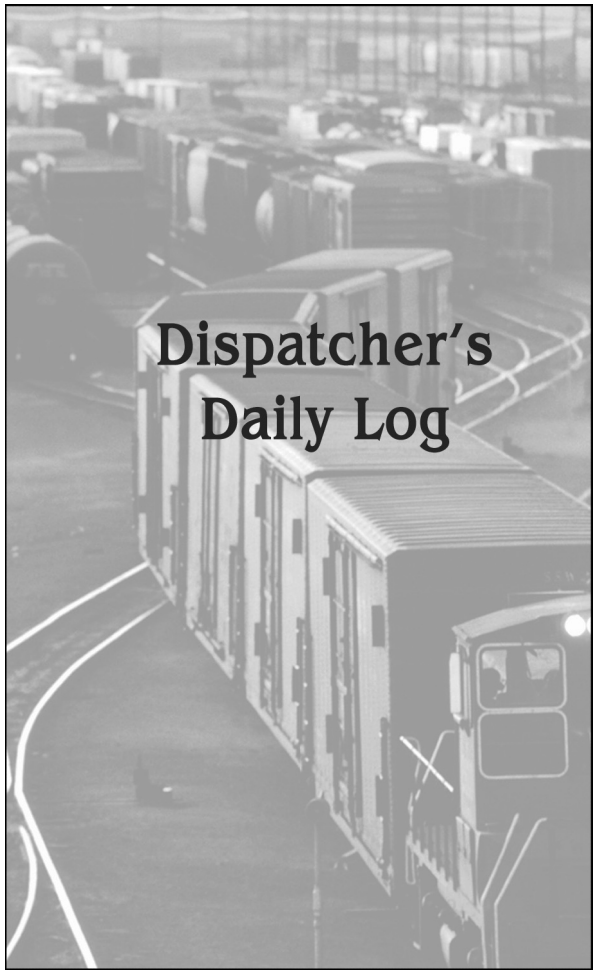
___Illness/injury of family member or friend

___Financial difficulties

___Change in living conditions

___Change in social activities

___Death of a close family member


Dispatcher's
Daily Log

ID Number_____

If you have questions, you can contact:

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FRA F6180.123 (07/05)

Welcome...
and thank you for participating in this project. The purpose of this study is to assemble data on both work and sleep patterns of railroad dispatchers. The data that you record will serve as a history of your work and sleep patterns and how you feel throughout the day. The study will examine the relationship between dispatchers' work schedules and their level of alertness/ fatigue.

Your participation is appreciated. Please contact us if you have any questions or comments.

Instructions

This log is divided into 14 sections, one for each day that you will be recording data. Each section contains both a Sleep and Nap Log and a Work Log.

Start a new section for each new day. On the section divider page, write the date and indicate whether or not you worked this day. Please start with Day 1. It is important that you provide data for 14 *consecutive* days.

When recording time, use the 2400 clock system. For example, 4:30 p.m. is 1630.

Complete the Sleep and Nap Log for *every* day of the study. Complete the Work Log for those days that you work.

If for any reason you do not record data at the appointed time, fill out your log as soon as possible to the best of your ability.

Sleep and Nap Log

Make entries on this log *upon awakening* and *at bedtime* ***every day***. Record your sleep on the day you awoke. In addition, if you took any naps, enter this information in the log. If you work third shift, record sleep after a work period on the day the sleep occurs.

Work Log

Make entries on the work log at the *start of your workday* when you arrive at your workplace, *midway through your shift* and at the *end of the workday* when you arrive home.

If you work third shift, enter information about your work period on the day that you begin your shift.

Study Compensation

Complete the last page of this log book to indicate your preference for the study compensation.

Day 1

Date _____/_____/2006

Today I: ❑ worked

❑ did not work

Sleep and Nap Log

Upon Awakening

Sleep Location

Home ☐ Away from home ☐

Time you went to bed	
Time you fell asleep	
Time you woke up	
Time you got up	
Number of awakenings during the night	

Rate your sleep

Ease of falling asleep

1 2 3 4 5

Very difficult Very easy

Ease of getting up

1 2 3 4 5

Very difficult Very easy

Length of sleep

1 2 3 4 5

Wholly insufficient More than sufficient

Quality of sleep

1 2 3 4 5

Very poor Very good

Indicate how you feel now

1 2 3 4 5

Very sleepy Very alert

Complete if you took any naps, or had subsequent sleep after a nighttime interruption.

Nap 1

Time fell asleep	
Time awoke	

Nap 2

Time fell asleep	
Time awoke	

Comments on today's sleep experience: _____

Work Log

Start of workday

Time you began commute to worksite	
Time you arrived at work	
Time started work	

Indicate how you feel now

1 2 3 4 5

Very sleepy Very alert

Midpoint of shift

Time Now	

Indicate how you feel now

1 2 3 4 5

Very sleepy Very alert

End of workday when you arrive home

Number of breaks today	
Longest break today, if any	min.
Time you completed today's work period	
Time you arrived home	

Indicate how you feel now

1 2 3 4 5

Very sleepy Very alert

Comments on today's work experience: _____

Appendix B.
Supporting Data

This appendix contains detailed data summaries that support the technical analysis in the main sections of this report.

Table B-1. Tukey HSD post hoc test results for health status and work schedule

Work Schedule	2	3	Relief	Extra Board
1	$p = 1.0$	$p = .268$	$p = .988$	$p = .533$
2	--	$p = .324$	$p = .994$	$p = .555$
3	--	--	$p = .645$	$p < .05$
Relief	--	--	--	$p = .337$

Table B-2. Tukey HSD post hoc test results for age and work schedule

Work Schedule	2	3	Relief	Extra Board
1	$p < .05$	$p < .05$	$p < .05$	$p < .05$
2	--	$p = .957$	$p = .989$	$p = .084$
3	--	--	$p = 1.000$	$p = .275$
Relief	--	--	--	$p = .234$

Table B-3. Tukey HSD post hoc test results for years as dispatcher and work schedule

Work Schedule	2	3	Relief	Extra Board
1	$p < .05$	$p < .05$	$p < .05$	$p < .05$
2	--	$p = .985$	$p = .889$	$p < .05$
3	--	--	$p = .993$	$p < .05$
Relief	--	--	--	$p < .05$

Table B-4. Significant Tukey HSD ANOVA and post hoc test results for sources of stress and work schedule

Work Schedule	3	Relief	Extra Board
Lack of control over work schedule $F(4, 435) = 19.07, p < .05$			
1		$p = .0$	$p = .0$
2			$p = .0$
3			$p = .0$
Relief			$p = .0$
Loss of sleep $F(4, 437) = 4.54, p < .05$			
1	$p = .042$		
2	$p = .027$		$p = .039$
Coordination with other departments $F(4, 436) = 6.08, p < .05$			
1		$p = .016$	$p = .0$
2			$p = .018$
3			$p = .013$
Pressure to finish a task $F(4, 437) = 4.88, p < .05$			
1		$p = .041$	$p = .001$
2			$p = .014$
Ambiguous operating rules or procedures $F(4, 437) = 2.94, p < .05$			
1			$p = .016$
2			$p = .033$
Job security $F(4, 437) = 3.40, p < .05$			
1	$p = .017$		$p = .030$
Communication problems $F(4, 437) = 4.04, p < .05$			
1			$p = .004$
2			$p = .011$
Relief			$p = .047$

Work Schedule	3	Relief	Extra Board
Inadequate time off $F(4, 437) = 5.14, p < .05$			
1	$p = .014$	$p = .017$	$p = .002$

Table B-5. Significance tests for sleep ratings by sleep disorder status (workdays)

Sleep Characteristic	ANOVA
Ease of Falling Asleep	$F(2, 438) = .03, p = .967$
Ease of Arising	$F(2, 438) = 1.71, p = .181$
Length of Sleep	$F(2, 438) = 2.38, p = .094$
Quality of Sleep	$F(2, 438) = 2.23, p = .109$

Table B-6. Significance tests for sleep ratings by sleep disorder status (all days)

Sleep Characteristic	ANOVA
Ease of Falling Asleep	$F(2, 438) = .03, p = .968$
Ease of Arising	$F(2, 438) = .62, p = .538$
Length of Sleep	$F(2, 438) = .88, p = .415$
Quality of Sleep	$F(2, 438) = 1.24, p = .290$

Table B-7. Tukey HSD post hoc test results for nap length on workdays by work schedule

Work Schedule	2	3	Relief	Extra Board
1	$p = .931$	$p < .05$	$p < .05$	$p < .05$
2	--	$p < .05$	$p < .05$	$p = .113$
3	--	--	$p = .489$	$p = .132$
Relief	--	--	--	$p = .869$

Table B-8. Tukey HSD post hoc test results for nap length by shift worked

Shift Worked	2	3
1	$p = .770$	$p < .05$
2	--	$p < .05$

Table B-9. Significance tests for alertness ratings by work schedule

Work Schedule	2	3	Relief	Extra Board
1	$\chi^2(2, n = 205) = .27$, $p = .87$	$\chi^2(2, n = 213) = 7.57$, $p < .05$	$\chi^2(2, n = 195) = 4.53$, $p = .10$	$\chi^2(2, n = 166) = 3.79$, $p = .15$
2	--	$\chi^2(2, n = 194) = 9.72$, $p < .05$	$\chi^2(2, n = 176) = 6.25$, $p < .05$	$\chi^2(2, n = 147) = 5.28$, $p = .07$
3	--	--	$\chi^2(2, n = 184) = .55$, $p = .76$	$\chi^2(2, n = 155) = .85$, $p = .65$
Relief	--	--	--	$\chi^2(2, n = 137) = 1.33$, $p = .51$

Table B-10. Significance tests for alertness ratings by sleep disorder status (workdays only)

Time of Rating	ANOVA
Upon Awakening	$F(2, 438) = .82$, $p = .440$
After Commute to Work	$F(2, 438) = 1.42$, $p = .243$
After Lunch	$F(2, 438) = 1.79$, $p = .169$
After Arriving Home	$F(2, 438) = 1.38$, $p = .253$

Appendix C.
Adjustments to the Data

Population Means versus Mean of Individual Means

Some analyses of the daily log data calculated a mean for each survey participant and then the analysis used the individual means. Analysis of the following measures used this method: actual hours worked (for 2 weeks), primary and total sleep by type of day and job schedule, sleep latency by job type and by type of day, and all sleep disorder comparisons. All other analysis of the data from the daily logs pooled the data from all participants without first computing a mean for each individual. For example, the analysis of commute time used the mean of the data for all workdays in the survey data. The researchers used this latter approach where it was desirable to characterize a typical day rather than the individual dispatcher's experience.

Relief Jobs

The schedule for a relief job may require the dispatcher to work different days and/or shifts. Two survey participants held relief jobs that worked the same shift each day but did not work the same desk each day. Since the focus of this study was on work schedules and sleep patterns, the analysis of the survey data treated these two relief jobs as straight shift jobs.

Type of Work Schedule

A few dispatchers held jobs that consisted of some days on a specific shift and the remainder on the extra board. For these jobs, the category for the majority of days determined the type of work schedule for that dispatcher. For example, if the dispatcher worked 3 d on second shift and 2 d on the extra board, then the job was a second shift job for purposes of analysis by work schedule.

Break Time

Since this study sought to determine the extent to which dispatchers are able to take breaks away from their desk, the analysis of break time did not include breaks that occurred while a dispatcher was in a training class, rode a train for territory familiarization, or was in a meeting. Comments in the log books made it possible to identify these situations.

Abbreviations and Acronyms

ACRE	Association of Commuter Rail Employees
ANOVA	analysis of variance
ATDA	American Train Dispatchers Association
d	day
FRA	Federal Railroad Administration
h	hour
HSD	honestly significant difference
in	inch
min	minute
mo	month
MOW	maintenance of way
n/a	not available
NARAP	North American Rail Alertness Partnership
NHIS	National Health Interview Survey
NSF	National Sleep Foundation
OMB	Office of Management and Budget
SAFTE	Sleep, Activity, Fatigue, and Task Effectiveness model
TCU	Transportation Communications International Union
yr	year