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Fatigue Management, Rail Operations Personnel

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Submitted by

One-Jang Jeng, Ph.D.
Research Associate Professor
New Jersey Institute of Technology
Department of Industrial and Manufacturing Engineering
Contact: onejang@gmail.com
&
George Fallat, P.E.
Deputy Director
New Jersey Institute of Technology
National Center for Transportation and Industrial Productivity

NJDOT Research Project Manager

Karl Brodtman

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16. Abstract

NJ TRANSIT maintains an Hours of Service (HOS) database for its rail operations personnel and crew assignments. For this study NJIT has partnered with Circadian Technologies Incorporated (CTI), which has developed a computer model that is capable of being interfaced with the HOS database to estimate fatigue and assign a "fatigue score", which varies from zero (low fatigue) to one hundred (high fatigue). Using the CTI fatigue estimator, "what if" scenarios, i.e. examining schedule parameter changes, can also performed. For example, if the schedule was modified to adjust start and end times, the fatigue estimator is capable of evaluating these changes in terms of fatigue levels.

The goal of this study is the development of recommendations that are practical in terms of reducing fatigue, capable of meeting applicable rules and regulations; addressing management and staff personnel concerns, and meeting current and future demands of NJ TRANSIT's rail passenger customers. Details of our research approach, findings, conclusions and recommendations are detailed in the respective sections of this report. Highlights of the literature review, HOS assessment, survey findings and recommendations are provided in the report.

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Finally, we would like to thank Anand Tharanathan, a Masters Degree candidate, as well as several students who assisted us on this project.

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SUMMARY

New Jersey Transit Corporation (NJ TRANSIT) operates over 1900 buses and 600 trains and serves over 300,000 customers annually. By the end of 2004, the agency reach a record of rail ridership approaching 64 million passenger trips, bus ridership exceeding 150 million passenger trips, and light rail ridership reaching 11.3 million passenger trips. [(1)] As an agency that depends upon the capabilities of both its equipment and operators, the ability to effectively manage operator fatigue is essential.

NJ TRANSIT currently employs a staff of over 1,500 rail operations personnel which consists of locomotive engineers, who operate the trains; conductors, who are responsible for collecting tickets and fares and ensuring passenger safety and yard masters who are responsible for ensuring that the safety and operation of rail equipment is maintained. Efforts to minimize fatigue associated with work schedules are not only essential to NJ TRANSIT's business viability, but is a key concern among the workers and their union representatives.

NJ TRANSIT maintains an Hours of Service (HOS) database for its rail operations personnel and crew assignments. For this study NJIT has partnered with Circadian Technologies Incorporated (CTI), which has developed a computer model that is capable of being interfaced with the HOS database to estimate fatigue and assign a "fatigue score", which varies from zero (low fatigue) to one hundred (high fatigue). Using the CTI fatigue estimator, "what if" scenarios, i.e. examining schedule parameter changes, can also performed. For example, if the schedule was modified to adjust start and end times, the fatigue estimator is capable of evaluating these changes in terms of fatigue levels.

An important goal of the study is the development of recommendations that are practical in terms of reducing fatigue, capable of meeting applicable rules and regulations; addressing management and staff personnel concerns, and meeting current and future demands of NJ TRANSIT's rail passenger customers. Details of our research approach, findings, conclusions and recommendations are detailed in the respective sections of this report. Highlights of the literature review, HOS assessment, survey findings and recommendations are provided below.

Literature Review

The NJIT research team conducted an in-depth literature review, which looks into potential factors that contribute to fatigue related transportation accidents. While a majority of transportation fatigue research focuses on highway operations, these findings also have relevance to rail operations. Some of the major findings are highlighted below:

- Poor driving performance is often associated with early morning to dawn driving, even when drivers are well rested; [2]

- Sleep deficits increase the risk of fatigue related accidents and sleep disorders significantly increase risk of accidents (ibid.);

- Operators have difficulty estimating alertness and sleep quality compared to objective measurements (ibid.);

- Crash risk is dependent upon the time of day during which vehicles are operated. However, research outcomes vary somewhat for fatigue levels related to the number of hours spent on task; [3]

- The length of sleep period prior to performing driving tasks is the most significant factor affecting fatigue. Length of work, period and the nature of tasks performed during the work period are contributing factors to fatigue, but are less significant. (ibid.) ;

- Fatigue effects are greatly exacerbated during low-demand driving episode. [4]

- A person's tendency to fall asleep during normal waking hours increases if they have slept less than 6 hours and also increases across successive days of restricted sleep. [5]

- Night driving and circadian influences together are greatest predictors of fatigue related accidents. (ibid.)

- Sleep shortfalls for night start workers much more likely than for day start shift (ibid.)

- Drivers are poor judges of their own fatigue generally rating themselves more alert. [5]

- Eight hours off between duty periods is not adequate-7.2 hours on average is their ideal sleep time. (ibid.)

- The strongest and most consistent factor influencing fatigue and driver alertness is the time of day. Drowsiness is greater at night. Peak drowsiness occurred during the 8 hours from late evening to dawn. (ibid.)

- Hours of driving (time on task) was not a strong or consistent predictor of observed fatigue. (ibid.)

- The most critical factors in predicting fatigue related accidents are the duration of the most recent sleep period, the amount of sleep in the past 24 hours and split sleep patterns. (ibid.)

The full findings of the literature review are contained in Appendix A, Literature Review.

Existing Hours of Service Assessment

NJ TRANSIT maintains a comprehensive database for scheduling its 1,500 plus rail operations staff. The database was developed and is routinely updated by Timerica Inc. Circadian Technologies, Incorporated (CTI) has developed a computer-based model that is capable of integrating the rail operations personnel and fatigue parameters to develop "fatigue indices". CTI developed the model based on its own research of rail operations personnel as well as a comprehensive body of medical research on circadian rhythm patterns. Schedule features, such as start and end times, days on and days off are entered into the model, which is capable of producing "fatigue indices" for individual operators as well as crew assignments. Fatigue indices range from 1 to 100, with low numerical values representing little fatigue producing effects and higher scores correlating to high fatigue levels. In general, the majority of operator schedules produce scores ranging from 20 to 60. Fatigue indices above 60 may be considered problematic for rail operations personnel.

Fatigue indices were developed for rail operations personnel having regular assignments as well as "Extra Board" assignments. Regular assignments are generally set schedules consisting of four to five consecutive days with two to three days off between work periods. Regular assignment shifts typically run ten consecutive hours during the day, with a set time period off. Extra Board assignments are available and are used when an employee is unable to work and by their nature, are not set and may or may not be filled. Fatigue indices were then calculated for both assignment categories. Some of the key findings are indicated below:

- Fatigue indices both for conductors and engineers were consistently higher for Extra Board assignments as compared to Regular Assignments.

- The percentage of conductors and engineers with high fatigue indices (60 or higher) was nearly double for Extra Board Assignments as compared to Regular Assignments.

- Fatigue for the regular assignment group arises mostly from overnight/early morning schedules.

- High fatigue indices for Extra Board assignments arise from a combination of long working hours, variations in start time, lack of scheduled nights off (sometimes no nights off), and multiple days on.

The full results were presented to NJ TRANSIT executive personnel on January 30, 2003 and are described in the Findings Section of this report.

Rail Operations Personnel Survey Results

To better understand fatigue for NJ TRANSIT rail operations personnel, a survey/questionnaire, consisting of 136 multiple-choice questions and four written questions, was prepared and distributed. The results of the surveys were used to identify and document advantages, disadvantages, suggested schedule and guideline improvements from the point of view of the NJ TRANSIT rail operations staff. Potential survey participants were randomly selected from the current list of 1,546 rail operations personnel. The NJIT research team randomly selected from a group of 100 assistant conductors/conductors and 100 assistant engineers/ locomotive engineers and mailed out a comprehensive survey questionnaire form and response sheet. Survey participants also had the opportunity to provide written comments directly on the survey form.

The NJIT research team worked very closely with NJ TRANSIT rail operations staff as well as union representatives from the United Transportation Union (UTU) and the Brotherhood of Locomotive Engineers (BLE) in developing and administering the survey. It was extremely important that the NJIT research team maintain a high level of confidentiality to ensure that the survey participants felt comfortable responding to the questions. BLE and UTU representatives were also helpful in following up with their respective members to ensure an adequate number of responses were received.

In all, 33 surveys were completed. Respondents also provided written comments to four questions posed at the end of the survey. Some of the key findings of the survey are provided below:

- The majority (61 %) of respondents indicated difficulty in obtaining an adequate amount of sleep.

- Over half of the respondents indicated at least some difficulty in maintaining alertness on the job, and fighting fatigue or drowsiness on the job.

- While 84 % of respondents indicated they required 7 to 8 hours of sleep to be alert and well rested, less than half reported they obtain 7 or more hours of rest.

- More than half (17 of 31) of the respondents indicate they do not use the napping/resting rooms and the majority (21 or 31) rated the quality of these facilities as “poor”. Written responses also suggest that more consistent work shifts, longer break time between trains, better rest facilities and improved working relationships between crew members and upper level management

could help reduce operator fatigue. Lack of job security was also noted as a concern among rail operations personnel.

Recommendations

Based on the results of the literature review, CTI's evaluation of the October 2002 schedule and survey questionnaire responses, several recommendations have been developed and are elaborated upon in the Recommendations of this report: Some of the key recommendations are provided below:

Eliminate split shifts where a night shift is followed by a day shift assignment. Schedule combinations that look at start time changes and number of consecutive hours worked should be examined further, both from fatigue index point of view and from actual reports of operators, to gain the maximum benefit of fatigue reduction.

Reduce the number of hours worked at night. To the extent possible, working long nighttime hours should be limited.

Engage in active discussions to comprehensively examine revamping the Extra Board concept. Extra Board assignments result in the highest fatigue indices and are, according to the body of research, the most fatigue inducing. However, the economic benefits and need to maintain adequate staffing levels when normally scheduled crew members are not available must be balanced with potential safety risks associated with potential fatigue related problems associated with Extra Board assignments. There needs to be an ongoing dialogue among NJ TRANSIT officials and union officials so that an equitable balance between the economic benefits and potential safety risks due to fatigue can be achieved.

INTRODUCTION

Operator fatigue has serious consequences, not only in terms or impaired service, but can lead to serious injury. Operator fatigue has been identified as a probable factor in a number of major crashes and costly incidents, such the crash of a BWI airport subway train, the Exxon Valdez tanker spill and the collision of New York City subway trains on the Williamsburg Bridge. Not surprisingly, rail operator fatigue is a topic that is receiving national attention. In a cover letter submitted along with the Federal Railroad Safety Enhancement Act of 1999 bill to the U. S. House of Representatives and Senate, then-U.S. Department of Transportation Secretary Rodney E. Slater stated that "fatigue hampers the alertness of employees and causes accidents, one of the most pervasive safety issues in the railroad industry" Experts agree that through better fatigue management, these types of serious incidents can be significantly reduced and that the overall level of safety and performance can be improved.

"Fatigue Management Plans" provide scheduling strategies that consider the human body's natural sleep/wake cycles (circadian rhythm) to optimize service and/or production while minimizing costs. According to Mr. Slater, "Carriers may tailor their fatigue management plans to best meet their various operating needs and these plans can be modified as knowledge of the science of fatigue and its practical applications evolves." Under provisions of the Federal Railroad Safety Enhancement Act of 1999 bill, Fatigue Management Plans amend the existing hours of service laws under the current United States Code. These changes are aimed at recognizing and reducing on-the-job fatigue and fatigue-caused accidents and injuries.

NJ TRANSIT is New Jersey's principal bus, rail and light rail commuter transit provider with service extending throughout the entire state and into New York City and Philadelphia. NJ TRANSIT currently operates 12 commuter rail lines and 2 light rail lines totaling nearly one thousand directional route miles with 163 rail and 27 light rail stations (See Figure 1). Rail service alone accommodates approximately 225,000 passenger trips per day. [(1)]

NJ TRANSIT's rail engineers are required to successfully complete a comprehensive training program. In addition, engineers are subject to fitness of duty (FOD) tests and routine drug testing. While fatigue management is an important safety issue for NJ TRANSIT, there are no acceptable methods to quantitatively measure operator fatigue, and testing operators for fatigue is impractical. Therefore, efforts to develop and implement effective fatigue management strategies are essential.

NJ TRANSIT maintains an HOS database for its staff of rail operations personnel and crew assignments. They want to use this database for comparison to HOS determinations using existing fatigue management modeling tools. The guidelines developed out of these efforts must be credible and practical in terms

of reducing fatigue, that comply with rules and regulations, that addresses management and staff personnel concerns and meet current and future demands of NJ TRANSIT's rail passenger customers.

In its continuing efforts to improve safety and reduce the turnover of skilled operating personnel, NJ TRANSIT and the New Jersey Department of Transportation (NJDOT) have initiated a research project to evaluate NJ TRANSIT'S existing Hours of Service (HOS) guidelines. Ultimately, it would be desirable to readily evaluate fatigue associated with proposed crew scheduling scenarios and make adjustments accordingly. From a practical perspective, this could only be accomplished through the use of a computer model that directly interfaces with NJ TRANSIT's existing crew scheduling software. This study represents the first phase of an overall implementation plan to address rail operator fatigue, which includes the development of recommendations to minimize fatigue. As part of this study, NJ TRANSIT has also requested the NJIT research team to prepare a technical scope of services from which a Request for Proposal (RFP) could be prepared. The RFP would enable NJ TRANSIT to solicit bids to develop an interactive fatigue management module that would interface with its existing HOS database.

The first phase of this study includes a comprehensive literature review of research conducted or sponsored by transportation agencies and professional organizations. The second phase consists of examining existing schedule guidelines, evaluating operator fatigue under a current HOS schedule scenario, evaluating operator fatigue under selected modifications to the schedule, and developing recommendations to minimize operator fatigue.

Figure 1. NJ TRANSIT Rail Map

RESEARCH APPROACH

Overview

The research approach provides NJ TRANSIT and NJDOT with a detailed insight and background of ongoing research in fatigue associated with transportation operations. The literature review provides both a general overview of information as to the social, physiological and psychological factors believed to cause fatigue and then specifically addresses fatigue for rail operations personnel.

A comprehensive body of research and literature exists for operator fatigue associated with "long haul" transportation operations, such as rail freight and truck freight operations. The nature of long haul freight operations often requires transportation operators to make one-way trips across several states and even through several regions of the country with relatively few stops. Turn-around times and one-way trip lengths are therefore generally much shorter for NJ TRANSIT's rail operations as compared to typical freight rail operations. Therefore, in examining fatigue for NJ TRANSIT rail operations personnel, appropriate scheduling practices, which have been identified largely for the freight transportation industry, need to be examined within the context of shorter trip lengths and turnaround times.

Circadian Technologies Incorporated (CTI) has developed a comprehensive survey/questionnaire largely geared to evaluate fatigue for its long haul freight rail clients. To better understand rail operator fatigue for NJ TRANSIT, the survey/questionnaire was modified based on input from NJ TRANSIT personnel and union officials who represent NJ TRANSIT's rail operations personnel. The survey was distributed to 200 randomly selected rail operations personnel. The survey consisted of 136 multiple-choice questions. Survey participants were also given the opportunity to provide written responses to general questions concerning fatigue. Survey results were then gathered and tabulated.

The results of the survey were used to verify CTI's quantitative assessment of a selected crew schedule. The assessment uses a computer-based model that integrates a comprehensive body of fatigue research and data. The model is capable of being interfaced with NJ TRANSIT's crew scheduling database and provides a numerical "fatigue score" for the crew assignments both individually and collectively. The results of the assessment and the results of the survey were discussed (see p. 29).

CTI produced a series of fatigue indices for the crew assignments for a specific time period. However, NJ TRANSIT desires to develop an interactive module that would interface directly with the crew scheduling software and evaluate fatigue with changing crew assignments. Such a tool would have to be developed and maintained by outside contractors. Therefore, the study also

includes a technical Scope of Services from which a Request for Proposal could be prepared and sent to outside vendors.

Finally, the research project includes several recommendations for minimizing operator fatigue while simultaneously maintaining crew assignments that are realistic, implementable and meet applicable guidelines. Following the initial evaluation of the selected crew assignment schedule, CTI performed a series of "what-if" scenarios by modifying selected schedule attributes such as start and end time and the number of contiguous days on. These efforts, the results of the survey and the close collaboration with NJ TRANSIT personnel provided the basis for our recommendations.

Details of the research approach for the various phases of the study are provided below.

Literature Review

The research approach for the literature review was conducted in two phases. Phase I included a general investigation of shiftwork ergonomics and health related issues. The literature search considers the areas of rail fatigue management, fatigue management models, HOS determination for rail operations personnel and for rail transit operations. The NJIT research team also examines existing and proposed operator regulations that pertain to NJ TRANSIT rail operations, such as the NJ TRANSIT rail operators union, Federal Railroad Administration (FRA), Federal Railroad Safety Enhancement Act and Northeast Operating Rules Advisory Council (NORAC).

The NJIT research team presented and discussed the results of the literature review with NJ TRANSIT senior executive personnel on January 30, 2003.

Fatigue Assessment

CTI has developed a computer based fatigue estimator model that assimilates a comprehensive body of medical research in the area of fatigue and human circadian rhythm patterns along with CTI's own data gathering activities. The model interfaces directly with crew scheduling database software, including the Timera software package used by NJ TRANSIT. Various crew schedule parameters, such as start and end times, days off and consecutive days worked provide inputs to CTI's fatigue estimator model. Outputs of the model include fatigue "scores", which range from zero (no fatigue-causing effects) to one hundred (high fatigue causing effects).

NJ TRANSIT's current HOS database develops schedules for its current staff of 1,546 rail operations personnel and is made up of the following job categories:

- 1096 Assistant Conductors/Conductors.
- 436 Assistant Engineers/Locomotive Engineers.
- 14 Yard Masters.

Job functions of assistant engineer/locomotive engineer personnel include operating the trains while assistant conductors/conductors check tickets, collect fares and ensure the safe ingress and egress of passengers. Yard Masters are responsible for the maintenance of equipment and trackage. Output from the HOS database includes a series of "assignments", which specify the route, start and end times and on/off duty times. New assignment schedules are generated when changes in train schedules and/or changes in personnel occur. Since each assignment must maintain a set number of persons per crew, there are provisions for employees, not normally assigned to a crew, to fill for a scheduled crewmember who may be on scheduled leave or is unable to report to duty. These assignments are termed "Extra Board" assignments.

The CTI model calculated fatigue indices for individual workers, grouping employees into their trade and whether they worked on the regular or Extra Board. Fatigue levels for "regular" assignments were evaluated based on NJ TRANSIT's October 27, 2002 crew assignment schedule. The information for each assignment was converted into the on-duty time for a week period. Each assignment was then repeated for four weeks to demonstrate any cumulative effects. Based on each assignment, the average fatigue indices were plotted. The histogram shows the distribution of employees and respective each fatigue indices for the schedule.

The following schedule parameters were used in evaluating the fatigue indices:

- Shift Start Time.
- Shift End Time.
- Shift Duration.
- Time Off Between Shifts.
- Time Off Between Shift Starts.
- Consecutive Scheduled Days On (Day on is a day with a shift start).
- Consecutive Scheduled Days Off (Day off is a day without a shift start).
- Consecutive Nights Off Between Shift Blocks (Night Off is defined as an 8-hour period without work between 10 pm and 8 am).

Low fatigue indices range from 0-30, average fatigue indices range from 31-60 and high fatigue indices from 61 to 100. The individual data were combined to analyze the average fatigue levels and the distribution of fatigue indices by job type, station terminal and overall.

Fatigue levels were also evaluated for "Extra Board" assignments. The analysis extracted information for each individual and was then converted into the on-duty time for the month of November. Based on the each assignment, average fatigue indices were calculated.

In addition to estimating fatigue indices for each crew assignment, the following analyses were performed:

- Evaluation of operational parameters (e.g., number of working hours per day, per week, number of consecutive days ‘on’ versus days ‘off’, etc.)
- Evaluation of general fatigue level, and rule violations, accidents, claims, etc. recorded in the HOS database if available.
- Identification of operational and bio-psychosocial weaknesses in the current system, (e.g. variations of shift start and end times, back/forward transitions of shift starts and shifts ends, per week, number of consecutive days ‘on’ versus days ‘off’, identify bad transitions between days ‘on’ and days ‘off’ and vice versa, etc.). The definition and identification of those weaknesses is derived from published research which is not be included in this report.

Results of these analyses are contained in the Results section and in Appendix B of this report.

Operator Survey/Questionnaire

The CTI fatigue estimator assimilates an extensive database of information collected from rail operations personnel as well as a comprehensive body of medical research. The purpose of the operator survey/questionnaire is to gain input specifically on NJ TRANSIT’s rail operations personnel and also to verify the results of CTI’s fatigue assessment which is solely based on specific schedules of NJ TRANSIT rail operations personnel.

CTI has developed a standard survey/questionnaire for gathering information from rail operations personnel. This survey has been used previously for freight and transit operations in North America. CTI’s survey/questionnaire was modified to gather input specific to NJ TRANSIT’s rail operations personnel. For example, it was necessary to include conductors and assistant conductors on the form. However, the vast majority of questions developed by CTI were not altered. The NJIT research team also solicited input from NJ TRANSIT personnel as well as the two rail operator unions, the Brotherhood of Locomotive Engineers (BLE) and the United Transportation Union (UTU) in tailoring the survey. The two unions also notified and encouraged their members to participate in the survey.

The survey form used in this project consists of 136 multiple-choice questions and addresses several areas previously being identified known to affect fatigue. There was also a section at the end of the survey where participants could include written comments. For the multiple choice section of the survey, participants were asked to mark their responses on a separate one-page form, which could then be automatically summarized. It would not have been practical to attempt to solicit responses from all 1,546 rail operations personnel. But in

order to ensure that there was an adequate sample size and cross section of potential respondents, 200 names were randomly selected from the full list of 1,546 rail operations personnel provided to NJIT. Surveys were sent out to100 UTU members and 100 BLE members. A return address, postage paid envelope was enclosed with the survey package.

Of the 200 surveys sent out, five surveys were returned to the NJIT research team due to inaccurate mailing addresses, 33 were completed and returned resulting in a response rate of 17 %. The survey findings are summarized and are discussed in the Results section of this report.

Development of Recommendations

Findings from the Literature Review, CTI's fatigue assessment and results of the survey provided the basis for developing recommendations for reducing fatigue for NJ TRANSIT's rail operations personnel. CTI also performed a series of "What if" scenarios on the October, 2002 crew assignment schedule, which was also selected for assessing fatigue, to determine potential impacts of modifying selected schedule parameters. Specifically, CTI examined the following:

- **Large number of consecutive days**: the effect of imposing a limit on the number of days that can be worked in a row - especially if the work is carried out in the early morning, evening or night (mostly Extra Board)
- **Repeated night work**: the effect of using a rotating schedule instead of fixed - e.g. rotate some of the people working days to working nights and vice versa.
- **Long hours per week**: the effect of placing a limit on the number of hours worked, especially in the evening or night
- **Wide variations in start time**: the effect of leveling out the start times (mostly Extra Board).

Various modifications and their impact to fatigue indices were examined. In some cases, several changes that address a single issue were examined. For example, three different schedule alterations were examined to reduce fatigue effects associated with long working hours. The results of these changes are included in the Findings section of this report. Performing what-if scenarios also provided an important basis for developing recommendations.

Prepare a Technical Scope of Services

As part of this study, CTI developed fatigue indices for a specific crew assignment schedule (October 27, 2002). In the future, NJ TRANSIT desires to initiate a subsequent phase to this study that would enable fatigue to be evaluated with changes in their crew assignment HOS database. Implementation of this concept would enable fatigue to be minimized while

simultaneously producing crew schedules that are realistic and practical. However, for such a system to be implemented, it is likely that NJ TRANSIT would need to employ the services of an outside contractor. Accordingly, NJ TRANSIT has included as part of the scope of work under this study the preparation of a technical Scope of Services which could be incorporated into a Request for Proposal (RFP) for future implementation of a fatigue estimator model that would interface directly with NJ TRANSIT current HOS crew assignment scheduling software.

RESULTS

This section of the report includes a summary CTI's fatigue assessment of a selected crew assignment schedule, key findings from the literature review, results of the survey questionnaire and results of the "What-if" scenario evaluation. The findings are summarized in each of these areas in the sections below.

Fatigue Assessment

NJ TRANSIT selected the October 27, 2002 crew assignment schedule as the case study for determining fatigue indices. Scores were determined for 290 Conductor Assignments, 260 Engineer Assignments and 112 Extra Board personnel. The analysis examines regular assignments and Extra Board assignments and looks at the engineer and conductor job categories both separately and overall. A full summary and assessment is contained in CTI's Fatigue Assessment Report, which is provided in Appendix B. Some key highlights of CTI Fatigue Assessment Report including the distribution of fatigue indices for engineers and conductors for both regular assignments and Extra Board assignments are discussed below.

Regular Assignments

Regular assignments are consistently scheduled work periods with established start and end times. From their analysis of the data, CTI was able to define regular assignments as having the following characteristics:

- Regular assignments have shift start times that occur between 4 am and 7 am and between 1 pm and 5 pm. Most shifts last between 9 and 11 hours, with some lasting 13 hours (presumably in utilizing a split shift arrangement - time during split shifts was counted as on-duty for the purposes of the fatigue assessment).

- All assignments (excluding Z assignments) are a consecutive block of 5 days with 2 off.

- All assignments had at least 2 consecutive nights off, with a night off defined as a period of time off between 10pm and 8am the next morning.

Fatigue indices and the frequency associated with each job category are provided in the following figures. Mean fatigue indices, which are noted on the figures, for NJ TRANSIT's Regular Assignment rail operations personnel are generally consistent with other studies conducted by CTI for other transportation operators.

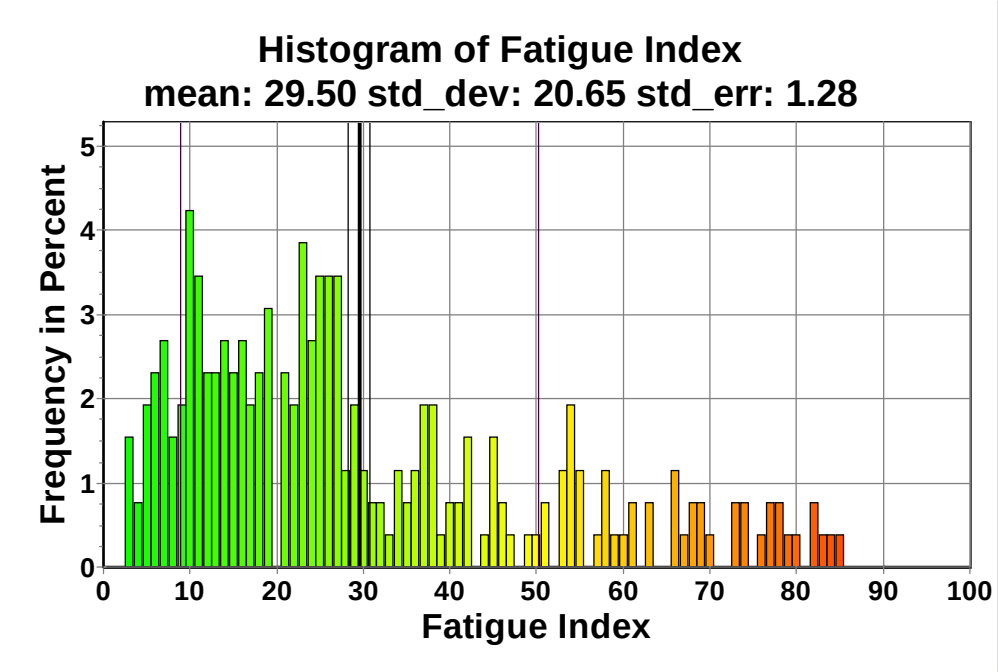


Figure 2. Engineers with Regular Assignments

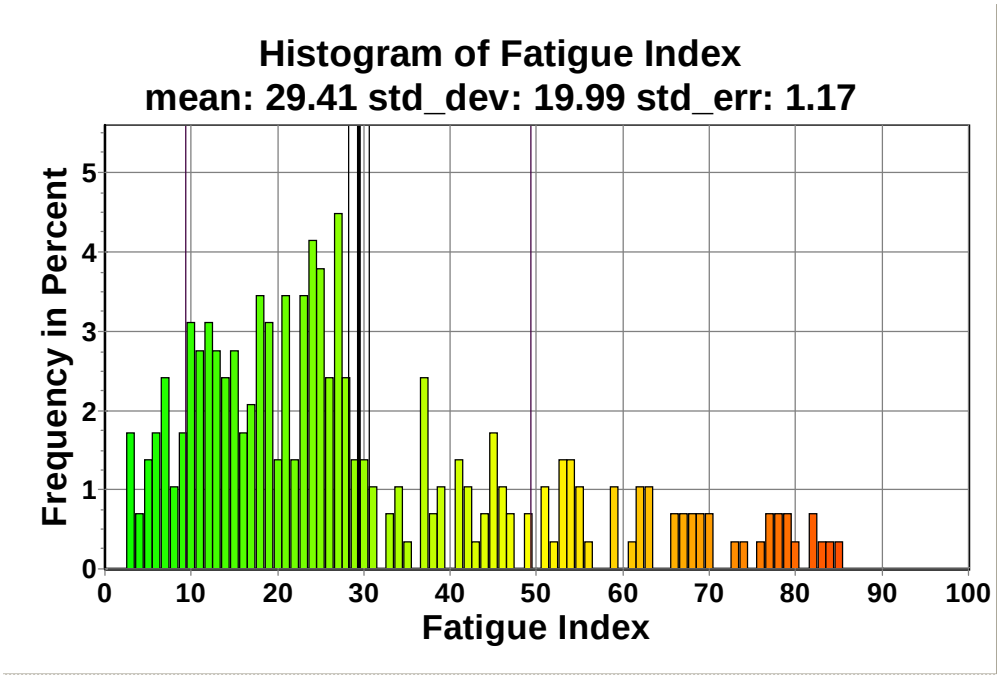


Figure 3. Conductors with Regular Assignments

Extra Board Assignments:

When a crewmember is absent or is unable to work, it is essential that substitute personnel be available to fulfill the absentee's duties and responsibilities. Therefore, NJ TRANSIT maintains an "Extra Board". The provision for Extra Board assignments not only provides a back up in the event a crewmember is absent, but also provides an opportunity for rail operations personnel to earn additional compensation.

By their very nature, Extra Board assignments are much less predictable than regular assignments in terms of typical schedule parameters and potentially have an adverse effect on individuals who take on these assignments. In terms of fatigue, working an Extra Board assignment will likely infringe on rest periods normally associated with regular assignments. Therefore, CTI evaluated the same scheduling parameters for Extra Board Assignments that were examined for Regular Assignments and their impact on fatigue for both the engineer and conductor job categories. The distribution of fatigue indices by job category is provided below.

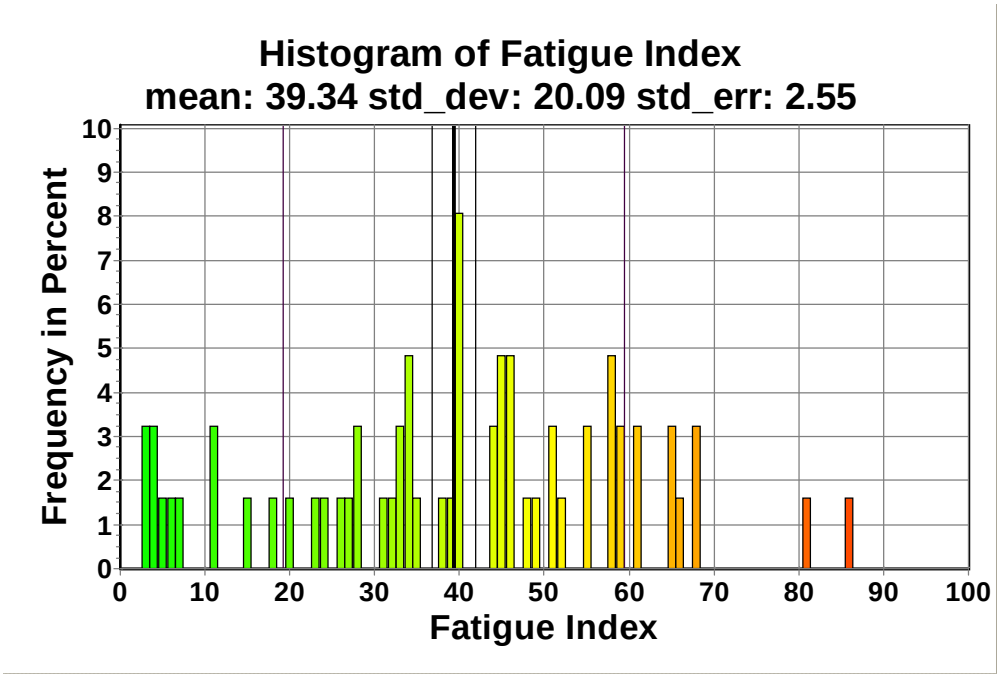


Figure 4. Extra Board Assignments for Engineers

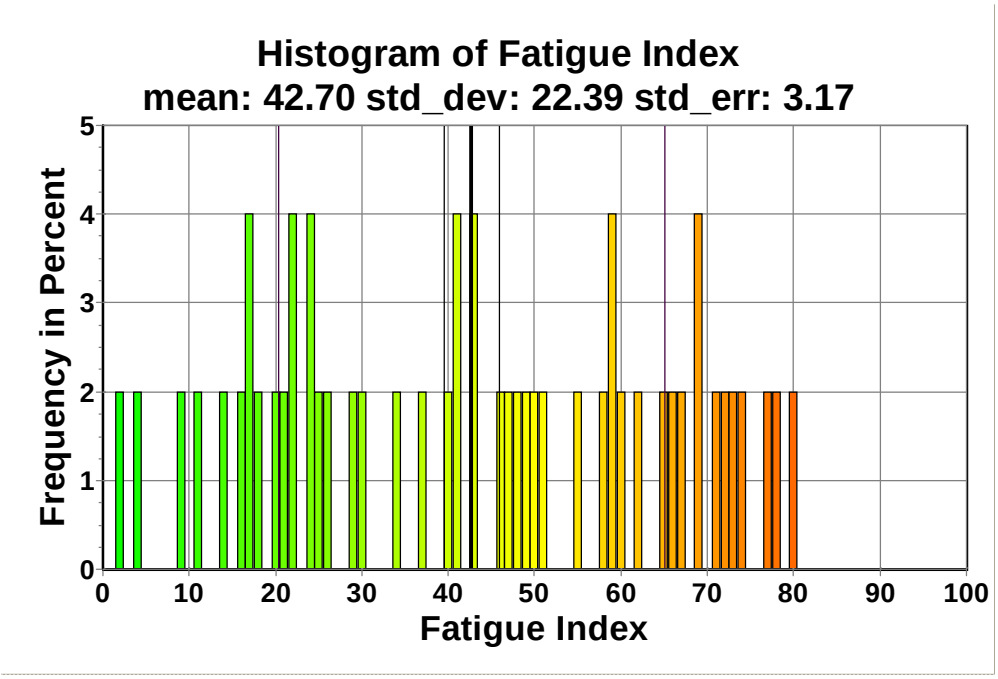


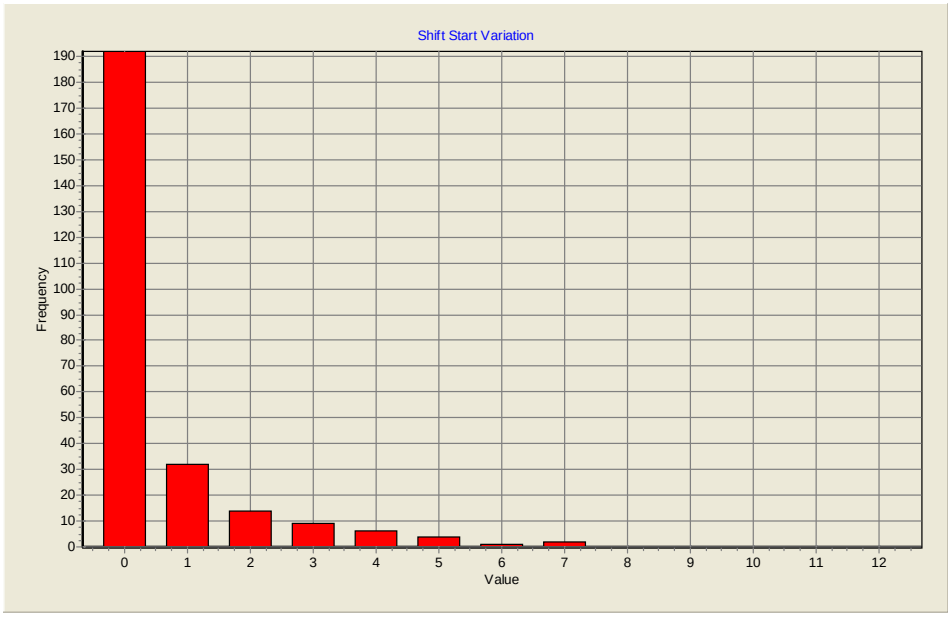
Figure 5. Extra Board Assignments for Conductors

It is noted that the mean fatigue score for Extra Board personnel in both job categories is much greater than scores for regular assignments, and there is a higher proportion of employees with high fatigue indices. Furthermore, there is a much greater "spread" or standard deviation associated with Extra Board Assignments. Hence, there is a greater potential for employees taking on Extra Board assignments to experience a high level of fatigue.

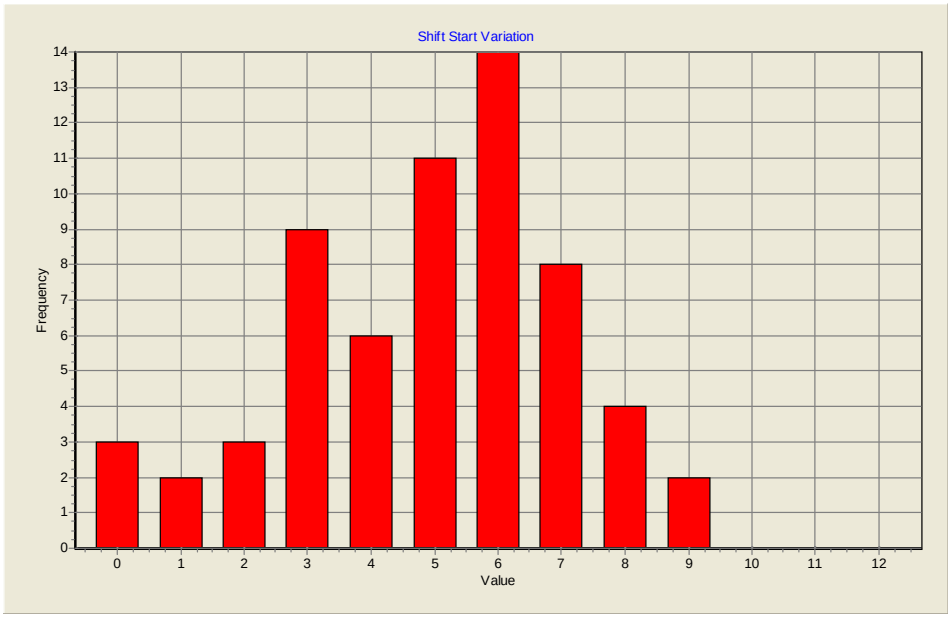
Variations in Shift Start Times

Research in the area of circadian rhythm patterns and the effects of specific schedule features has found that variation in shift start times can significantly impact fatigue. Therefore, variations in shift start times were examined for engineer and conductor job categories. The analysis examines the variation in shift start times over the month. A numerical value of 12 is the worst and represents a constant switching of schedules from night to day, or morning to evening. A value of 0 is the best – no switching – a constant start time. The results of the analysis are depicted in Figure 6.

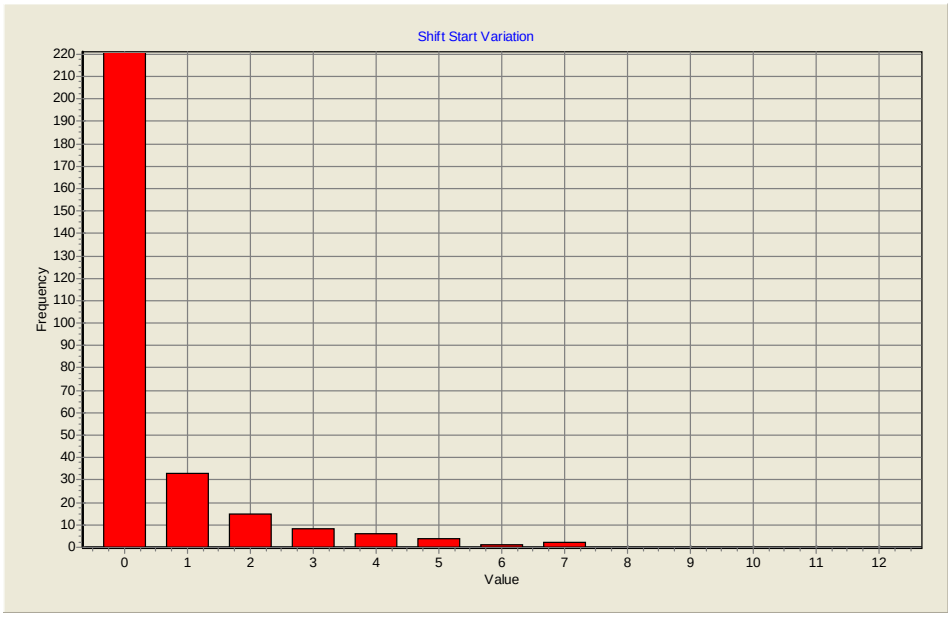
A (1) Engineers – Regular Assignments



A (2) Engineers – Extra Board



B (1) Conductors-Regular Assignment



B (2) Conductors –Extra Board

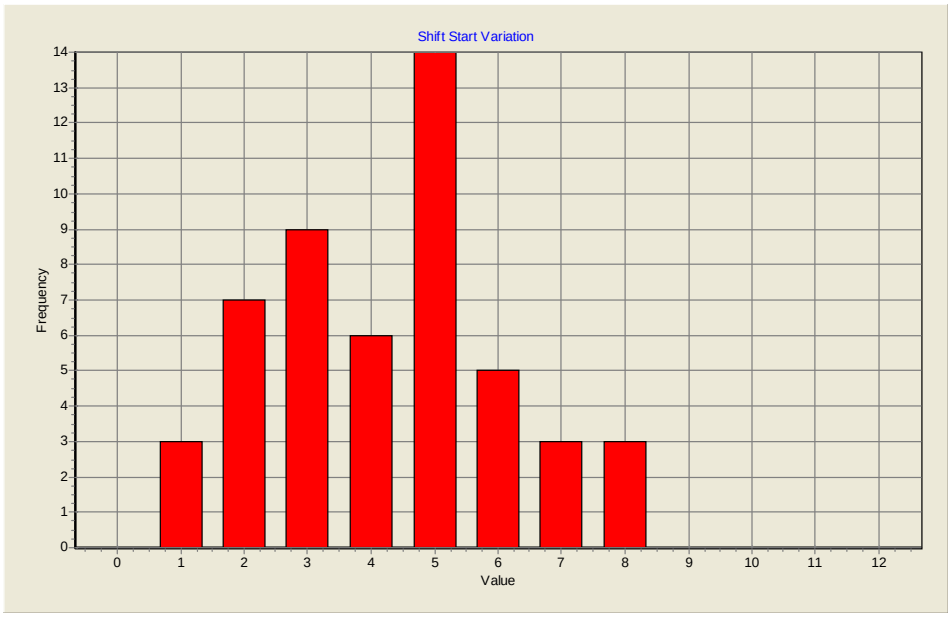


Figure 6. Shift Start Times by Assignment and Job Category:
A (1) Engineers – Regular Assignments,
A (2) Engineers – Extra Board
B (1) Conductors-Regular Assignment
B (2) Conductors –Extra Board

Based on the analysis, shift start times were found to be highly consistent for regular assignments and much less consistent for Extra Board assignments in both job categories. These findings are also consistent with the lower fatigue

indices for regular assignments for all job categories. Other key findings of the Fatigue Evaluation are highlighted below:

Regular Assignments:

- The average fatigue score for conductors (all terminals) was 29.4.
- The average fatigue score for engineers (all terminals) was 29.5.
- The percentage of conductors and engineers with low fatigue indices (30 or lower) was 65.8%.
- The percentage of conductors and engineers with high fatigue indices (60 or higher) was 11.1%.

Extra Board

- The average fatigue score for Extra Board conductors was (all terminals) was 42.7.
- The average fatigue score for Extra Board engineers was (all terminals) was 39.3.
- The percentage of conductors and engineers with low fatigue indices (30 or lower) was 33%.
- The percentage of conductors and engineers with high fatigue indices (60 or higher) was 19.6%.
- Fatigue in regular assignment group arises mostly from overnight/early morning schedules.
- Fatigue in Extra Board likely arises from long work hours, variations in start time, lack of scheduled nights off (sometimes no nights off), and multiple days on.

Overall, it was found that fatigue in the regular assignment group arises mostly from overnight/early morning schedules and fatigue in Extra Board likely arises from long work hours, variations in start time, lack of scheduled nights off (sometimes no nights off), and multiple days on.

Operator Survey

The results of the operator surveys were used to identify and document advantages, disadvantages, and suggested schedule and guideline improvements from the point of view of the NJ TRANSIT rail operations staff. Potential survey participants were randomly selected from the current list of 1,546 rail operations personnel. The NJIT research team randomly selected from a group of 100 assistant conductors/conductors and 100 assistant engineers/locomotive engineers and mailed out a comprehensive survey questionnaire form and response sheet. Survey participants also had the opportunity to provide written comments directly on the survey form.

The NJIT research team worked very closely with NJ TRANSIT rail operations staff as well as union representatives from the United Transportation Union (UTU) and the Brotherhood of Locomotive Engineers (BLE) in developing and administering the survey. It was extremely important that the NJIT research team maintain a high level of confidentiality to ensure that the survey participants felt comfortable responding to the questions. BLE and UTU representatives were also helpful in following up with their respective members to ensure an adequate number of responses were received.

The final survey consisted of 136 multiple-choice questions and was divided into three basic sections. The first part of the survey seeks specific personal and job-related information such as age, gender, job title and number of years on the job. The second part asks respondents to provide personal information in a number of different areas, including health issues, sleeping habits, off-duty activities as well as their personal assessment of sleep. Some questions applied a rating system where respondents were asked to rank difficulty or importance to a specific question. For example, one question asks, "How difficult is it to get an adequate level of sleep?" Respondents are then asked to mark "A" for "Very Difficult", "B" for "Difficult", "C" for "Somewhat Difficult" and so on. Other questions ask more objective questions. The third part of the survey provides an opportunity for respondents to provide written responses to somewhat open-ended questions. A copy of the survey form is provided in Appendix C.

Of the 200 surveys sent out, 5 were returned to senders due to inaccurate mailing addresses, and a total of 31 surveys were completed and returned. Although the response rate of approximately 16 per cent is somewhat disappointing, the surveys provide some interesting insights and findings. Nearly half of the respondents who completed the surveys also provided written comments to four questions posed at the end of the survey.

Some of the survey results are highlighted below:

- The average age of the respondents is 42.7 years;
- There were 25 males and 5 females who responded (the gender for 1 respondent is unknown).
- In all, 13 respondents were conductors and 18 were locomotive engineers.
- Approximately one-third of the respondents are on the Extra Board list. Among them, 6 were called 1-2 times, 2 were called 3-4 times, and one was called 7 or 8 times in the last month.

Other key findings are provided below.

Multiple Choice Response Section

Participants were asked to rate their ability to get a sufficient quantity of sleep. 28% of the respondents indicated “very difficult”, 33% “difficult”, and 23% “sometimes difficult”.

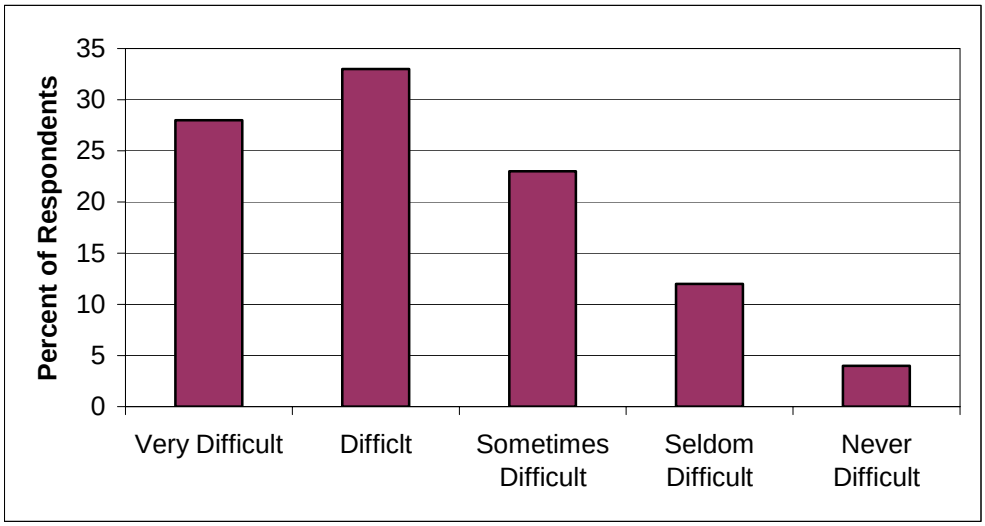


Figure 7. Getting Sufficient Quantity of Sleep

Results were somewhat similar for getting a good quality of sleep: 33% indicated “very difficult”; 23% “difficult” and 28% “sometimes difficult.”

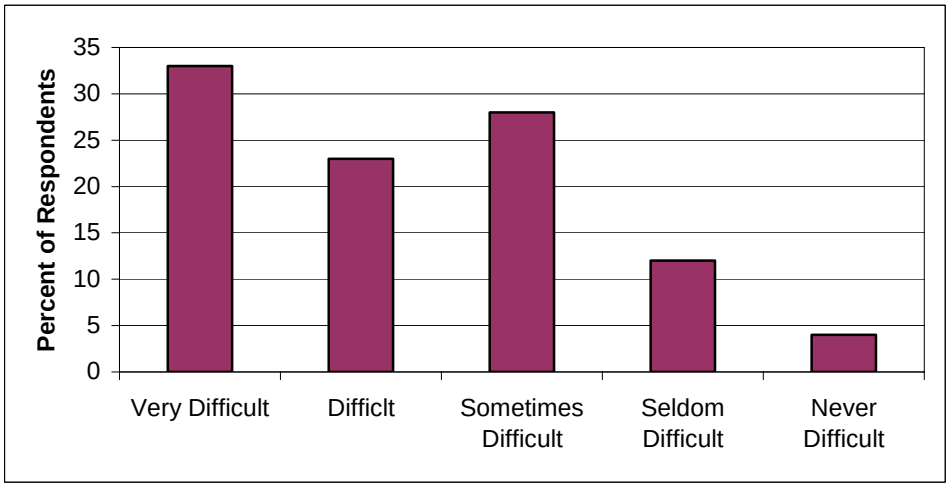


Figure 8. Getting Sufficient Quality of Sleep

Locomotive engineers and conductors reported that it was “very difficult” (9%), “often difficult” (13%), or “sometimes difficult” (50%) fighting fatigue or drowsiness on the job.

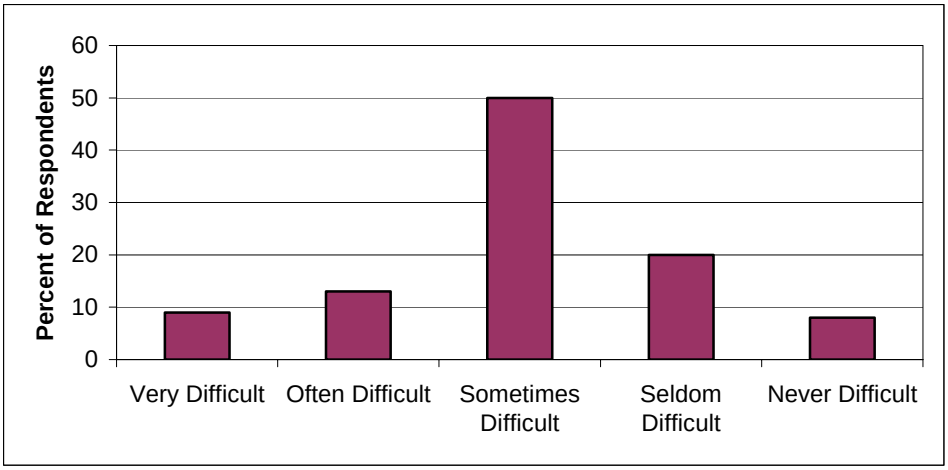


Figure 9. Difficulty Fighting Fatigue on the Job

The majority of respondents (84%) felt that they needed about 7 to 8 hours of sleep to be alert and well rested. However, for day shift workers: 15 % indicated they have less than 5 hr. of sleep, 46% have 5-6 hr. of sleep, 27% have 7 hr. of sleep, 8% have 8 hr. of sleep, and 4% had over 8 hr. of sleep. For night shift workers, 22% indicated they have less than 5 hr. of sleep, 39% have 5-6 hr. of sleep, 22% have 7 hr. of sleep, 6% have 8 hr. of sleep, and 11% have over 8 hr. of sleep.

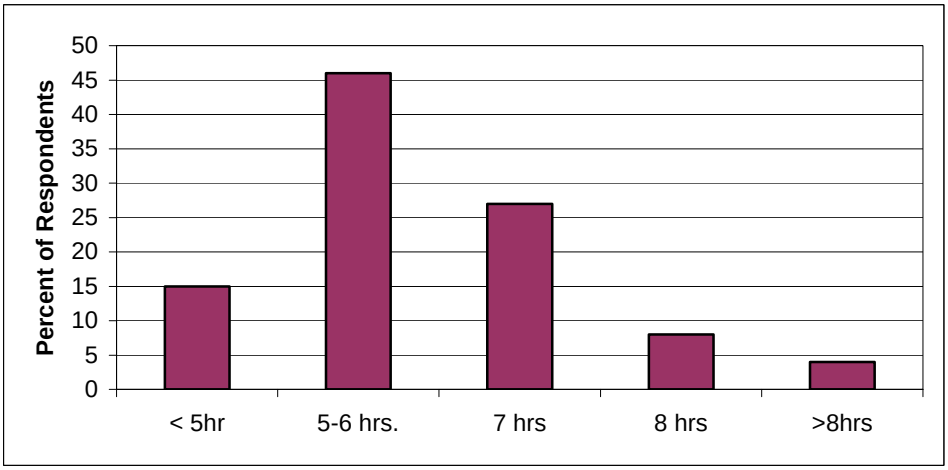


Figure 10. Reported Number of Hours of Sleep for Day Shift Workers

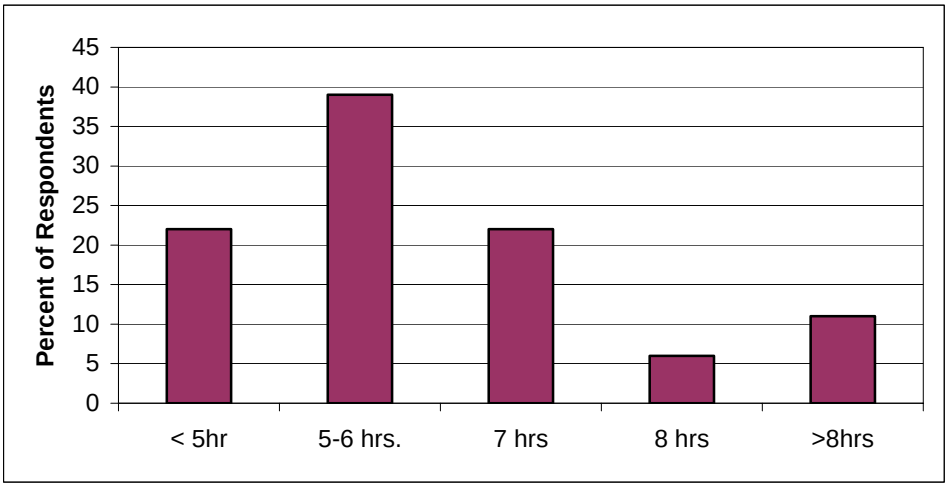


Figure 11. Reported Number of Hours of Sleep for Night Shift Workers

For the number of consecutive days worked when respondents felt most fatigued, 20 % responded they felt most fatigued on the fourth consecutive day and 47 % felt most fatigued on the fifth consecutive day.

Respondents were asked about the “napping” or “resting“ rooms. More than half (17 of 31) do not use the napping/resting rooms and the majority (21 or 31) rated the quality of these facilities as “poor”. No further information was provided from the survey respondents why they had those facilities received such poor ratings.

A full summary of multiple-choice responses is contained in Appendix C.

Written Response Section

Survey respondents were asked to provide written comments to the four questions included at the end of the multiple-choice section. The essay questions along with a summary of responses are provided below.

1. What do you find is the most fatiguing aspect of your job and what jobs do you find most difficult?

Several responses directly related to working hours, including inconsistent work shift, inadequate break time between trains (short “turns”), and shifts that begin early in the morning and end late in the day (split shifts). Other comments pertained to actual working conditions, including poor equipment conditions, stress from management and co-workers and poor rest facilities.

2. What measures do you think would be most likely to improve the overall alertness of the train crews?

Responses were somewhat similar to those provided in Question 1. They included more consistent work shifts, in terms of both starting and ending time of shifts, and increased rest periods between trains. Several also suggested uninterrupted work periods.

3. What methods do you currently use to help you reduce your fatigue and increase alertness?

Respondents provided a number of suggestions both on and off the job. Some respondents indicated they use caffeine and nicotine and take short naps on their breaks to help them stay awake and alert on the job. One respondent also indicated staying focused on job responsibilities helped them to stay alert. Other suggestions included exercise, maintaining a balanced life and getting an adequate nights' sleep.

4. Is there any other important information that you wish to share with us relative to your personal preferences, problems, or recommendations regarding working on the trains?

Responses to Question 4 varied considerably. However, transit security and dealing with the public was consistently raised as a matter of concern among the respondents. Other comments included the need to provide cleaner windows and crew cabs, standard cab controls and better rest facilities. In general, it was suggested from the written comments of the survey results that work environment may need to be improved.

What-If Scenarios

As indicated above, CTI identified a number of schedule features that negatively impact fatigue. Throughout the body of general literature and research concerning operator fatigue, there are a number of schedule features known to induce fatigue. For the "what-if" case study evaluation, it is hypothesized that the majority of the severe fatigue problems were caused by four possible scenarios:

1. Large number of consecutive days with assignment times that affect sleep
2. Repeated night work
3. Long hours per week
4. Wide variations in start time affecting length of sleep

In order to qualify and quantify the validity of the four scenarios, CTI evaluated schedule modifications that focus on altering these parameters and determining their impact on reducing fatigue for engineers and conductors. A cross-section of employees for whom the initial fatigue assessment showed high scores was

selected. Fatigue modeling was carried out on their assignments to determine the impacts of implementing various what-if scenarios.

Potential causes for high fatigue indices and CTI's proposed modifications to specific parameters are indicated below:

1. **Large number of consecutive days:** Examine the effect of imposing a limit on the number of days that can be worked in a row - especially if the work is carried out in the early morning, evening or night (mostly Extra Board).

2. **Repeated night work:** Examine the effect of using a rotating schedule instead of fixed - e.g. rotate some of the people working days to working nights and vice versa (mostly yard work).

3. **Long hours per week:** Examine placing a limit on the number of hours worked, especially in the evening or night.

4. **Wide variations in start time affecting length of sleep:** Examine leveling out the start times (mostly Extra Board).

The first scenario examines the impact of too many consecutive days worked. For example, in one case an employee was found to work 25 out of 27 days. Since lack of recuperation generally leads to fatigue, the fatigue index for this employee was 77.5. By instituting a modification that would require 2 days off in every 7-day block, the fatigue index drops to 61. This is a significant reduction in fatigue, especially for those who work variable and night shift schedules. Impacts associated with modifications to address repeated night work were examined in the second scenario. In one instance, an employee was found to consistently work night shifts with a resulting fatigue index of 77.4. CTI proposed to modify the schedule so that every other week the employee would work a similar shift length for day hours. Again, the results were significant, reducing the fatigue index to 64.0

The third scenario examines the impacts of long work hours. Long hours alone do not necessarily lead to fatigue. For example, 64 hours per week worked on average, resulted in a fatigue index of 25.8, which is considered low fatigue inducing. Furthermore, long hours worked in the day only, with little variation in start time may not be fatigue inducing. However, when long hours are combined with night/evening shifts and changes in start times, fatigue occurs. For example, 76 hours per week worked on average combined with night/evening shifts, resulted in a fatigue index 77.6, which is well into "red zone", i.e. high fatigue.

Three different schedule alterations were examined to reduce fatigue effects associated with long working hours combined with evening shift work and changes in start times. The first alteration simply removed a day per week. This resulted in a slight improvement to the fatigue index, reducing it to 69.4. The

second modification removed a night shift a week. However, the fatigue index only drops to 69.2.

A third modification removed some of the night shifts that are causing high levels of fatigue, resulting in a significant reduction of the fatigue index to 58.6. While the large decrease in the fatigue index indicates that using software based rules developed by CTI work well, this alteration may actually be difficult to implement as the future work schedule of the Extra Board is unknown.

In general, it was found that high fatigue is being caused when a day or afternoon shift is followed by a 4-6 hour break, than an evening/night shift. Adding a minimum recovery time between shifts would help to alleviate fatigue, particularly for those on the Extra Board.

The fourth scenario looked at the effects of variable start times. CTI's fatigue estimator does not use start time variation as a determinant of fatigue. Therefore, even though start times may vary, fatigue indices would only be affected if night/early start times were reduced. However, wide variations in start times in conjunction with night/early start times resulted in a fatigue index of 71.3 for one individual modeled. Decreasing the variation in start time (with the same approximate length of shifts) resulted in a significant reduction in the fatigue index to 44.5. However, it is noted that this dramatic reduction is largely a result of increasing nighttime sleep, and removing afternoon followed by night shifts (as per the third scenario). Decreasing the variation in start time, again with the same approximate length of shifts, but making more shifts begin at night actually increased the fatigue index to 82.1. Therefore, reductions in shift start variation may help, but an increase in poorly planned night shifts could increase fatigue indices.

CONCLUSIONS

CTI's fatigue assessment of selected operator schedules, the impact of schedule modifications on operator fatigue and a comprehensive survey of NJ TRANSIT's rail operations personnel provided the basis for several interesting conclusions, which are described in detail below.

Existing Schedules

Overall, schedules for NJ TRANSIT's rail operations personnel were not found to be significantly fatigue inducing for regularly scheduled assignments as compared to fatigue indices for other rail operations personnel. For example, the mean fatigue index for NJ TRANSIT's engineers' regular assignments was 29.5. This is very similar to other CTI fatigue assessment study results. Furthermore, fatigue indices for engineers and conductors, on average, were found to be very similar. For regular assignments, therefore, there does not appear to be a particular distinction between the engineer and conductor job categories in terms of fatigue indices.

Extra Board assignments have the highest fatigue indices, with mean scores of 39.3 and 42.7 for engineers and conductors, respectively. As with fatigue indices associated with regular assignments, the fatigue indices for engineer and conductor job category are very similar. It is therefore hypothesized that the major factor affecting rail operation personnels at NJ Transit is the scheduling, including day/night shifts, weekly working hours, and variation of shift starting time. It also suggests that use of fatigue management models which take all aspect of scheduling variables into consideration may effectively reduce fatigue of rail operation personnel.

What-If Scenarios

While fatigue indices for regular schedule NJ TRANSIT rail operations personnel were found to be comparable to those throughout the rail transportation operations sector, there were a number of concerns brought out regarding Extra Board assignments as well as split and nighttime assignments. Therefore, various schedule modifications or "what-if scenarios", were examined that focused specifically on the effects of fatigue indices.

All of the scenarios were found to have an impact on fatigue, with some scenarios having greater impact than others. Interestingly, implementing some of these scenarios led to an increase in fatigue.

Based on the results of CTI's evaluation, the most significant *reductions* in fatigue occurred where there is a set maximum number of consecutive days worked. CTI examined, for instance the effect of instituting a five- day work block

followed by a two-day rest period for Extra Board personnel. The reductions in fatigue were dramatic, with the fatigue index going from 77.4 to 61. Results were similar for rail operations personnel working consecutive night shifts.

Reducing shift start variation is also an area that NJ TRANSIT should examine further. CTI found reductions when shift start times were more consistent. However, schedulers are cautioned that while consistent shift start times are more conducive to reduce fatigue, night start times, even if consistent, would actually increase fatigue indices.

Operator Survey

The results of the operator survey paint a less positive picture of fatigue and overall stress of NJ TRANSIT rail operations personnel. For example, CTI's quantitative assessment of fatigue indicates low mean fatigue indices (30 or less) for nearly two-thirds of the total rail operations personnel assignments. However, the majority of survey respondents Indicated difficulty in maintaining alertness on the job.

Written responses to questions point to other fatigue related concerns. Several respondents indicated short turn around times are fatigue inducing. No further information was provided by those respondents as how short is considered to become fatigue inducing. This was not raised as an issue in CTI's evaluation as it examines merely hours on duty. Written responses also pointed out that split shifts are as problematic as a fatigue related issue. Again, this was not specifically addressed CTI's schedule evaluation. However, this is consistent with CTI's what-if scenario evaluation where fatigue indices were shown to increase for nighttime starts. Other fatigue inducing issues specifically raised in the survey included lack of adequate rest facilities, security concerns and dealing with the public. Further studies are needed in order to investigate those concerns with quantitative and objective data.

RECOMMENDATIONS

Results of CTI's evaluation, what if scenario development and the operator survey provide the basis for several study recommendations.

1. ***Decrease the number of consecutive days on***. Long hours alone are generally not fatigue inducing. However, long hours combined with night shift starts can significantly increase fatigue indices. As an initial step, it is recommended that the number of consecutive days off be reduced so that as a minimum at least two days off are provided for every seven days (i.e. two days off, five consecutive days worked).

2. ***Eliminate split shifts where a night shift is followed by a day shift assignment.*** This recommendation follows up the previous recommendation. Again, it is not so much the number of consecutive hours, but whether the start times occurred at night and the consistency of start times in the day and evening. However, while better consistency of start times and elimination of one or two night starts was found to reduce fatigue, the reduction in fatigue indices was not found to be significant. Several combinations of scheduling that look at start times changes and number of consecutive hours worked should be examined further, both from fatigue index point of view and from actual reports of operators, to gain the maximum benefit of fatigue reduction.

3. ***Modify schedules so that personnel working nighttime shifts can be shifted to days every other week*****.** Nighttime starts are noted to be particularly fatigue inducing and the switch to days every other week can have very positive benefits on reducing fatigue.

4. ***Reduce the number of hours worked at night.*** Again, long hours in and of itself may not be fatigue inducing, but working long nighttime hours can adversely affect alertness. To the extent possible, therefore, working long nighttime hours should be limited.

5. ***Engage in active discussions to comprehensively examine revamping the Extra Board concept.*** Extra Board assignments provide the opportunity for rail operations personnel to earn additional pay and enable trains to operate on their required near 24/7 basis. However, it is these very assignments that produce the highest fatigue indices and are, according to the body of research, the most fatigue inducing. Therefore, the economic benefits and necessity of maintaining Extra Board assignments to NJ TRANSIT and its rail operations personnel must be balanced with potential safety risks associated with the host of fatigue related problems associated with Extra Board assignments. As a follow up to this study, it is also recommended that this issue be examined in further detail and that there be extensive dialogue with both the UTU and BLE so that an equitable balance can be achieved.

6. ***Define new rules and model.*** Finally, implementation of the recommendations above would require defining new rules and a new model that results in reduced number of hours worked at night and moves shifts around to create more even pattern. Due to the complexity of assignments and work schedules, this would be achieved by effectively integrating a computer-based module that works interactively with existing schedule software.

APPENDIX A

Literature Review

LITERATURE REVIEW

What is Fatigue?

Traditionally, fatigue was viewed as a simple condition related to the amount of time spent working on a given task. [7] Scientific research, however, has shown that fatigue is related to much more than just the time on a task. [8] Researchers have studied factors that affect fatigue, such as duration and quality of sleep [9, 10, 11], shiftwork and work schedules [12, 13], circadian rhythms [14], and time of day. [15] Others have examined the influence of drugs and alcohol on fatigue and compared performance impaired by fatigue. [16, 17] Sleep disorders and the characteristics of sleep patterns at different ages have also been studied. [18, 19] Cumulative sleep loss and circadian disruption can lead to a physiological state characterized by impaired performance and diminished alertness. [20] Fatigue can impair information processing and reaction time, increasing the probability of errors and ultimately leading to transportation accidents. [21, 22]

Causes and Remedies of Fatigue:

A USDOT/FRA report in 1991 identified causes of fatigue. [23] These are:

- uncertainty about the time of one's next assignment,
- excessive working hours,
- long commutes and waiting times before beginning work,
- unsatisfactory conditions for sleeping at some terminals, and
- the decision not to rest during the day even when subject to call the next night.

Suggestions for remedying the situation included:

- a minimum of eight hours notice before being called to work,
- greater predictability in scheduling trains,
- division of assignments according to blocks of time.

According to NTSB, about one-third of train accidents, employee injuries, and deaths are caused by human factors. [24] Accidents are attributed to a significant extent by the loss of alertness associated with fatigue. It has been reported that work and rest schedules of railroad and train crews are often more irregular and unpredictable than they are in other transportation modes.

Results Related to Fatigue and Rest in Occupational Setting Involving Continuous Operations

A number of key findings have been summarized by various authors over the past few years relating to fatigue and rest in the occupational setting involving continuous operations. The following list was generated from a review of several articles published by Rosekind [25], Rosekind, *et al.* [26], Dinges and Kribbs [27] and Dinges [28]. They are listed in the form of points to aid in grasping the significance of the findings. Those interested in a more detailed review of the findings should consult the original sources.

- Sleep deprivation results in cognitive performance deficits.
- Disruption of circadian rhythms leads to a decrease in performance.
- Human beings are not very good at estimating their current level of alertness.
- Repeated disruption of sleep schedules can lead to decreased performance.
- Sleep inertia can lead to performance decrements.
- Inability to get regular sleep may lead to disruption of the circadian rhythm.
- Short naps have been found to restore an individual's capacity for performance under certain conditions.
- Time off alone may not guarantee a rested workforce. Education, planning, and predictability are needed to maximize utilization of work/rest schedules.
- With repeated loss of sleep a sleep debt builds up over time.
- With increased sleep loss and increased sleepiness a person may become vulnerable to performance problems.
- Quality of sleep is an important factor. Poor quality sleep can leave a person feeling fatigued and non-restored.
- There can be a discrepancy between how people are feeling and how sleepy they are physiologically.
- Scientific evidence suggests that being on an altered shift schedule, like nights, does not lead to an altered internal circadian pattern.
- Shift workers that go back and forth between shifts experience more difficulties between the circadian rhythms and sleep times.
- Moving a shift schedule forward involves easier physiological adaptations.

Effects of Sleep Loss and Sleepiness:

The following conclusions regarding the effects of sleep loss and sleepiness were abstracted from several articles written by David Dinges of the University of Pennsylvania. [26, 27] They cover several aspects of research which are relevant to transportation operations.

1. Fatigue affects performance. Fatigue erodes performance such as vigilance, sustained attention.
    - Four main processes affect performance decrements: circadian phase, acute sleep loss, cumulative sleep loss, and sleep inertia.
    - Fatigue can cause lapses or micro sleeps.
    - Night work which interferes with the circadian rhythm can cause lapses to increase 4 to 10 fold.
    - The longer one is awake beyond 14-16 hours the greater the occurrence of lapses.
    - Chronic under-sleeping creates a cumulative sleep debt, which can produce a cumulative increase in lapses on vigilance tasks.
    - Sleep inertia creates lapses.

2. Fatigue produces a variety of performance decrements:
    - performance variability,
    - slowed physical and mental reaction time,
    - increase in number of work related errors,
    - increased tendency to persistently repeat behaviors,
    - increase in false responding,
    - increases memory errors,
    - decreased vigilance, and
    - reduced motivation and laxity.

3. Magnitude of fatigue effects vary by individual This limited review should serve to alert readers that the "science of fatigue and alertness" is still in its infancy. Those looking for definitive "proof" of a particular point of view are likely to be disappointed. The results of investigations to this point can only be used to generate basic guidelines to follow in developing fatigue countermeasures.

The railroad industry must actively manage employee fatigue and alertness problems to maintain an optimal level of operational safety and productivity.

Given the necessity to operate nights and irregular hours, weekends and holidays under a wide range of physical conditions and service demands, we must explore every reasonable avenue to ensure employees are fit, alert, and well-rested. Effective fatigue management programs must address train crews, dispatchers, signalmen, track workers, and others - both operating and non-operating personnel. Work scheduling is a particular problem in on-call operations because of start-time variability, "call" predictability, and the common use of "shorter-than 24-h work/rest schedules". [29]

In a 1999 speech, US Secretary of Transportation Rodney Slater stated, " We *know that alertness is a key to safe vehicle operation. To reduce crashes and accidents and their personal and financial consequences, we need to ensure that vehicle operators are ready and capable of operating their vehicles or other transportation equipment".*

In testimony before the Senate Subcommittee on Surface Transportation and Merchant Marine 22 on 16 September 1998, the Administrator of the Federal Railroad Administration (FRA), Jolene Molitoris, stated, *"About one-third of train accidents and employee injuries and deaths are caused by human factors. We know fatigue underlies many of them".*

The (US) Hours of Service Act (law)

- Enacted in 1907 and revised in 1969,
- Intended to promote the safety of employees and travelers upon railroads by limiting the hours of service of certain railroad employees.

As per Section 2 (45 United States Code Section 62), for "train and engine service",

- An employee may not be required or allowed to remain or go on duty after 12 continuous hours on duty, or 12 h in broken service in a 24-h period starting at beginning of work tour; or at the end of that 24-h period, if there has not been at least eight consecutive hours of off duty time even if the employee had fewer than 12 h on duty. The minimum off-duty periods are 8 or 10 consecutive hours, depending on whether 12 continuous hours were worked. There is a 4-hour minimum for interim rest period.

There are several aspects of railroad operations that can cause fatigue and alertness problems:

- the irregularity of work schedules in freight operations,
- the need for split-shifts in commuter and urban operations, and

- the high potential for complacency and boredom in some freight operations. [29]

Major Concerns for Freight Operation Crews

- Scheduling based on the availability of goods, the availability of crew and rolling stock, and the priority on delivery time.
- Higher proportion of night operations.
- Irregularity and unpredictability of shift start time
- Factors such as weather, equipment breakdown, and maintenance-of-way problems also result in irregular work schedule completion.
- Some freight runs include long grades where the train moves at very slow speed for hour after hour and the crew has almost nothing to do resulting into boredom. [29]

Humans normally have regular circadian rhythms. One major role of these rhythms is to regulate the time of sleep onset. These rhythms are entrained about the normal 24-h diurnal cycle. Disruption by a factor such as work schedule can seriously limit the ability of an engineer to achieve adequate sleep. [29]

Freight engineers face a number of challenges in getting adequate sleep. Their schedules are both irregular and unpredictable. Work schedules are not likely to coincide with the worker's circadian rhythms or with the schedules of their families or communities. Finally nights spent away from home are sometimes spent in uncomfortable and noisy bunkhouses. [29]

Major Concerns for Passenger Train Crews

- While passenger train crews usually have regular and predictable schedules and sleep at home more often, they too face challenges in getting adequate rest.
- Crews involved in commuter operations are often required to work a split shift. Split shift schedules (even those allowed under the Hours of Service Act) impact the ability of the train crew to get appropriate rest. They can result in situations where individuals can work far more than 12 h in a 24-h period without an adequate sleep period.[29]

Causes for Mental Lapses Affecting Alertness or Vigilance Resulting in Unsafe Performance

- Reduced sleep or physical or mental fatigue,
- Lack of stimulation,
- Cognitive under-load or overload,
- Repetitiveness. Engineers often operate over the same territory over years or decades. This repetitiveness can breed complacency because the engineer is likely to encounter the same signal conditions run after run. A change in a critical signal may go undetected. [29]

Alerters

The dangers of accidents caused by non-alert, incapacitated, or sleeping train crews have been evident from the beginning of railroading, but measuring, or even detecting, reduced alertness in revenue service has been very difficult. Alerters are used to alert the engineers. Alerters function by detecting activities made by the engineer. They are based on the idea that a non-responding engineer is likely to be an incapacitated engineer. Failure to touch the alerter or in some systems to touch the operating controls is taken as an indication that the engineer is asleep or otherwise indisposed. In general, if the engineer fails to provide a measurable movement within a preset time, an alarm goes off. If no appropriate movement occurs in response to the alarm, a penalty brake application is made. [29]

Shortcomings of Alerters

- In learning to work with an alerter the engineer has learned to take a periodic action in the absence of a stimulus. Such movements are certainly possible at very low states of arousal.
- Alerters can be designed to require that an engineer make a timely response to a stimulus, but there is concern that systems that require even moderately complex responses may distract the engineer from planning or conducting cognitive activities critical for safety.[29]

Positive Train Control (PTC) Systems:

The future holds the potential for significant improvement in preventing fatigue-related problems. One emerging factor that can alleviate many fatigue-related problems is the adoption of positive train control (PTC) systems. As PTC is perfected and comes on line, the regularity and predictability of train movements should improve markedly. The detection of the onset of diminished alertness will also become more practical. This will be possible because data will be available on the actual performance of the train and the train operator. In theory, real time monitoring, and recording of this data stream, would allow a comparison of the locomotive operators' actual performance with the expected performance of the engineer for a given train, train position, route, and operating

conditions. If the performance of the train is substandard (falls outside anticipated boundaries), it will be detected that the engineer is impaired. [29]

Fatigue Management: Lessons from Research

A study [2] on 221 serious truck accidents conducted by American Automotive Association in 1985, estimated that fatigue was the primary cause in 40% of the accidents and a contributing cause in 60% of the total accidents. Here serious accident meant that the truck had to be towed from the scene of the accident.

Many physiological functions, as well as mental alertness, follow a general pattern of rising during the day and falling during the night. Performance, particularly on vigilance tasks, is the poorest in the early morning hours- 2:00 to 6:00 a.m. It coincides with the pattern of circadian rhythm which suggests that the early morning hours are around the circadian low point. Our circadian rhythm is kept to a 24 hour cycle by time-givers: namely, the rising and setting of the sun, knowledge of clock time, and work time. When a person works at night, the circadian rhythm will adjust so that physiological activity is higher during the work period, and lower during sleep. However, this adjustment is slow, taking up to 10 days, and incomplete, because the usual time giving cues of sun rising and setting and work time are in conflict with one another [30]. The performance rhythms adjust only partially.

The data collected by Kogi [31], suggests that most sleep is obtained when sleep is initiated in the evening around 9:00 p.m. It decreases if initiated after 1:00 a.m. The sleep amount is least if it is initiated in the afternoon. Sleep obtained at the optimum time of day typically lasts 7.5-8 hours.

Guidelines for regulators, managers, and drivers:

- Driving should be avoided during the circadian low point of the day (2:00-6:00 a.m.).
- If driving must be done during this period, it is critical that drivers be well-rested and that they not enter this time period towards the end of a long trip.
- Rest is most restorative it taken starting 9:00 p.m. to 1:00 a.m.
- Since daytime sleep is shorter and poorer quality than night sleep, drivers working at night should avoid successive night shifts.
- Drivers are poor judges of their own condition. Hence others should be involved in the determination of whether a driver is adequately rested.

Fatigue Data Collection:

Like most industries, consistent and reliable fatigue data is often lacking in the railroad industry.[29]

Because there is limited fatigue-related data available for conducting good quality statistical analyses, the Federal Railroad Administration (FRA) is planning to modify its incident reporting system to include fatigue related factors. FRA is also planning to modify its incident investigation methods and training to recognize fatigue as a possible contributing factor to incidents.

Efforts are also being made to evaluate the feasibility of developing a near-miss incident reporting system in the railroad industry. For every actual incident, many more near-miss incidents occur. This way with a larger database assumptions can be minimized, additional analyses can be made, and results can be interpreted with a greater amount of confidence.

FRA's Office of Research and Development (OR&D) has begun a project to develop a database of railroad work schedules so that ergonomic assessments and comparisons of different work schedules on fatigue and performance can be conducted.

Event recorders on locomotives record most performance activity, including speed, throttle position, dynamic braking, air braking etc. Hence these devices may be a useful source of data for evaluating the effects of different pilot projects on fatigue. OR&D also collects fatigue data from other sources like structured interviews, surveys, focus groups, work/rest activity diaries, wrist actigraphs, meta-analysis, naturalistic observations, cognitive task analysis, and literature reviews.

OR&D has compiled a comprehensive bibliography of scientific research on fatigue in railroad operations which is available on the FRA website. http://www.volpe.dot.gov/frarnd/rndpubs.htm

Research is being conducted in four major areas to develop valid and reliable tools that can aid in the measurement of fatigue and its effects on operational performance:

1. Cognitive workload, task load, and performance modeling,
2. Job analysis and staffing analysis,
3. Work schedule evaluation, and
4. Locomotive simulator experiments.

Fatigue Countermeasure Strategies:
NARAP(North American Rail Alertness Partnership) has identified eight key components for an effective countermeasure program in its North American Rail Alertness Partnership strategic plan (1997).

1. Education and training,
2. Employee scheduling practices,

3. Emergency response requirements,
4. Alertness strategies,
5. Evaluation of policies and procedures,
6. Adequate rest environment,
7. Work environment, and
8. Implementation strategies.

APPENDIX B

October 27 Fatigue Assessment Report

New Jersey Transit Fatigue Risk Report

Assignments for 27th October 2002

19 December 2002

Introduction

- CTI conducted an analysis of Conductor and Engineer assignments from the October 27th bid. The results of the analysis are summarized in this Fatigue Risk Report.
- This report provides the overall fatigue index for New Jersey Transit conductors and engineers, and the fatigue indices by terminal.
- The purpose of this report is to serve as a benchmark of fatigue indices for assessment of assignments, both between terminals and for comparison to future modeled assignments.

Rail System


PORT JERVIS - SUFFERN
MAIN LINE
BERGEN COUNTY LINE
PASCACK VALLEY LINE
MONTCLAIR-BOONTON LINE
MORRISTOWN LINE
GLADSTONE BRANCH
RARITAN VALLEY LINE
NORTHEAST CORRIDOR LINE
NORTH JERSEY COAST LINE
ATLANTIC CITY LINE
NEWARK CITY SUBWAY
HUDSON-BERGEN LIGHT RAIL
SOUTHERN NEW JERSEY LIGHT RAIL
NEWARK - NEW YORK
PHILADELPHIA - CAMDEN
NJTRANSIT
The Way To Go.
PASSENGER RAIL SYSTEM
6 a.m. to midnight:
In New Jersey (800) 772-2222
Outside New Jersey (973) 762-5100
Text Telephone (TT) (800) 772-2287
www.njtransit.com
November 2003
Princeton Branch
ROCKLAND
PASSAIC
BERGEN
WARREN
SUSSEX
ORANGE
MORRIS
ESSEX
HUDSON
BRONX
QUEENS
KINGS
SOMERSET
UNION
HUNTERDON
MIDDLESEX
MERCER
MONMOUTH
BUCKS
BURLINGTON
CAMDEN
ATLANTIC
OCEAN
PHILADELPHIA

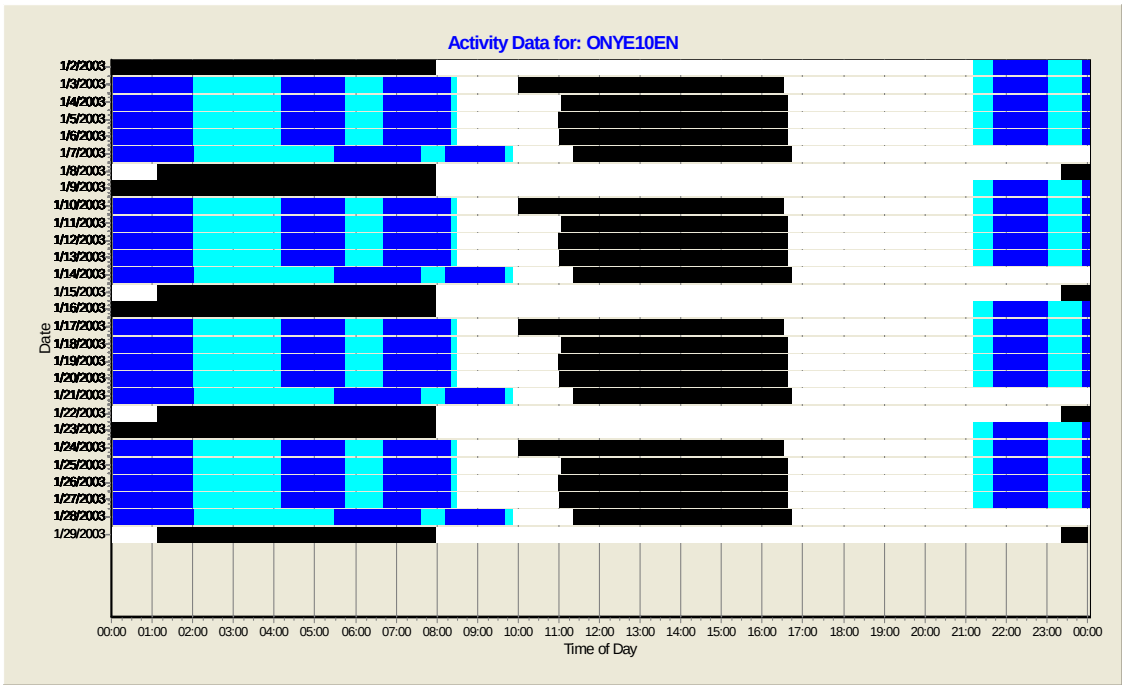
Methodology – Regular Assignments

- To evaluate fatigue levels we used data from 27th October assignments. The information for each assignment was converted into the on-duty time for a week period
- Each assignment was repeated for 4 weeks to demonstrate any cumulative effects
- On-duty, not on-train, time was coded as light blue, on-train duty was coded as dark blue
- Based on the each assignment, we calculated the average fatigue indices.
- The fatigue indices are plotted as a distribution graph which shows the percentage of employees who recorded each fatigue index from 1-100 during the month.
- Low fatigue indices range from 0-30, average fatigue indices range from 31-60 and high fatigue indices from 61 to 100.
- The individual data were combined to analyze the average fatigue levels and the distribution of fatigue indices by job type, terminal and overall.

Methodology
Parameters Evaluated

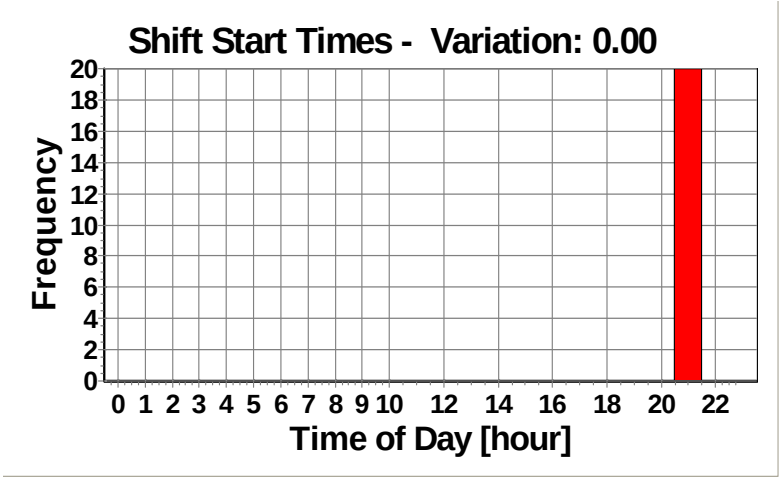
- Fatigue Index
- Shift Start Time
- Shift End Time
- Shift Duration
- Time Off Between Shifts
- Time Off Between Shift Starts
- Consecutive Scheduled Days On (Day on is a day with a shift start)
- Consecutive Scheduled Days Off (Day off is a day without a shift start)
- Consecutive Nights Off Between Shift Blocks (Night Off is defined as an 8-hour period without work between 10 pm and 8 am)

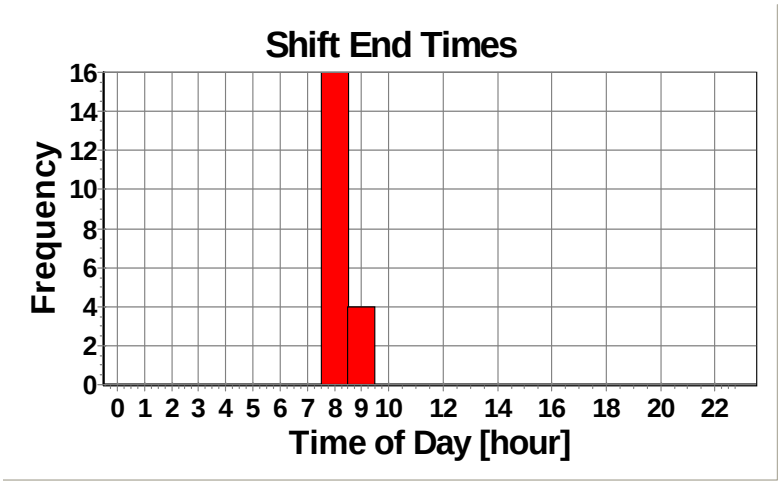
Sample Assignment Data - One Person

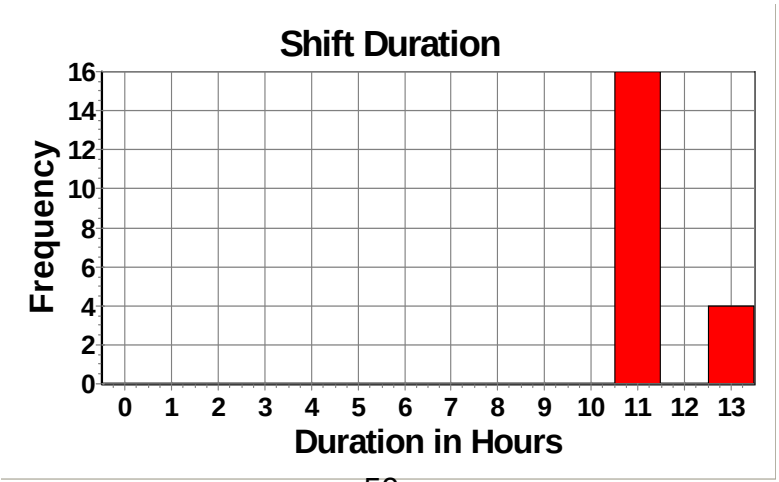


- On-duty, not on-train, time was coded as light blue, on-train duty was coded as dark blue
- White is off-duty awake
- Black is where the software program has predicted sleep
- Program allows for 90 minutes either side of work where sleep is not allowed

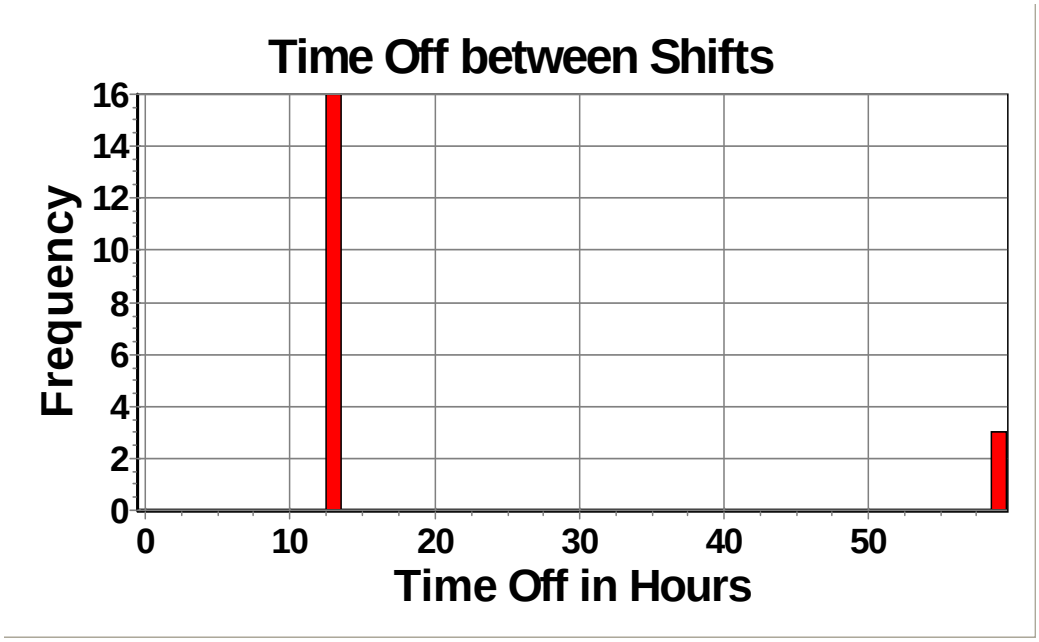
Sample Schedule Management Data – One Person

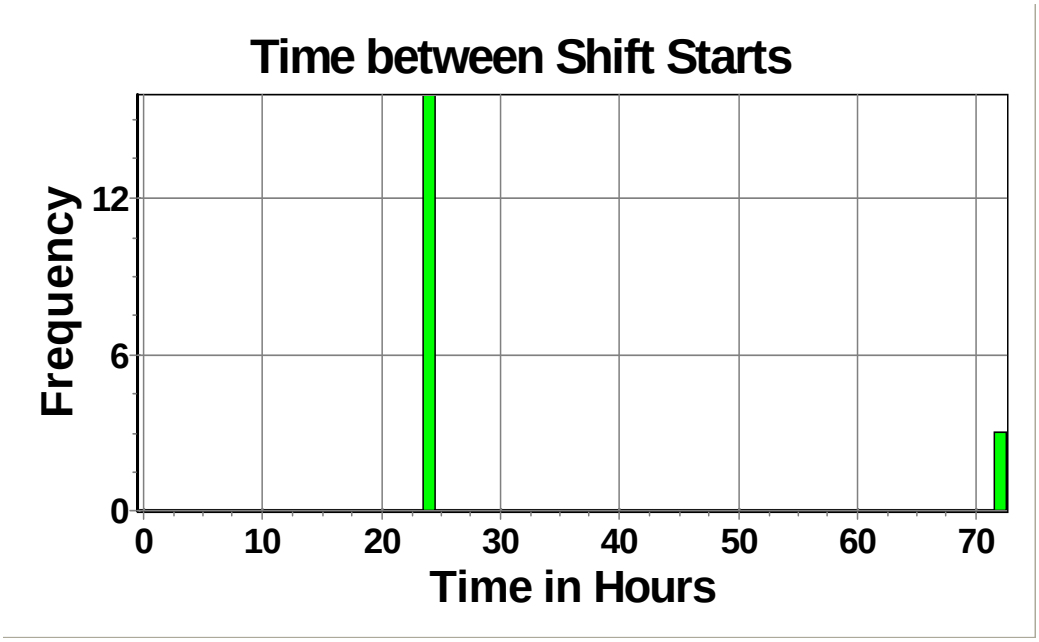




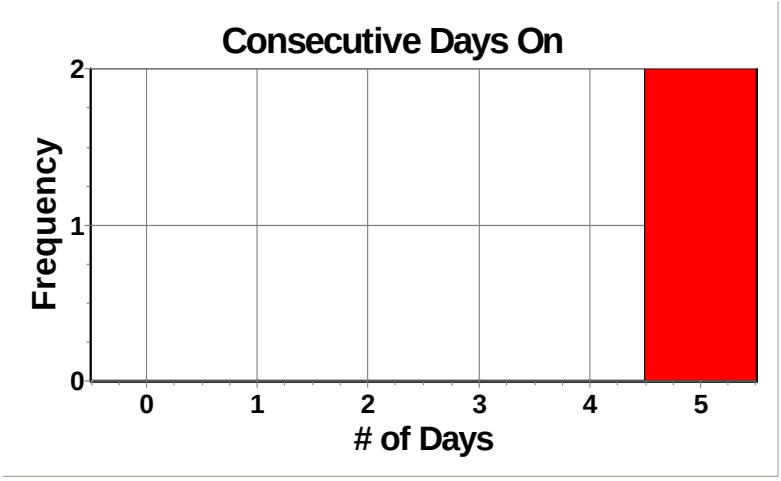


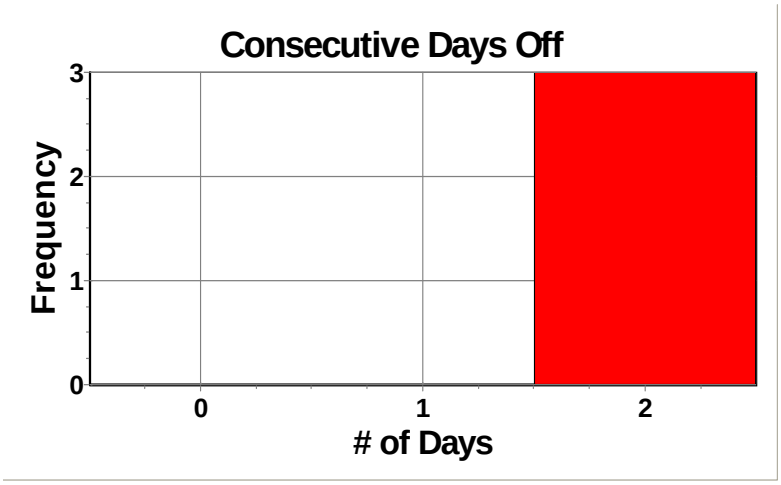
Sample Schedule Management Data – One Person

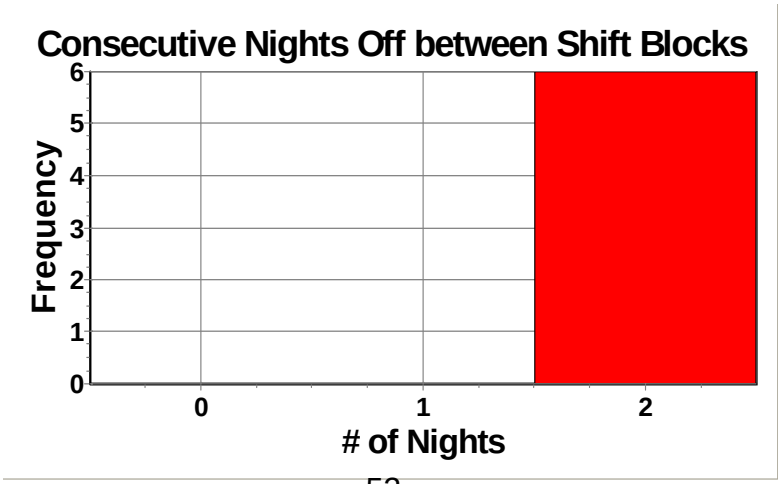




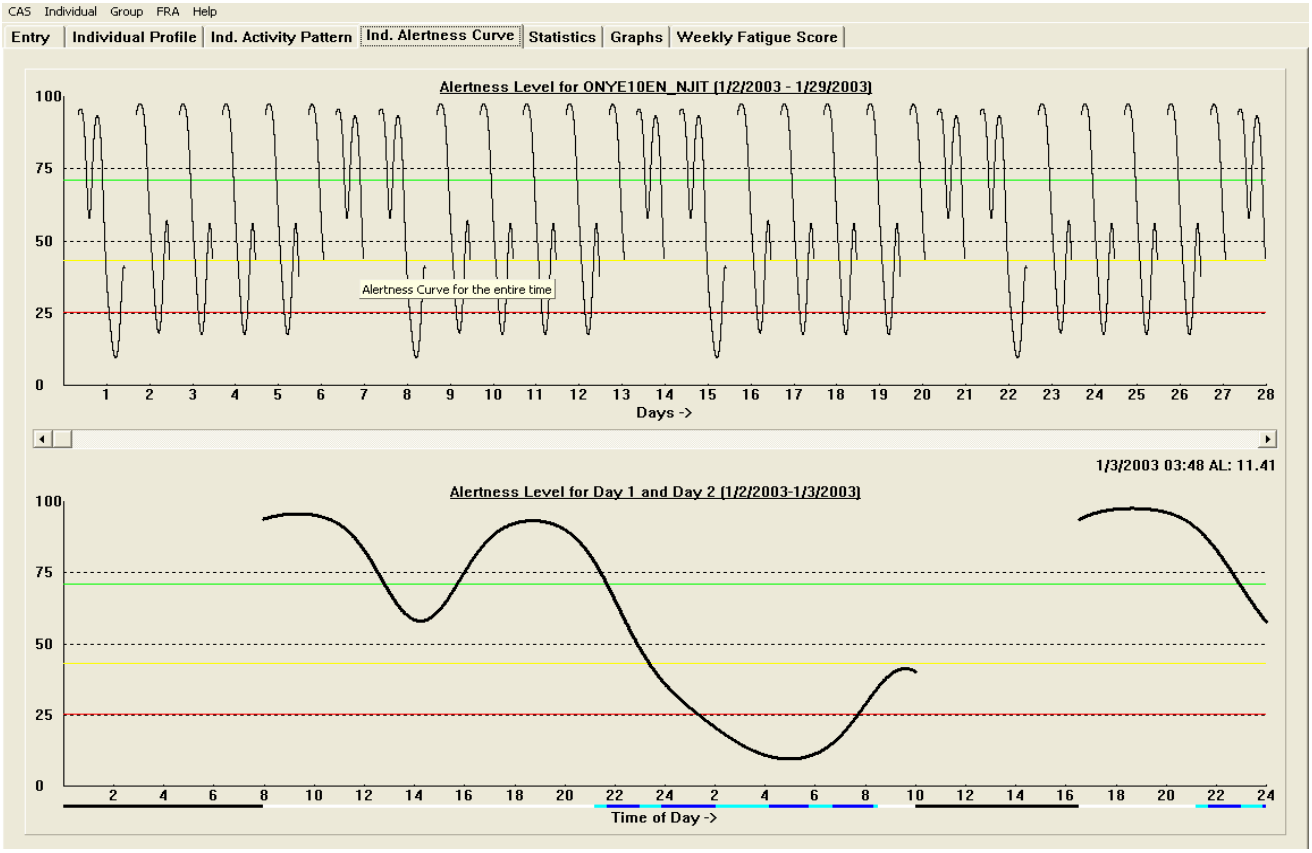
Sample Schedule Management Data – One Person







Alertness Curve and Fatigue Index



- Schedule and sleep pattern combine to produce alertness curve for any given time over month
- Alertness plus other factors combine to produce a fatigue index
- This person has a fatigue index of 81.6 (very high)

Methodology – Extra Board Assignments

- To evaluate fatigue levels we used data from Timera system. The information for each person was converted into the on-duty time for the month of November.

- On-duty time was coded dark blue. Information about on-train time was not collected.

- Based on the each assignment, we calculated the average fatigue indices.

- The fatigue indices are plotted as described before

Summary of Results Overall

- 290 Conductor Assignments
- 260 Engineer Assignments
- 112 Extra Board People

Regular Assignments

Summary of Results Overall – Regular Assignments

- The average fatigue index for conductors was (all terminals) 29.4
- The average fatigue index for engineers was (all terminals) 29.5
- The percentage of conductors and engineers with low fatigue indices (30 or lower) was 65.8%
- The percentage of conductors and engineers with high fatigue indices (60 or higher) was 11.1%

Summary of Results:
Schedule Management Data – Regular Assignments

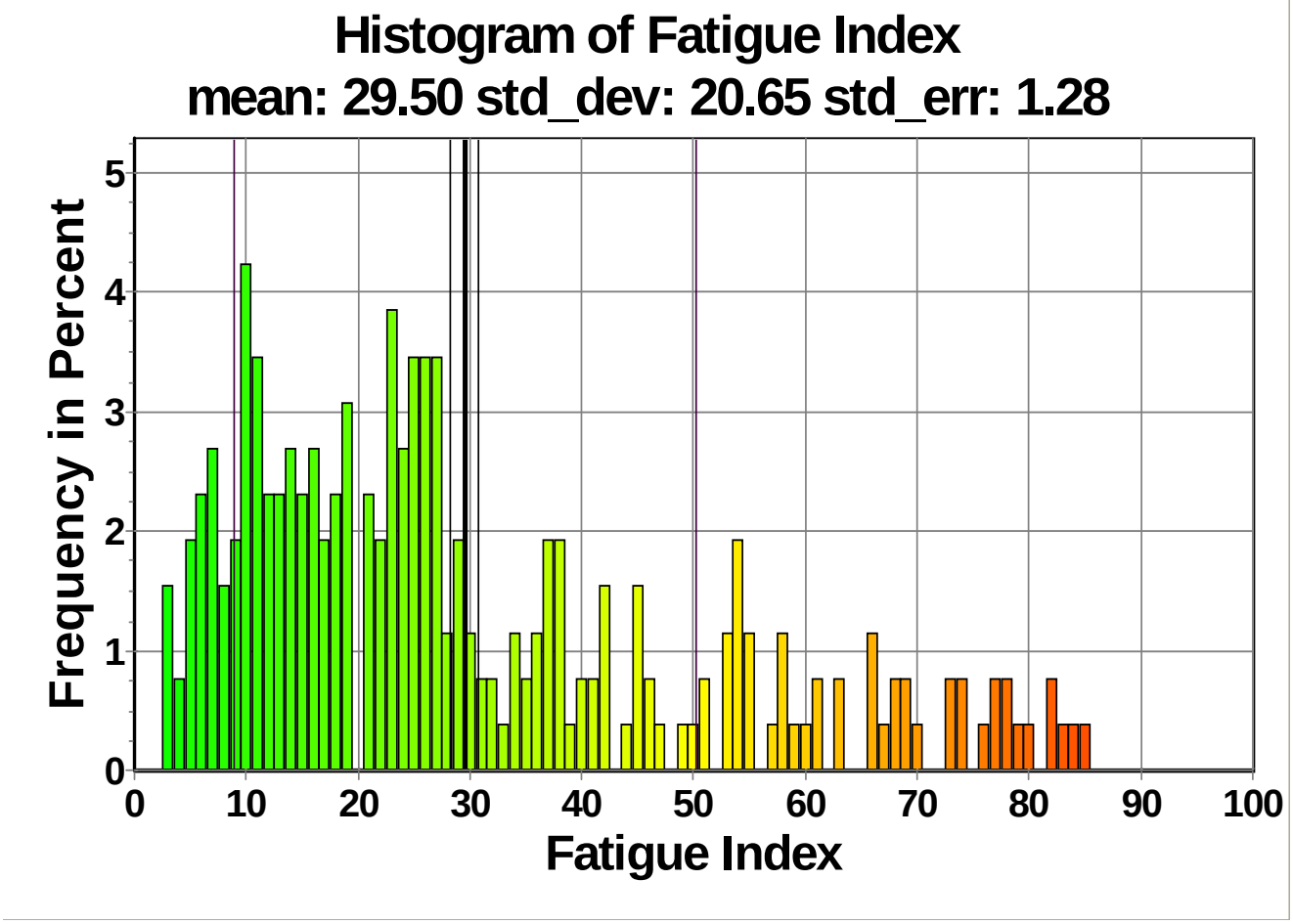
- Shift starts: The peak times for shift starts are between 4am and 7am, and 1pm and 5pm.

- Shift Duration: Most shifts last between 9 and 11 hours, with some lasting 13 hours (presumably in utilizing a split shift arrangement - time during split shifts was counted as on-duty for the purposes of the fatigue assessment.

- Scheduled days on/off: All assignments (excluding Z assignments) are a consecutive block of 5 days with 2 off.

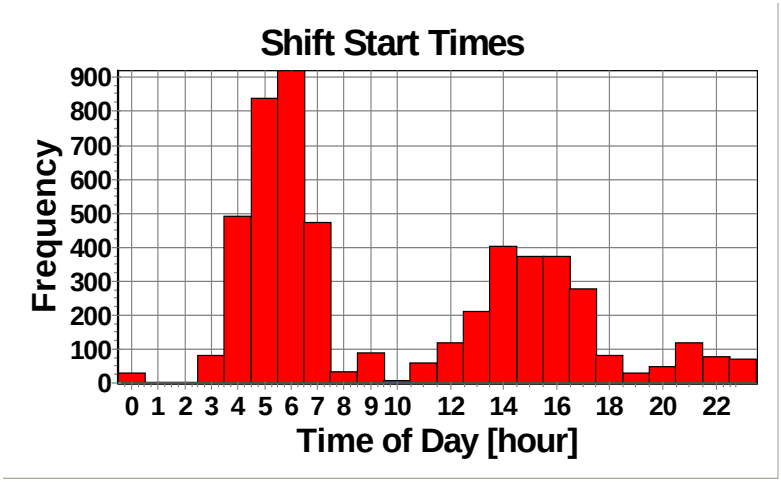
- Scheduled Nights off: A night off is defined as a period of time off between 10pm and 8am the next morning. All assignments had at least 2 consecutive nights off.

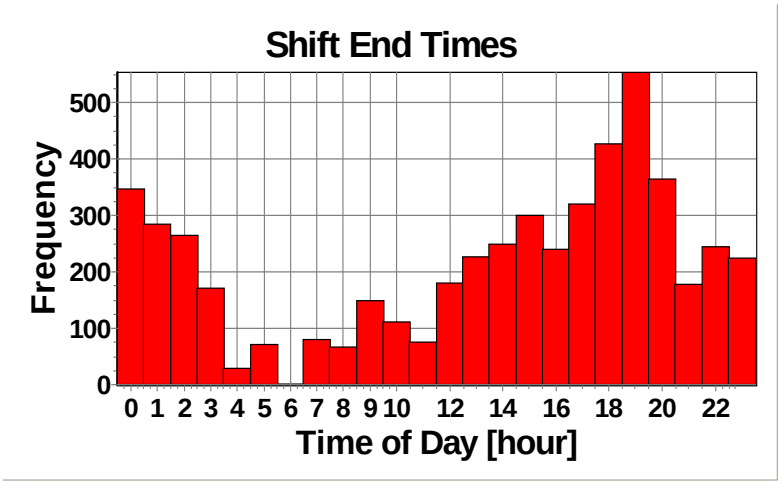
Distribution of Fatigue Indices for All Engineers

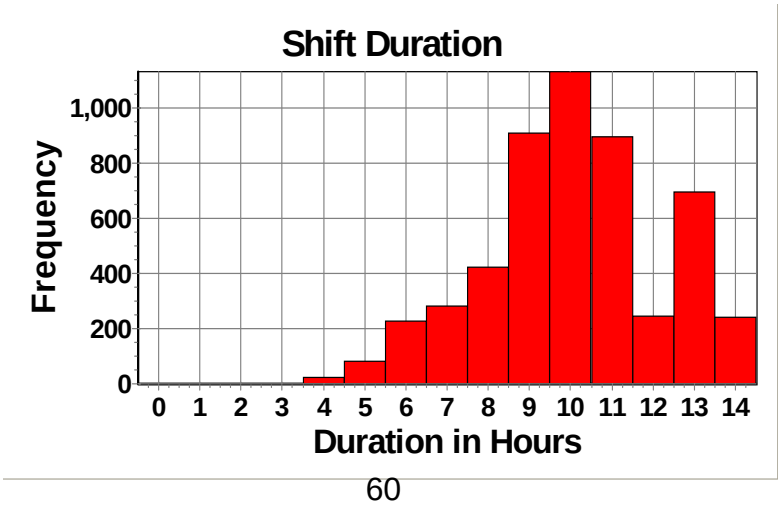


- Combination of all engineer fatigue indices
- Low fatigue is less than 30, medium 30 to 60, and high over 60
- Y axis is percent of engineers who have that fatigue index

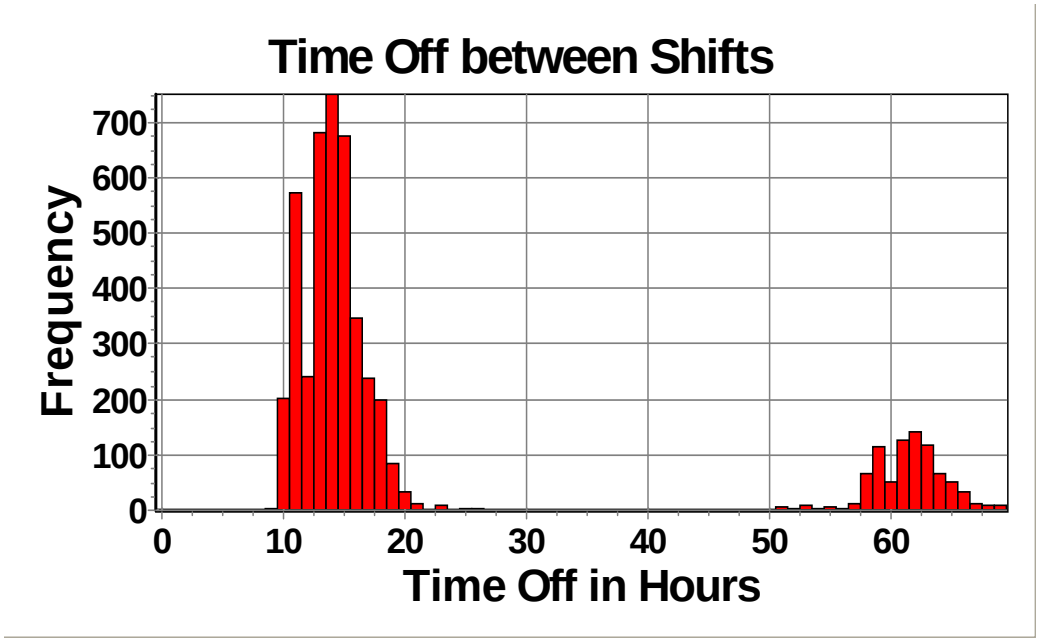
Schedule Management Data : All Engineers

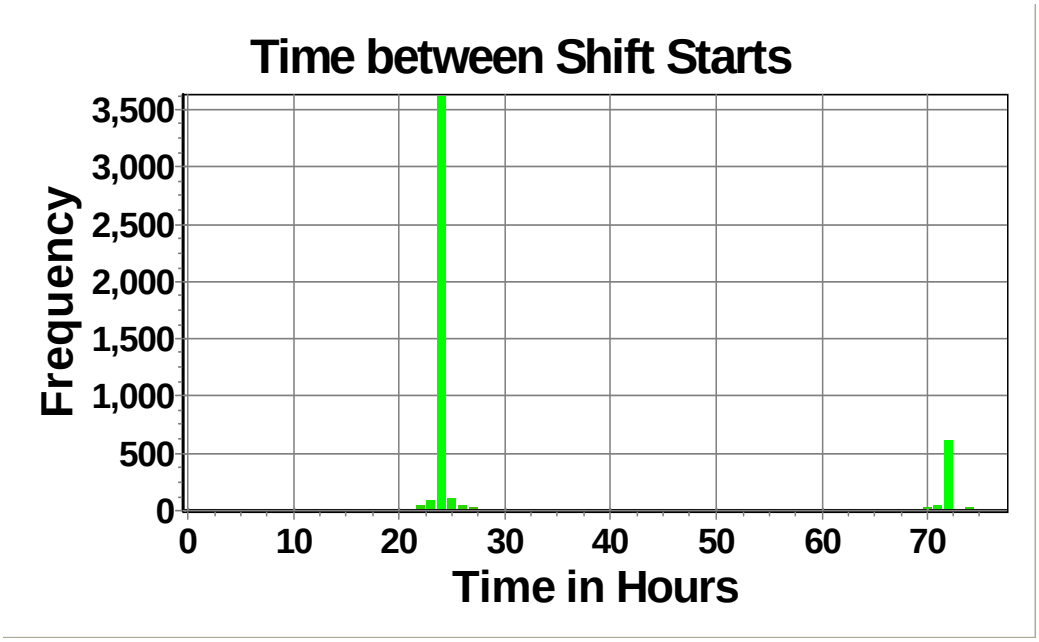




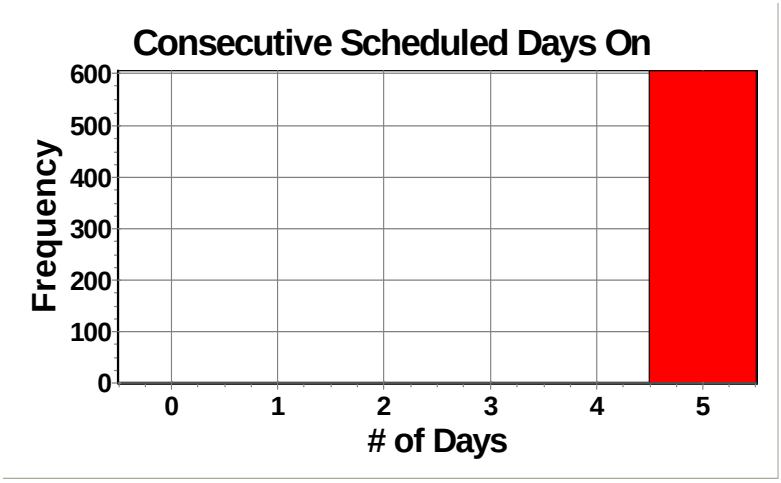


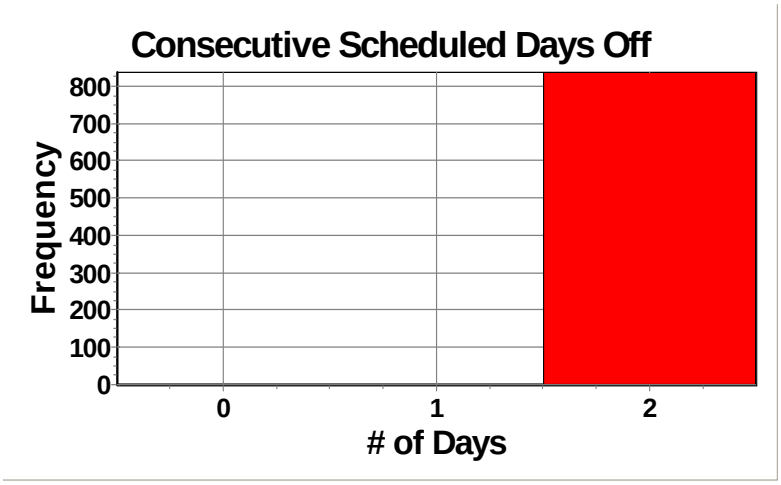
Schedule Management Data : All Engineers

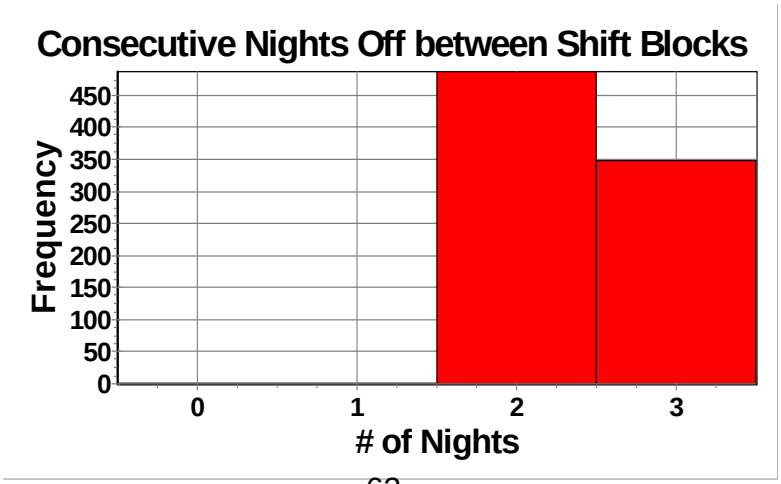




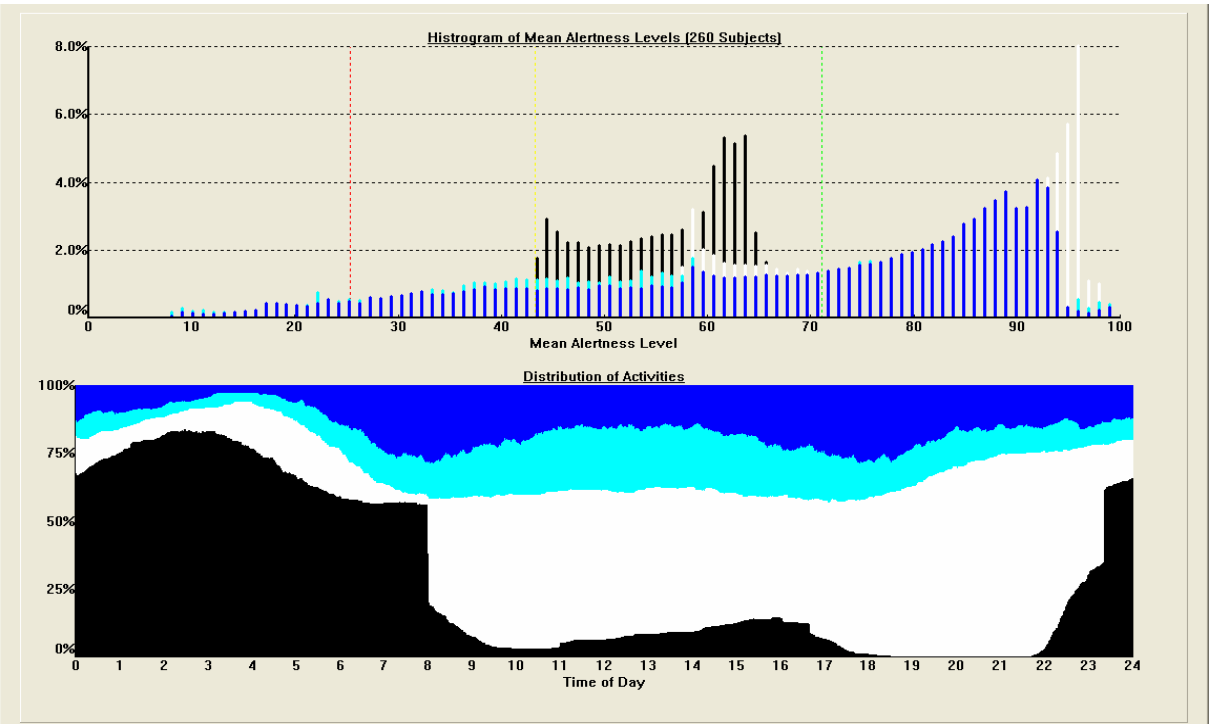
Schedule Management Data : All Engineers



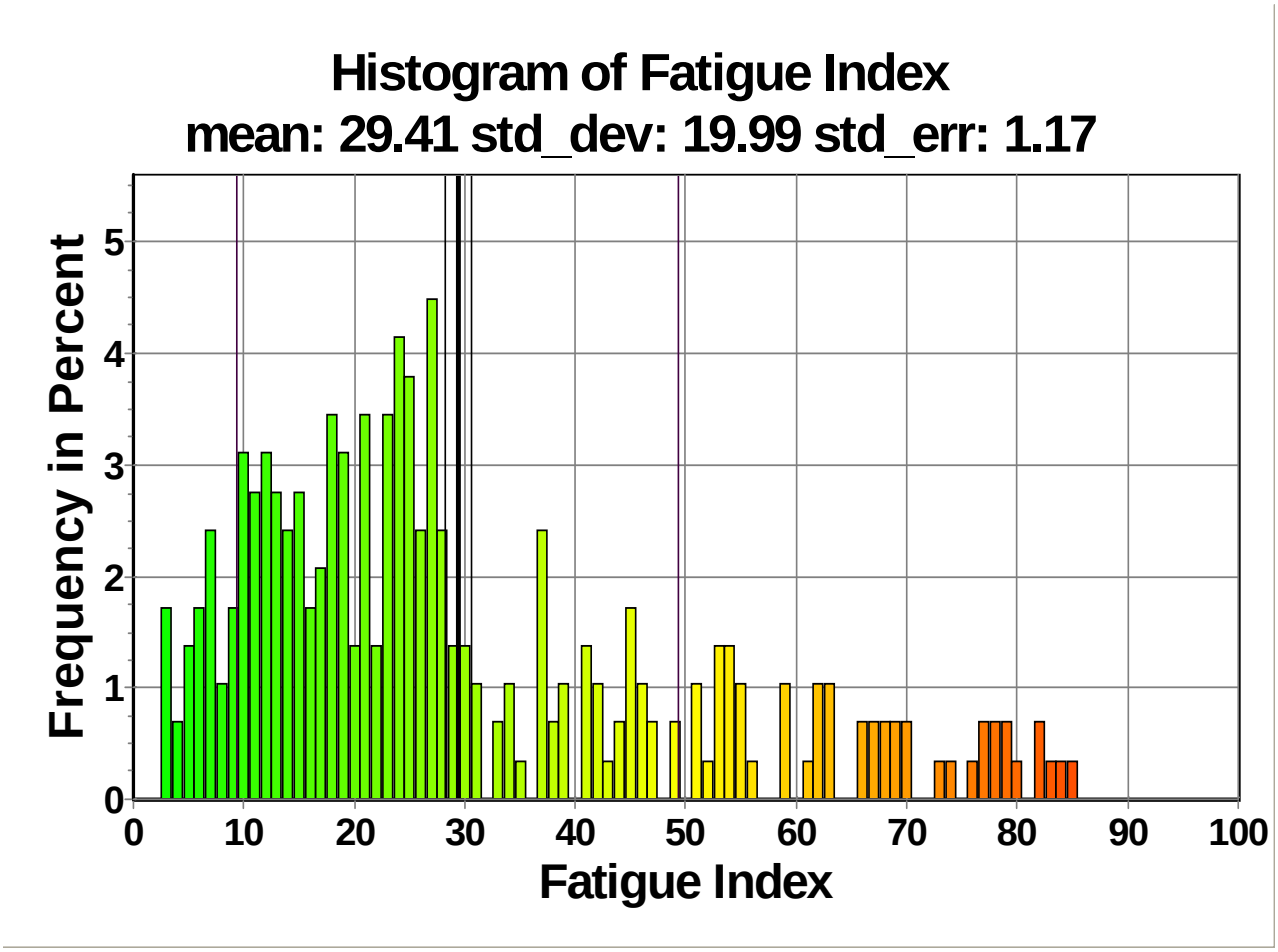




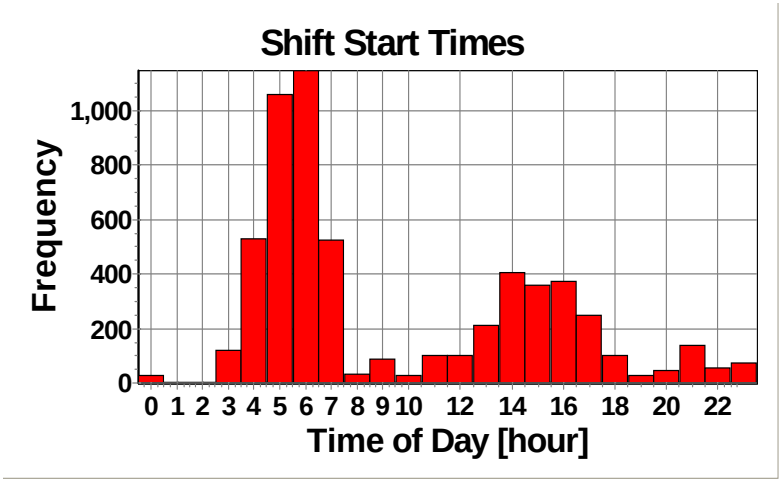
Schedule Management Data : All Engineers

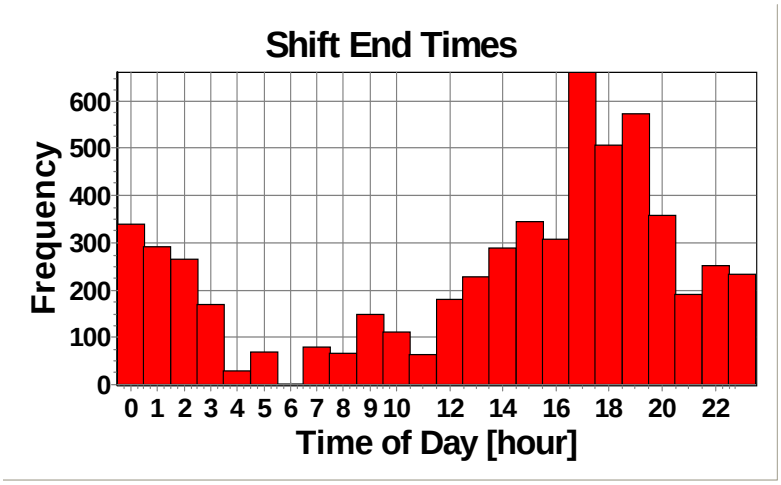


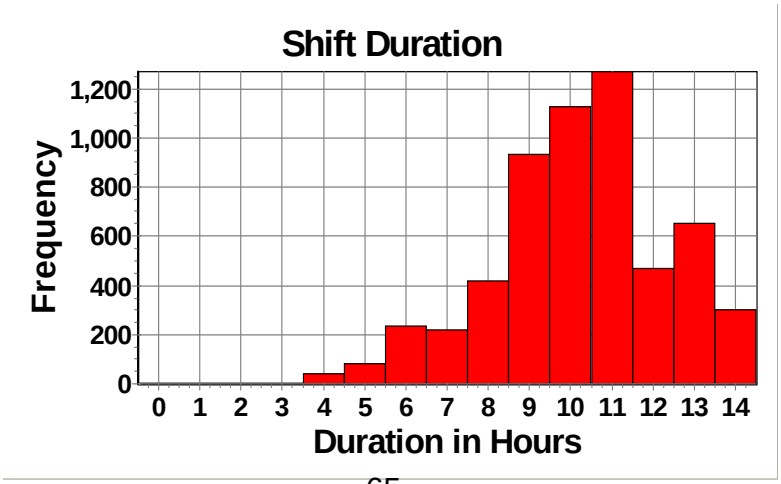
Distribution of Fatigue Indices for All Conductors



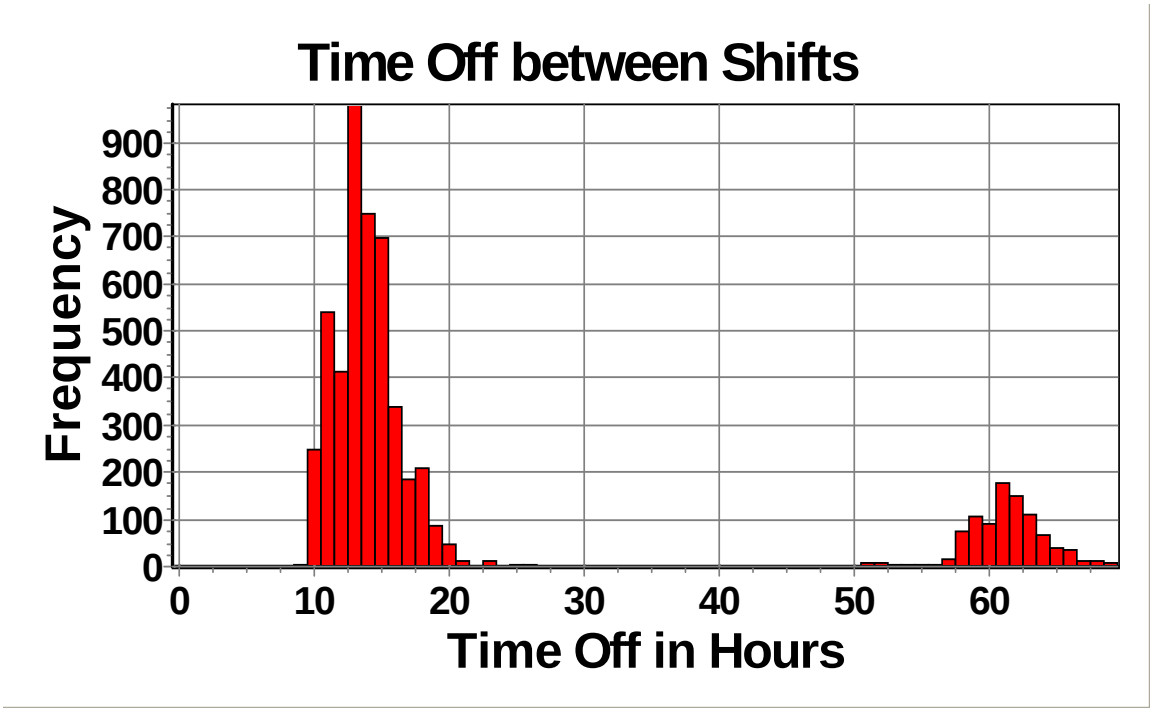
Schedule Management Data : All Conductors

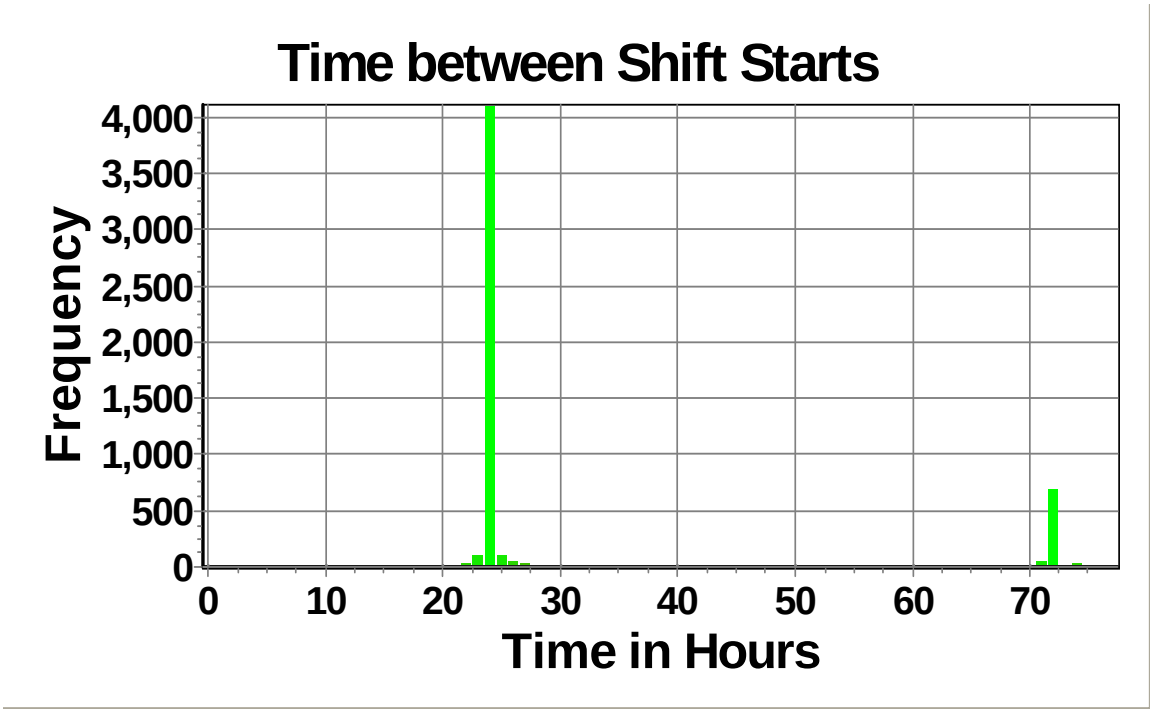




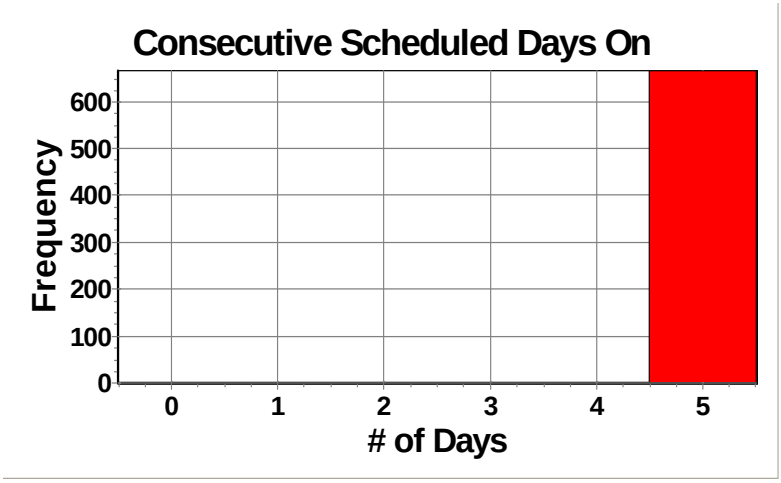


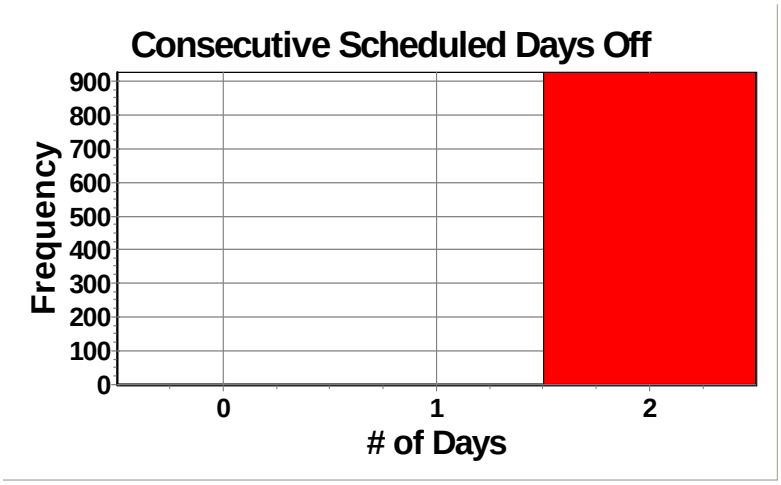
Schedule Management Data : All Conductors

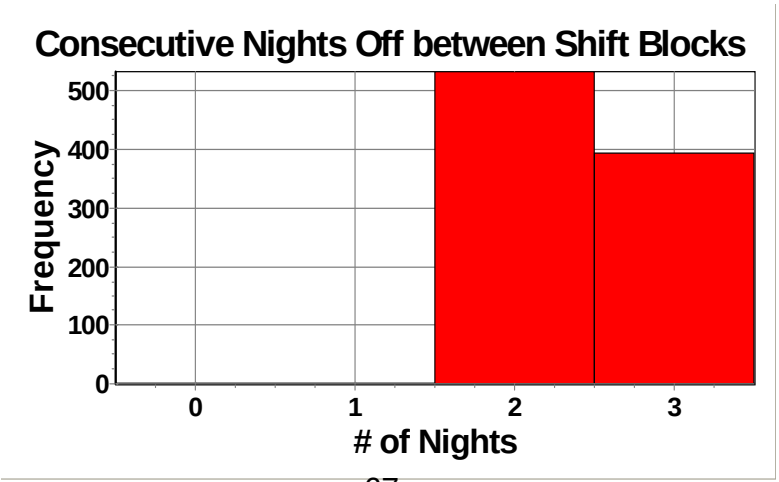




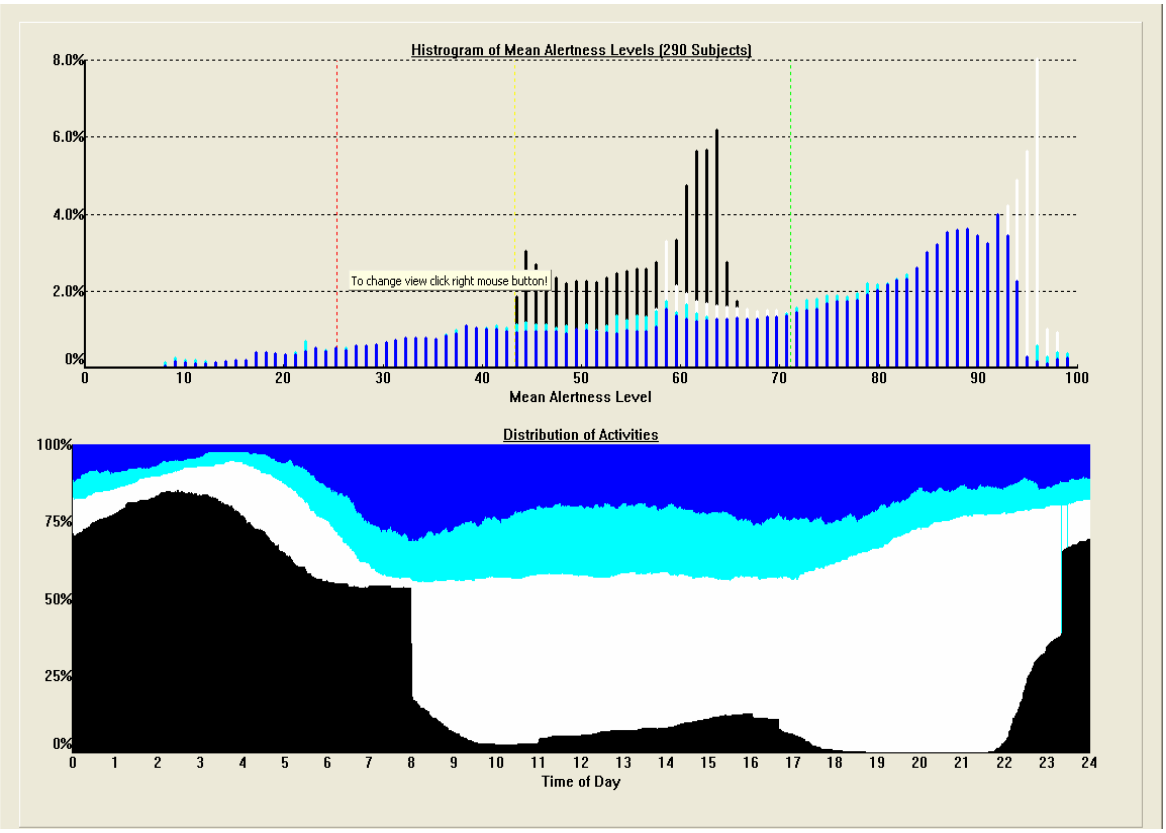
Schedule Management Data : All Conductors



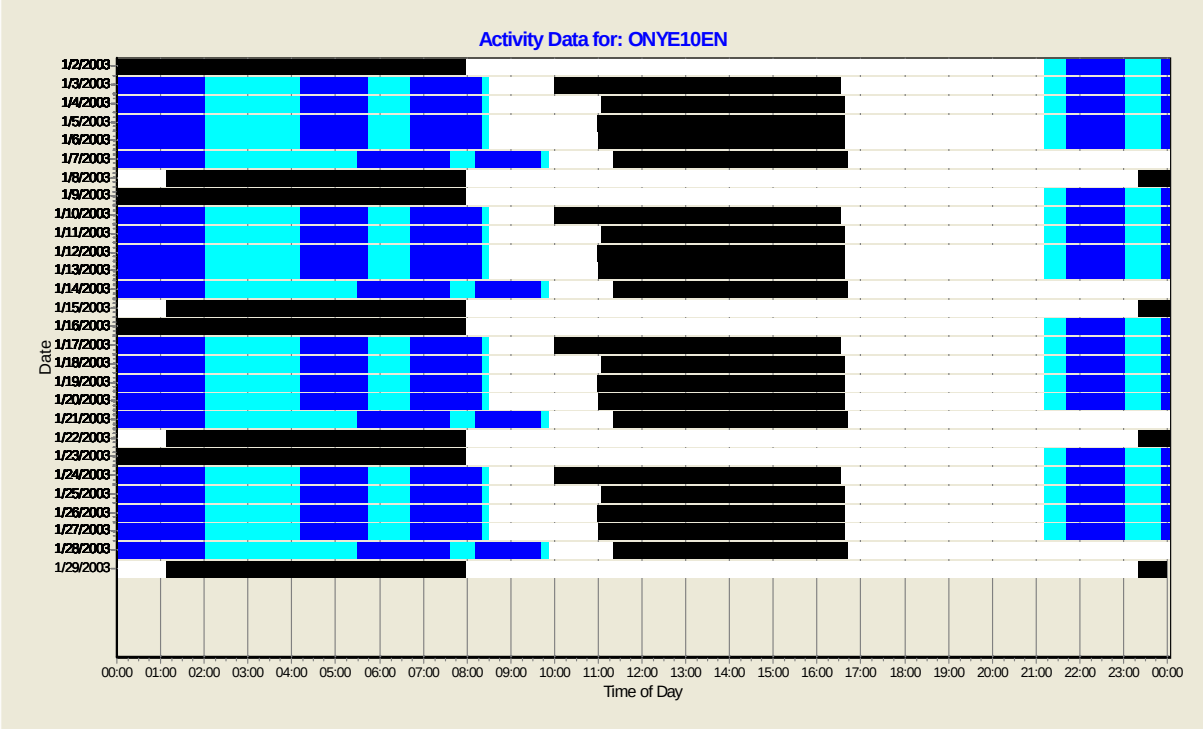


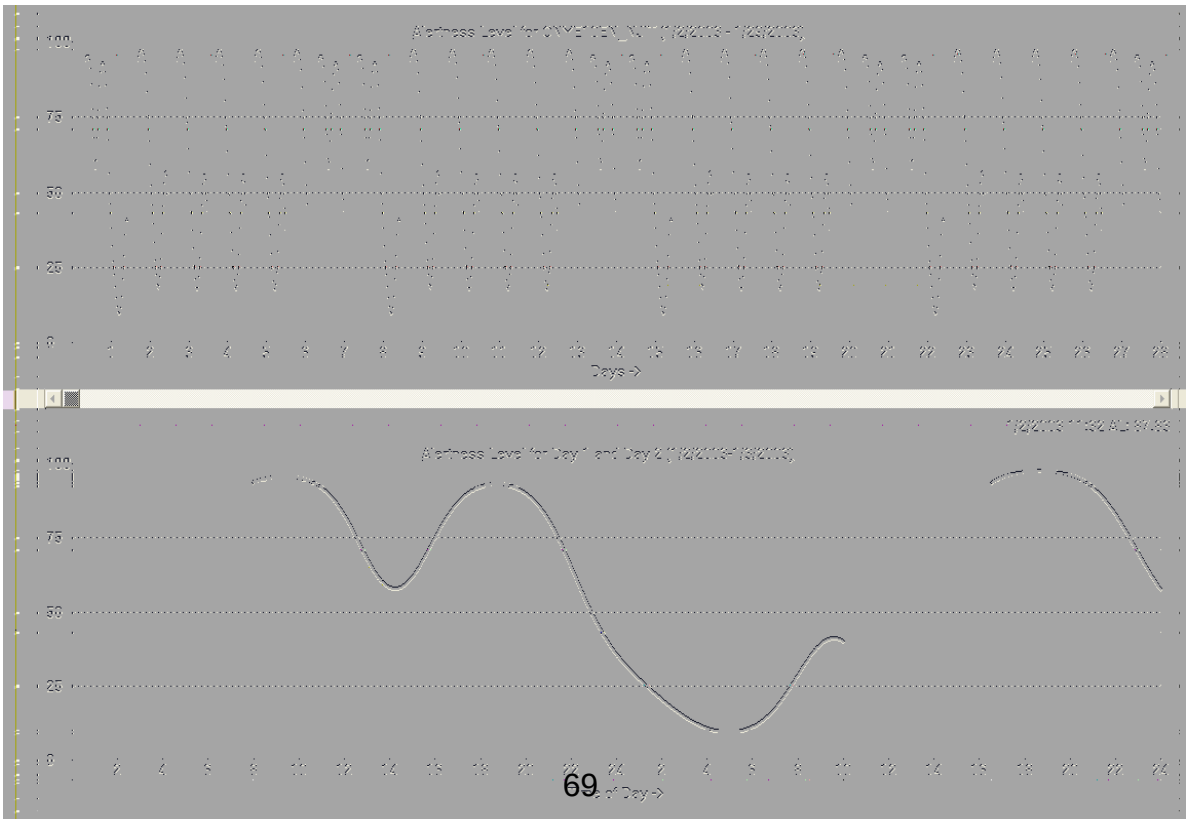


Schedule Management Data : All Conductors

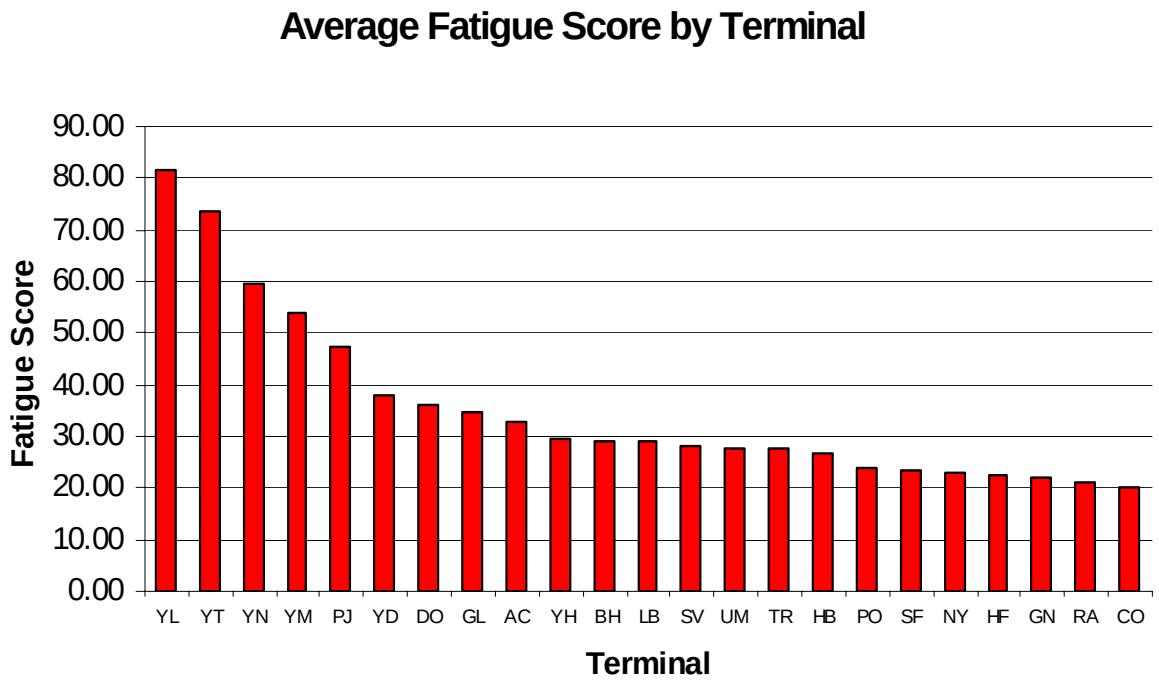


High Fatigue Index: ONYE10EN



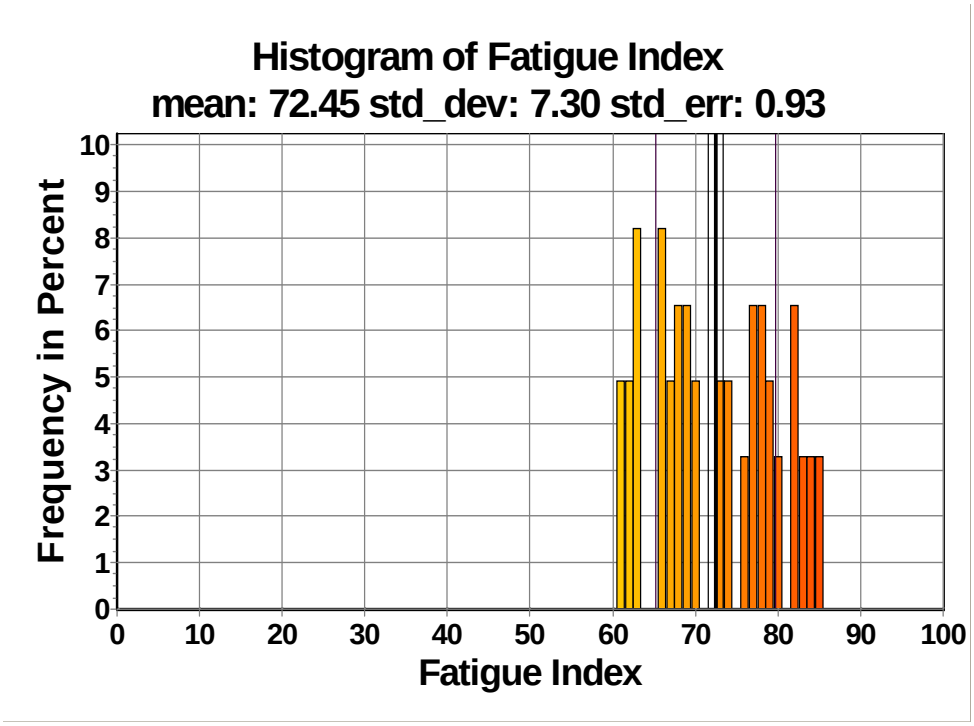


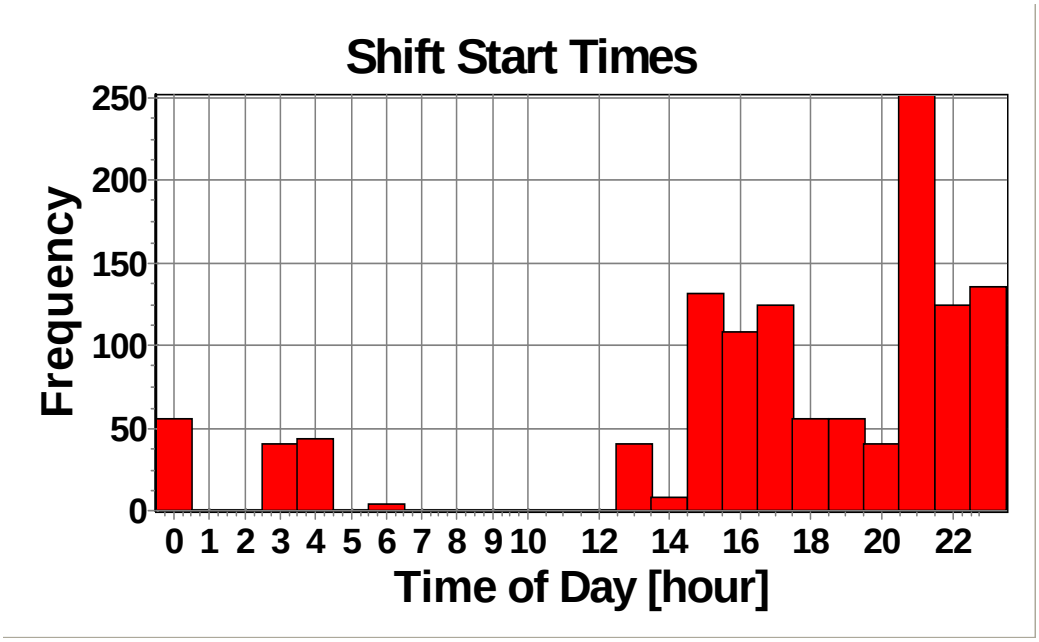
Average Fatigue Index by Terminal



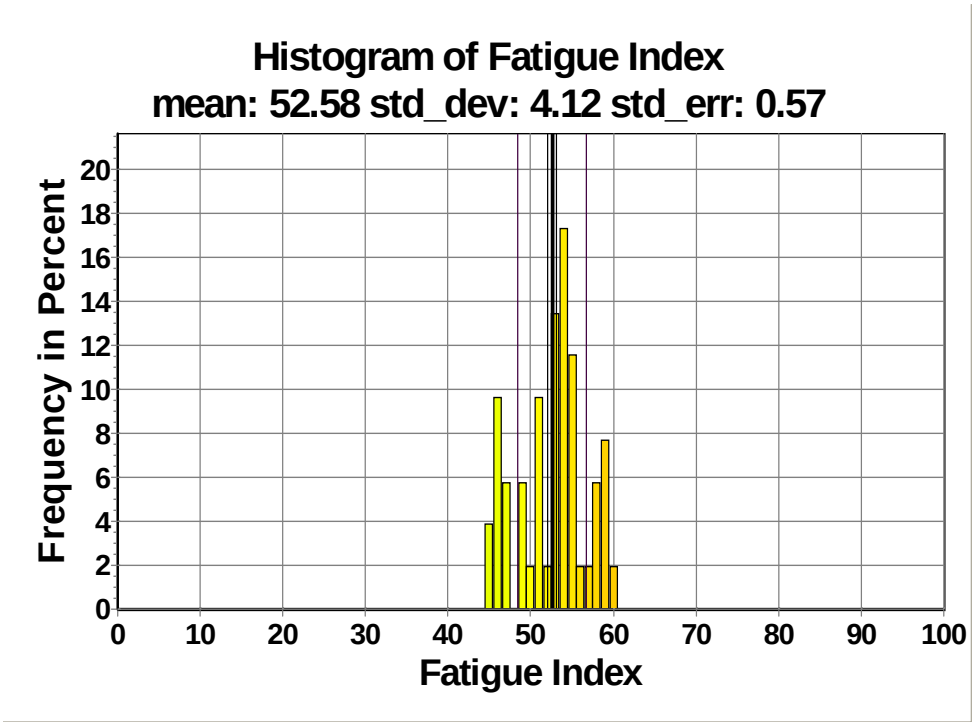
Combination of Engineers and Conductors

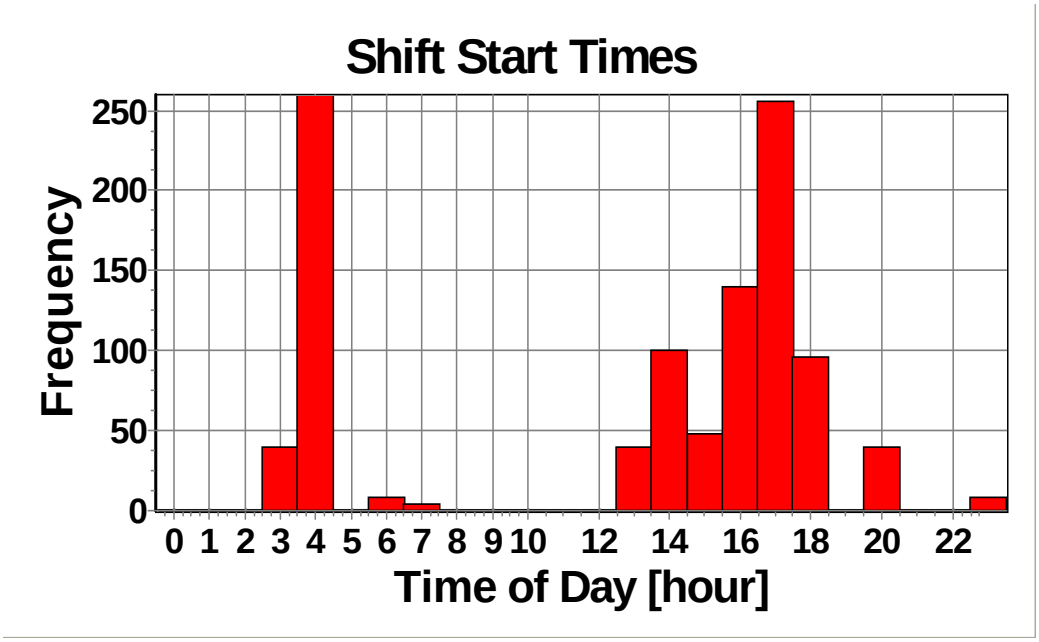
High Fatigue Assignments (>60)



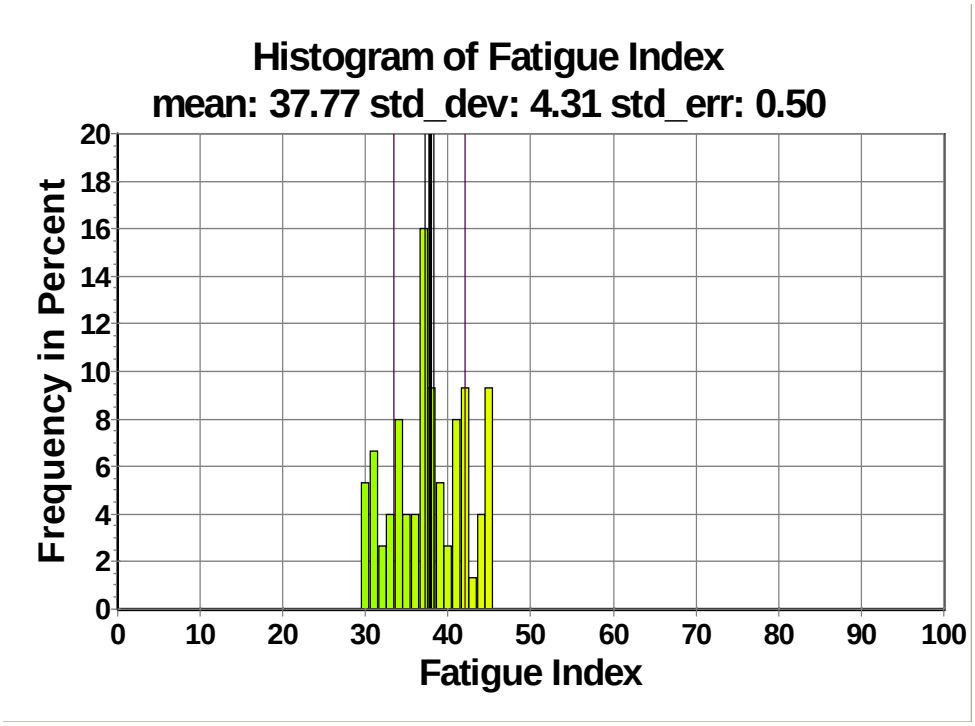


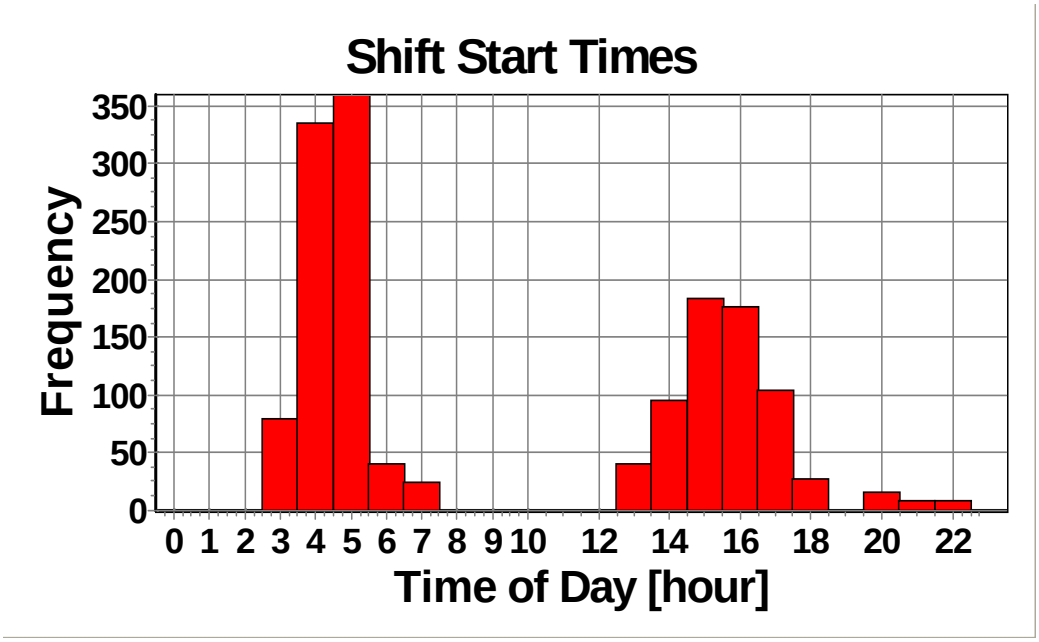
Medium High Fatigue Indices (45-60)



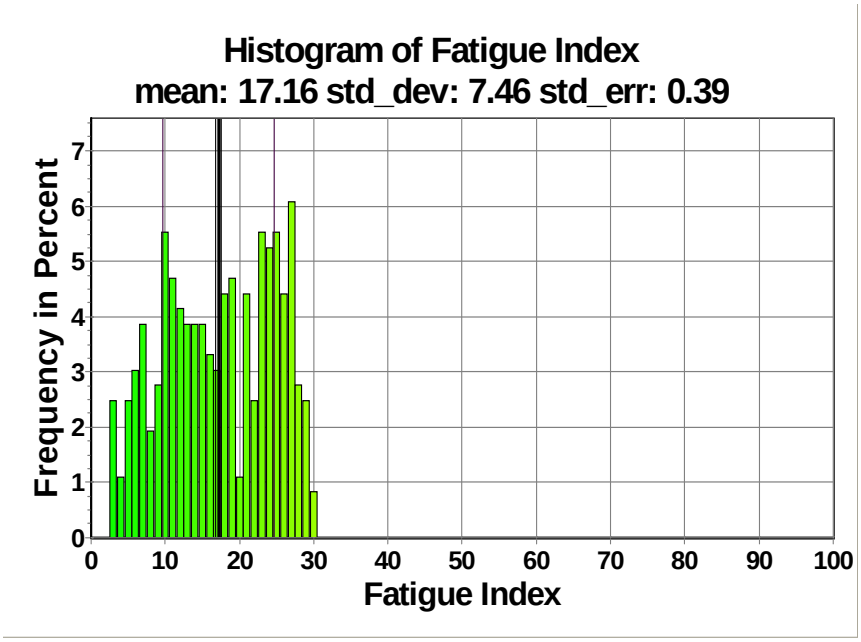


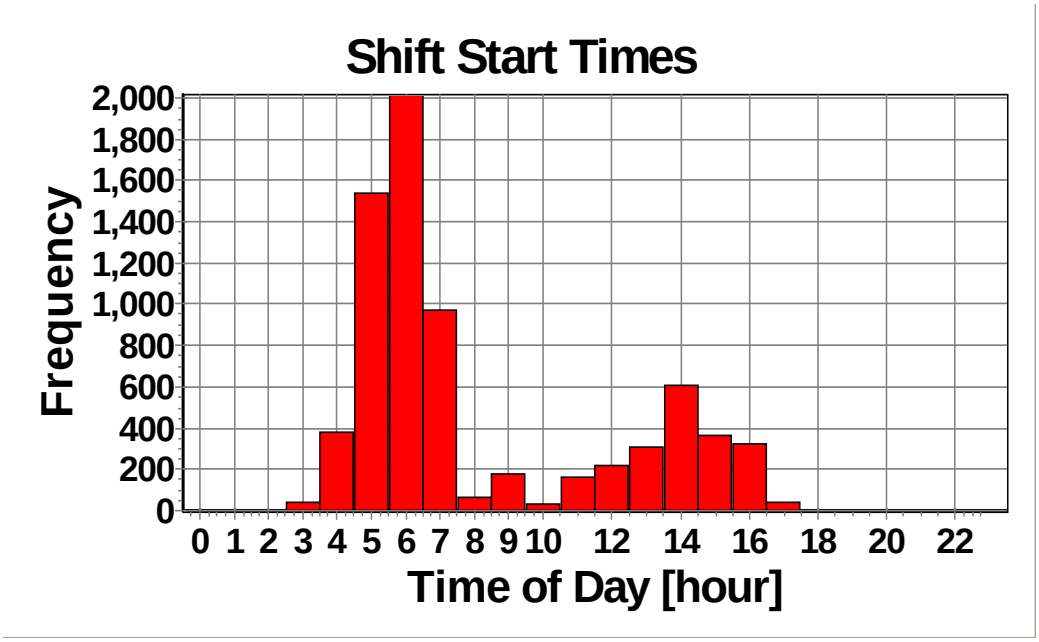
Medium Low Fatigue Indices (30-45)





Low Fatigue Indices (<30)



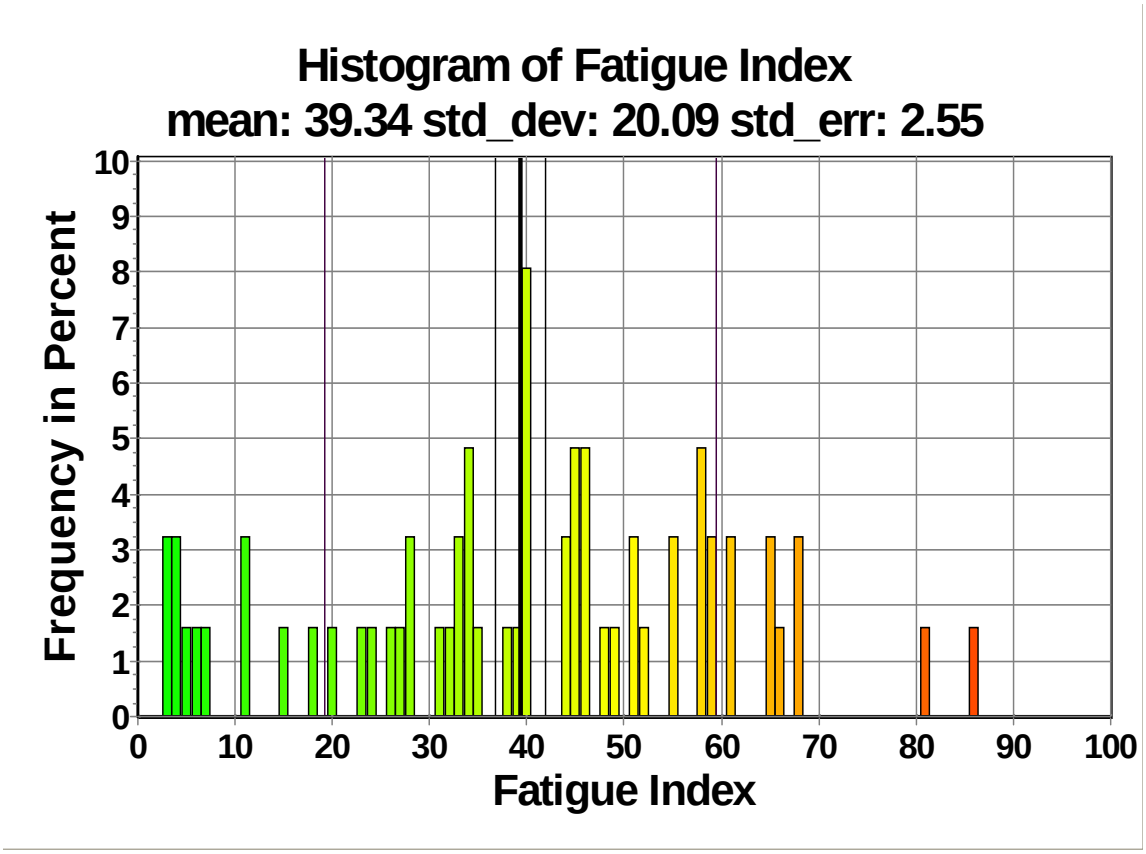


Extra Board

Summary of Results Overall – Extra Board

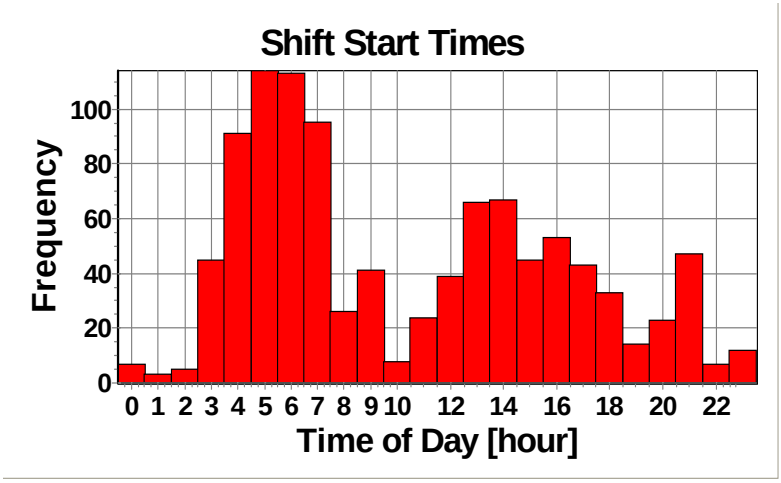
- The average fatigue index for extra board conductors was (all terminals) was 42.7
- The average fatigue index for extra board engineers was (all terminals) was 39.3
- The percentage of conductors and engineers with low fatigue indices (30 or lower) was 33%
- The percentage of conductors and engineers with high fatigue indices (60 or higher) was 19.6%

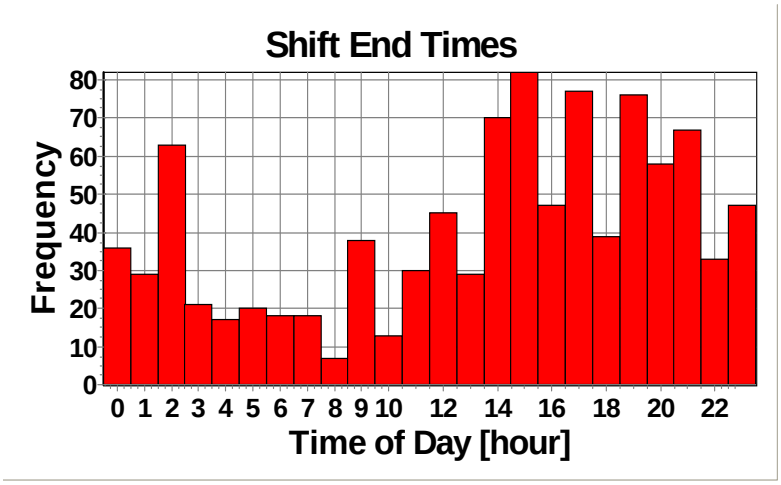
Distribution of Fatigue Indices for All Extra Board Engineers

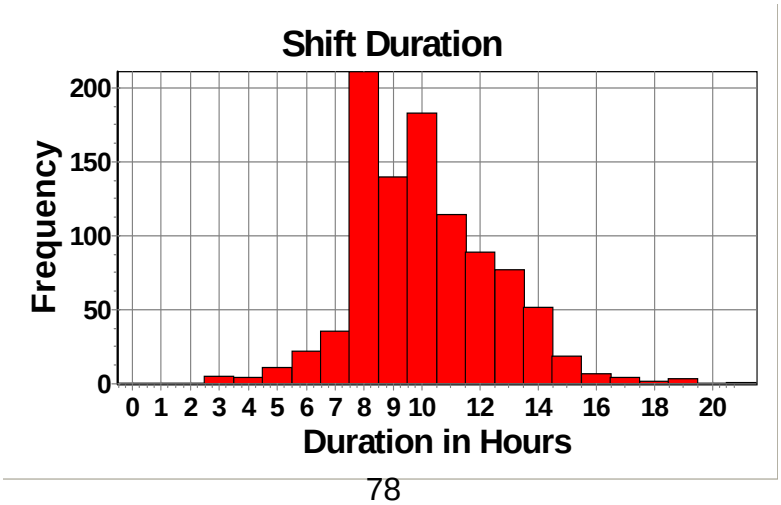


- Combination of all extra board engineer fatigue indices
- Low fatigue is less than 30, medium 30 to 60, and high over 60
- Y axis is percent of engineers who have that fatigue index

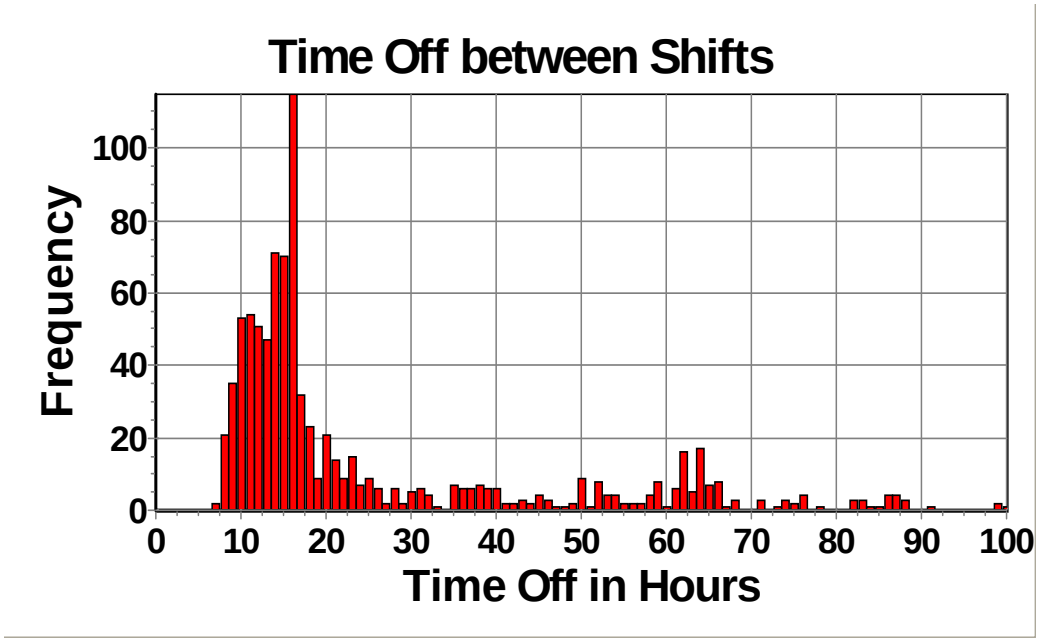
Schedule Management Data: All Extra Board Engineers

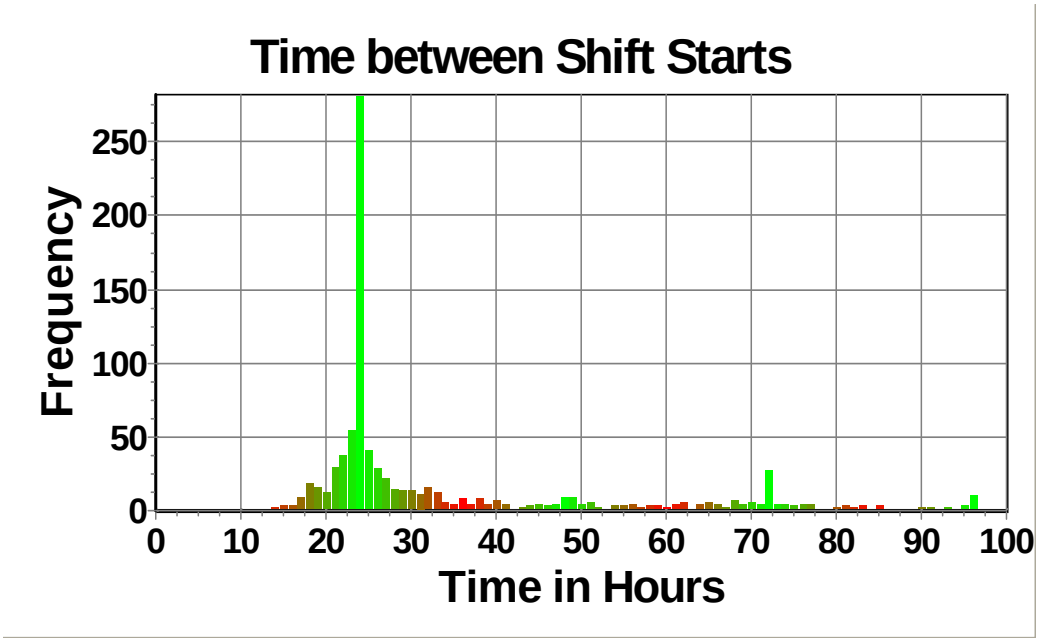




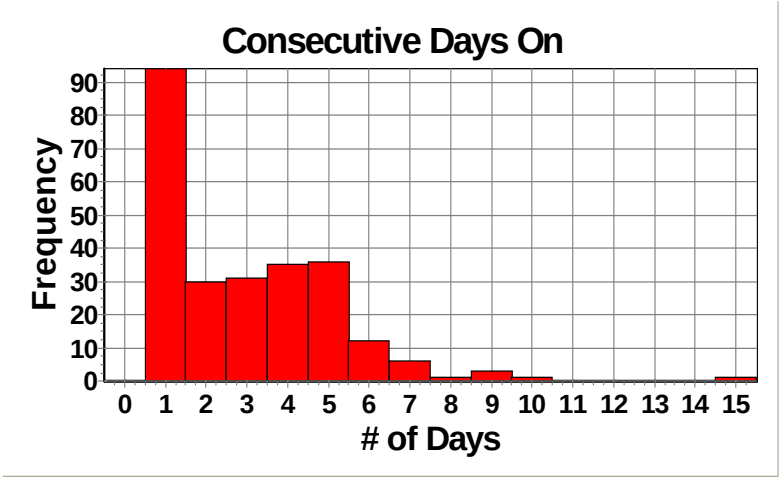


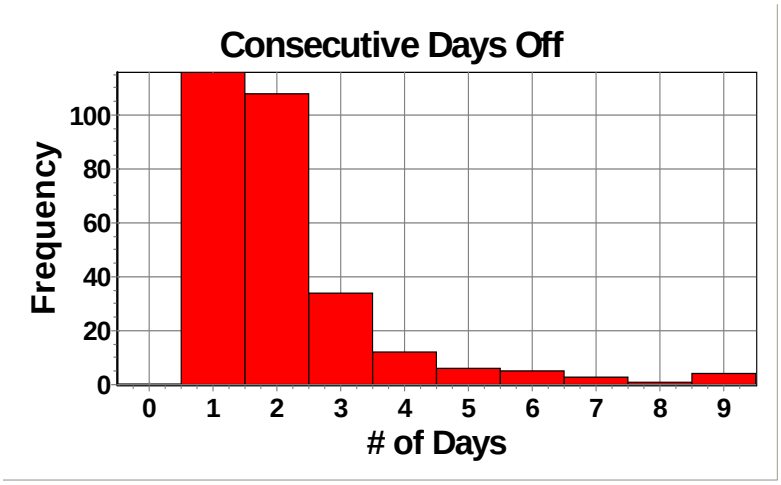
Schedule Management Data: All Extra Board Engineers

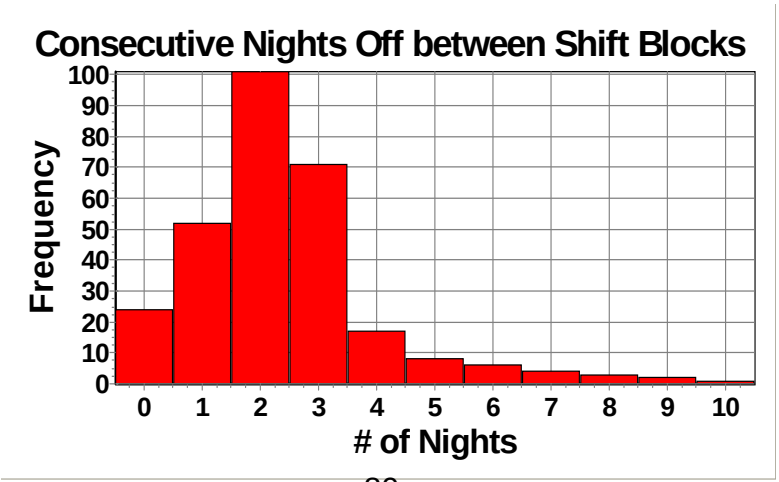




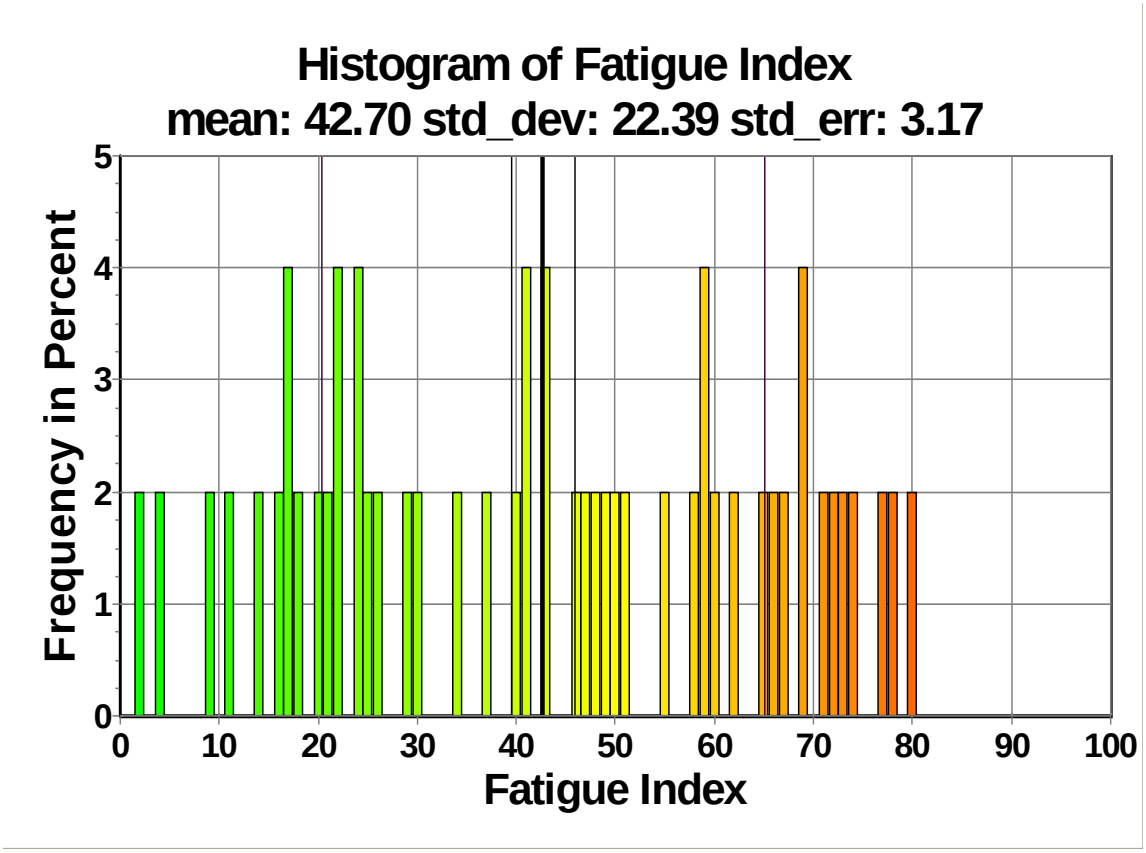
Schedule Management Data: All Extra Board Engineers



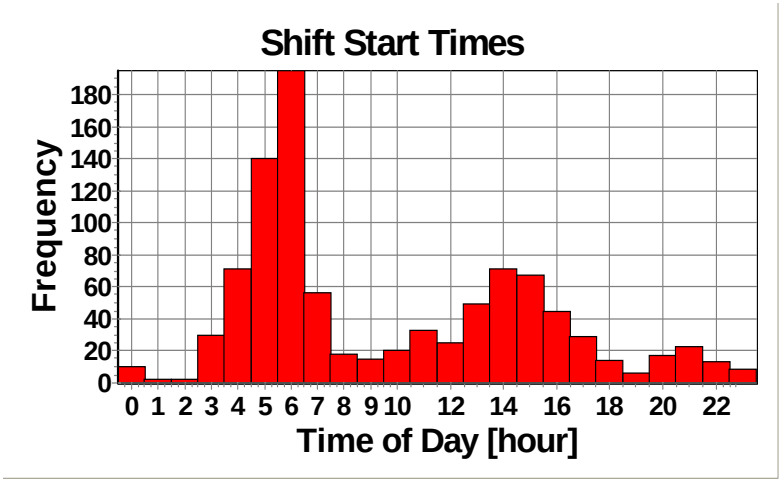


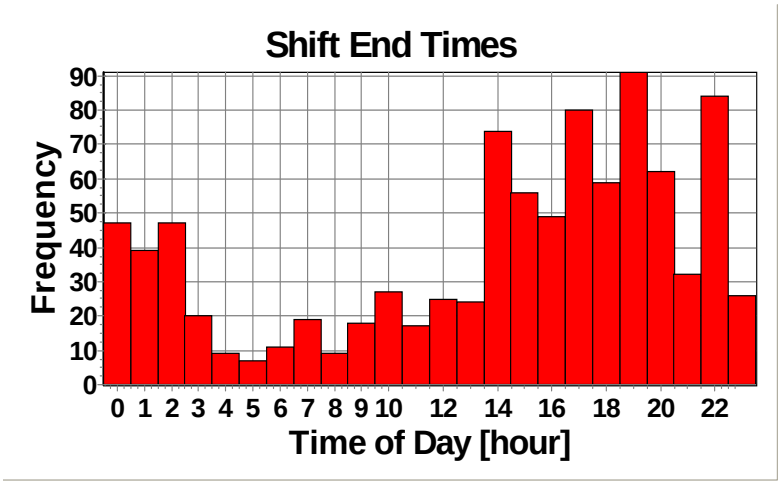


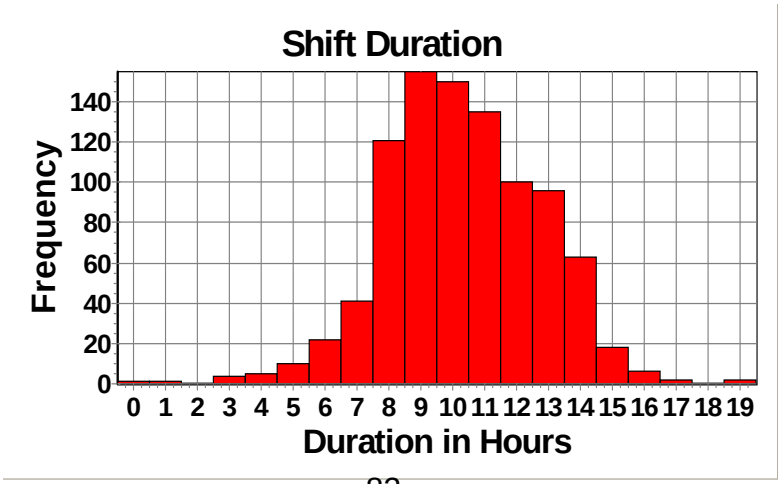
Distribution of Fatigue Indices for All Extra Board Conductors



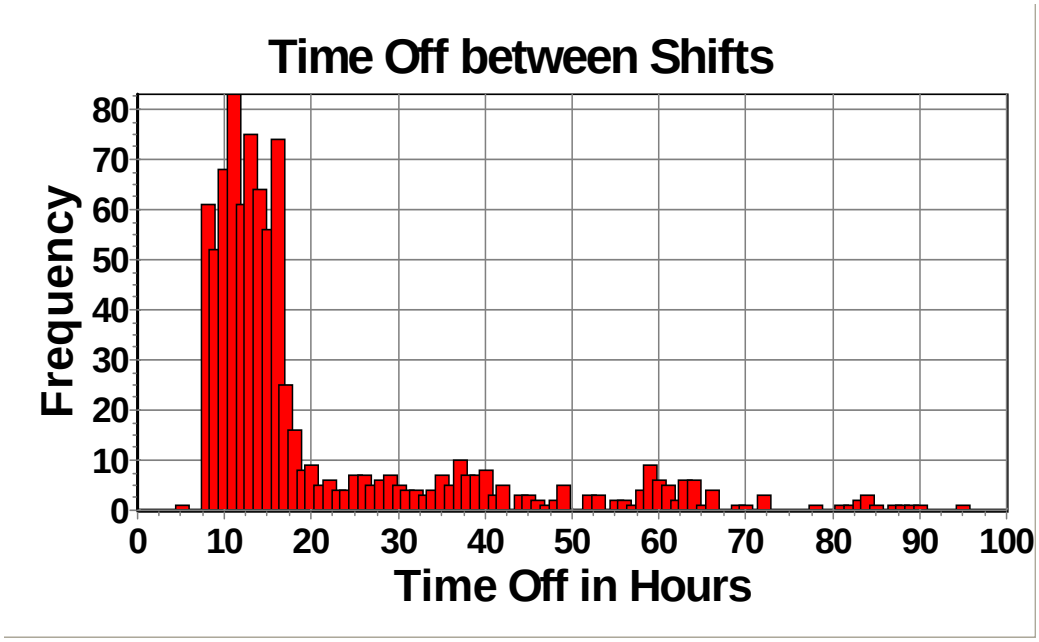
Schedule Management Data: All Extra Board Conductors

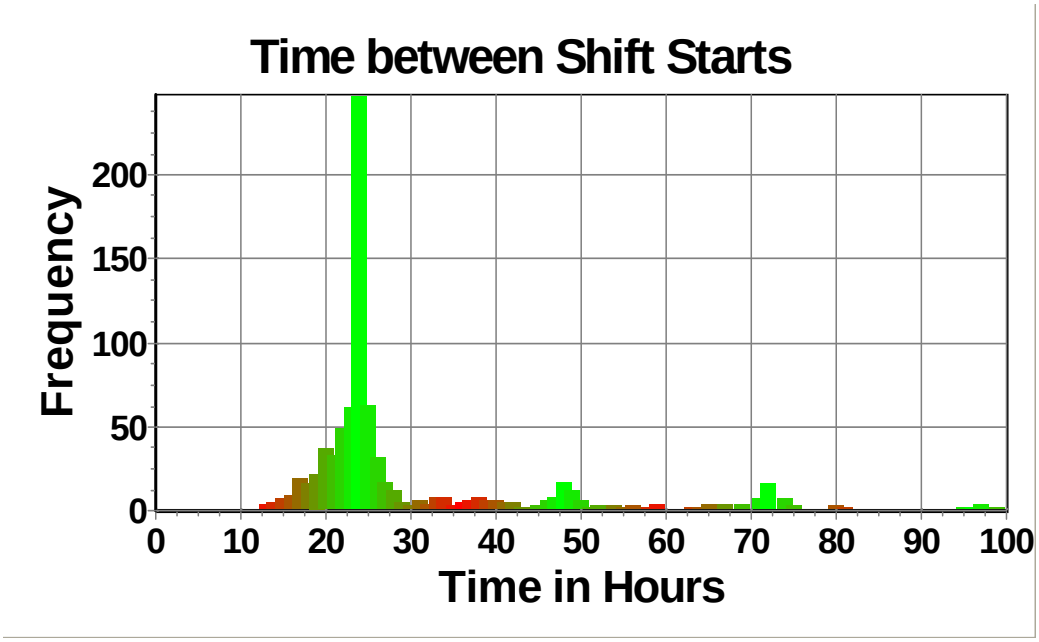




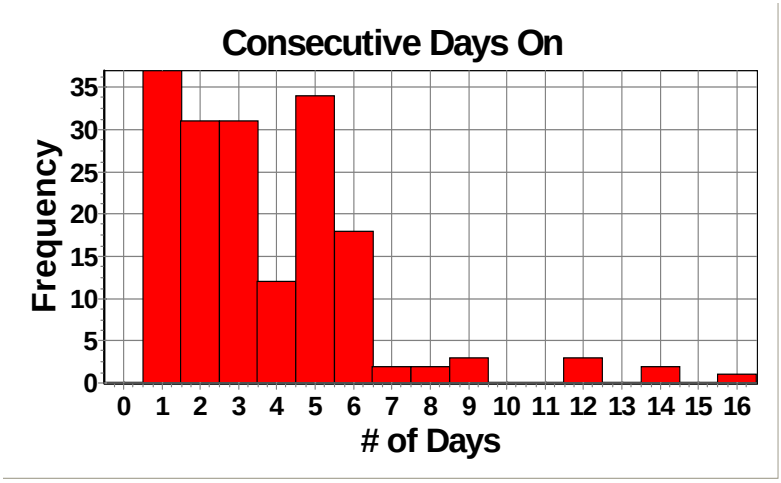


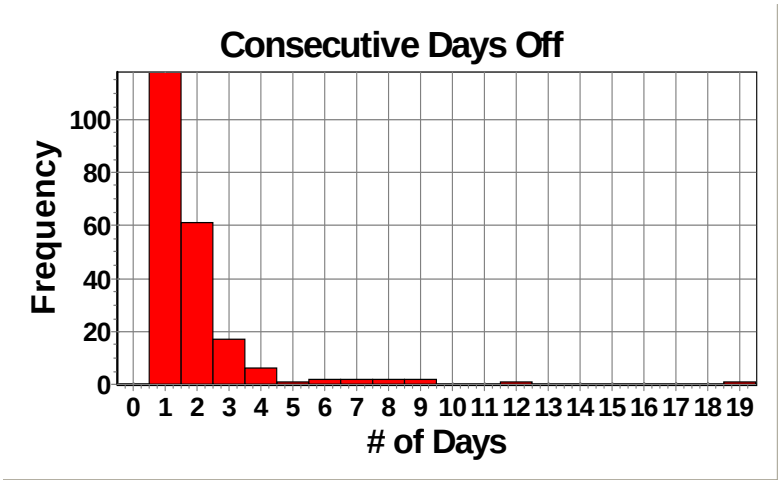
Schedule Management Data: All Extra Board Conductors

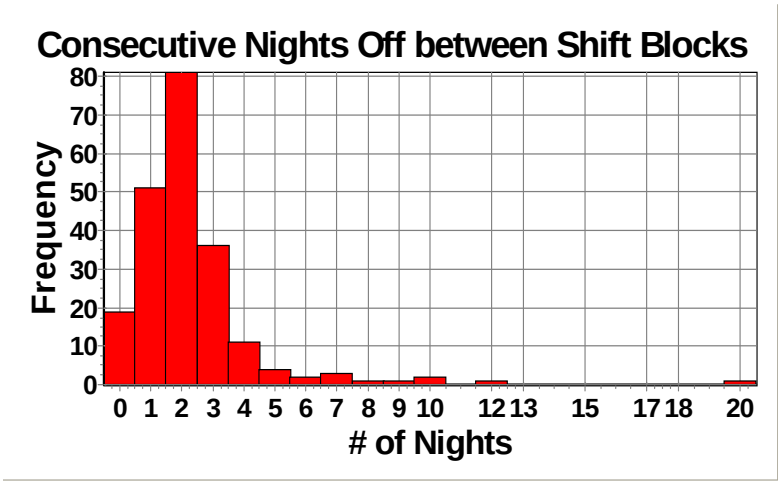




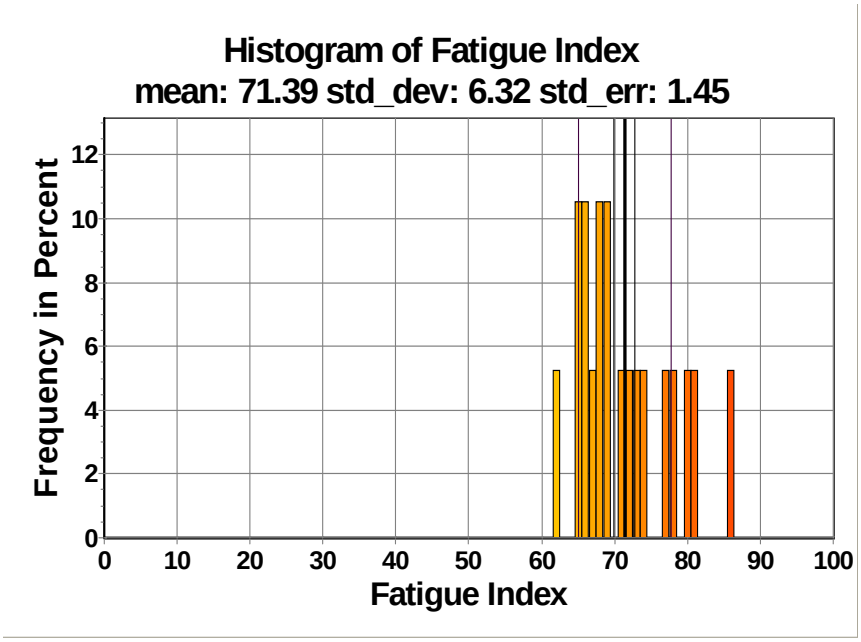
Schedule Management Data: All Extra Board Conductors

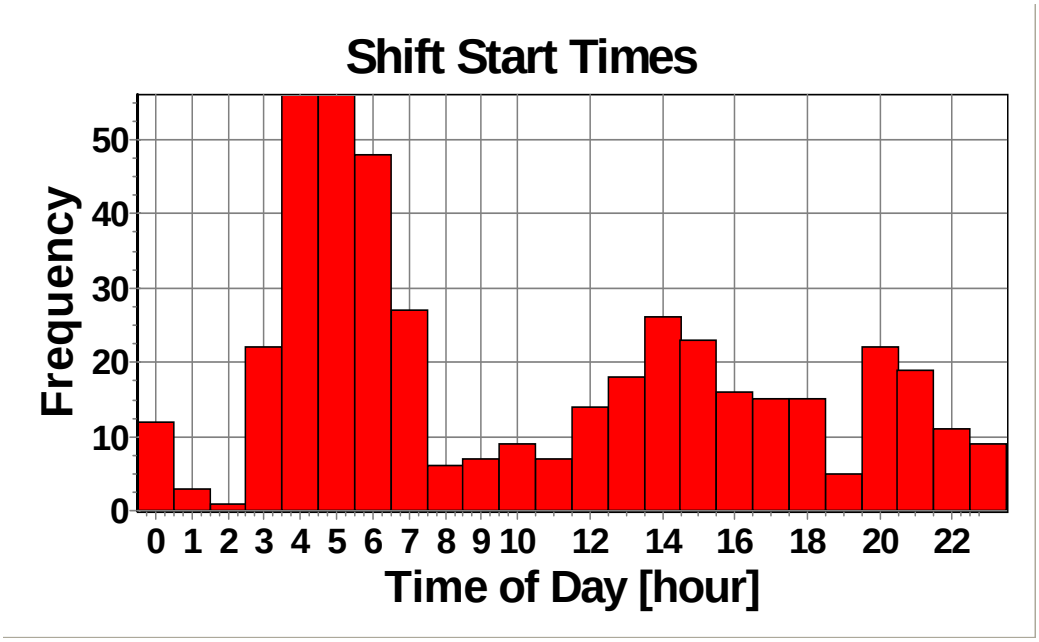




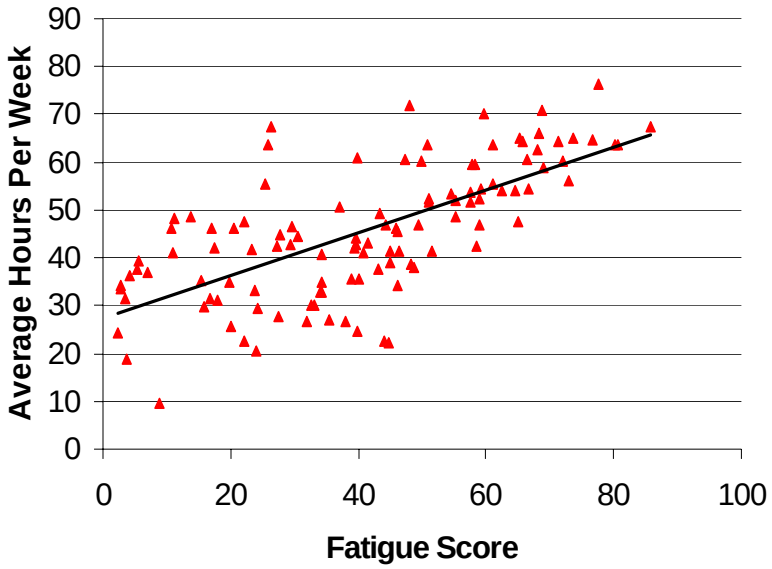


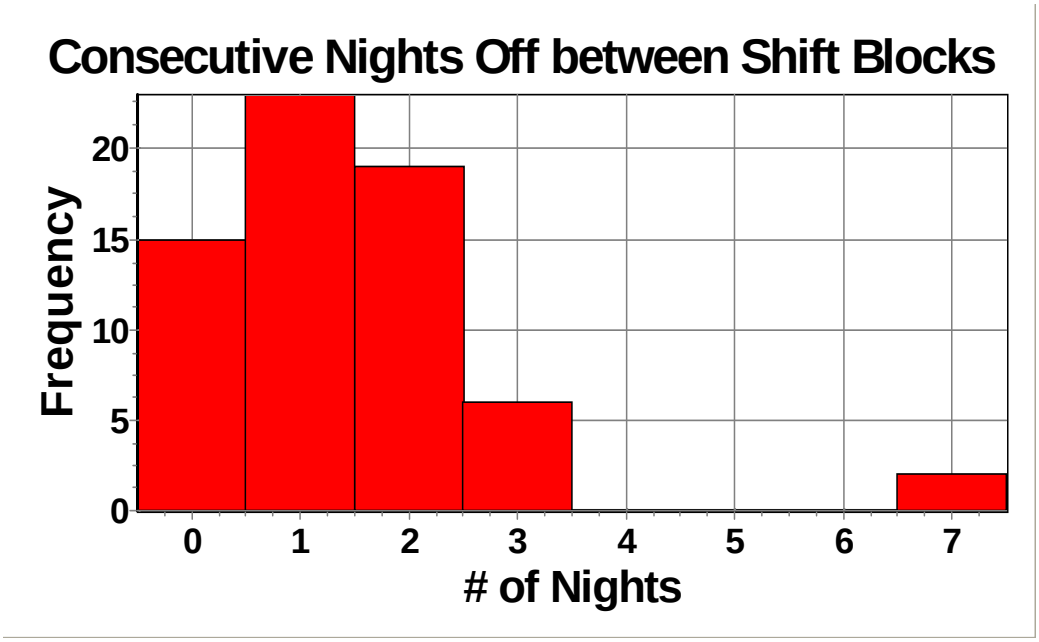
High Fatigue Indices (>60) Extra Board



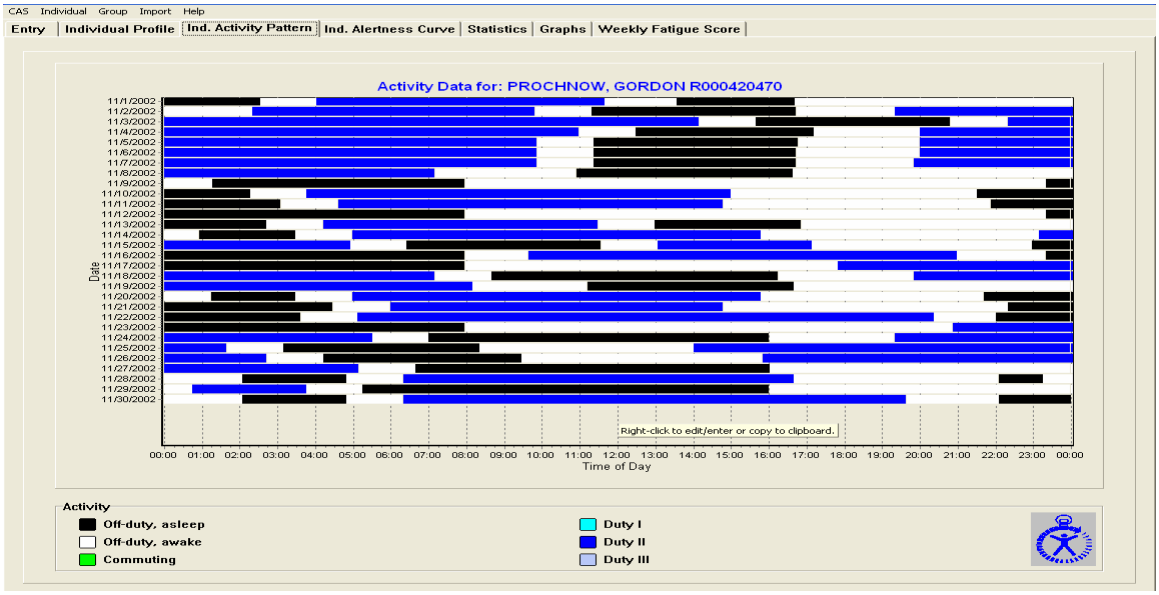


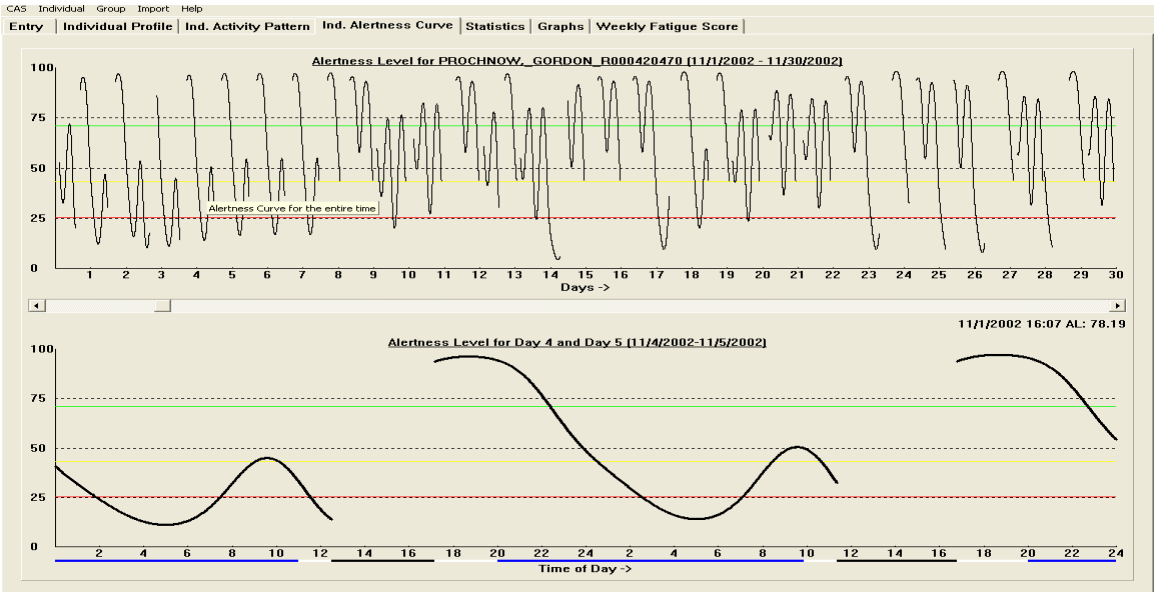
Fatigue Indices vs. Hours Worked



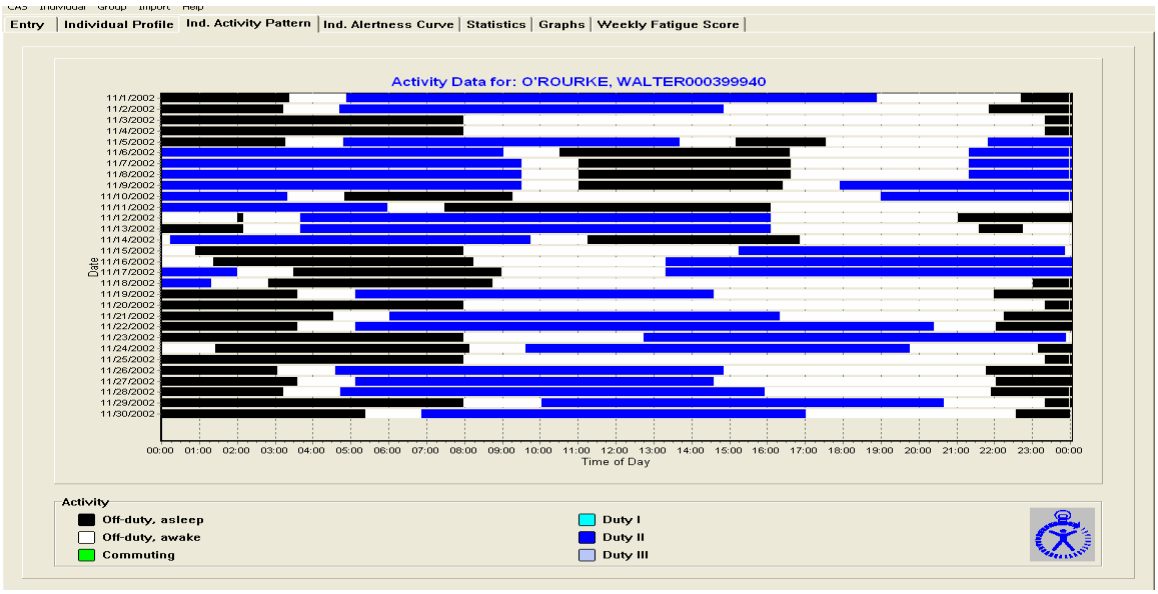


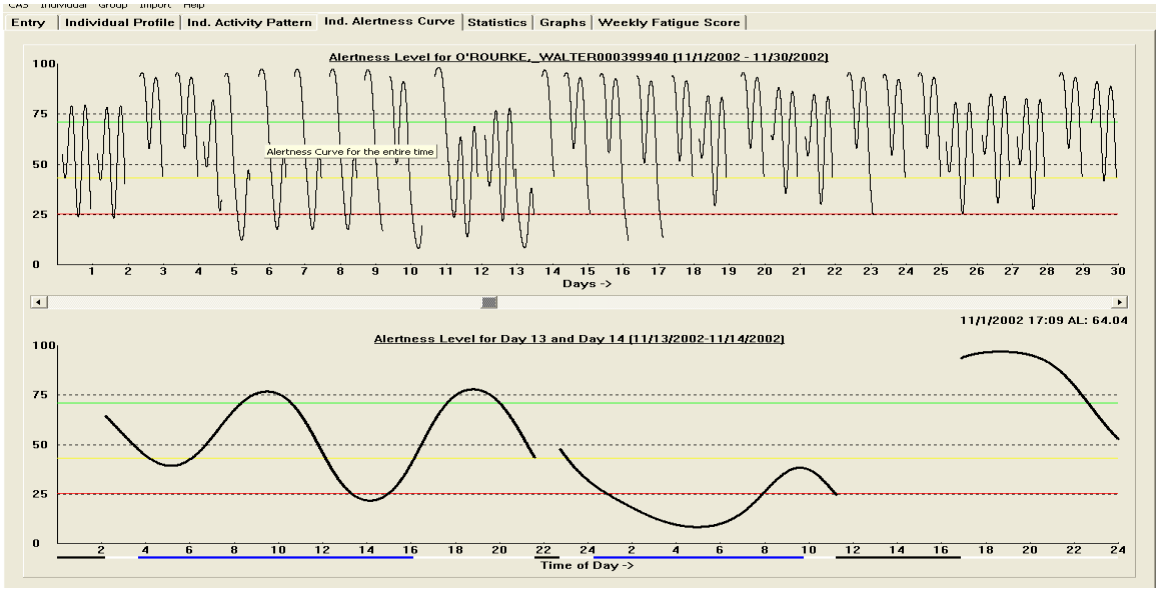
Prochnow Assignment Data





O'Rourke Assignment Data





Preliminary Findings

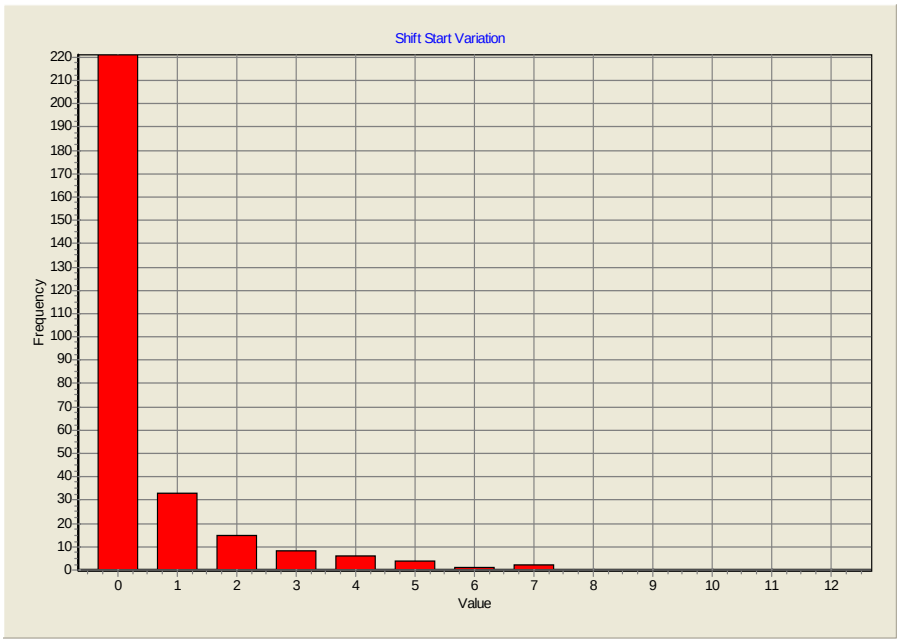
- Fatigue in regular assignment group arises mostly from overnight/early morning schedules.
- Fatigue in extra board likely arises from long work hours, variations in start time, lack of scheduled nights off (sometimes no nights off), and multiple days on.
- More research will determine this

Shift Start Time Variation

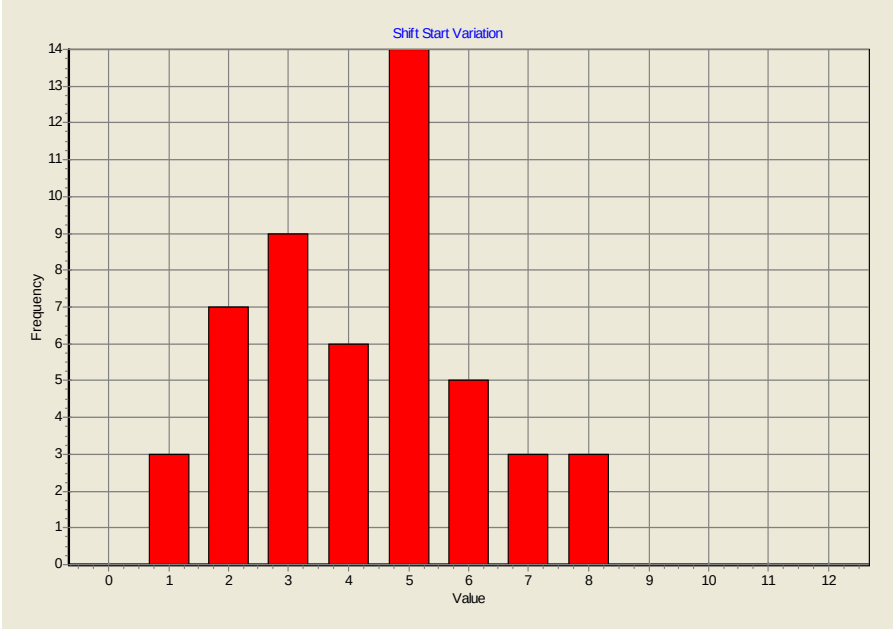
- Indicates variation of the start times for each shift over the month
- 12 is the worst and represents a constant switching of schedules from night to day, or morning to evening
- 0 is the best – no switching – a constant start time

Shift Start Time Variation

Regular Assignment Conductors

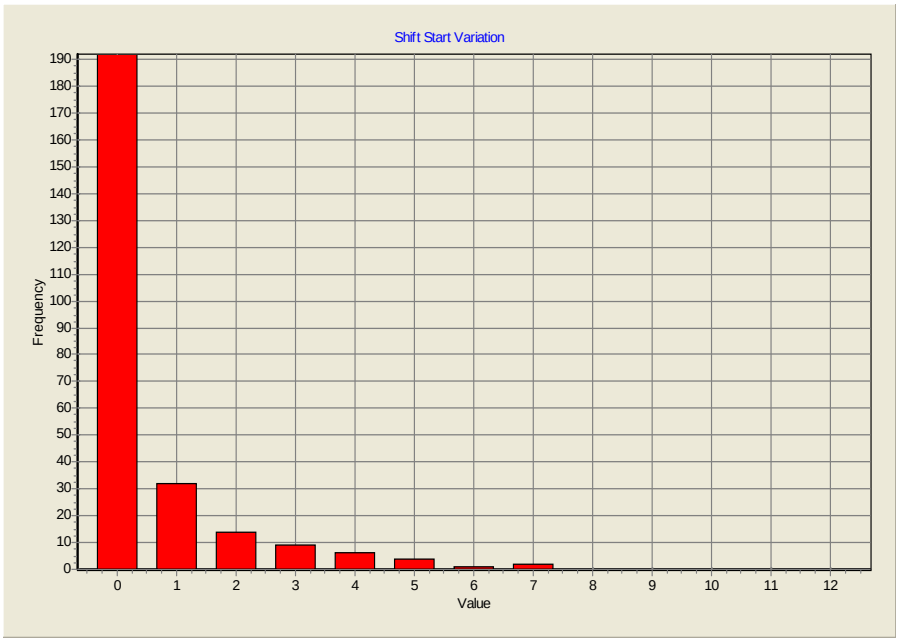


Extra Board Conductors

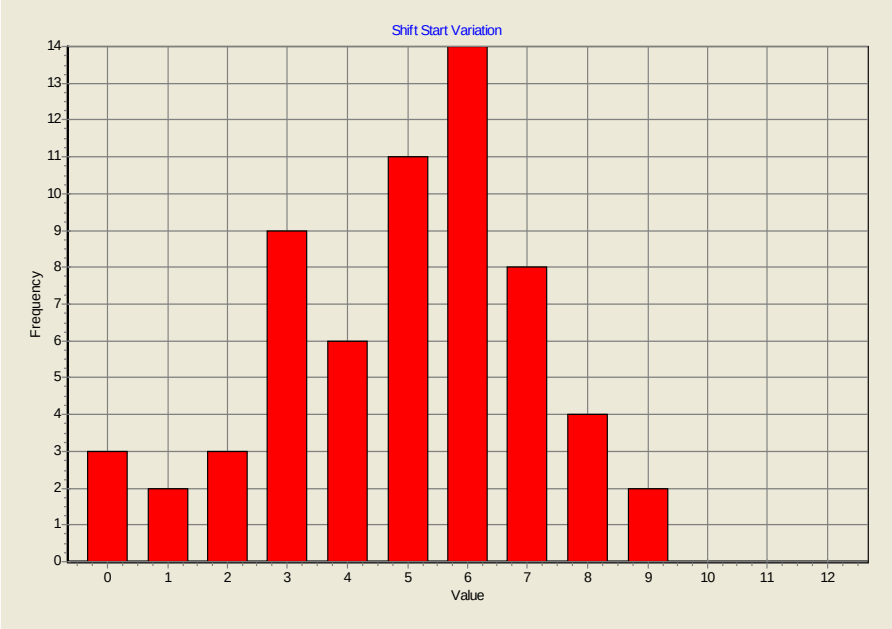


Shift Start Time Variation

Regular Assignment Engineers



Extra Board Engineers



APPENDIX C

Operator Survey and Summary of Results

The purpose of this **confidential** survey questionnaire is to find out how satisfactory the current schedule is to your needs, and what personal preferences you have in schedule features that you feel would be best for you. **There are no right or wrong answers,** only your personal experience, opinions, and feelings. This is your opportunity for personal input.

Please mark your computer answer sheet with a #2 pencil to indicate your best answer for each question. **Be sure that the number you answer on the score sheet matches the question number on the survey.**

There are separate pages for any comments you may wish to make about your schedule preferences and/or shiftwork in general. **When finished with the questionnaire, please put your comments sheet (if any) along with your computer answer sheet into the stamp-addressed envelope and mail it back to New Jersey Institute of Technology**.

All of the data you provide will be held in confidence by **New Jersey Institute of Technology**. **No one at NJTRANSIT will have any access to your individual survey sheets,** which will be kept in locked files. This is a condition that the company has agreed to because of the importance of addressing this issue. **Only group data will be reported back to you** and the company to show the overall response to each question.

Circadian Technologies, Inc.
24 Hartwell Ave.
Lexington,
MA 02421 USA

781-676-6900
or 800-284-5001 (ph)
781-676-6999 (fax)

GENERAL PERSONAL INFORMATION

1. What is your **gender**?
   - **A.** Female
   - **B.** Male

2. What is your **age**? (The first row is tens, the second in ones, so if you 35 years old, you would fill in the "3" in the first row and "5" in the second row)

3. What is your **height**? (The first row is in feet, the second in inches, so if you are 5'-10" you will fill in the "5" in the first row and "10" in the second row)

4. What is your **weight**? (The first row is hundreds, the second row in tens and the third row in ones, so if you weight 194 pounds you will fill in the "1" in the first row, "9" in the second row and "4" in the third row)

5. Question 5 intentionally left blank. Please skip.

JOB RELATED INFORMATION

6. What is your current job function?
   - **A.** Regular local passenger with no split shifts
   - **B.** Regular local passenger **with** split shifts
   - **C.** Regular Yard Service
   - **D.** Extra-List

7. What is your current job title?
   - **A.** Assistant Conductor
   - **B.** Conductor
   - **C.** Locomotive Engineer Trainee
   - **D.** Locomotive Engineer
   - **E.** Yard Master

8. Are you registered on the supplemental list?
   - **A.** Yes
   - **B.** No

9. If you were on the supplemental list, how many times were you called in the last month? (leave blank if you were not on the list)
   - **A.** 1 or 2 times
   - **B.** 3 or 4 times
   - **C.** 5 or 6 times
   - **D.** 7 or 8 times
   - **E.** More than 9 times

10. What type of locomotive do you mostly work on?
    - **A.** Arrows
    - **B.** Diesel
    - **C.** Electric
    - **D.** Cab Cars
    - **E.** All Different Types

11. How many years have you been working in the transit/railroad industry?
    - **A.** Less than 1 year
    - **B.** 1 year or more, but less than 5 years
    - **C.** 5 years or more, but less than 10 years
    - **D.** 10 years or more, but less than 15 years
    - **E.** 15 years or more

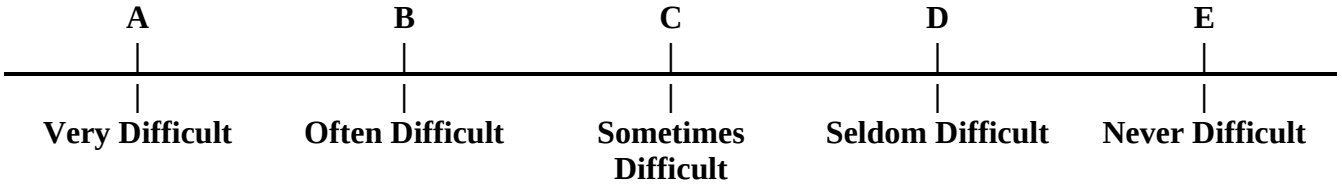
12. How many years have you been working shiftwork at NJTRANSIT?
    - **A.** Less than 1 year
    - **B.** 1 year or more, but less than 5 years
    - **C.** 5 years or more, but less than 10 years
    - **D.** 10 years or more, but less than 15 years
    - **E.** 15 years or more

13. What time do you usually start work?
    - **A.** Early Morning (4:01 AM to 7AM)
    - **B.** Day (7:01AM to 6PM)
    - **C.** Evening (6:01PM to 11PM)
    - **D.** Night (11:01PM to 4AM)
    - **E.** Start time changes frequently

14. How many **minutes** does it take you to get to work "**one way**"?
    - **A.** 1-14
    - **B.** 15-29
    - **C.** 30-44
    - **D.** 45-59
    - **E.** 60 or more

RATING YOUR CURRENT SCHEDULE

For questions 15-18, mark your response according to the scale below:



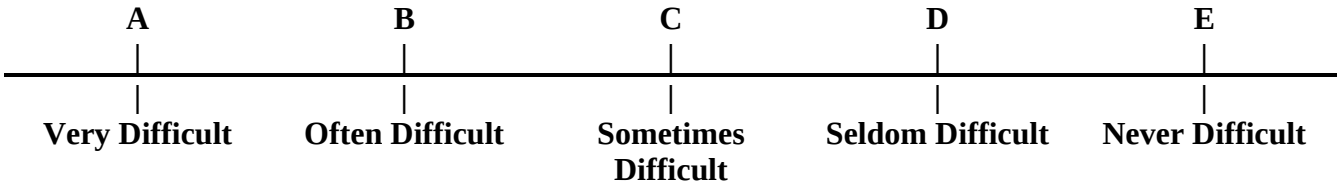
15. Scheduling childcare / elderly care.

16. Taking educational courses.

17. Attending family or social events.

18. Maintaining a positive disposition.

For questions 19-26, mark your response according to the scale below:



19. Fulfilling domestic / household responsibilities.

20. Attending religious services.

21. Having adequate time for entertainment and recreational activities.

22. Getting sufficient quantity of sleep.

23. Getting good quality of sleep.

24. Staying alert while working.

25. Doing your job safely.

26. Fighting fatigue or drowsiness on the job.

27. This question intentionally left blank. Please skip.

For questions 28-34, mark your response according to the scale below:

A	B	C	D	E
Always a problem	**Often a problem**	**Sometimes a problem**	**Infrequently a problem**	**Never a problem**

28. Length of your current shifts?

29. Number of workdays in a row?

30. Days on and off pattern of your current schedule?

31. Amount of weekend time off you are currently getting?

32. Number of scheduled days off you are currently getting (excluding overtime)?

33. Length of scheduled breaks (in-between blocks of work days)?

34. Need to come in on a scheduled day off (for training, on-call responsibilities, etc.)?

For questions 35-38, mark your response according to the scale below:

A	B	C	D	E
Very High	**High**	**Moderate**	**A little**	**Not at all**

35. How **mentally demanding** is your job?

36. How **physically demanding** is your job?

37. How **monotonous or boring** is your job?

38. How **fatiguing** is your job?

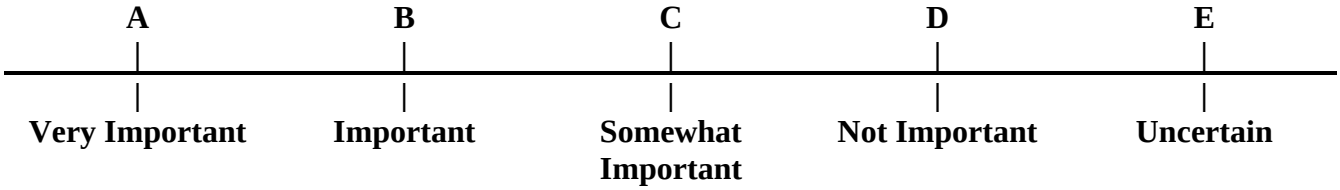
39. How many days during the past year were you called in to work on your scheduled days off?
    - **A.** 0
    - **B.** 1-9
    - **C.** 10-19
    - **D.** 20-29
    - **E.** 30 or more

40. How **well adjusted** are you to your **current shift schedule**?
    - **A.** Poorly adjusted (having lots of problems)
    - **B.** Getting by
    - **C.** Slightly adjusted
    - **D.** Well adjusted
    - **E.** Very well adjusted (having no problems)

SCHEDULE FEATURES

These questions will help you to sort out the shift schedule features that are most important to you, and thus provide the criteria for designing new schedule alternatives.

For questions 41-44, mark your response according to the scale below:



41. How important is it for you to have a schedule that gives you the most days off possible?

42. How important is it for you to minimize the number of consecutive shifts worked?

43. How important is it for you to maximize the total number of full weekends off (i.e. both Saturday and Sunday) you receive each year?

44. How important is it for you to maintain consistent starting times in a given workweek?

45. Concerning days off, which would you prefer?
    - **A.** Have each break about the same length
    - **B.** Have one longer break per cycle

46. I would prefer that all jobs be consecutive hours rather than being split into two blocks:
    - **A.** Strongly Agree
    - **B.** Agree
    - **C.** No Preference
    - **D.** Disagree
    - **E.** Strongly Disagree

47. Would you prefer relatively fixed start times or rotating start times?
    - **A.** Fixed (always work the same schedule)
    - **B.** Rotating (Schedule change weekly, bi-weekly or monthly)
    - **C.** No Preference

48. In general, how would you rate the amount of time you spend between split shifts (don't answer if you do not work split shifts)
    - **A.** Far too long
    - **B.** More than enough
    - **C.** Enough
    - **D.** Not enough
    - **E.** Far too little

49. When working a split job, where do you nap between jobs?
    - **A.** Napping rooms at terminal
    - **B.** Home
    - **C.** Don't usually nap
    - **D.** Other place

50. What is your preferred type of job?
    - **A.** Days
    - **B.** Afternoons
    - **C.** Nights
    - **D.** Splits

51. I would consider alternative schedules that are physiologically better and allow me to get better sleep.
    - **A.** Strongly Agree
    - **B.** Agree
    - **C.** No Preference
    - **D.** Disagree
    - **E.** Strongly Disagree

HEALTH ISSUES

This section seeks to identify health issues that may impact fatigue. Please note that the responses are being conveyed directly to the New Jersey Institute of Technology and the information provided to us would be used strictly for research purposes. Please be assured that responses to questions in this or any other section of the survey will be held in the strictest confidence. Information that could link responses to specific individuals would not, under any circumstances, be released to NJ TRANSIT, the New Jersey Department of Transportation or any other outside parties. We ask that you please answer as many questions as you are willing or able.

For questions 52-56 below, please use the scale to indicate your typical consumption of each medication.

A	B	C	D	E
Daily	**Several times/week**	**Once/week**	**Several times/month**	**Seldom, if ever**

52. Antacids or prescribed medication for indigestion, heartburn or ulcers

53. Stimulants (i.e., No-Doz, Vivarin, Amphetamines, etc.)

54. Depressants (i.e., Valium, Melatonin, sleeping pills, etc.)

55. Pain Relievers (i.e., Tylenol, Aspirin, Advil, Motrin, etc.)

56. Cold or Allergy Tablets (i.e., Seldane, Dristan, Histapan, Allerest, etc.)

For questions 57-62, mark your response according to the scale below:

A	B	C	D	E
0	**1 - 3**	**4 - 6**	**7 - 9**	**10 or more**

57. During a typical day shift, how many 12 oz. cups or cans of caffeinated beverages do you drink on average? (Only answer if you work this shift)

58. During a typical evening shift, how many 12 oz-cups or cans of caffeinated beverages do you drink on average? (Only answer if you work this shift)

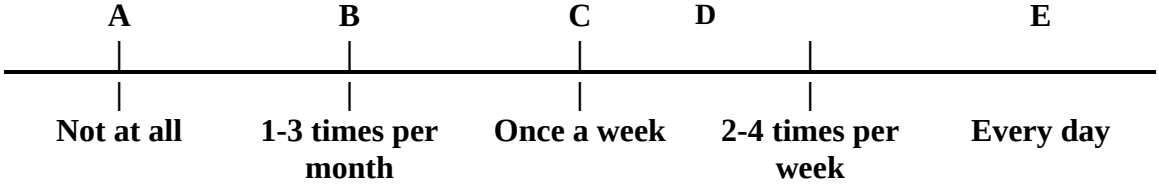
59. During a typical night shift, how many 12 oz. cups or cans of caffeinated beverages do you drink on average? (Only answer if you work this shift)

60. During a typical 24-hour period when you are not working, how many 12 oz. cups or cans of caffeinated beverages (i.e., coffee, tea, soda, etc.) do you drink on average?

61. During a typical 24-hour period when you are not working, how many alcoholic beverages do you drink on average?

62. During a typical 24-hour period when you are working, how many alcoholic beverages do you drink on average?

For questions 63-70, please use the scale below to indicate if you have experienced any of the following in the past 3 months:



63. Disturbed appetite

64. Having to watch what you eat to avoid stomach upsets?

65. Feeling nauseous

66. Heartburn

67. Indigestion

68. Bloated stomach or gas

69. Constipation or diarrhea

70. Abdominal pain

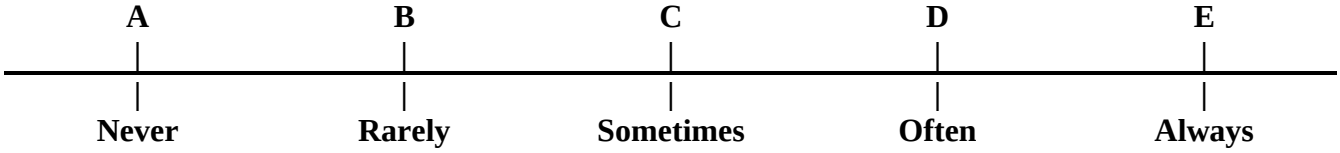
71. Are you currently on any formal weight reduction or medical diet program?
    - **A.** Yes
    - **B.** No

72. Are you aware of how nutrition, diet, and eating practices relate to working shiftwork?
    - **A.** I am not aware of what proper shiftwork nutrition should be
    - **B.** I am aware but don't have good dietary practices for shiftwork
    - **C.** I am aware and I do have good dietary practices for shiftwork

73. How often do you exercise (i.e., cardiovascular activities such as brisk walking, jogging, etc.)?
    - **A.** Never
    - **B.** Once per week
    - **C.** 2-3 times per week
    - **D.** Every day

74. How many years have you used tobacco products?
    - **A.** Never
    - **B.** 1
    - **C.** 2-12
    - **D.** 13-25
    - **E.** 26 or more

For questions 75-82, please use the scale below to indicate your appropriate response:



75. I am told I snore loudly and bother others

76. I am told I stop breathing or hold my breath while asleep

77. I awake suddenly gasping for breath, unable to breathe

78. I sweat a great deal while sleeping

79. I have high blood pressure

80. I have a problem with my nose blocking up when I am trying to sleep

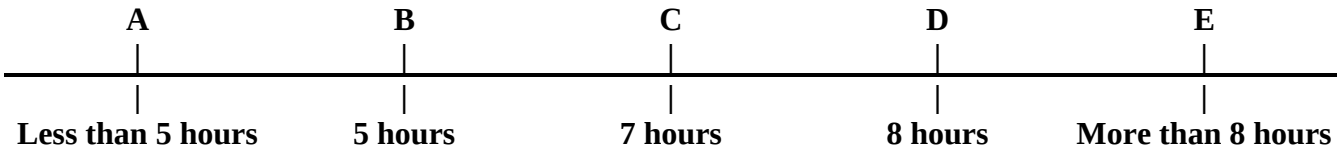
81. My snoring or breathing problem is much worse if I sleep on my back

82. My snoring or breathing problem is much worse if I fall asleep right after drinking alcohol

SLEEP AND FATIGUE ISSUES

The following questions will provide information about how your quantity and quality of sleep relate to your current shift schedules.

For questions 83 – 87, please use the scale below to indicate your appropriate response.



83. How many hours of sleep per 24-hour period (in general) do you feel you need to be alert and well rested?

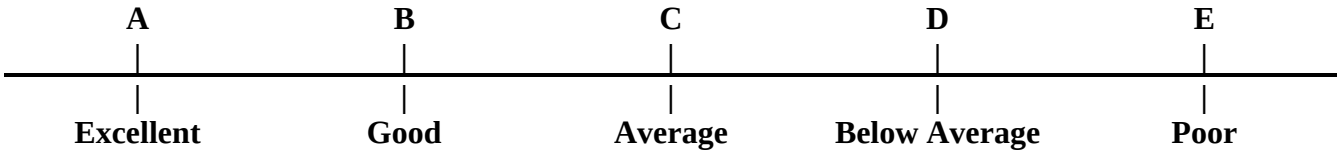
84. How many hours of sleep per 24-hour period are you actually getting, on average, when you work the day shift? (Only answer if you work this shift)

85. How many hours of sleep per 24-hour period are you actually getting, on average, when you work the evening shift? (Only answer if you work this shift)

86. How many hours of sleep per 24-hour period are you actually getting, on average, when you work the night shift? (Only answer if you work this shift)

87. How many hours of sleep per 24-hour period are you actually getting, on average, during your days off?

For questions 88 - 91, please mark your response according to the scale below:



88. How would you rate the quality of sleep that you are getting on vacations or days off?

89. How would you rate the quality of nighttime sleep that you are getting when working the day shift? (Only answer if you work this shift)

90. How would you rate the quality of nighttime sleep that you are getting when working the evening shift? (Only answer if you work this shift)

91. How would you rate the quality of daytime sleep that you are getting when working the night shift? (Only answer if you work this shift)

92. When you are on vacation or other long breaks, do you naturally rise early, or do you sleep in late?
    - **A.** Rise Early (Before 7am)
    - **B.** Rise Late (after 9am)
    - **C.** Rise somewhere in between 7 and 9am

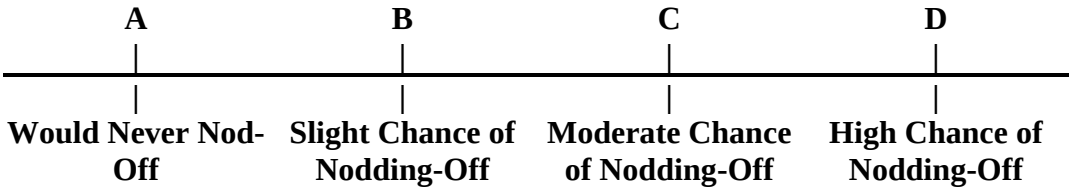
93. During your last workweek, what was the longest number of consecutive hours you went without sleep?
    - **A.** 1-17
    - **B.** 18-20
    - **C.** 21-23
    - **D.** 24-26
    - **E.** 27 or more

94. How often do you intentionally take naps during your waking hours off the job?
    - **A.** Every day
    - **B.** Several times per week
    - **C.** Once per week
    - **D.** Seldom take naps off the job
    - **E.** Never take naps

95. How often do you intentionally take naps while on the job?
    - **A.** Every day
    - **B.** Several times per week
    - **C.** Once per week
    - **D.** Seldom take naps on-the-job
    - **E.** Never take naps

96. How do you typically prepare for the first night shift? (Only answer if you work this shift)
    - **A.** Stay up the night before and sleep most of the day
    - **B.** Rise at normal time that day, stay up all day, then come to work
    - **C.** Stay up all day, but take a nap prior to coming to work
    - **D.** Other, please explain in the comments section

For questions 97 –104, please use the scale below to indicate how likely you are to have a hard time keeping your eyes open and keeping from nodding-off to sleep (as opposed to just relaxing or feeling tired). Note: Select only one of the choices below for each situation.



97. Sitting and reading

98. Watching TV

99. Sitting, inactive, in a public place (i.e., in a meeting, in a theater or dinner show, etc.)

100. As a passenger in a car for an hour or more without stopping for a break

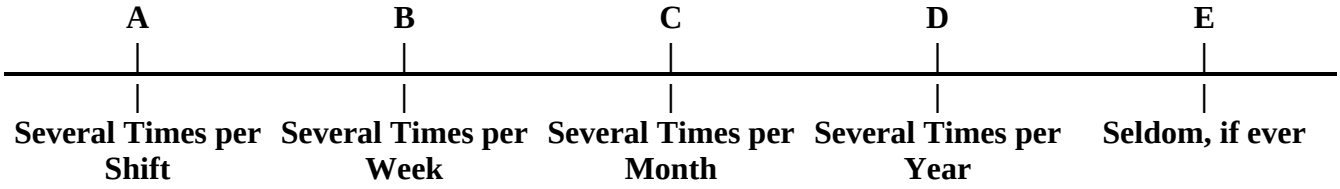
101. Lying down to rest in the afternoon when circumstances permit

102. Sitting and talking to someone

103. Sitting quietly after a lunch without alcohol

104. In a car, while stopped for a few minutes in traffic or at a light

For questions 105 - 108, please mark your response according to the scale below:



105. How often do you find yourself fighting sleep or briefly nodding-off while working?

106. How often do you find yourself fighting sleep or briefly nodding-off while commuting to and from work?

107. How often do you make mistakes or errors of inattention while working on your current schedule?

108. How often do you feel fatigued, drowsy or sluggish while working on your current schedule?

109. How many automobile accidents have you had commuting to or from work in the past 12 months?
    A. 0
    B. 1-2
    C. 3-4
    D. 5-6
    E. Over 7

110. How many near automobile accidents have you had commuting to or from work in the past 12 months?
    A. 0
    B. 1-2
    C. 3-4
    D. 5-6
    E. Over 7

111. Were any of these accidents or near misses due to fatigue or lack of alertness?
    A. Yes
    B. No
    C. Uncertain

112. What do you feel is the most fatiguing type of job?
    A. Days
    B. Afternoons
    C. Nights
    D. Splits

113. Where does your longest period of restful sleep take place during a typical workweek?
    A. At home
    B. Away from home
    C. At work
    D. Other

114. If you awake during sleep before you are completely rested, the reason is usually:
    A. The alarm
    B. Uncomfortable (temperature, toilet needs, thirsty, etc.)
    C. Noise
    D. Physical Soreness
    E. Other

115. At home, if you awake before being completely rested, what do you usually do in order to get back to sleep?
    A. Read
    B. Watch TV
    C. Drink an alcoholic beverage
    D. Drink a non-alcoholic beverage
    E. Other

116. If you wake before being completely rested, how do you usually get back to sleep?
    A. Easily
    B. With some difficultly
    C. Usually cannot return to sleep
    D. It depends on the time of day

117. On the occasions that you did not sleep well or had inadequate rest, what best describes the effect on your personality?
    A. No real or pronounced effect
    B. Dopey, sluggish, or dreamy
    C. Distracted, starring, or hypnotic
    D. Grouchy, irritable, or uncooperative
    E. Other

118. Before going to bed at home during the workweek, do you usually take something to help you sleep?
    A. Prescription medication
    B. Nonprescription medication
    C. Alcoholic beverage
    D. Home remedy
    E. Other

119. How often do you take dietary supplements?
    A. Daily
    B. Several times a week
    C. Several times a month
    D. Rarely
    E. Never

ERGONOMIC ISSUES

120. How often do you use the napping/resting rooms?
    A. Don't use
    B. Once a week
    C. Twice a week
    D. Three times a week
    E. Four or more times a week

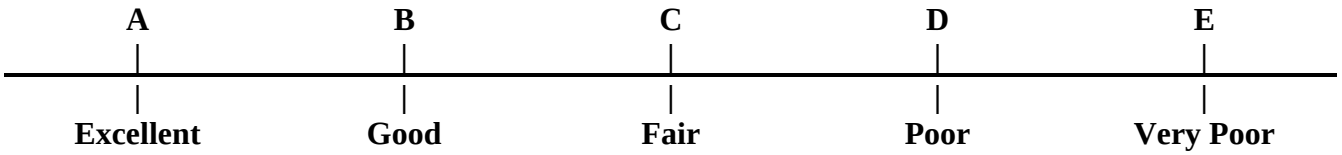
121. How would you rate the quality of the resting rooms
   - **A.** Excellent
   - **B.** Good
   - **C.** Fair
   - **D.** Poor
   - **E.** Don't use the rooms

122. At what time of day do you have the most trouble sleeping?
   - **A.** Day
   - **B.** Evening
   - **C.** Nighttime
   - **D.** Can sleep anytime
   - **E.** Have trouble sleeping anytime

123. On your current job, how much earlier than normal do you have to get up in order to be at work on time?
   - **A.** Don't have to get up earlier
   - **B.** 1 hour
   - **C.** 2 hours
   - **D.** 3 hours
   - **E.** 4 or more hours

124. On what day of consecutive work do you feel the most fatigued?
   - **A.** 1st day of work
   - **B.** 2nd day of work
   - **C.** 3rd day of work
   - **D.** 4th day of work
   - **E.** 5th or later day of work

For questions 125 - 129, please mark your response according to the scale below:



When working in the locomotive cab, how is the:

125. Ability to control heating or cooling to personal comfort level.

126. Cab seating in providing comfort and support throughout the work period.

127. Level of cab noise.

128. Vibration level.

129. The effect on the cab environment on your alertness.

OTHER PERSONAL INFORMATION

The following section would help us to determine company demographics as well as activities outside the workplace that may impact fatigue. Again, we will not use this information to identify any individuals. Please answer as many questions as you are willing or able.

130. What is your race?*
    - **A.** White
    - **B.** Black, African Amer., or Negro
    - **C.** American Indian or Alaska Native
    - **D.** Asian/Chinese
    - **E.** Other or more than one race

131. Are Spanish/Hispanic/Latino?*
    - **A.** No, not Spanish/Hispanic/Latino
    - **B.** Yes, Mexican, Mexican Amer., Chicano
    - **C.** Yes, Puerto Rican
    - **C.** Yes, Cuban
    - **D.** Yes, other Spanish/Hispanic/Latino group

132. What is your current marital status?
    - **A.** Single
    - **B.** Married
    - **C.** Separated
    - **D.** Divorced
    - **E.** Other

133. How many children **under 18** do you have at home?
    - **A.** None
    - **B.** One
    - **C.** Two
    - **D.** Three or more

134. What primary childcare arrangements do you currently have?
    - **A.** Child care provider
    - **B.** Relatives
    - **C.** Spouse or partner
    - **D.** Other
    - **E.** Does not apply (no children at home)

*These questions are optional.

135. If you do any **additional work** (including a farm or other home business) other than your current job at [company], please indicate the approximate average **number of hours per week** that you work on your second job.
    - **A.** 1-10
    - **B.** 11-20
    - **C.** 21-30
    - **D.** 31 or more
    - **E.** Does not apply

136. Does your spouse or partner **work full time**?
    - **A.** Yes, straight day work
    - **B.** Yes, straight evening or night work
    - **C.** Yes, rotating shifts
    - **D.** No, does not work outside the home
    - **E.** Does not apply

EMPLOYEE COMMENTS

If you wish to provide any written comments, please return the employee comments section along with your completed survey sheet (detach from rest of survey)

1. What do you find is the most fatiguing aspect of your job and what jobs do you find the most difficult?

2. What measures do you think would be most likely to improve the overall alertness of the train crews?

3. What methods do you currently use to help you reduce your fatigue and increase alertness?

4. Is there any other important information that you wish to share with us relative to your personal preferences, problems, or recommendations regarding working on the trains?

_____

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THANK YOU FOR YOUR TIME IN FILLING OUT THIS SURVEY! YOUR RESPONSES ARE VERY IMPORTANT TOWARD DETERMINING NEW AND BETTER WAYS TO IMPROVE ALERTNESS AND REDUCE FATIGUE.

Survey Results Talley

1. What is your gender?

	Total
Female	5
Male	26
Sum	31

Relative by Column:

	Total
Female	16.13%
Male	83.87%
Sum	100%

2. What is your age?

Average
41.8

3. What is your height?

Average
70.5

4. What is your weight?

Average
194.5

5. At NJT, what is your current job?

	Total
Regular local passenger with no split shifts	18
Regular local passenger with split shifts	6
Regular Yard Service	1
Extra-list	4
Sum	29

Relative by Column:

	Total
Regular local passenger with no split shifts	62.07%
Regular local passenger with split shifts	20.69%
Regular Yard Service	3.45%
Extra-list	13.79%
Sum	100%

6. At NJT, what is your current title?

	Total
Assistant Conductor	6
Conductor	7
Locomotive Engineer Trainee	2
Locomotive Engineer	16
Yard Master	0
Sum	31

Relative by Column:

	Total
Assistant Conductor	19.35%
Conductor	22.58%

Locomotive Engineer Trainee	6.45%
Locomotive Engineer	51.61%
Yard Master	0.00%
Sum	100%

7. Are you registered on the supplemental list?

	Total
Yes	12
No	19
Sum	31

Relative by Column:

	Total
Yes	38.71%
No	61.29%
Sum	100%

8. If you were on the supplemental list, how many times were you called in the last month? (leave blank if you were not on the list)

	Total
1 or 2 times	6
3 or 4 times	2
5 or 6 times	0
7 or 8 times	1
More than 9 times	0
Sum	9

Relative by Column:

	Total
1 or 2 times	66.67%
3 or 4 times	22.22%
5 or 6 times	0.00%
7 or 8 times	11.11%
More than 9 times	0.00%
Sum	100%

9. What type of locomotive do you mostly work on?

	Total
Arrows	4
Diesel	4
Electric	1
Cab Cars	1
All Different Types	20
Sum	30

Relative by Column:

	Total
Arrows	13.33%
Diesel	13.33%
Electric	3.33%
Cab Cars	3.33%
All Different Types	66.67%
Sum	100%

10. How many years have you been working shiftwork?

	Total
Less than 1 year	2

1 year or more, but less than 5 years	9
5 years or more, but less than 10 years	6
10 years or more, but less than 15 years	0
15 years or more	14
Sum	31

Relative by Column:

	Total
Less than 1 year	6.45%
1 year or more, but less than 5 years	29.03%
5 years or more, but less than 10 years	19.35%
10 years or more, but less than 15 years	0.00%
15 years or more	45.16%
Sum	100%

11. How many years have you been working shiftwork at [company]?

	Total
Less than 1 year	4
1 year or more, but less than 5 years	10
5 years or more, but less than 10 years	4
10 years or more, but less than 15 years	2
15 years or more	11
Sum	31

Relative by Column:

	Total
Less than 1 year	12.90%
1 year or more, but less than 5 years	32.26%
5 years or more, but less than 10 years	12.90%
10 years or more, but less than 15 years	6.45%
15 years or more	35.48%
Sum	100%

12. What time do you usually start work?

	Total
Early Morning (4:01 AM to 7AM)	9
Day (7:01AM to 6PM)	10
Evening (6:01PM to 11PM)	2
Night (11:01PM to 4AM)	0
Start time changes frequently	10
Sum	31

Relative by Column:

	Total
Early Morning (4:01 AM to 7AM)	29.03%
Day (7:01AM to 6PM)	32.26%
Evening (6:01PM to 11PM)	6.45%
Night (11:01PM to 4AM)	0.00%
Start time changes frequently	32.26%
Sum	100%

13. How many minutes does it take you to get to work "one way"?

	Total
1 to 14	2
15 to 29	6
30 to 44	6
45 to 59	10

60 or more	8
Sum	32

Relative by Column:

	Total
1 to 14	6.25%
15 to 29	18.75%
30 to 44	18.75%
45 to 59	31.25%
60 or more	25.00%
Sum	100%

14. Scheduling childcare / elderly care.

	Total
Very Difficult	4
Often Difficult	5
Sometimes Difficult	6
Seldom Difficult	1
Never Difficult	14
Sum	30

Relative by Column:

	Total
Very Difficult	13.33%
Often Difficult	16.67%
Sometimes Difficult	20.00%
Seldom Difficult	3.33%
Never Difficult	46.67%
Sum	100%

15. Taking educational courses.

	Total
Very Difficult	15
Often Difficult	5
Sometimes Difficult	0
Seldom Difficult	2
Never Difficult	7
Sum	29

Relative by Column:

	Total
Very Difficult	51.72%
Often Difficult	17.24%
Sometimes Difficult	0.00%
Seldom Difficult	6.90%
Never Difficult	24.14%
Sum	100%

16. Attending family or social events.

	Total
Very Difficult	12
Often Difficult	9
Sometimes Difficult	3
Seldom Difficult	2
Never Difficult	3
Sum	29

Relative by Column:

	Total
Very Difficult	41.38%
Often Difficult	31.03%
Sometimes Difficult	10.34%
Seldom Difficult	6.90%
Never Difficult	10.34%
Sum	100%

17. Maintaining a positive disposition.

	Total
Very Difficult	4
Often Difficult	7
Sometimes Difficult	8
Seldom Difficult	5
Never Difficult	7
Sum	31

Relative by Column:

	Total
Very Difficult	12.90%
Often Difficult	22.58%
Sometimes Difficult	25.81%
Seldom Difficult	16.13%
Never Difficult	22.58%
Sum	100%

18. Fulfilling domestic / household responsibilities.

	Total
Very Difficult	4
Often Difficult	11
Sometimes Difficult	10
Seldom Difficult	3
Never Difficult	3
Sum	31

Relative by Column:

	Total
Very Difficult	12.90%
Often Difficult	35.48%
Sometimes Difficult	32.26%
Seldom Difficult	9.68%
Never Difficult	9.68%
Sum	100%

19. Attending religious services.

	Total
Very Difficult	6
Often Difficult	6
Sometimes Difficult	8
Seldom Difficult	4
Never Difficult	7
Sum	31

Relative by Column:

	Total
Very Difficult	19.35%

Often Difficult	19.35%
Sometimes Difficult	25.81%
Seldom Difficult	12.90%
Never Difficult	22.58%
Sum	100%

20. Having adequate time for entertainment and recreational activities.

	Total
Very Difficult	11
Often Difficult	10
Sometimes Difficult	5
Seldom Difficult	0
Never Difficult	5
Sum	31

Relative by Column:

	Total
Very Difficult	35.48%
Often Difficult	32.26%
Sometimes Difficult	16.13%
Seldom Difficult	0.00%
Never Difficult	16.13%
Sum	100%

21. Getting sufficient quantity of sleep.

	Total
Very Difficult	8
Often Difficult	9
Sometimes Difficult	7
Seldom Difficult	2
Never Difficult	3
Sum	29

Relative by Column:

	Total
Very Difficult	27.59%
Often Difficult	31.03%
Sometimes Difficult	24.14%
Seldom Difficult	6.90%
Never Difficult	10.34%
Sum	100%

22. Getting good quality of sleep.

	Total
Very Difficult	9
Often Difficult	7
Sometimes Difficult	8
Seldom Difficult	3
Never Difficult	3
Sum	30

Relative by Column:

	Total
Very Difficult	30.00%
Often Difficult	23.33%
Sometimes Difficult	26.67%
Seldom Difficult	10.00%

Never Difficult	10.00%
Sum	100%

23. Staying alert while working.

	Total
Very Difficult	0
Often Difficult	5
Sometimes Difficult	7
Seldom Difficult	8
Never Difficult	9
Sum	29

Relative by Column:

	Total
Very Difficult	0.00%
Often Difficult	17.24%
Sometimes Difficult	24.14%
Seldom Difficult	27.59%
Never Difficult	31.03%
Sum	100%

24. Doing your job safely.

	Total
Very Difficult	0
Often Difficult	3
Sometimes Difficult	5
Seldom Difficult	11
Never Difficult	11
Sum	30

Relative by Column:

	Total
Very Difficult	0.00%
Often Difficult	10.00%
Sometimes Difficult	16.67%
Seldom Difficult	36.67%
Never Difficult	36.67%
Sum	100%

25. Fighting fatigue or drowsiness on the job.

	Total
Very Difficult	2
Often Difficult	5
Sometimes Difficult	11
Seldom Difficult	5
Never Difficult	7
Sum	30

Relative by Column:

	Total
Very Difficult	6.67%
Often Difficult	16.67%
Sometimes Difficult	36.67%
Seldom Difficult	16.67%
Never Difficult	23.33%
Sum	100%

26. Length of your current shifts?

	Total
Always a problem	3
Often a problem	2
Sometimes a problem	13
Infrequently a problem	4
Never a problem	9
Sum	31

Relative by Column:

	Total
Always a problem	9.68%
Often a problem	6.45%
Sometimes a problem	41.94%
Infrequently a problem	12.90%
Never a problem	29.03%
Sum	100%

27. Number of work days in a row?

	Total
Always a problem	2
Often a problem	2
Sometimes a problem	6
Infrequently a problem	11
Never a problem	8
Sum	29

Relative by Column:

	Total
Always a problem	6.90%
Often a problem	6.90%
Sometimes a problem	20.69%
Infrequently a problem	37.93%
Never a problem	27.59%
Sum	100%

28. Days on and off pattern of your current schedule?

	Total
Always a problem	4
Often a problem	4
Sometimes a problem	4
Infrequently a problem	8
Never a problem	9
Sum	29

Relative by Column:

	Total
Always a problem	13.79%
Often a problem	13.79%
Sometimes a problem	13.79%
Infrequently a problem	27.59%
Never a problem	31.03%
Sum	100%

29. Amount of weekend time off you are currently getting?

	Total
Always a problem	6

Often a problem	8
Sometimes a problem	2
Infrequently a problem	6
Never a problem	9
Sum	31

Relative by Column:

	Total
Always a problem	19.35%
Often a problem	25.81%
Sometimes a problem	6.45%
Infrequently a problem	19.35%
Never a problem	29.03%
Sum	100%

30. Number of scheduled days off you are currently getting (excluding overtime)?

	Total
Always a problem	4
Often a problem	3
Sometimes a problem	7
Infrequently a problem	8
Never a problem	9
Sum	31

Relative by Column:

	Total
Always a problem	12.90%
Often a problem	9.68%
Sometimes a problem	22.58%
Infrequently a problem	25.81%
Never a problem	29.03%
Sum	100%

31. Length of scheduled breaks (in-between blocks of work days)?

	Total
Always a problem	6
Often a problem	2
Sometimes a problem	8
Infrequently a problem	8
Never a problem	7
Sum	31

Relative by Column:

	Total
Always a problem	19.35%
Often a problem	6.45%
Sometimes a problem	25.81%
Infrequently a problem	25.81%
Never a problem	22.58%
Sum	100%

32. Need to come in on a scheduled day off (for training, on-call responsibilities, etc.)?

	Total
Always a problem	1
Often a problem	2

Sometimes a problem	5
Infrequently a problem	6
Never a problem	16
Sum	30

Relative by Column:

	Total
Always a problem	3.33%
Often a problem	6.67%
Sometimes a problem	16.67%
Infrequently a problem	20.00%
Never a problem	53.33%
Sum	100%

33. How mentally demanding is your job?

	Total
Very High	12
Highly	10
Moderately	6
A little	1
Not at all	2
Sum	31

Relative by Column:

	Total
Very High	38.71%
Highly	32.26%
Moderately	19.35%
A little	3.23%
Not at all	6.45%
Sum	100%

34. How physically demanding is your job?

	Total
Very High	5
Highly	5
Moderately	10
A little	8
Not at all	4
Sum	32

Relative by Column:

	Total
Very High	15.63%
Highly	15.63%
Moderately	31.25%
A little	25.00%
Not at all	12.50%
Sum	100%

35. How monotonous or boring is your job?

	Total
Very High	5
Highly	3
Moderately	7
A little	11
Not at all	6

Sum	32

Relative by Column:

	Total
Very High	15.63%
Highly	9.38%
Moderately	21.88%
A little	34.38%
Not at all	18.75%
Sum	100%

36. How fatiguing is your job?

	Total
Very High	4
Highly	6
Moderately	15
A little	3
Not at all	4
Sum	32

Relative by Column:

	Total
Very High	12.50%
Highly	18.75%
Moderately	46.88%
A little	9.38%
Not at all	12.50%
Sum	100%

37. How many days during the past year were you called in to work on your scheduled days off?

	Total
0	14
1 to 9	12
10 to 19	3
20 to 29	2
30 or more	1
Sum	32

Relative by Column:

	Total
0	43.75%
1 to 9	37.50%
10 to 19	9.38%
20 to 29	6.25%
30 or more	3.13%
Sum	100%

38. How well adjusted are you to your current shift schedule?

	Total
Poorly adjusted (having lots of problems)	4
Getting by	10
Slightly adjusted	4
Well adjusted	8
Very well adjusted (having no problems)	5
Sum	31

Relative by Column:

	Total
Poorly adjusted (having lots of problems)	12.90%
Getting by	32.26%
Slightly adjusted	12.90%
Well adjusted	25.81%
Very well adjusted (having no problems)	16.13%
Sum	100%

39. How important is it for you to have a schedule that gives you the most days off possible?

	Total
Very important	13
Important	6
Uncertain	8
Unimportant	5
Very unimportant	0
Sum	32

Relative by Column:

	Total
Very important	40.63%
Important	18.75%
Uncertain	25.00%
Unimportant	15.63%
Very unimportant	0.00%
Sum	100%

40. How important is it for you to minimize the number of consecutive shifts worked?

	Total
Very important	9
Important	8
Uncertain	8
Unimportant	7
Very unimportant	0
Sum	32

Relative by Column:

	Total
Very important	28.13%
Important	25.00%
Uncertain	25.00%
Unimportant	21.88%
Very unimportant	0.00%
Sum	100%

41. How important is it for you to maximize the total number of full weekends off (i.e. both Saturday and Sunday off together) that you receive each year?

	Total
Very important	15
Important	7
Uncertain	5
Unimportant	4
Very unimportant	1
Sum	32

Relative by Column:

	Total
Very important	46.88%
Important	21.88%
Uncertain	15.63%
Unimportant	12.50%
Very unimportant	3.13%
Sum	100%

42. How important is it for you to maintain consistent starting times in a given work week?

	Total
Very Important	14
Important	12
No Preference	5
Unimportant	1
Very Unimportant	0
Sum	32

Relative by Column:

	Total
Very Important	43.75%
Important	37.50%
No Preference	15.63%
Unimportant	3.13%
Very Unimportant	0.00%
Sum	100%

43. Concerning days off, which would you prefer?

	Total
Have each break about the same length	15
Have one longer break per cycle	15
Sum	30

Relative by Column:

	Total
Have each break about the same length	50.00%
Have one longer break per cycle	50.00%
Sum	100%

44. I would prefer that all jobs be consecutive hours rather than being split into two blocks:

	Total
Strongly Agree	13
Agree	6
No Preference	5
Disagree	2
Strongly Disagree	5
Sum	31

Relative by Column:

	Total
Strongly Agree	41.94%
Agree	19.35%
No Preference	16.13%
Disagree	6.45%

Strongly Disagree	16.13%
Sum	100%

45. Would you prefer reletively fixed start times or rotating start times?

	Total
Fixed (always work the same schedule)	23
Rotating (Schedule change weekly, bi-weekly or monthly)	1
No Preference	7
Sum	31

Relative by Column:

	Total
Fixed (always work the same schedule)	74.19%
Rotating (Schedule change weekly, bi-weekly or monthly)	3.23%
No Preference	22.58%
Sum	100%

46. In general, how would you rate the amount of time you spend between split shifts (don't answer if you do not work split shifts)?

	Total
Far too Long	0
More than Enough	1
Enough	11
Not Enough	4
Far too Little	0
Sum	16

Relative by Column:

	Total
Far too Long	0.00%
More than Enough	6.25%
Enough	68.75%
Not Enough	25.00%
Far too Little	0.00%
Sum	100%

47. When working a split job, where do you nap between jobs?

	Total
Napping rooms at terminal	14
Home	2
Don't usually nap	6
Other place	3
Sum	25

Relative by Column:

	Total
Napping rooms at terminal	56.00%
Home	8.00%
Don't usually nap	24.00%
Other place	12.00%
Sum	100%

48. What is your preferred type of job?

	Total
Days	11
Afternoons	13

Nights	6
Splits	1
Sum	31

Relative by Column:

	Total
Days	35.48%
Afternoons	41.94%
Nights	19.35%
Splits	3.23%
Sum	100%

49. I am willing to review alternative schedules that are physiologically better and allow me to get better sleep.

	Total
Strongly Agree	11
Agree	9
No Preference	5
Disagree	4
Strongly Disagree	1
Sum	30

Relative by Column:

	Total
Strongly Agree	36.67%
Agree	30.00%
No Preference	16.67%
Disagree	13.33%
Strongly Disagree	3.33%
Sum	100%

50. Antacids or prescribed medication for indigestion, heartburn or ulcers

	Total
Daily	1
Several times/week	2
Once/week	2
Several times/month	3
Seldom, if ever	22
Sum	30

Relative by Column:

	Total
Daily	3.33%
Several times/week	6.67%
Once/week	6.67%
Several times/month	10.00%
Seldom, if ever	73.33%
Sum	100%

51. Stimulants to keep you awake (i.e., No-Doz, Vivarin, Amphetamines, etc.)

	Total
Daily	0
Several times/week	1
Once/week	0
Several times/month	0

Seldom, if ever	30
Sum	31

Relative by Column:

	Total
Daily	0.00%
Several times/week	3.23%
Once/week	0.00%
Several times/month	0.00%
Seldom, if ever	96.77%
Sum	100%

52. Depressants to help you sleep (i.e., Valium, etc.)

	Total
Daily	0
Several times/week	1
Once/week	0
Several times/month	0
Seldom, if ever	30
Sum	31

Relative by Column:

	Total
Daily	0.00%
Several times/week	3.23%
Once/week	0.00%
Several times/month	0.00%
Seldom, if ever	96.77%
Sum	100%

53. Pain Relievers (i.e., Tylenol, Aspirin, Advil, Motrin, etc.)

	Total
Daily	3
Several times/week	4
Once/week	4
Several times/month	8
Seldom, if ever	12
Sum	31

Relative by Column:

	Total
Daily	9.68%
Several times/week	12.90%
Once/week	12.90%
Several times/month	25.81%
Seldom, if ever	38.71%
Sum	100%

54. Cold or Allergy Tablets (i.e., Seldane, Dristan, Histapan, Allerest, etc.)

	Total
Daily	3
Several times/week	3
Once/week	2
Several times/month	3
Seldom, if ever	20
Sum	31

Relative by Column:

	Total
Daily	9.68%
Several times/week	9.68%
Once/week	6.45%
Several times/month	9.68%
Seldom, if ever	64.52%
Sum	100%

55. During a typical day shift, how many 12 oz. cups or cans of caffeinated beverages do you drink on average? (Only answer if you work this shift)

	Total
0	4
1 to 3	16
4 to 6	6
7 to 9	0
10 or more	0
Sum	26

Relative by Column:

	Total
0	15.38%
1 to 3	61.54%
4 to 6	23.08%
7 to 9	0.00%
10 or more	0.00%
Sum	100%

56. During a typical evening shift, how many 12 oz-cups or cans of caffeinated beverages do you drink on average? (Only answer if you work this shift)

	Total
0	6
1 to 3	13
4 to 6	4
7 to 9	0
10 or more	0
Sum	23

Relative by Column:

	Total
0	26.09%
1 to 3	56.52%
4 to 6	17.39%
7 to 9	0.00%
10 or more	0.00%
Sum	100%

57. During a typical night shift, how many 12 oz. cups or cans of caffeinated beverages do you drink on average? (Only answer if you work this shift)

	Total
0	4
1 to 3	8
4 to 6	3

7 to 9	1
10 or more	0
Sum	16

Relative by Column:

	Total
0	25.00%
1 to 3	50.00%
4 to 6	18.75%
7 to 9	6.25%
10 or more	0.00%
Sum	100%

58. During a typical 24-hour period when you are not working, how many 12 oz. cups or cans of caffeinated beverages (i.e., coffee, tea, soda, etc.) do you drink on average?

	Total
0	6
1 to 3	22
4 to 6	3
7 to 9	0
10 or more	0
Sum	31

Relative by Column:

	Total
0	19.35%
1 to 3	70.97%
4 to 6	9.68%
7 to 9	0.00%
10 or more	0.00%
Sum	100%

59. During a typical 24-hour period when you are not working, how many alcoholic beverages do you drink on average?

	Total
0	19
1 to 3	7
4 to 6	4
7 to 9	0
10 or more	1
Sum	31

Relative by Column:

	Total
0	61.29%
1 to 3	22.58%
4 to 6	12.90%
7 to 9	0.00%
10 or more	3.23%
Sum	100%

60. During a typical 24-hour period when you are working, how many alcoholic beverages do you drink on average?

	Total
0	26
1 to 3	2

4 to 6	2
7 to 9	1
10 or more	1
Sum	32

Relative by Column:

	Total
0	81.25%
1 to 3	6.25%
4 to 6	6.25%
7 to 9	3.13%
10 or more	3.13%
Sum	100%

61. Disturbed appetite

	Total
Almost Never	16
Seldom	7
Often	2
Almost Always	5
Sum	30

Relative by Column:

	Total
Almost Never	53.33%
Seldom	23.33%
Often	6.67%
Almost Always	16.67%
Sum	100%

62. Having to watch what you eat to avoid stomach upsets?

	Total
Almost Never	21
Seldom	2
Often	1
Almost Always	2
Sum	26

Relative by Column:

	Total
Almost Never	80.77%
Seldom	7.69%
Often	3.85%
Almost Always	7.69%
Sum	100%

63. Feeling nauseous

	Total
Almost Never	22
Seldom	4
Often	2
Almost Always	2
Sum	30

Relative by Column:

	Total
Almost Never	73.33%

Seldom	13.33%
Often	6.67%
Almost Always	6.67%
Sum	100%

64. Heartburn

	Total
Almost Never	16
Seldom	10
Often	1
Almost Always	2
Sum	29

Relative by Column:

	Total
Almost Never	55.17%
Seldom	34.48%
Often	3.45%
Almost Always	6.90%
Sum	100%

65. Indigestion

	Total
Almost Never	15
Seldom	8
Often	3
Almost Always	2
Sum	28

Relative by Column:

	Total
Almost Never	53.57%
Seldom	28.57%
Often	10.71%
Almost Always	7.14%
Sum	100%

66. Bloated stomach or gas

	Total
Almost Never	9
Seldom	11
Often	1
Almost Always	6
Sum	27

Relative by Column:

	Total
Almost Never	33.33%
Seldom	40.74%
Often	3.70%
Almost Always	22.22%
Sum	100%

67. Constipation or diarrhea

	Total
Almost Never	14
Seldom	7

Often	5
Almost Always	4
Sum	30

Relative by Column:

	Total
Almost Never	46.67%
Seldom	23.33%
Often	16.67%
Almost Always	13.33%
Sum	100%

68. Abdominal pain

	Total
Almost Never	19
Seldom	6
Often	4
Almost Always	0
Sum	29

Relative by Column:

	Total
Almost Never	65.52%
Seldom	20.69%
Often	13.79%
Almost Always	0.00%
Sum	100%

69. Are you currently on any formal weight reduction or medical diet program?

	Total
Yes	2
No	30
Sum	32

Relative by Column:

	Total
Yes	6.25%
No	93.75%
Sum	100%

70. Are you aware of how nutrition, diet, and eating practices relate to working shiftwork?

	Total
I am not aware of what proper shiftwork nutrition should be	13
I am aware but don’t have good dietary practices for shiftwork	9
I am aware and I do have good dietary practices for shiftwork	10
Sum	32

Relative by Column:

	Total
I am not aware of what proper shiftwork nutrition should be	40.63%
I am aware but don’t have good dietary practices for shiftwork	28.13%
I am aware and I do have good dietary practices for shiftwork	31.25%
Sum	100%

71. How often do you exercise (i.e., cardiovascular activities such as brisk walking, jogging, etc.) (NJT only)

	Total
Never	11
Once per week	8
2-3 times per week	9
Every day	4
Sum	32

Relative by Column:

	Total
Never	34.38%
Once per week	25.00%
2-3 times per week	28.13%
Every day	12.50%
Sum	100%

72. How many years have you smoked tobacco?

	Total
Never	17
1	2
2 to 12	7
13 to 25	3
26 or more	3
Sum	32

Relative by Column:

	Total
Never	53.13%
1	6.25%
2 to 12	21.88%
13 to 25	9.38%
26 or more	9.38%
Sum	100%

73. I am told I snore loudly and bother others

	Total
Never	8
Rarely	6
Sometimes	9
Usually	5
Always	4
Sum	32

Relative by Column:

	Total
Never	25.00%
Rarely	18.75%
Sometimes	28.13%
Usually	15.63%
Always	12.50%
Sum	100%

74. I am told I stop breathing or hold my breath while asleep

	Total
Never	25
Rarely	3

Sometimes	1
Usually	1
Always	2
Sum	32

Relative by Column:

	Total
Never	78.13%
Rarely	9.38%
Sometimes	3.13%
Usually	3.13%
Always	6.25%
Sum	100%

75. I awake suddenly gasping for breath, unable to breathe

	Total
Never	24
Rarely	4
Sometimes	1
Usually	1
Always	1
Sum	31

Relative by Column:

	Total
Never	77.42%
Rarely	12.90%
Sometimes	3.23%
Usually	3.23%
Always	3.23%
Sum	100%

76. I sweat a great deal while sleeping

	Total
Never	16
Rarely	6
Sometimes	7
Usually	2
Always	1
Sum	32

Relative by Column:

	Total
Never	50.00%
Rarely	18.75%
Sometimes	21.88%
Usually	6.25%
Always	3.13%
Sum	100%

77. I have high blood pressure

	Total
Never	19
Rarely	2
Sometimes	5
Usually	3
Always	3

Sum	32

Relative by Column:

	Total
Never	59.38%
Rarely	6.25%
Sometimes	15.63%
Usually	9.38%
Always	9.38%
Sum	100%

78. I have a problem with my nose blocking up when I am trying to sleep

	Total
Never	15
Rarely	4
Sometimes	2
Usually	6
Always	5
Sum	32

Relative by Column:

	Total
Never	46.88%
Rarely	12.50%
Sometimes	6.25%
Usually	18.75%
Always	15.63%
Sum	100%

79. My snoring or breathing problem is much worse if I sleep on my back

	Total
Never	11
Rarely	4
Sometimes	5
Usually	5
Always	7
Sum	32

Relative by Column:

	Total
Never	34.38%
Rarely	12.50%
Sometimes	15.63%
Usually	15.63%
Always	21.88%
Sum	100%

80. My snoring or breathing problem is much worse if I fall asleep right after drinking alcohol

	Total
Never	20
Rarely	3
Sometimes	2
Usually	2
Always	3
Sum	30

Relative by Column:

	Total
Never	66.67%
Rarely	10.00%
Sometimes	6.67%
Usually	6.67%
Always	10.00%
Sum	100%

81. How many hours of sleep per 24-hour period (in general) do you feel you need to be alert and well rested?

	Total
Less than 5 Hours	0
5 - 6 Hours	3
7 Hours	15
8 Hours	11
More than 8 Hours	3
Sum	32

Relative by Column:

	Total
Less than 5 Hours	0.00%
5 - 6 Hours	9.38%
7 Hours	46.88%
8 Hours	34.38%
More than 8 Hours	9.38%
Sum	100%

82. How many hours of sleep per 24-hour period are you actually getting, on average, when you work the day shift? (Only answer if you work this shift)

	Total
Less than 5 Hours	5
5 - 6 Hours	12
7 Hours	7
8 Hours	2
More than 8 Hours	1
Sum	27

Relative by Column:

	Total
Less than 5 Hours	18.52%
5 - 6 Hours	44.44%
7 Hours	25.93%
8 Hours	7.41%
More than 8 Hours	3.70%
Sum	100%

83. How many hours of sleep per 24-hour period are you actually getting, on average, when you work the evening shift? (Only answer if you work this shift)

	Total
Less than 5 Hours	5
5 - 6 Hours	7
7 Hours	4
8 Hours	1
More than 8 Hours	2

Sum	19

Relative by Column:

	Total
Less than 5 Hours	26.32%
5 - 6 Hours	36.84%
7 Hours	21.05%
8 Hours	5.26%
More than 8 Hours	10.53%
Sum	100%

84. How many hours of sleep per 24-hour period are you actually getting, on average, when you work the night shift? (Only answer if you work this shift)

	Total
Less than 5 Hours	5
5 - 6 Hours	4
7 Hours	1
8 Hours	1
More than 8 Hours	1
Sum	12

Relative by Column:

	Total
Less than 5 Hours	41.67%
5 - 6 Hours	33.33%
7 Hours	8.33%
8 Hours	8.33%
More than 8 Hours	8.33%
Sum	100%

85. How many hours of sleep per 24-hour period are you actually getting, on average, during your days off?

	Total
Less than 5 Hours	0
5 - 6 Hours	2
7 Hours	8
8 Hours	13
More than 8 Hours	9
Sum	32

Relative by Column:

	Total
Less than 5 Hours	0.00%
5 - 6 Hours	6.25%
7 Hours	25.00%
8 Hours	40.63%
More than 8 Hours	28.13%
Sum	100%

86. How would you rate the quality of sleep that you are getting on vacations or days off?

	Total
Excellent	12
Good	9
Average	8
Below Average	1

Poor	2
Sum	32

Relative by Column:

	Total
Excellent	37.50%
Good	28.13%
Average	25.00%
Below Average	3.13%
Poor	6.25%
Sum	100%

87. How would you rate the quality of nighttime sleep that you are getting when working the day shift? (Only answer if you work this shift)

	Total
Excellent	2
Good	4
Average	9
Below Average	7
Poor	3
Sum	25

Relative by Column:

	Total
Excellent	8.00%
Good	16.00%
Average	36.00%
Below Average	28.00%
Poor	12.00%
Sum	100%

88. How would you rate the quality of nighttime sleep that you are getting when working the evening shift? (Only answer if you work this shift)

	Total
Excellent	3
Good	2
Average	5
Below Average	6
Poor	2
Sum	18

Relative by Column:

	Total
Excellent	16.67%
Good	11.11%
Average	27.78%
Below Average	33.33%
Poor	11.11%
Sum	100%

89. How would you rate the quality of daytime sleep that you are getting when working the night shift? (Only answer if you work this shift)

	Total
Excellent	1

Good	1
Average	3
Below Average	3
Poor	4
Sum	12

Relative by Column:

	Total
Excellent	8.33%
Good	8.33%
Average	25.00%
Below Average	25.00%
Poor	33.33%
Sum	100%

90. When you are on vacation or other long breaks, do you naturally rise early, or do you sleep in late?

	Total
Rise Early (Before 7am)	16
Rise Late (after 9am)	8
Rise somewhere in between 7 and 9am	8
Sum	32

Relative by Column:

	Total
Rise Early (Before 7am)	50.00%
Rise Late (after 9am)	25.00%
Rise somewhere in between 7 and 9am	25.00%
Sum	100%

91. During your last work week, what was the longest number of consecutive hours you went without sleep?

	Total
1 to 17	11
18 to 20	14
21 to 23	2
24 to 26	1
27 or more	1
Sum	29

Relative by Column:

	Total
1 to 17	37.93%
18 to 20	48.28%
21 to 23	6.90%
24 to 26	3.45%
27 or more	3.45%
Sum	100%

92. How often do you intentionally take naps during your waking hours off-the-job?

	Total
Every day	5
Several times per week	13
Once per week	1
Seldom take naps off-the-job	7
Never take naps	5

Sum	31

Relative by Column:

	Total
Every day	16.13%
Several times per week	41.94%
Once per week	3.23%
Seldom take naps off-the-job	22.58%
Never take naps	16.13%
Sum	100%

93. How often do you intentionally take naps while on the job?

	Total
Every day	6
Several times per week	6
Once per week	4
Seldom take naps on-the-job	8
Never take naps	8
Sum	32

Relative by Column:

	Total
Every day	18.75%
Several times per week	18.75%
Once per week	12.50%
Seldom take naps on-the-job	25.00%
Never take naps	25.00%
Sum	100%

94. How do you typically prepare for the first night shift? (only answer if you work this shift)

	Total
Stay up the night before and sleep most of the day	2
Rise at normal time that day, stay up all day, then come to work	2
Stay up all day, but take a nap prior to coming to work	10
Other, please explain in the comments section	0
Sum	14

Relative by Column:

	Total
Stay up the night before and sleep most of the day	14.29%
Rise at normal time that day, stay up all day, then come to work	14.29%
Stay up all day, but take a nap prior to coming to work	71.43%
Other, please explain in the comments section	0.00%
Sum	100%

95. Sitting and reading

	Total
Would Never Nod-Off	6
Slight Chance of Nodding-Off	9
Moderate Chance of Nodding-Off	7
High Chance of Nodding-Off	9
Sum	31

Relative by Column:

	Total
Would Never Nod-Off	19.35%
Slight Chance of Nodding-Off	29.03%
Moderate Chance of Nodding-Off	22.58%
High Chance of Nodding-Off	29.03%
Sum	100%

96. Watching TV

	Total
Would Never Nod-Off	3
Slight Chance of Nodding-Off	11
Moderate Chance of Nodding-Off	10
High Chance of Nodding-Off	6
Sum	30

Relative by Column:

	Total
Would Never Nod-Off	10.00%
Slight Chance of Nodding-Off	36.67%
Moderate Chance of Nodding-Off	33.33%
High Chance of Nodding-Off	20.00%
Sum	100%

97. Sitting, inactive, in a public place (i.e., in a meeting, in a theater or dinner show, etc.)

	Total
Would Never Nod-Off	14
Slight Chance of Nodding-Off	7
Moderate Chance of Nodding-Off	8
High Chance of Nodding-Off	2
Sum	31

Relative by Column:

	Total
Would Never Nod-Off	45.16%
Slight Chance of Nodding-Off	22.58%
Moderate Chance of Nodding-Off	25.81%
High Chance of Nodding-Off	6.45%
Sum	100%

98. As a passenger in a car for an hour or more without stopping for a break

	Total
Would Never Nod-Off	6
Slight Chance of Nodding-Off	14
Moderate Chance of Nodding-Off	6
High Chance of Nodding-Off	5
Sum	31

Relative by Column:

	Total
Would Never Nod-Off	19.35%
Slight Chance of Nodding-Off	45.16%
Moderate Chance of Nodding-Off	19.35%
High Chance of Nodding-Off	16.13%
Sum	100%

99. Lying down to rest in the afternoon when circumstances permit

	Total
Would Never Nod-Off	2
Slight Chance of Nodding-Off	5
Moderate Chance of Nodding-Off	5
High Chance of Nodding-Off	18
Sum	30

Relative by Column:

	Total
Would Never Nod-Off	6.67%
Slight Chance of Nodding-Off	16.67%
Moderate Chance of Nodding-Off	16.67%
High Chance of Nodding-Off	60.00%
Sum	100%

100. Sitting and talking to someone

	Total
Would Never Nod-Off	25
Slight Chance of Nodding-Off	6
Moderate Chance of Nodding-Off	0
High Chance of Nodding-Off	0
Sum	31

Relative by Column:

	Total
Would Never Nod-Off	80.65%
Slight Chance of Nodding-Off	19.35%
Moderate Chance of Nodding-Off	0.00%
High Chance of Nodding-Off	0.00%
Sum	100%

101. Sitting quietly after a lunch without alcohol

	Total
Would Never Nod-Off	11
Slight Chance of Nodding-Off	10
Moderate Chance of Nodding-Off	9
High Chance of Nodding-Off	1
Sum	31

Relative by Column:

	Total
Would Never Nod-Off	35.48%
Slight Chance of Nodding-Off	32.26%
Moderate Chance of Nodding-Off	29.03%
High Chance of Nodding-Off	3.23%
Sum	100%

102. In a car, while stopped for a few minutes in traffic or at a light

	Total
Would Never Nod-Off	23
Slight Chance of Nodding-Off	7
Moderate Chance of Nodding-Off	1
High Chance of Nodding-Off	1
Sum	32

Relative by Column:

	Total
Would Never Nod-Off	71.88%
Slight Chance of Nodding-Off	21.88%
Moderate Chance of Nodding-Off	3.13%
High Chance of Nodding-Off	3.13%
Sum	100%

103. How often do you find yourself fighting sleep or briefly nodding-off while working?

	Total
Several Times per Shift	1
Several Times per Week	8
Several Times per Month	6
Several Times per Year	7
Seldom, if ever	10
Sum	32

Relative by Column:

	Total
Several Times per Shift	3.13%
Several Times per Week	25.00%
Several Times per Month	18.75%
Several Times per Year	21.88%
Seldom, if ever	31.25%
Sum	100%

104. How often do you find yourself fighting sleep or briefly nodding-off while commuting to and from work?

	Total
Several Times per Shift	3
Several Times per Week	2
Several Times per Month	8
Several Times per Year	6
Seldom, if ever	13
Sum	32

Relative by Column:

	Total
Several Times per Shift	9.38%
Several Times per Week	6.25%
Several Times per Month	25.00%
Several Times per Year	18.75%
Seldom, if ever	40.63%
Sum	100%

105. How often do you make mistakes or errors of inattention while working on your current schedule?

	Total
Several Times per Shift	0
Several Times per Week	2
Several Times per Month	4
Several Times per Year	10
Seldom, if ever	16
Sum	32

Relative by Column:

	Total

Several Times per Shift	0.00%
Several Times per Week	6.25%
Several Times per Month	12.50%
Several Times per Year	31.25%
Seldom, if ever	50.00%
Sum	100%

106. How often do you feel fatigued, drowsy or sluggish while working on your current schedule?

	Total
Several Times per Shift	3
Several Times per Week	12
Several Times per Month	10
Several Times per Year	1
Seldom, if ever	6
Sum	32

Relative by Column:

	Total
Several Times per Shift	9.38%
Several Times per Week	37.50%
Several Times per Month	31.25%
Several Times per Year	3.13%
Seldom, if ever	18.75%
Sum	100%

107. How many automobile accidents have you had commuting to work in the past 12 months?

	Total
0	28
1 to 2	3
3 to 4	0
5 to 6	0
Over 7	0
Sum	31

Relative by Column:

	Total
0	90.32%
1 to 2	9.68%
3 to 4	0.00%
5 to 6	0.00%
Over 7	0.00%
Sum	100%

108. How many near accidents have you had commuting to work in the past 12 months?

	Total
0	12
1 to 2	15
3 to 4	4
5 to 6	1
Over 7	0
Sum	32

Relative by Column:

	Total

0	37.50%
1 to 2	46.88%
3 to 4	12.50%
5 to 6	3.13%
Over 7	0.00%
Sum	100%

109. Were any of these commuting accidents or near misses due to fatigue or lack of alertness?

	Total
Yes	8
No	17
Uncertain	2
Sum	27

Relative by Column:

	Total
Yes	29.63%
No	62.96%
Uncertain	7.41%
Sum	100%

110. What do you feel is the most fatiguing type of job?

	Total
Days	4
Afternoons	4
Nights	14
Splits	9
Sum	31

Relative by Column:

	Total
Days	12.90%
Afternoons	12.90%
Nights	45.16%
Splits	29.03%
Sum	100%

111. Where does your longest period of restful sleep take place during a typical workweek?

	Total
At home	29
Away from home	1
At work	1
Other	1
Sum	32

Relative by Column:

	Total
At home	90.63%
Away from home	3.13%
At work	3.13%
Other	3.13%
Sum	100%

112. If you awake during sleep before you are comletely rested, the reason is usually:

	Total
The alarm	5
Uncomfortable (temperature, toilet needs, thirsty, etc.)	14
Noise	5
Physical Soreness	0
Other	8
Sum	32

Relative by Column:

	Total
The alarm	15.63%
Uncomfortable (temperature, toilet needs, thirsty, etc.)	43.75%
Noise	15.63%
Physical Soreness	0.00%
Other	25.00%
Sum	100%

113. At home, if you awake before being completely rested, what do you usually do in order to get back to sleep?

	Total
Read	1
Watch TV	9
Drink an alcoholic beverage	0
Drink a non alcoholic beverage	1
Other	21
Sum	32

Relative by Column:

	Total
Read	3.13%
Watch TV	28.13%
Drink an alcoholic beverage	0.00%
Drink a non alcoholic beverage	3.13%
Other	65.63%
Sum	100%

114. If you wake before being completely rested, how do you usually get back to sleep?

	Total
Easily	7
With some difficultly	11
Usually cannot return to sleep	5
It depends on the time of day	9
Sum	32

Relative by Column:

	Total
Easily	21.88%
With some difficultly	34.38%
Usually cannot return to sleep	15.63%
It depends on the time of day	28.13%
Sum	100%

115. On the occasions that you did not sleep well or had inadequate rest, what best describes the effect on your personality?

	Total
No real or pronounced effect	8

Dopey, sluggish, or dreamy	5
Distracted, starring, or hypnotic	3
Grouchy, irritable, or uncooperative	13
Other	3
Sum	32

Relative by Column:

	Total
No real or pronounced effect	25.00%
Dopey, sluggish, or dreamy	15.63%
Distracted, starring, or hypnotic	9.38%
Grouchy, irritable, or uncooperative	40.63%
Other	9.38%
Sum	100%

116. Before going to bed at home during the workweek, do you usually take something to help you sleep?

	Total
Prescription medication	1
Nonprescription medication	2
Alcoholic beverage	1
Home remedy	2
Other	18
Sum	24

Relative by Column:

	Total
Prescription medication	4.17%
Nonprescription medication	8.33%
Alcoholic beverage	4.17%
Home remedy	8.33%
Other	75.00%
Sum	100%

117. How often do you take dietary supplements?

	Total
Daily	8
Several times a week	1
Several times a month	2
Rarely	6
Never	15
Sum	32

Relative by Column:

	Total
Daily	25.00%
Several times a week	3.13%
Several times a month	6.25%
Rarely	18.75%
Never	46.88%
Sum	100%

118. How often do you use the napping/resting rooms?

	Total
Don't use	17
Once a week	7
Twice a week	0

Three times a week	2
Four or more times a week	6
Sum	32

Relative by Column:

	Total
Don't use	53.13%
Once a week	21.88%
Twice a week	0.00%
Three times a week	6.25%
Four or more times a week	18.75%
Sum	100%

119. How would you rate the quality of the resting rooms

	Total
Excellent	0
Good	2
Fair	4
Poor	22
Don't use the rooms	4
Sum	32

Relative by Column:

	Total
Excellent	0.00%
Good	6.25%
Fair	12.50%
Poor	68.75%
Don't use the rooms	12.50%
Sum	100%

120. At what time of day do you have the most trouble sleeping?

	Total
Day	15
Evening	1
Nighttime	2
Can sleep anytime	8
Have trouble sleeping anytime	6
Sum	32

Relative by Column:

	Total
Day	46.88%
Evening	3.13%
Nighttime	6.25%
Can sleep anytime	25.00%
Have trouble sleeping anytime	18.75%
Sum	100%

121. On your current job, how much earlier than normal do you have to get up in order to be at work on time?

	Total
Don't have to get up earlier	11
1 hour	6
2 hours	5
3 hours	6
4 or more hours	4

Sum	32

Relative by Column:

	Total
Don't have to get up earlier	34.38%
1 hour	18.75%
2 hours	15.63%
3 hours	18.75%
4 or more hours	12.50%
Sum	100%

122. On what day of consecutive work do you feel the most fatigued?

	Total
1st day of work	4
2nd day of work	3
3rd day of work	3
4th day of work	6
5th or later day of work	15
Sum	31

Relative by Column:

	Total
1st day of work	12.90%
2nd day of work	9.68%
3rd day of work	9.68%
4th day of work	19.35%
5th or later day of work	48.39%
Sum	100%

123. Ability to control heating or cooling to personal comfort level.

	Total
Excellent	1
Good	6
Fair	9
Poor	9
Very Poor	6
Sum	31

Relative by Column:

	Total
Excellent	3.23%
Good	19.35%
Fair	29.03%
Poor	29.03%
Very Poor	19.35%
Sum	100%

124. Cab seating in providing comfort and support throughout the work period.

	Total
Excellent	0
Good	6
Fair	6
Poor	9
Very Poor	10
Sum	31

Relative by Column:

	Total
Excellent	0.00%
Good	19.35%
Fair	19.35%
Poor	29.03%
Very Poor	32.26%
Sum	100%

125. Level of cab noise.

	Total
Excellent	0
Good	3
Fair	8
Poor	9
Very Poor	12
Sum	32

Relative by Column:

	Total
Excellent	0.00%
Good	9.38%
Fair	25.00%
Poor	28.13%
Very Poor	37.50%
Sum	100%

126. Vibration level.

	Total
Excellent	1
Good	4
Fair	11
Poor	10
Very Poor	6
Sum	32

Relative by Column:

	Total
Excellent	3.13%
Good	12.50%
Fair	34.38%
Poor	31.25%
Very Poor	18.75%
Sum	100%

127. The effect on the cab environment on your alertness is ....

	Total
Excellent	1
Good	11
Fair	10
Poor	6
Very Poor	3
Sum	31

Relative by Column:

	Total
Excellent	3.23%

Good	35.48%
Fair	32.26%
Poor	19.35%
Very Poor	9.68%
Sum	100%

128. What is your race?

	Total
White	20
Black or African American	4
American Indian or Alaska Native	0
Asian/Chinese	1
Other or more than one race	3
Sum	28

Relative by Column:

	Total
White	71.43%
Black or African American	14.29%
American Indian or Alaska Native	0.00%
Asian/Chinese	3.57%
Other or more than one race	10.71%
Sum	100%

129. Are you Spanish/Hispanic/Latino? (NJT question only)

	Total
No, not Spanish/Hispanic/Latino	19
Yes, Mexican, Mexican Amer., Chicano	0
Yes, Puerto Rican	1
Yes, Cuban	2
Yes, other Spanish/Hispanic/Latino group	0
Sum	22

Relative by Column:

	Total
No, not Spanish/Hispanic/Latino	86.36%
Yes, Mexican, Mexican Amer., Chicano	0.00%
Yes, Puerto Rican	4.55%
Yes, Cuban	9.09%
Yes, other Spanish/Hispanic/Latino group	0.00%
Sum	100%

130. What is your current marital status?

	Total
Single	7
Married	20
Separated	0
Divorced	3
Other	1
Sum	31

Relative by Column:

	Total
Single	22.58%
Married	64.52%
Separated	0.00%
Divorced	9.68%

Other	3.23%
Sum	100%

131. How many children under 18 do you have at home?

	Total
None	17
One	8
Two	5
Three or more	1
Sum	31

Relative by Column:

	Total
None	54.84%
One	25.81%
Two	16.13%
Three or more	3.23%
Sum	100%

132. What primary childcare arrangements do you currently have?

	Total
Child care provider	2
Relatives	4
Spouse or partner	6
Other	3
Does not apply (no children at home)	17
Sum	32

Relative by Column:

	Total
Child care provider	6.25%
Relatives	12.50%
Spouse or partner	18.75%
Other	9.38%
Does not apply (no children at home)	53.13%
Sum	100%

133. If you do any additional work (including a farm or other home business) other than your current job at [company], please indicate the approximate average number of hours per week that you work on your second job.

	Total
1 to 10	2
11 to 20	2
21 to 30	1
31 or more	0
Does not apply	26
Sum	31

Relative by Column:

	Total
1 to 10	6.45%
11 to 20	6.45%
21 to 30	3.23%
31 or more	0.00%
Does not apply	83.87%
Sum	100%

134. Does your spouse or partner work full time?

	Total
Yes, straight day work	14
Yes, straight evening or night work	0
Yes, rotating shifts	1
No, does not work outside the home	2
Does not apply	15
Sum	32

Relative by Column:

	Total
Yes, straight day work	43.75%
Yes, straight evening or night work	0.00%
Yes, rotating shifts	3.13%
No, does not work outside the home	6.25%
Does not apply	46.88%
Sum	100%

135. What do you find is the most fatiguing aspect of your job and what jobs do you find the most difficult?

No crosstab results available

136. What measures do you think would be most likely to improve the overall alertness of the train crews?

No crosstab results available

137. What methods do you currently use to help you reduce your fatigue and increase alertness?

No crosstab results available

138. Is there any other important information that you wish to share with us relative to your personal preferences, problems, or recommendations regarding working on the trains?

No crosstab results available

GLOSSARY

circadian rhythm

extra board

fatigue index

fatigue management

rail operations

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