Transport Canada Transports Canada

Rail Safety

Oversight and Expertise

Fatigue Management Plans

Requirements and Assessment Guidelines

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Canada

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Introduction

Transport Canada's mandate to establish the hours of work and rest periods for railway operating employees exists because the establishment of hours of work rules is integrally linked with the department's mandate to regulate the safety of Canada's railways. For reasons of efficiency, it has been agreed that all facets of railway safety be regulated by a single department.

Transport Canada recognizes that fatigue is one of the most critical safety issues facing the railway industry today. There is no doubt that fatigue has a detrimental impact on human performance and safety. While solutions to fatigue exist, there is no 'one size fits all' solution, which will easily solve all fatigue-related problems. One counter measure alone is not enough, nor is the sole reliance on legislated maximum hours of work.

A tremendous amount of research has been done on fatigue and fatigue management over the last decade, and we now know enough to implement some effective solutions. We are confident that implementing the guidelines that follow will not only improve railway safety, but offer a better life style to those who are involved in a 24/7 work environment.

It is not the intention of this document to prescribe solutions. These guidelines, which reflect the recommendations of contemporary fatigue professionals for the mitigation of fatigue in the workplace, present practices you may find useful in developing your Fatigue Management Plans (FMP).

Fatigue Management Plans

Addressing safety from the point of view of risk management has become increasingly accepted as a way of dealing with many types of safety situations. Rather than implementing an overall prescriptive approach and running the risk of creating more problems by using the same approach in all situations, risk management allows us to identify situations in which a high degree of risk is anticipated, and then put in place a series of countermeasures that can be used to minimize the likelihood of injury or harm.

In the study of fatigue management, the need to identify situations or conditions that are high risk and that might potentially lead to high-risk behaviour is considered important. Accordingly, this document is intended to apply to specific high-risk conditions in which a person could exhibit the negative or detrimental effects of fatigue. Given such conditions, the FMP should be designed to minimize the possibility of fatigue occurring, and/or counteract the detrimental effects of fatigue should it occur.

Background

Inquiries into the Trudel, Quebec and Hinton, Alberta collisions in 1986, found that crew fatigue may have played a significant role. In the spring 1987, *Interim Mandatory Rest Orders* were issued, based on the Hinton Inquiry Recommendations, requiring crews to remain off duty for periods of six and eight hours after having worked in excess of eight and ten consecutive hours respectively. In July 1993, the Interim Orders were replaced by a Rule that required eight hours of rest after working in excess of ten hours, but did not include a maximum limit on the number of hours that operating crews could work.

In August 1993, instances where CN and VIA crews remained on duty in excess of twenty hours were identified and Orders were issued under the *Railway Safety Act* (RSA), limiting the number of hours operating crews could remain on duty. The Order limited operating crews to 12 continuous hours in a single tour of duty. Because imposition of the 12-hour limit on short notice would have impacted negatively on railway operations, provisions were also made to limit on-duty time to 18 hours in a 24 hour period, 16 consecutive hours in work/emergency service and 14 consecutive hours on certain assignments in remote areas where it was not practical to relieve crews.

In 1995, CN, CP and VIA Rail contracted Circadian Technologies Inc., to conduct a comprehensive scientific study of the fatigue/alertness problems being experienced by railway operating employees. This study included the evaluation, under field conditions, of various countermeasures that would improve the alertness of operating employees while on duty. In order to help ensure that Canadian regulatory requirements would be based on a sound scientific approach to combat the fatigue issue in Canada, Transport Canada Rail Safety became part of the North American Rail Alertness Partnership (NARAP), which was a forum of Canadian and American railways, unions, industry associations, academics and regulators interested in addressing the fatigue problems in the rail industry.

In accordance with the *Railway Safety Act*, the new *Work/Rest Rules for Railway Operating Employees* received Ministerial approval on October 18, 2002, and came into force on April 1, 2003. The time lapse between approval and coming into force was to allow the federally regulated railways time to develop and submit Fatigue Management Plans, which are essential to the effectiveness of the Rule.

Since 2003, the industry has increased its training to employees and automated systems to track hours of work for employees. The need to address hours of work for supervisors who occasionally perform operating duties was also identified and FMPs were developed for them.

In December 2006, the Minister of Transport, Infrastructure and Communities initiated the Railway Safety Act Review to address concerns raised by a series of high-profile accidents. The review was aimed at identifying gaps in the RSA, and making recommendations to strengthen the regulatory regime to meet the changing nature of the railway industry and its operations.

In February 2007, the Minister asked an independent Advisory Panel to lead the review. The scope of the review encompassed many key issues concerning railway safety in a broad sense. In particular, the Advisory Panel set out to address the efficiency and effectiveness of the regulatory framework established under the RSA; the provisions and operation of the Act; environmental concerns with respect to railway transportation and accidents; inter-face with non-railway users; and related safety issues.

These broad areas encompassed many issues of interest, including fatigue management, and the Panel's final report **made Recommendation #43**, as follows:

- *Fatigue management is dealt with in complementary ways, such as work/rest rules, fatigue management plans, and terms and conditions of employment.*
- *The current work/rest rules do not provide a satisfactory baseline framework for managing the risks associated with fatigue in railway operations. The rules should be amended to reflect current science on fatigue management.*
- *A robust system of fatigue management plans is needed. Transport Canada should audit them as it does for safety management system plans.*
- *Fatigue management is also an issue that railways and employees should address in the establishment of terms and conditions of employment.*

A working group with members of government, industry and labour was formed in October 2008 to address this recommendation. This group included Dr. Patrick Sherry, a world-leading fatigue management specialist from the National Centre for Intermodal Transportation at the University of Denver, as well representatives from Transport Canada, Railway Association of Canada, CN, CP, VIA, the Société des chemins de fer du Québec and the Teamsters Canada Rail Conference.

This Transport Canada document, *Fatigue Management Plans: Requirements and Assessment Guidelines*, and its incorporation as a regulatory requirement into the *Work/Rest Rules for Railway Operating Employees* was produced in a collective manner to meet the requirements of the recommendation.

Text of the Rule

Fatigue Management Plans **must be filed with Transport Canada** in order to meet the requirements of the rule and in accordance with section 7.1 of the *Work/Rest Rules for Railway Operating Employees.*

These FMPs must address the key aspects of fatigue management programs in place within the railway as specified in the following sections of the *Work/Rest Rules*:

6.1 Requirements

6.1.3 Fatigue management plans shall reflect the nature of the operations under consideration, including work trains on a particular territory, taking into account such items as size, complexity, traffic density, traffic patterns, run length and geographical considerations.

6.2 Development and Implementation

6.2.1 Railways, operating employees and their designated representatives will be involved in the development and implementation of fatigue management plans including changes to such plans.

6.2.2 Fatigue management plans must consider but not be limited to the following:

a) Education and training
b) Scheduling practices
c) Dealing with emergencies
d) Alertness strategies
e) Rest environments
f) Implementation policies
g) Evaluation of fatigue management plans and crew management effectiveness

6.2.3 a) Fatigue management plans shall address how operating employees, who work more than one tour of duty under the provisions of subsection 5.1.3, will be afforded the opportunity to be involved in the decision to accept a subsequent tour of duty, based on their fitness at that time.

b) Where railway companies have processes in place that provide rest provisions that allow employees to elect to take rest prior to a subsequent shift or tour of duty, such will satisfy the requirements of paragraph a).

c) Fatigue management plans shall also address the circumstances under which operating employees in road service, not taking rest, will be provided the option to take a break of up to 45 minutes off-duty between consecutive working tours of duty where the combined on-duty time will exceed 12 hours.

6.2.4 A specific fatigue management plan must be in place to address fatigue of operating employees in the following circumstances:

a) where continuous on-duty hours exceed 12 hours;
b) where there are more than 64 hours on-duty in a 7 day period; and
c) emergency situations.

Risk Factors for Fatigue

Based on a review of the existing research in this field (including research by Fatigue Experts Group in Australia, the Fatigue Experts Group in Canada, and the report of the consultant to Transport Canada (Sherry, 2000), a number of risk factors have been identified as likely to increase operator impairment as a result of fatigue.

1. The total length of the work shift exceeding 14-16 hours.
2. Continuous hours of wakefulness beyond 19 hours.
3. Working between the hours of 0000 and 0600.
4. Obtaining less than six hours of continuous sleep in a 24-hour period.
5. Break times that do not permit reasonable recuperative times (<8 hrs).
6. Continuous work beyond 64 hours in a seven-day period.
7. Less than two consecutive nights of recuperative sleep.
8. Continuous work for over five hours without at least a 30-minute break.
9. Undiagnosed or untreated medical conditions (eg. sleep apnea) that may affect fatigue.
10. Differences in ability to sleep and respond to conditions (eg. age, hardiness).
11. Quality of sleep.

While the above list has been designated as "risk factors" it cannot be said that, for example, simply giving a person two consecutive nights of sleep will be sufficient to prevent accidents. Nor does it stand to reason that exceeding the risk factors will automatically lead to an accident. These risk factors are based on the best judgment of the science available at this time, and there is not necessarily a one-to-one causal relationship between these factors and the occurrence of accidents or injuries.

As can be seen in Figure1, which is adapted from the Australian Fatigue Experts Group report on driver fatigue, there are a number of factors that contribute to the occurrence of driver fatigue that are also applicable to persons in the rail industry. Based on these findings we can identify a number of different types of activities and countermeasures that can be used to develop an effective plan to mitigate the effects of fatigue.

The main way to address the problem of fatigue is to develop FMPs that prevent the causes and/or mitigate the effects of fatigue. The main countermeasures that can be used in developing FMPs are grouped according to the list below. These countermeasures, which are fully detailed in Annex 1 (the revised FMP Assessment Worksheet), should be applied in combination to minimize the risks associated with fatigue:

- Education and Training;
- Scheduling Practices;
- Dealing with Emergencies;
- Alertness Strategies;

- Rest Environments;
- Implementation Policies; and
- Evaluation of FMPs and Crew Management (CM) Effectiveness

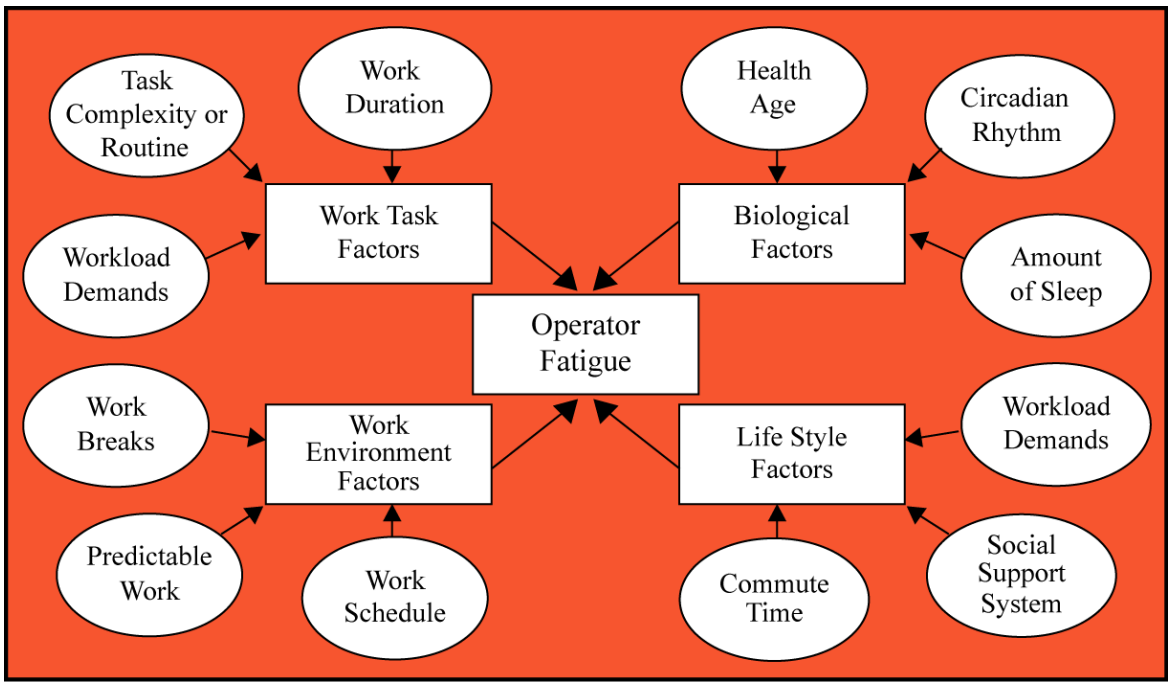

Figure 1. Factors Contributing to Fatigue.

Guidelines for Developing FMPs

The following outline is recommended for developing an ideal FMP. Additional detail on each component follows below.

FMP Components

a) Statement of Principles
b) General Plan
   - Specific Plans
   - Local Plans
c) Accountability
   - Point of Contact
   - Roles & Responsibilities
d) Evaluation of Plan
   - Monitoring
   - Data collection procedures
   - Data storage
   - Reporting
e) Risk Assessment

a) Statement of Principles
The first component of an FMP should be some overall statement of its philosophy or principles with respect to the issues of fatigue in the work place. This type of statement is useful to labour and management who will be implementing the FMP in various settings and under various circumstances throughout the railway. In addition, this general statement of principles will provide Transport Canada with an understanding of the direction and goals that the company seeks to address in its FMP. Such a statement will be useful in clarifying and elaborating upon special circumstances, should they arise.

b) General Plans (as per Section 6, Work/Rest Rules)
A second component of the FMP should address the "general" approach to Fatigue Management (FM) within the organization. This general, company-wide approach or plan should be implemented throughout all levels of the organization and across the entire system. In other words, it is expected that all employees subject to the Work Rest Rules will be under one general FMP.

While the general plan will reflect the approach to fatigue management across the entire system, Specific FMPs will be generated for various operations and locations that represent specific risks (*as per Section 6.2.4 Work/Rest Rules*). Specific FMPs should be available at

a central location accessible to TC and also on-site at the specific location. In some instances, Local FMPs should also be developed for locations with unique risks. These local FMPs should be referenced in the General FMP, and should be available to local labour, management, and TC upon request.

c) Accountability

The third component of the FMP should focus on accountability. The general, company-wide FMP should designate an individual to be responsible for the establishment and monitoring of all FMPs (general, specific and local) that exist throughout the organization. This individual would be the main contact person between TC and the organization, and would facilitate the development of these plans. The General FMP should also include information on the roles and responsibilities of those involved with the development, approval, and implementation of the plan.

d) Evaluation of Plan

The fourth major component of the FMP should describe the system that the company will use to determine its success in fatigue management. This evaluation should take place on two levels:

1. There is a need to determine that the FMP is being implemented as planned throughout the system; and
2. There is a need to determine whether the FMP is actually contributing to the reduction or mitigation of fatigue in the field.

Evaluation data should consist of various data points and measurements designed to demonstrate that the railway is in fact reducing fatigue and improving alertness. The railway should describe:

- How it is able to monitor its own compliance with the rule;
- How the data will be maintained; and
- How the data will be made available for review by Transport Canada.

The type of data to be included will consist of:

- Review of duty times;
- Review of time-off taken;
- Times persons have been relieved for fatigue related reasons;
- Utilization of fatigue countermeasures such as napping times or facilities; and
- Frequency of occurrence of incidents and injuries possibly associated with fatigue
- or fatigue-related factors.

e) Risk Assessment

The fifth key component of an FMP is risk assessment. Implied within the FMP process is the concept of risk assessment for fatigue, and FMPs are essentially intended to plan for and implement countermeasures in the event of an employee developing a *risk* for fatigue-

impaired performance. Accordingly, it is strongly recommended that railways develop and assess the risk for fatigue incurred within its operations. This risk assessment should be part of the process during development of the General FMP and addressed specifically in any Specific and Local FMPs.

Strategies to Address Key Risk Factors

As noted above, there are numerous situations that are likely to result in fatigue. Six situations with the highest risk have been identified as Key Risk Factors. Five others are identified as Additional Risk Factors.

List of Key Risk Factors

1. The total length of the work shift exceeding 14-16 hours;
2. Continuous hours of wakefulness beyond 19 hours;
3. Working between the hours of 0000 and 0600;
4. Obtaining less than six hours of continuous sleep in a 24-hour period;
5. Break times that do not permit reasonable recuperative times (<8 hrs); and
6. Continuous work beyond 64 hours in a seven-day period.

Additional Risk Factors

- Less than two consecutive nights of recuperative sleep;
- Continuous work for over five hours without at least a 30-minute break;
- Undiagnosed or untreated medical conditions (eg. sleep apnea) that may affect fatigue;
- Differences in ability to sleep and respond to conditions (eg. age, hardiness); and
- Quality of sleep.

The six Key Risk Factors are listed below with suggested countermeasure strategies that might be included in your FMP. **Please note**: Some content in each of the following sections is repeated in order to ensure adequate and complete coverage of important strategies to address each Key Risk Factor.

About the Graphs: Several of the Key Risk Factor strategies were examined for their overall effectiveness in reducing fatigue. The impact of the strategy can be determined by looking at when and how far below the recommended fatigue threshold the line plotted in the graph drops. To read the graph first look at the vertical axis which represents the degree of cognitive effectiveness the person might be performing at. The scale ranges from 0 to 100. Similar, but not exactly equivalent to a percent, the scale can be thought of as showing how effective the person is.

For example, a score of 90 suggests that they might be at 90% effectiveness. In other words, the scale is showing a persons effectiveness or alertness on a scale of 0-100. It represents a person's degree of effectiveness in completing simple tasks, detecting a

change in environment, or solving problems within a given time frame. The *horizontal axis* shows the length of time awake or on duty. The solid bars at the base of the graphs show the person's sleep/wake patterns and time of day.
In figure 2, the red horizontal bar indicates the time period that the person was working. The blue horizontal bar indicates the time period that the person was sleeping. The grey bars indicate the period during which it was night-time or dark.

The 'optimal effectiveness cut-off level' is indicated by a dotted line at approximately 75 per cent. A study conducted by the US DOT has suggested that effectiveness scores below 70 have been associated with a greater risk of having a human factors caused accident. Thus, when a person falls below 75 we begin to get concerned as they are approaching the "red zone" that occurs when a person falls below 70.

Key Risk Factor #1

The total length of the work shift exceeding 14-16 hours.

Education. The first countermeasure that should be utilized in this, and most, cases is education. The role of education cannot be overemphasized. In order for employees to function optimally when involved in situations with a high risk for fatigue they must be fully aware of the effects of fatigue and the ways that they can prepare for fatigue-related situations.

Educational programs should cover a number of topics related to the nature of shift work, various types of shifts, biological rhythms of sleep and fatigue, effects of fatigue on performance, sleep hygiene techniques, and general health and wellness issues. The aim of the education program should be to prepare an individual to use their knowledge to obtain adequate sleep and rest prior to going on duty for extended periods. A secondary aim of educational programs will be to ensure that employees have adequate knowledge to use to combat fatigue when they are at work.

Time for Sleep. Adequate time off to recover from the effects of extended work hours is needed in order to be able to get needed sleep. It should be noted that simply giving employees time-off may not be sufficient to allow recovery if those time-off hours are daylight hours. Many individuals who have been acclimated to night-time sleep will have difficulty falling asleep during the day. Consequently, there should be sufficient time for the person to actually obtain the needed rest, taking into account the fact that even though a person is off they may not be able to rest.

In the case of a work shift exceeding 14-16 hours, it is recommended that there be an opportunity for at least six to eight hours of continuous sleep before beginning the next work period. This also means that, in some cases, a person who has been on a reduced or restricted sleep schedule for several days may need to be more closely monitored. Further, when employees have worked a long shift, they should be given additional time off to recuperate prior to beginning another shift.

Should the duty period exceed 19 hours, the best research available suggests that performance decrements are much more likely. Consequently, when this occurs, rest should be made available as soon as possible.

Another countermeasure if the duty period exceeds 19 hours, would be to ensure that there are opportunities for the individual to nap for at least 20 minutes - but not to exceed 45 minutes - during the work period. Short naps have been shown to have a very positive effect on performance that can last several hours. Despite the potential negative effects of sleep inertia (i.e. the grogginess typically associated with waking up) the benefits outweigh the negatives.

Another point to consider when developing an FMP for long hours of work is the selection of individuals who are properly rested to perform the work.. Choosing individuals who have had at least eight hours of sleep *during the 24-hour period before (preferably during night before)* the work is to be conducted, will lead to a greater likelihood that they will be able to perform the work adequately.

Sleep Hygiene. Appropriate conditions are needed so that a person is able to obtain adequate and restful sleep. For example, darkened rooms and reduced noise will contribute to more restful and recuperative sleep.

Diet. The judicious use of over-the-counter food stimulants is also recommended. For example, caffeine is useful in improving alertness. Caffeine is found in any number of common foods and beverages, and employees in high-risk situations should be encouraged to utilize caffeinated foods and chewing gum. Of course, to maximize the positive effects of these foods, it is necessary to utilize them in an effective manner and to consume them so as to achieve the greatest possible benefit. Again, education should be provided to enable persons to use these products wisely.

Body Clock. If the work period is going to take place the period of time when the individual is likely to be wide awake then there is no problem. However, if they are going to be working into a period when the circadian clock would likely increase the likelihood of being asleep, additional counter measures such as added monitoring, the need for additional crews, supervision and contact with other people are recommended. There may also be a need for opportunity napping.

Activities. Several studies have shown that there is some benefit in trying to remain physically active as a means of warding off sleep. The technique of walking around, talking, or performing various interesting and stimulating duties as a means of counteracting the effects of drowsiness have been shown to be useful. Essentially, short breaks that increase activity are needed to help offset the immediate propensity for sleep.

Environment. Whenever possible, positive environmental conditions such as good lighting, proper temperature, and some appropriate noise level, should be maintained. Bright light is more likely to lead to alertness. When trying to fall asleep, the use of white

noise or soft and soothing music is recommended. Conversely, sounds that stimulate interest and attention are more likely to lead to alertness.

Key Risk Factor #2

Continuous hours of wakefulness beyond 19h.

The existing rule specifies that a work period should not exceed 12 hours. However, a situation may occasionally arise in which employees, for whatever reason, work longer hours. The situation in which a person is continuously awake beyond 19 hours can occur if there is an extended duty period. In some cases, employees may work as long as 18 hours in one day when they, for example, work nine hours, gets three off and then work another nine hours for a total of 18 hours on duty.

Figure 2. Effectiveness of a 19-hour day shift.

Figure 2 shows the effectiveness level of a 19-hour day shift. As can be seen from the chart, effectiveness decreases dramatically about three quarters of the way into the shift. As mentioned previously, this situation is problematic in that most research indicates that the average individual shows a decrease in cognitive performance following 19 hours of wakefulness that is equivalent to other major influences on cognitive effectiveness (such as alcohol).

Figure 3 on the other hand, shows the estimated effectiveness levels of a 19-hour night shift even after a full night's sleep preceding the work shift. The effectiveness level is below the optimal cut-off score for more than half of the shift.

Figure 3. Effectiveness of 19-hour night shift.

Education. Employees need to be educated as to the performance risk associated with extended wakefulness. The research studies, which demonstrate a significant reduction in performance associated with each hour of wakefulness beyond 19 hours, should be shared with employees. Educational programs should be fairly direct in reviewing the data associated with the effects of these types of situations.

Time for Sleep. Should employees be exposed to these types of conditions, effort should be undertaken fairly quickly to ensure that they have sufficient recovery time to obtain needed rest. As noted above, simply providing employees time off may not be sufficient to recover if those time-off hours are in daylight. For the most part, individuals who have been acclimated to night-time sleep will find it difficult to fall asleep during the day. Consequently, there should be sufficient time for the person to actually obtain the needed

rest, taking into account the fact that even though a person is off, they may not be able sleep.

Diet. The judicious use of over-the-counter food stimulants is also recommended. For example, caffeine is useful in improving alertness. Caffeine is found in any number of common foods and beverages, and employees in high-risk situations should be encouraged to utilize caffeinated foods and chewing gum. Of course, to maximize the positive effects of these foods it is necessary to utilize them in an effective manner and to consume them so as to achieve the greatest possible benefit. Again, education should be provided to enable persons to use these products wisely.

Body Clock. If the extended work period is going to take place during 0000-0600, the body clock will make it highly likely that excessive drowsiness may occur. Consequently, if a person is going to be working into a period when the circadian clock would likely increase the likelihood of being asleep, then additional counter measures such as added monitoring, need for additional crews, supervision and contact with other people may be needed. There may also be a need for opportunity napping.

Activities. Several studies have shown that there is some benefit in trying to remain physically active as a means of warding off sleep. The technique of walking around, talking, or performing various interesting and stimulating duties as a means of counteracting the effects of drowsiness have been shown to be useful. Essentially, short breaks that increase activity are needed to help offset the immediate propensity for sleep.

Key Risk Factor #3

Working between the hours of 0000 and 0600.

A work situation in which the individual is working between the hours of 0000 and 0600 is likely to cause a greater propensity for sleep than one where persons are working during daylight hours. FMPs designed to address the issues of working the night shift or the mid-night shift should address education issues as a significant preventative measure.

Additional components of the FMP should include adequate time for sleep, use of non-prescriptive stimulating foods or beverages, activity, and alertness enhancing environments.

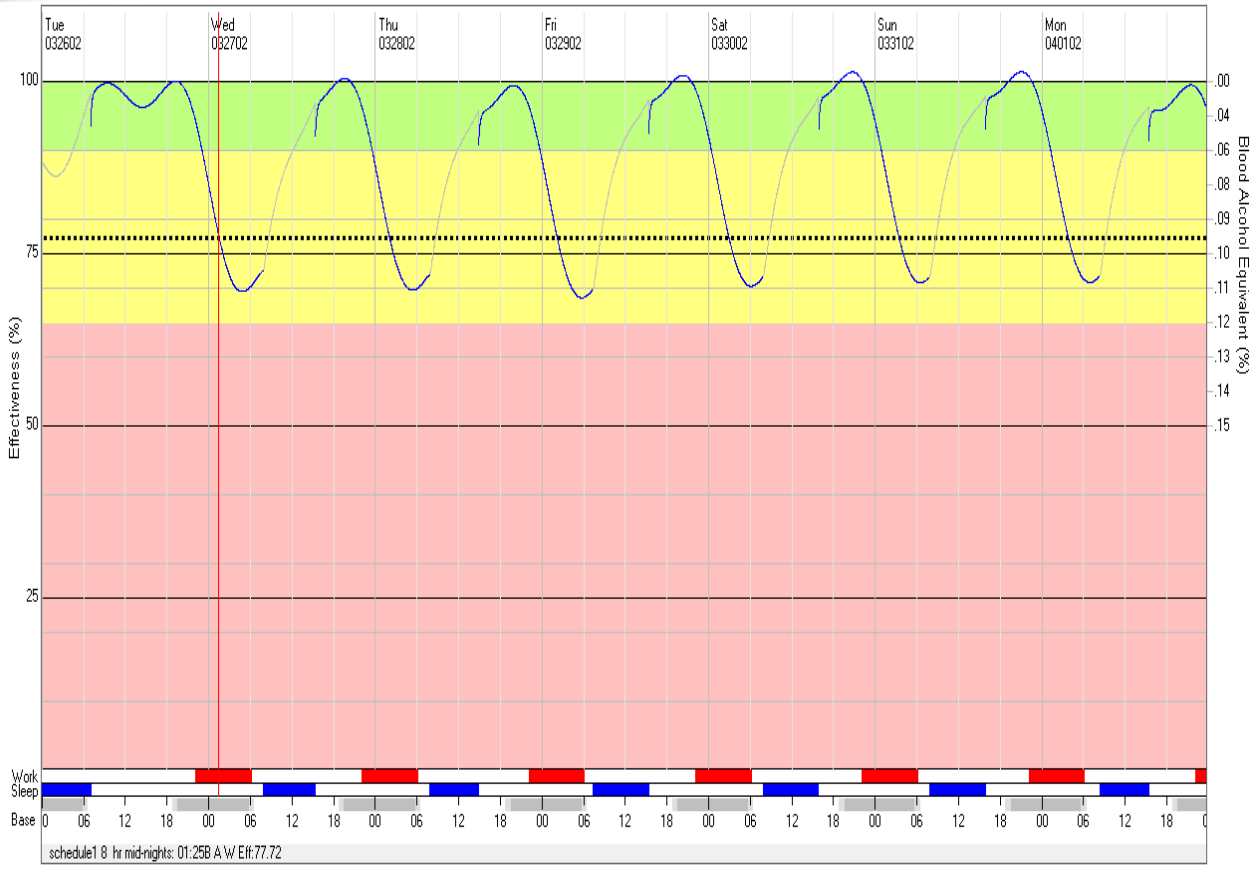

Figure 4. Eight-hour midnight shifts.

Persons working during 0000 and 0600 are faced with considerable obstacles to overcoming fatigue and maintaining alertness. This is largely due to the fact that they are combating the body's natural circadian rhythm that is telling the body to sleep. Figure 4 shows the estimated effectiveness levels predicted by the fatigue model that can occur indicating that the person spends about 50% of the time below the optimal effectiveness or alertness level. Studies have shown that alertness and the ability to pay attention is at its lowest point during this time period. There is also a much greater likelihood of traffic accidents during this time as well.

This work period is made more difficult by the fact that since the person is not sleeping during the night, they must make up the sleep during the day. Sleep obtained during the daylight hours is less recuperative than that obtained during the night, again due to the influence of the circadian rhythm. Most night-shift workers report obtaining only four to six hours of sleep in the daytime.

Education. An educational program, as described above, should include a number of topics related to the nature of shift work, including various types of shifts, biological rhythms sleep and fatigue, effects of fatigue on performance, sleep hygiene techniques, and general health and wellness issues. The effects of the education program should ultimately be to prepare an individual to use their knowledge to obtain adequate sleep and rest prior to, and

after, working during 0000 to 0600 periods. A secondary aim of educational programs will be to ensure that employees have adequate knowledge to combat fatigue when they are at work.

A number of preventative measures should be described in the education program. For example, getting as much sleep as possible before going on duty, and avoiding extended work hours before pulling a midnight shift. Trying to sleep in the morning immediately after work is a good strategy as well.

Time for Sleep. Ideally the person working the midnight shift should have had sufficient time for sleep before going on duty. The importance of the person being well rested before going on duty is underscored by the fact that alertness and performance are directly related to amount of time awake. One of the highest risk scenarios is for a person to be awake during the daylight hours and then be expected to work during the 000-0600 period. While a well-rested person can likely accomplish this, other factors such as boredom, darkness, and lack of stimulation can increase the drowsiness and sleepiness experienced during this time period.

Furthermore, a person who has been awake for a number of hours and is then expected to remain alert during 0000-0600 will be fighting fatigue more than most. Consequently education must alert the employee to the risks associated with this time period.

Following a tour of duty in which the individual has been on-duty during the midnight hours (0000 to 0600) there should also be sufficient time off to obtain at least eight hours of sleep. Again, since it is difficult to obtain quality sleep during the daylight hours this recommendation and countermeasure assumes that while difficult it is something that should be attempted. This further implies that there is an assumption that working the midnight shift over time may contribute to the development of a sleep debt. An individual may need additional time off to completely eliminate or pay back the sleep debt. While this is not always possible for persons working night shifts, there should be an acknowledgement of the importance of this principle in your FMP.

Naps. For persons working this shift, it is also important to acknowledge the need for time to nap during the midnight hours. Use of break time for short naps should be an acceptable part of the work situation. However, the risks of sleep inertia are more pronounced during this time period and may need to be planned for and anticipated for naps taken between 0000 - 0600. FMPs should address the need for, and the guidelines surrounding, napping for employees required to work between 0000 and 0600.

To see the estimated effect of a planned nap during a midnight shift refer to *Figure 5* and compare to *Figure 4*. As can be seen, the planned naps on the second and third work shifts (represented by the inverted triangles) have a delaying effect on how soon the person reaches the cut-off level, and almost prevents the subject from falling below the accepted range of alertness.

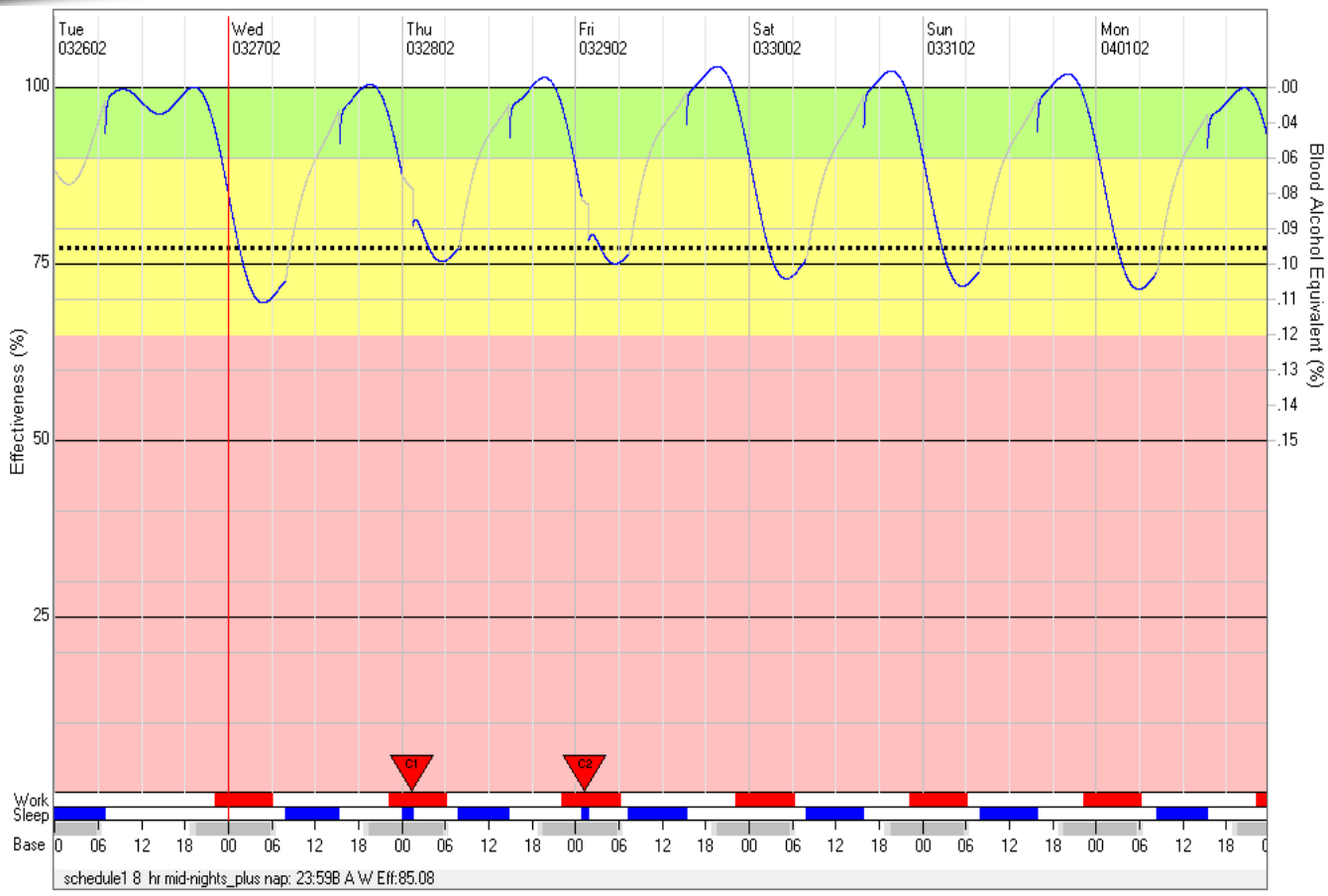

Figure 5. Effects of planned naps.

Naps during this time period are particularly problematic as the body's propensity for prolonged sleep is great and therefore the individual may have difficulty ending the nap or waking up. Therefore, naps should only be initiated if there are sufficient safeguards in place for the individual to awaken. Nevertheless, based on the estimates provided by the fatigue model, the benefits would seem to outweigh the risks.

Diet. The judicious use of over-the-counter food stimulants is also recommended. For example, caffeine is useful in improving alertness. Caffeine is found in any number of common foods and beverages, and employees in high-risk situations should be encouraged to utilize caffeinated foods and chewing gum. Of course, to maximize the positive effects of these foods it is necessary to utilize them in an effective manner and to consume them so as to achieve the greatest possible benefit. Again, education should be provided to enable persons to use these products wisely. On the midnight shift, the use of caffeine before the end of shift or after 3 a.m. should be discouraged as it can lead to difficulty sleeping after work.

Other dietary issues that occur during the 0000-0600 period have to do with the fact that the body's digestive system is likely slowed or delayed during this time period. Consequently, efforts should be made to limit the amount of food intake during this

period. Light snacks, foods requiring little digestive effort such as liquids are more likely to be digested than high amounts of protein.

Activities. Several studies have shown that there is some benefit in trying to remain physically active as a means of warding off sleep. The technique of walking around, talking, or performing various duties that is interesting and stimulating as a means of counteracting the effects of drowsiness. One researcher suggests that midnight shifts should be structured with periodic rest breaks and snacks.

In addition to being physically active, it is also important to be psychologically active. Engaging in varied tasks and altering your pace can enhance your alertness as well. In sum, short breaks that increase activity are needed to help offset the immediate propensity for sleep.

Environment. Whenever possible, positive environmental conditions such as proper lighting, proper temperature, and some appropriate noise level should be maintained. In order to ward off drowsiness and fatigue the environment should be properly lighted. Bright light is more likely to lead to alertness. To the extent possible, bright light should be a part of the environment during 0000 to 0600 work shifts. If conditions permit, bright light will act as a stimulus to increased alertness. Darkly lit environments promote sleep.

In addition, noise in the environment should be constantly changing and not monotonous. A social environment where it is possible to talk to others will also encourage alertness. Listening to talk radio or news shows can also enhance attention.

Key Risk Factors # 4 & 5

Less than six hours of sleep in a 24-hour period.
Break or Off Duty times that do not permit reasonable recuperative times (<8 hrs).

Education. The first countermeasure that should be utilized in this, and most, cases is education. The role of education cannot be overemphasized. In order for employees to function optimally when involved in situations with high risk for fatigue they must be fully aware of the effects of fatigue and the ways that they can prepare for fatigue related situations.

The primary role of education relative to these risk factors is to minimize the likelihood that they will occur. In other words, ensuring that a person will in fact get at least six hours of sleep. In the case of an insufficient amount of sleep in a 24-hour period or in a period preceding work, the most important countermeasure is of course careful planning prior to this situation developing. In other words, if the employee knows that this situation will develop, they should attempt to get as much sleep as possible during the night hours preceding this situation occurring.

> For example: if an individual has obtained less than four hours of sleep, and is expected to work during the period of 0000-0600, and has not had sufficient "anchor sleep" in the preceding 48 hours, he or she may be at risk of not being able to perform the duty assigned to them at expected levels of alertness. A robust FMP plan would provide a mechanism for employees to report such situations but it must also be noted that prevention, by being provided adequate opportunities for rest and obtaining that rest, is a shared responsibility and is the best method. Accordingly, labour and management should work collaboratively to develop fatigue reporting mechanisms and procedures so that both parties can more effectively manage fatigue levels in the overall workforce. The results from these reporting mechanisms and procedures should be used when evaluating the effectiveness of crew scheduling and fatigue management practices

Education programs should also cover a number of topics related to the nature of shift work, various types of shifts, biological rhythms sleep and fatigue, effects of fatigue on performance, sleep hygiene techniques, and general health and wellness issues. The aim of the education program should be to prepare an individual to use their knowledge to obtain adequate sleep and rest prior to going on duty for extended periods. A secondary aim of educational programs in dealing with this risk factor should be to ensure that employees have adequate knowledge to combat fatigue when they are at work.

Time For Sleep. Adequate time off to recover from the effects of abbreviated sleep periods is essential. The hours off should be sufficient to allow the employee to obtain at least eight hours of uninterrupted sleep. It should be recognized that eight hours is not necessarily sufficient if the eight hours occur during the daylight hours. For the most part, individuals who have been acclimated to night-time sleep will be unlikely to fall asleep during the day.

Figure 6 shows the problems associated with not having sufficient time for recuperative sleep and also displays the gradual decline in performance over time associated with having limited and poor opportunities for sleep. Consequently, there should be sufficient time for the person to actually obtain the needed rest, taking into account the fact that even though a person is off they may not be able to.

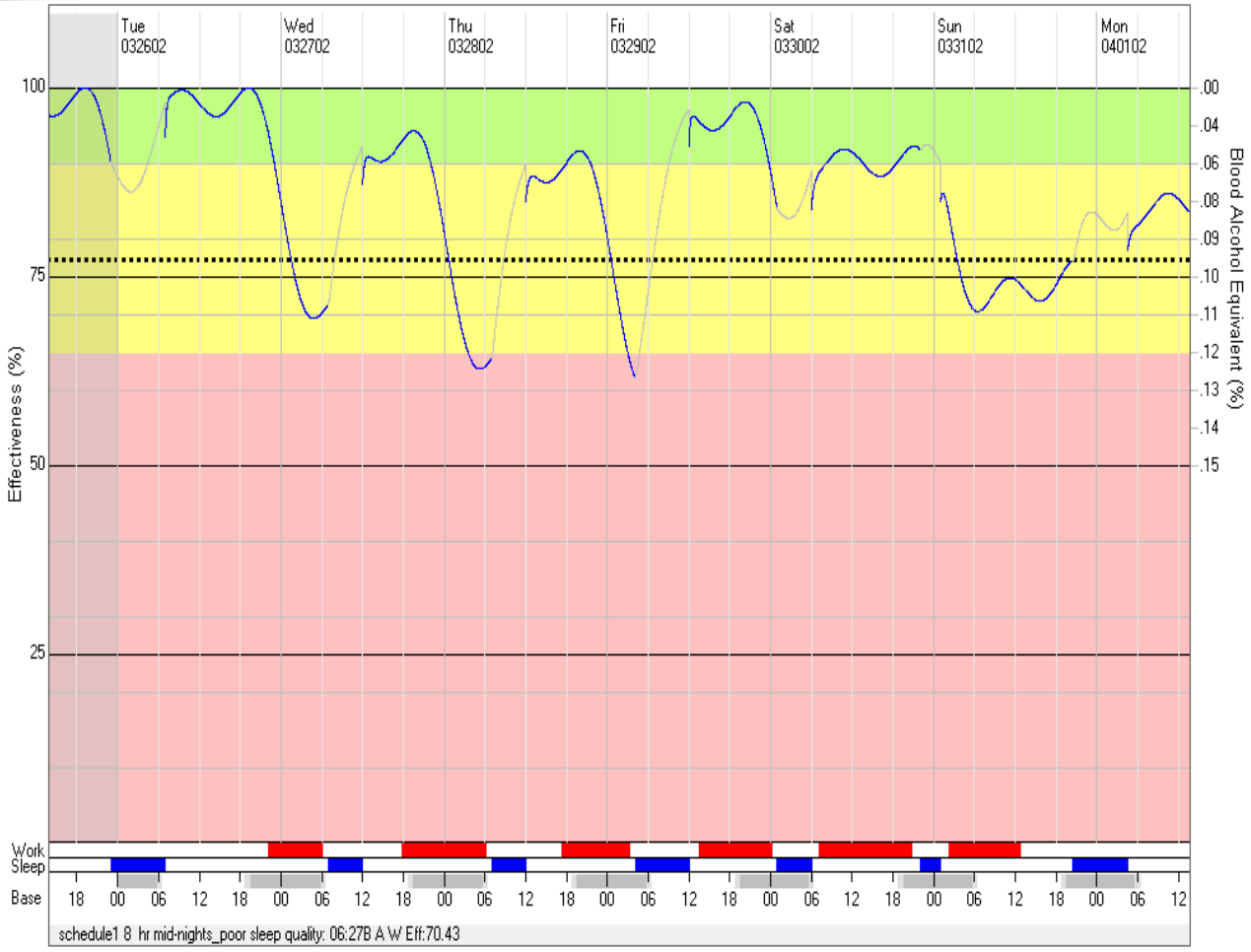

Figure 6. Effects of poor sleep opportunities.

A final consideration with respect to these particular risk factors should be to plan to obtain sufficient rest before making oneself available for another tour of duty. The individual should, if at all possible, book additional time off in order to be able to recover

from this type of extended work period. If possible, booking ten or preferably 12 hours off in order to ensure a full eight hours of sleep is suggested. If the time off is during the daylight hours, the individual may still need additional recovery time, since the likelihood of sleeping a full eight hours during daylight hours is less likely.

Napping. Another countermeasure in these situations would be to ensure that there are opportunities for the individual to nap for at least 30 minutes - but not to exceed 45 minutes - during the work period. Short naps have been shown to have a very positive effect on performance that can last several hours. Despite the potential negative effects of sleep inertia (i.e. the grogginess typically associated with waking up) the benefits outweigh the negatives.

Diet. The judicious use of over-the-counter food stimulants is also recommended. For example, caffeine is useful in improving alertness. Caffeine is found in any number of common foods and beverages, and employees in high-risk situations should be encouraged to utilize caffeinated foods and chewing gum. Of course, to maximize the positive effects of these foods it is necessary to utilize them in an effective manner and to consume them so as to achieve the greatest possible benefit. Again, education should be provided to enable persons to use these products wisely.

Another factor to consider relative to diet when dealing with shortened or restricted sleep periods is that eating should occur when the body's circadian clock or rhythm is most likely to be engaged. In other words, when the body experiences the greatest propensity for sleep, there will also be reduced readiness for digestion.

Activities. Several studies have shown that there is some benefit in trying to remain physically active as a means of warding off sleep. The technique of walking around, talking or performing various interesting and stimulating duties are thought to be an effective means of counteracting the effects of drowsiness.

Environment. Whenever possible, positive environmental conditions such as proper lighting, proper temperature, and some appropriate noise level, should be maintained. Bright light is more likely to lead to alertness. When trying to fall asleep the use of white noise or soft and soothing music is recommended. Conversely, sounds that stimulate interest and attention are more likely to lead to alertness.

Key Risk Factor # 6

Continuous work beyond 64 hours in a seven-day period

Education. The first counter-measure that should be utilized in this, and most, cases is *Education.* The role of education cannot be overemphasized. In order for employees to function optimally when involved in situations with high risk for fatigue, they must be

fully aware of the effects of fatigue and the ways that they can prepare for fatigue related situations.

In the case of work exceeding 64 hours in a seven-day period it is highly recommended that there be an opportunity for at least *two nights of sleep* before beginning the next work period. Again, this implies the recognition of the need to reduce an accumulated sleep debt. This may mean that when employees have worked a long shift that they be given additional time off to recuperate. Most experts in the field refer to this as an *anchor sleep* that prepares the person for subsequent activities.

The danger with the situation of excessive hours of work in a seven-day period is the probability of developing a sleep debt. A sleep debt occurs when an individual

consistently obtains less than 7 hours of sleep over time. The human can function without 8 hours of sleep, however, an individual becomes more fatigued the greater the sleep debt.

Education programs should cover a number of topics related to the nature of shift work, various types of shifts, biological rhythms sleep and fatigue, effects of fatigue on performance, sleep hygiene techniques, and general health and wellness issues. The aim of the education program should be to prepare an individual to use their knowledge to obtain adequate sleep and rest prior to going on duty for extended periods. A secondary aim of educational programs should be to ensure that employees have adequate knowledge to combat fatigue when they are at work.

Time For Sleep. Adequate time off to recover from the effects of extended work exceeding 64 hours in a seven day period, are also needed in order to be able to get needed sleep. Of course, it must be noted, that simply giving employees time off may not be sufficient to recover if those time-off hours are daylight hours. For the most part, individuals who have been acclimated to night time sleep will find it hard to fall asleep during the day. Consequently, there should be sufficient time for the person to actually obtain the needed rest, taking into account the fact that even though a person is off they may not be able to.

In addition, to the need for night time sleep, most experts agree that two nights of sleep are needed to recover from the effects of sleep deprivation. Sleep deprived persons have not returned to optimal performance until after they have received at least two nights of sleep.

Another counter measure in this situation would be to ensure that there are opportunities for the individual to nap for at least 30 minutes - but not to exceed 45 minutes - during the work period. Short naps have been shown to have a very positive effect on performance that can last several hours. Despite the potential negative effects of sleep inertia (i.e. the grogginess typically associated with waking up) the benefits outweigh the negatives.

Another point to consider when developing an FMP for long hours of work, is the selection of individuals to perform the work who are properly rested. Choosing individuals who have had at least eight hours of sleep *during the night before* the work is to be conducted will lead to a greater likelihood that they will be able to perform the work adequately.

Diet. The judicious use of over-the-counter food stimulants is also recommended. For example, caffeine is useful in improving alertness. Caffeine is found in any number of common foods and beverages, and employees in high-risk situations should be encouraged to utilize caffeinated foods and chewing gum. Of course, to maximize the positive effects of these foods it is necessary to utilize them in an effective manner and to consume them so as to achieve the greatest possible benefit. Again, education should be provided to enable persons to use these products wisely.

Activities. Several studies have shown that there is some benefit in trying to remain physically active as a means of warding off sleep. The technique of walking around,

talking, or performing various interesting and stimulating duties is a means of counteracting the effects of drowsiness.

Environment. Whenever possible, positive environmental conditions such as proper lighting, proper temperature, and some appropriate noise level should be maintained. Bright light is more likely to lead to alertness. When trying to fall asleep the use of white noise or soft and soothing music is recommended. Conversely, sounds that stimulate interest and attention are more likely to lead to alertness.

Especially important for persons engaged in work exceeding 64 hours in a seven-day period, are facilities *at the work place* that can be used for napping. Persons in this type of situation are more likely to be at risk for driving as they have developed a sleep debt. Therefore, commuting may be more of a risk for these individuals.

Sample FMP: CANALERT

One excellent example of a FMP is demonstrated by the CANALERT project. Several years ago, Transport Canada began to address fatigue issues and charged the various railways to develop policies and procedures to deal with their crew rest and fatigue problems. Through the combined efforts of Canadian National, Canadian Pacific and VIA Rail, in conjunction with the Brotherhood of Locomotive Engineers, a task force was formed and Circadian Technologies was hired to provide assistance. As a result, a pilot project in Calgary and Jasper was initiated in 1995 called CANALERT. Various aspects of this program could be included in FMPs developed by the railways.

Time Pool Scheduling: With traditional crew scheduling, employees assigned to handle trains "over the road" are called for duty at any time around the clock. The CANALERT project set up three time pools or specific blocks of time for locomotive engineers to designate when they would begin their next assignment. Engineers starting their assignments between 5:00 and 15:00 were called Larks. Those starting between 13:00 and 23:00 were called Owls and those between 21:00 and 07:00 were called Cats. The calling windows were only in effect for assignments beginning at the home terminal. Returns to home were governed by the traditional first-in/first-out policy.

A protected zone was established for the times when an engineer on a given schedule would be most likely to experience fatigue. An engineer was permitted to take a return train home without rest only if he could be guaranteed to arrive before the beginning of his protected zone. Otherwise, the engineer was required to rest for at least three hours at the away-from-home terminal. Finally, a "special protected zone" was created to ensure that protection was available for engineers traveling during a time when fatigue might be a problem. During this special zone an engineer was permitted to take a nap if they felt the need to do so.

In addition to time windows, engineers were assigned a regular work schedule. Each engineer worked one day and was off the next. In addition, two assigned days off were

built into each 28-day schedule. These assigned days off were built into the regular work schedule and therefore resulted in at least three consecutive days off. Engineers were also allowed to book up to eight hours rest at the away-from-home terminal.

Improved Rest Facilities: Existing bunkhouses were stationed next to the train yards. The bunkhouses at Blue River, B.C. were given specific improvements, including added sound-proofing to interior walls, blackout curtains, and white-noise generators.

Enroute Napping Policy: A napping policy was put into place. Whenever a train arrived at a siding where a delay was expected, the engineer could notify rail traffic control and request a 20-minute opportunity nap. Engineers were provided with mattresses and blindfolds to aid in "napping." If the engineer was continuing to operate during the time of the protected zone, a negotiated nap was permitted.

Terminal Napping Facilities: Rest facilities with comfortable chairs in a quiet location were established in the Calgary and Jasper terminals. These were available for engineers to rest as they waited for their trains or before driving home at the end of a trip.

Lifestyle Training and Individual Counselling: A four-hour training program called "Managing a Road Lifestyle" was developed for employees and their families.

Effective April 27, 1997 the East (Brooks) and West (Laggan) districts began operating as time pools with three specific time windows of operation. Please note that the agreements for Engineers and Conductors are almost identical. Employees who bid into these pools were required to specify their preferred time pool within the specific pool. Employees are assigned to time pools according to seniority basis. The crews operated on a first in first out basis with each time pool having a window that overlapped the next time pool by one hour. During this overlap period crews could continue to be called from the earlier time pool until it was exhausted. Crews would then be called from the next time pool during the overlap period.

Pool	Overlap	Duty Period	Total Duty Cycle	
Lark	0500 –0600	0600 – 1500	1 hr + 9 hr	10 hr Window
Owl	1400 – 1501	1501 – 2359	1 hr + 9 hr	10 hr Window
Cat	2300 – 0001	0001 – 0559	1 hr + 6 hr	7 hr Window

Figure 7. Canalert Time Pool Duty cycle

The time pools were designed to minimize the likelihood that a person would be working in a time period that interrupted their natural circadian rhythm. The Protected Zone was identified as part of the CANALERT 95 project to be the zone during which, according to a person's circadian clock, they would be most likely to fall asleep. These time windows were designed with the intent of minimizing the impact on a person's natural circadian rhythm. Or, put another way, this zone is the time at which the person would most likely be sleeping and therefore, the most likely time for a person to receive recuperative sleep.

To prevent and protect employees from being on duty at a time during which they would usually be sleeping, employees who have not had at least three hours of Circadian Rest (rest during their Recuperative period) should complete their trip prior to the time of the Protected Zone. The Protected Zone is that time that was established as being the most likely recuperative period for the employee. The recuperative zones for the various pools were as follows:

	Overlap	Duty	Recuperative Zone	Protected Zone	Special
Lark	0500 – 0600	0600 –1500	1700 –0900	0300 – 0700	0100 – 0300
Owl	1400 –1501	1501 – 2359	2000 – 1200	0700 – 1100	0400 – 0700
Cat	2300 – 0001	0001 – 0559	0800 – 2100	1800 – 2200	0400 – 0800

Figure 8. Protected Time Zones

In addition to establishing these recuperative zones and protected zones, labour and management agreed that the normal running times of certain classes of trains (expedited vs. general freight) should be considered when calling a person for duty. For example, an employee in the Lark Time Pool at their away from home terminal is called at 2130 hours to handle a lower speed train. Under normal circumstances the employee might wish to accept the call in order to get home promptly. However, the CANALERT '97 agreement precludes the employee accepting the assignment, as the person would require at least six hours completing the trip. This would cause the employee to be on duty during the Protected Zone.

FMP Assessment Guidelines and Scoring Worksheet

The FMP Assessment Guidelines and Scoring Worksheet (revised March 2010) is intended as a checklist to identify the typical components that should be included in an FMP. It is not expected that every plan include every single component listed. However, it is expected that a well-developed plan would include many of these components.

Note: *C denotes a 'core' component, which must be included in all FMPs.*

Education and Training:

		Education and Training	Score	Observed
C	1	Sleep Hygiene	3	
	2	Diet Health & Lifestyle	1	
C	3	Body Clock	3	
	4	Definitions of Fatigue & Alertness	1	
C	5	Sleep Disorders	3	
	6	Stress Management	1	
C	7	Sleep & Performance	3	
	8	Various Sleep Schedules	1	
	9	Countermeasures	1	
	10	Individual and Age Differences	1	
		Sub-Total	18	

The Education & Training Components of a Fatigue Management Plan (FMP) should consist of the FOUR core components listed above. In addition, a truly comprehensive program would include information on all ten of the components listed above. In particular, the education program should attempt to describe to participants the essentials of **Sleep Hygiene** including a discussion of the factors that influence a person's readiness to obtain sleep, factors affecting sleep quality, and factors affecting duration of sleep. This component is critical and must be included.

While not a critical component of the required FMP, **Diet & Lifestyle** can also affect sleep and sleep quality should also be discussed. In particular, the participants should be informed as to how various foods and food groups that are consumed at key times can affect the body's readiness for sleep. An education and training program that does not include a section on the **Body Clock** or the circadian cycle and rhythms would be seriously deficient. Railway employees need to understand the arousal and recovery cycles that accompany the body clock and also how this will affect sleep and sleep propensity not to mention work performance and alertness. This component is critical and must be included.

Definitions of sleep and alertness are important and should be discussed. There is some controversy as to what fatigue actually is. Never the less, some people need to understand that there are differences between physical fatigue that might come from muscular exertion and fatigue that is associated with sleep loss. Typically when we are referring to fatigue in the transportation industry we are referencing the lack of alertness and attention that is associated with decrements in cognitive performance.

Sleep disorders are another critical component of any education & training program. The most typical for this population is Sleep Apnea, which is characterized by snoring and interrupted breathing during sleep. The other disorders that are somewhat less common include restless leg, narcolepsy and others. The importance point here is that program participants be made aware of the relationship between sleep disorders and subsequent operational deficiencies in performance that can accompany those disorders.

A module on **Stress Management**, while not critical, could be included in the training program again because of its relationship between the presence of stress and the potential for sleep disruption. It has been shown that persons who are experiencing high levels of stress can experience either lack of sleep, early awakening, or sometimes even excessive sleep.

A training program would also not be complete if a section were not devoted to the relationship between **Sleep and Performance**. Understanding this relationship is critical to effective and successful fatigue management programs in general. Lack of sleep is directly and linearly associated with a decrease in performance, cognitive performance and work performance. It is imperative that persons working in the rail transportation industry understand this critical relationship. Furthermore, there are specific levels and cut-offs that should be discussed that program participants would recognize that need to be adhered to and beyond which it is clear that they have exceeded the likely levels of optimal performance. It should be noted that hours of service guidelines and rules are typically designed not to create optimal levels of performance but to mark the line beyond which it is unsafe to operate equipment.

Sleep Schedules should be discussed in the education and training modules also. The description of sleep schedules that are typical in the rail industry and the effects that they will have on performance should be discussed and identified. Essentially, the types of schedules that lead to the development of a sleep debt over time should be reviewed and examined.

The general topic of **Countermeasures** should be included in the program. The typical countermeasures include but are not limited to: napping, sleeping, exercise, activity, short breaks, judicious use of caffeine, and preventative anchor sleep. This may vary from individual to individual but needs to be discussed in an educational program. While a railway may not wish to recommend a specific type of aid that will increase alertness a thorough discussion of the various alternatives and the strengths and weaknesses of each will help a railway employee make an informed decision. Moreover, by learning about the stimulating effects of various substances naturally occurring in the environment hey

will also learn when not to use them in order to maximize the likelihood of obtaining adequate sleep during rest periods.

Finally, some discussion of the importance of both **Individual Differences** and Age differences. For the most part, on average people need about eight hours of sleep per night or 24-hour period. However, some individuals have remarkable stamina and resilience when it comes to being able to withstand the effects of sleep deprivation and restricted sleep. Individuals should be exposed to this concept so that they can come to monitor their own typical sleep needs and understand their schedules so as to appropriately manage their needs for restorative and recuperative sleep. At the same time, sleeping habits and sleep needs change as a person ages. Most of the research suggests that people continue to need approximately eight hours of sleep. However, they are likely to have increasing difficulty actually sleeping a full eight hours at one time. Therefore they need to address this and take recovery naps.

Scheduling Practices:

		Scheduling Practices	Score	Observed
C	1	The total length of the work shift is not greater than 12 hours.	3	
	2	Recognition of the potential for fatigue when working between the hours of 0000 and 0600.	1	
	3	Recovery periods permit opportunities to obtain rest when obtaining less than six hours of continuous sleep in a 24-hour period.	1	
C	4	Off-duty times permit reasonable recuperative times.	3	
C	5	Work time is limited to 64 hours in a seven-day period.	3	
	6	Recovery periods permit two consecutive nights of sleep.	1	
	7	Twenty-minute break periods are scheduled approximately every four hours.	1	
C	8	To the extent possible, work schedules that are highly predictable are offered.	2	
	9	Opportunities for napping exist.	1	
C	10	When periods of wakefulness exceed 19 continuous hours sufficient opportunity for sleep is provided.	3	
		Sub-Total	19	

Scheduling practices described in the FMP should be reviewed and assessed for the five critical core components and five recommended components delineated in the above table. The work schedule should ensure that the length of a work shift is **no greater than 12 hours**. In addition, work schedules that require employees to perform work-related tasks during the period **between 0000-0600 should be minimized**. When night shifts are required, there should be sufficient opportunity in the schedule for recovery prior to working another shift and or sufficient time to prepare for such a shift. It is recommended that employees operating equipment or performing safety sensitive tasks during 0000-0600 be given the opportunity to nap.

Scheduling practices that do not provide the employees with the **likelihood of obtaining 6 hours of continuous sleep** following performance of work tasks or duties should also be avoided. Research suggests that it is unlikely that a person will obtain more than 6 hours of sleep during daylight hours unless they are really exhausted. Persons who have been working regular daylight jobs are unlikely to be able to suddenly switch and sleep for eight hours during the day. Accordingly, there will likely be a need for persons to have sufficient recovery time to adjust to schedule changes. It is recommended that at least TWO nights of recovery time be afforded to those who have been exposed to excessive work hours or prolonged duty times as well as restrictive sleep and midnight shifts.

Most research suggests that there is a need for work or **rest breaks** periodically during the workday. In fact, performance is likely to be enhanced if breaks are afforded individuals. The number of breaks provided should be spaced out so that they occur at least every two hours, and there is at least one during a 5-hour period.

Predictability in the work schedule is not directly related to alertness per se. However, predictability allows employees to be better prepared and diminishes the likelihood that the person will be caught unawares and short of sleep. The worst cases scenario is when a person extends their wakefulness not anticipating a call for duty, and then must work long hours and into the 0000-0600 period of increased sleepiness.

Scheduling practices that provide **opportunities to nap** and recover are likely to be more forgiving and more productive. Employees who have the opportunity to nap for at least 20 minutes to alleviate the effects of fatigue are likely to be able to perform at or near optimal for at least 3 hours subsequent to the nap.

Finally, employees who are awake for 19 or more hours are going to be functioning well below optimal levels of performance. Therefore, they should be afforded immediate opportunities to sleep or nap in order to avoid being a danger to themselves or others.

Dealing with Emergencies:

Dealing with Emergencies			Score	Observed
C	1	Definition of emergency situations	4	
C	2	Provision of specialized considerations for extra duty	4	
		Sub-Total	8	

A section of the FMP should be devoted to how railway management expects to **address emergency situations** or unexpected deviations from planned schedules. This should include a definition of what constitutes an emergency and the procedures that will be put in place to minimize the likelihood that persons in emergencies will be expected to perform safety-sensitive tasks or duties if they have been awake for long periods of time, or been deprived of sleep. The plan should make recommendations for how employees and supervisors will minimize fatigue for persons performing emergency duties. Specific sections of the plan should address situations in which individuals exceed 12 hours of on-

duty time, and also for situations in which the emergency work takes place between the hours of 0000 and 0600.

Alertness Strategies:

Alertness Strategies			Score	Observed
C	1	FMP should include a list of recommended and approved alertness strategies.	5	
	2	Technological aids (alerters)	1	
	3	Napping strategies	1	
	4	Breaks	1	
	5	Checklists to stay alert.	1	
	6	Other communication strategies as needed.	1	
	7	Appropriate use of exercise	1	
	8	Use of light, sound, and temperature.	1	
		Sub-Total	12	

Alertness strategies or countermeasures should be recommended for employees in FMPs. These strategies should be implemented when the person feels that they are likely to experience levels of fatigue that may interfere with their work performance. The intent of this section is to ensure employees have received information on what are considered recommended or approved fatigue alertness strategies that can be used in an operational environment during emergency situations. It is recognized that the most effective technique is to obtain sleep. However, when this is not possible, other strategies may be used. For example, short breaks with some light exercise can restore alertness for a brief period. Selective and appropriate use of natural stimulants is also a possibility. Napping is also a technique that can be used. Persons should be informed of the appropriate use of naps in this circumstance. Employees should be informed of and given opportunities to utilize the alertness strategies at their discretion in order to maximize their productivity.

Rest Environments:

		Rest Environments	Score	Observed
C	1	Standard policy for review of facilities	2	
	2	Certification of lodging	1	
	3	Sleep aids	1	
C	4	Light reduction	2	
C	5	Sound reduction techniques	2	
C	6	Temperature controls	2	
	7	Exercise facilities	1	
	8	Eating facilities	1	
C	9	Wake up policies - do not disturb	2	
	10	Location or proximity to tracks or switching operations	1	
		Sub-Total	15	

Rest environments will play a critical role in addressing the needs of persons affected by fatigue risk. FMPs should include the FIVE critical core items and the five recommended items. Most importantly, a well-designed FMP should include a specific section describing the rest environments that are available and the criteria for evaluating their suitability for railway personnel. Critical to the successful implementation of an FMP is the standard policy for review *of facilities* that assists both employees and vendors of lodging services to provide adequate sleep and rest facilities. Such a policy may lead to certification of lodging facilities. A committee or team or procedure will need to be specified that describes how various facilities will be reviewed and the result of the review made public.

The most important criteria that must be included in a successful review of a facility will be the requirement that facilities have the ability to: reduce sound, reduce light and reduce or control temperature. These three characteristics are very important and the plan cannot be approved without these three components. Additional criteria include, but are not limited to: exercise facilities, eating and dining areas, white noise reduction equipment, and wake or do not disturb policies that prevent the employees from being disturbed when sleeping.

Implementation Policies:

Implementation Policies			Score	Observed
C	1	General principles	5	
C	2	General Plan	5	
	3	Local Plan	1	
	4	Risk Assessment	1	
C	5	Commitment to FMP Rule	3	
		Sub-Total	15	

Overall, an FMP should have a format and content that is easily discernable. It is recommended that all railways develop a standard format for explaining and delineating the various components of the FMP. The FMP should begin with a statement of general principles that the railway is attempting to implement. Then a general description of the plans should be attempted. Typically this will consist of a set of statements advocating a scheduled railway or the like.

It is important the plan identify those persons who are responsible both at a corporate level and at a local level for implementing the plan. It is not sufficient to identify someone at corporate headquarters who has no operational authority at a local level, since chances are that a typical employee will not be able to avail himself or herself of access to such a person. Therefore, a local supervisor should be responsible and identified for implementation purposes.

The plan should include some recognized approach for assessing risk associated with fatigue. By this, we mean that some form of a fatigue model or scheduling tool that has appropriate scientific validity be employed to examine the likelihood of a schedule or condition for creating or developing fatigue levels that might not be considered optimal, or put another way, that creates conditions that are sub-optimal.

The FMP should clearly describe how it will be implemented, and who is responsible at an immediate local level for ensuring that it is implemented.

Evaluation of FMPs and Crew Management Effectiveness:

Evaluation of FMPs and CM Effectiveness			Score	Observed
C	1	Specification of fatigue metrics	2	
C	2	Specification of data gathering methods	2	
C	3	Systematic review of crew scheduling data	2	
C	4	Accident analysis	2	
C	5	Opportunity for consultation (e.g. Employee representatives; health and safety committees)	2	
	6	Systematic review of plan measurement data	1	
	7	Use of bio behavioural models (e.g. FAST, FAID)	1	
	8	Utilization of expert review of the FMP	1	
		Sub-Total	13	

	Overall Score	100	

An important new aspect of FMPs that will contribute to their overall improvement and effectiveness is the specification of a method for evaluating the effectiveness of the plan. The assumption here, is that there is a need to continually improve the management of fatigue in the workplace, and that without an effective and up-to-date plan there will be no way to ensure that the plan is actually managing - and thereby reducing - the effects of fatigue. Consequently, there will need to be a plan to capture data related to fatigue and additional data related to how well fatigue is being managed.

Importantly, the FMP will need to include at least some behavioural indicators of fatigue. This may consist of signs and symptoms that employees exhibit that could indicate the presence of fatigue. These can include drowsiness, sluggishness, self-reports of fatigue or sleepiness and the like.

Implicit in such a plan is the need to identify **appropriate measurements and metrics** that will be captured to facilitate the evaluation of the FMP. Simply gathering accident data will not be sufficient as there are many factors that contribute to the occurrence of accidents. Rather other metrics such as self-reported levels of fatigue, the number of layoffs for fatigue requested and granted , total number of hours on duty, average start times, average discrepancy between posted start times and actual start times.

Another important and very critical item to be included in the plan will be the specification of what measurements will be used as an indicator of fatigue. This may be any one of a number of different measures such as self-report, hours on duty, hours away from home terminal etc. The carrier will need to specify these metrics at the outset of the plan. In addition to the metrics, the plan will also need to include a specification of methods for gathering the data.

Crew scheduling data is an important source of information that can help specify the extent to which employees are exposed to the risk of fatigue. Crew work schedules will need to be reviewed and examined to determine the extent to which they either create the likelihood of long work hours and or the likelihood of limited or restricted sleep, thereby promoting sleep deprivation.

A successful FMP will also include a provision for examining the extent to which fatigue was a factor in accidents that are reported in the railway. In other words, accident analysis and investigation techniques may need to be modified to include an assessment of the role of fatigue.

Lastly, the plan should include a systematic review of all of the above gathered data, in consultation with management and labour, to determine whether the data gathered do in fact relate to a problematic situation. In other words, the data needs to be reviewed and analyzed to determine the effects of the FMP on the overall level of fatigue within the organization. In addition, the use of outside experts or scientists familiar with the science of sleep and fatigue, who can help evaluate the Fatigue Management Plan or offer their opinion as to the adequacy of suggested fatigue countermeasures for the operations environment, should be a useful and accepted means of determining whether the FMP is adequate to address the risk of fatigue in the workplace.

In order to allow successful analyses, the FMP may incorporate the use of behavioural models, expert review, and overall performance evaluation.

Glossary of Terms

Acute Sleep Loss. A term used to describe the condition of obtaining significantly less sleep than needed for cognitive functioning. This may occur with less than 4 hours of sleep in a 24-hour period.

Alertness. A term used to describe the normal and activated state of the brain, which usually occurs when a person is awake. An alert person has a good attention span and is capable of performing typical physical and mental functions. Alertness is a dynamic state, which is also thought to gradually decrease in effectiveness as the number of hours of wakefulness increases.

Apnea. A term associated with the medical condition – Sleep Apnea. An *apnea* is a pause or cessation in breathing that lasts 10 seconds or longer. A person with the sleep-apnea syndrome has many apneas or breathing pauses during sleep periods. These episodes disrupt the individual's normal sleep cycle and may lead to sleep deprivation and tiredness during the daytime hours.

Circadian Rhythm. (circa = around or about; diem = day) Self- sustained biological rhythms that have a period of about 24 hours.

Clockwise or Forward Rotating Shift. A work schedule in which the shift moves forward, from day to evening to night.

Counter clockwise or Backwards Rotating Shift. A work schedule in which the shift moves backward, from night to evening to day.

Fast Rotation. A work schedule in which shift rotations occur within a period of less than 1 week.

Fatigue. (Physical) Physical discomfort from overworking a group of muscles. (Mental) Difficulty concentrating, difficulty processing important signals, and problems staying awake in critical situations. Fatigue can cause the impairment of physiological and/or cognitive performance.

Fixed Shift. A work schedule in which the hours of work remain the same over time.

Irregular Shift. A work schedule that is variable and unpredictable. Also called a variable shift. Often associated with work in road train service and yard Extra board.

Microsleep. A lapse from wakefulness into sleep that lasts just a few seconds; often associated with excessive daytime sleepiness and automatic behaviour. Typically associated with "nodding off".

Non-restorative Sleep. Sleep that is not refreshing, usually including little or no REM sleeps stage.

REM Sleep. Named for the rapid eye movement that typically occurs during this state. It is a period of intense brain activity often associated with dreams. During the REM stage there is a paralysis of voluntary muscles. In humans, REM sleep occurs regularly about every 90 minutes.

Sleep Debt. The state of chronic fatigue and sleepiness that results from the lack of sufficient sleep or disrupted sleep.

Sleep Hygiene. The personal habits and practices that are related to effective sleep. These often include regularity of bedtime and arise time, restriction of alcohol and caffeine before bedtime, exercise, proper sleeping environment, and other factors.

Sleep Inertia. A short-lived feeling of lethargy or grogginess and sluggishness immediately after awakening from a sleep period. The period that is typically associated with "waking up" and "getting going".

Sleep Latency. The time from "lights out" or when the person closes their eyes to begin sleep until the actual beginning of sleep.

Sleep Stages. The brain goes through four phases of sleep, starting with light sleep and becoming progressively deeper. After the deepest stage of non-REM is reached, REM sleep episodes occur in a fairly regular pattern. It appears that all stages of sleep are required in order to maintain or restore alertness.

Fatigue Management Plans

Annex 1: FMP Assessment Worksheets

Revised: March 30, 2010
Transport Canada

FMP Assessment Guidelines and Scoring Worksheet

Note: *C denotes a 'core' component, which must be included in all FMPs.*

		Education and Training	Score	Observed
C	1	Sleep Hygiene	3	
	2	Diet Health & Lifestyle	1	
C	3	Body Clock	3	
	4	Definitions of Fatigue & Alertness	1	
C	5	Sleep Disorders	3	
	6	Stress Management	1	
C	7	Sleep & Performance	3	
	8	Various Sleep Schedules	1	
	9	Countermeasures	1	
	10	Individual and Age Differences	1	
		Sub-Total	18	

		Scheduling Practices	Score	Observed
C	1	The total length of the work shift is not greater than 12 hours.	3	
	2	Recognition of the potential for fatigue when working between the hours of 0000 and 0600.	1	
	3	Recovery periods permit opportunities to obtain rest when obtaining less than six hours of continuous sleep in a 24-hour period.	1	
C	4	Off-duty times permit reasonable recuperative times.	3	
C	5	Work time is limited to 64 hours in a seven-day period.	3	
	6	Recovery periods permit two consecutive nights of sleep.	1	
	7	Twenty-minute break periods are scheduled approximately every 4 hours.	1	
C	8	To the extent possible, work schedules that are highly predictable are offered.	2	
	9	Opportunities for napping exist.	1	
C	10	When periods of wakefulness exceed 19 continuous hours sufficient opportunity for sleep is provided.	3	
		Sub-Total	19	

		Dealing with Emergencies	Score	Observed
C	1	Definition of emergency situations	4	
C	2	Provision of specialized considerations for extra duty	4	
		Sub-Total	8	

		Alertness Strategies	Score	Observed
C	1	FMP should include a list of recommended and approved alertness strategies.	5	
	2	Technological aids (alerters)	1	
	3	Napping strategies	1	
	4	Breaks	1	
	5	Checklists to stay alert.	1	
	6	Other communication strategies as needed.	1	
	7	Appropriate use of exercise	1	
	8	Use of light, sound, and temperature.	1	
		Sub-Total	12	

		Rest Environments	Score	Observed
C	1	Standard policy for review of facilities	2	
	2	Certification of lodging	1	
	3	Sleep aids	1	
C	4	Light reduction	2	
C	5	Sound reduction techniques	2	
C	6	Temperature controls	2	
	7	Exercise facilities	1	
	8	Eating facilities	1	
C	9	Wake up policies - do not disturb	2	
	10	Location or proximity to tracks or switching operations	1	
		Sub-Total	15	

		Implementation Policies	Score	Observed
C	1	General principles	5	
C	2	General Plan	5	
	3	Local Plan	1	
	4	Risk Assessment	1	
C	5	Commitment to FMP Rule	3	
		Sub-Total	15	

		Evaluation of FMPs and CM Effectiveness	Score	Observed
C	1	Specification of fatigue metrics	2	
C	2	Specification of data gathering methods	2	
C	3	Systematic review of crew scheduling data	2	
C	4	Accident analysis	2	
C	5	Opportunity for consultation (e.g. Employee representatives; health and safety committees)	2	
	6	Systematic review of plan measurement data	1	
	7	Use of bio behavioural models (e.g. FAST, FAID)	1	
	8	Utilization of expert review of FMP	1	
		Sub-Total	13	

	Overall Score	100	