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Options for Changes to Hours of Service for Commercial Vehicle Drivers

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16. Abstract

This report presents options dealing with potential changes to the Canadian hours of service (HOS) regulations. They were developed by an expert panel, established by Transport Canada (TC), that included experts in shiftwork, sleep and human performance. The proposals provide ideas for remedying certain deficiencies in the way that current regulations address (or fail to address) those driver fatigue factors that are accepted as being among the most significant. A number of national and international considerations as well as implementation issues associated with instituting HOS changes are discussed.

The report also lists many current commercial driver practices that are considered poor from the fatigue perspective, and describes the psychophysiological concerns and consequences on driving safety associated with each. A taxonomy of good practice for work and rest scheduling of commercial drivers is presented, based on what is known about human physiology and fatigue while being mindful of motor carrier and driver operational considerations.

Transport Canada has taken the position that HOS changes should be guided by currently available scientific knowledge. The options presented are not intended to reflect TC policy or management decisions, nor to provide a recommended course of action. Rather, they are intended to stimulate discussions with stakeholders, by illustrating potential approaches to incorporating scientific knowledge on sleep, circadian rhythms and human performance into an HOS regulatory framework.

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16. Résumé

Ce rapport présente des options pour la modification de la réglementation canadienne sur les heures de service (HS) des conducteurs de véhicules utilitaires. Ces options sont le fruit du travail d'un groupe d'experts réuni par Transports Canada (TC), formé de spécialistes du travail par quarts, du sommeil et de la performance humaine. Les idées proposées visent à corriger certaines lacunes de la réglementation présentement en vigueur, qui reflète une méconnaissance des facteurs maintenant reconnus comme cruciaux dans la fatigue des conducteurs. Un certain nombre d'enjeux nationaux et internationaux associés à la modification de la réglementation, de même que les modalités d'instauration des modifications sont également abordés.

Le rapport fait état de nombreuses pratiques courantes chez les conducteurs de véhicules utilitaires, considérées comme mauvaises du point de vue de la prévention de la fatigue, et décrit les effets psychophysiologiques de ces pratiques et leurs conséquences sur la sécurité de la conduite. Il expose les règles de l'art concernant l'aménagement des horaires de travail et de repos des conducteurs de véhicules utilitaires. Celles-ci sont fondées sur l'état actuel des connaissances sur la physiologie humaine et la fatigue, et tiennent compte des impératifs opérationnels avec lesquels doivent composer les transporteurs routiers et les conducteurs de véhicules utilitaires.

Transports Canada a adopté la position selon laquelle toute modification des HS doit se faire l'écho de connaissances scientifiques de pointe. Les options présentées ici ne doivent être interprétées ni comme des décisions de principe ou de gestion de TC, ni comme des recommandations à l'intention du Ministère. Elles visent simplement à alimenter les discussions au sein du milieu, en montrant des façons d'incorporer les données scientifiques sur le sommeil, les rythmes circadiens et la performance humaine à une réglementation sur les HS.

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SUMMARY – Options for Changes to Hours of Service for Commercial Vehicle Drivers

INTRODUCTION

In April 1997, Transport Canada (TC) established an expert panel in shiftwork, sleep and human performance to assist in developing an initial set of options for potential changes to the hours of service (HOS) regulations, which are contained in the federal Commercial Vehicles Drivers Hours of Service Regulations (15 November 1994), and in the National Safety Code Standard no. 9. The initiative was undertaken in response to TC's position that any changes to the HOS regulations should be guided by the available scientific knowledge. The options to be proposed were not intended to reflect TC policy or management decisions, nor to present a recommended course of action. Rather, they were to illustrate potential approaches to incorporating current scientific knowledge about fatigue into an HOS regulatory framework so that they could be used to animate discussions with stakeholders. This report provides the results of this initiative. It includes:

- Options for changes to the HOS regulations, together with their scientific basis and any potential operational constraints;

- Implementation issues associated with changing HOS that touch upon national and international interests, and will require prior attention; and,

- A taxonomy of good practice for work and rest scheduling of commercial drivers based on what is known about human physiology and fatigue, while being mindful of motor carrier and driver operational considerations.

When considering the proposed options, the reader should note that the scientific body of evidence concerning the various fatigue factors and their related impacts on human performance is such that some interactions are well understood (and backed up by convincing data) while others are less so. Thus, the proposals presented are based on the results of specific studies to the extent possible and, where these are lacking or less convincing, on basic principles derived from the scientific body of knowledge.

The reader should also be aware that these deliberations took the existing hours of service as the starting position, rather than using a blank sheet approach that sought to make sweeping changes. This was a carefully considered and conservative approach that took into account the limitations of current scientific knowledge, the complex nature of the trucking industry and the unforeseeable impacts of major changes on road safety and industry economics, as well as constraints imposed by long distances between cities in the major Canadian transportation corridors. Thus, the proposed changes to the HOS are designed to increase safety by ensuring substantial improvements over the

existing situation, in terms of enhanced fatigue management and increased operational flexibility in the event of schedule perturbations.

OPTIONS FOR DAILY WORK/REST CYCLES

The development of driver fatigue, loss of alertness and impaired performance is tied inextricably to sleep and circadian rhythms, both of which have a daily periodicity. Time of day (circadian rhythm) effects lead to poorer night performance and day sleeping. In turn, poor sleep exacerbates the normal drop in performance found at circadian low points of the day. As a result, night driving cannot be treated as equivalent to day driving, from either performance or sleep perspectives. Moreover, reduced quantity and quality of sleep will result in increasingly poorer performance. Length of time awake since the last principal sleep is another important determinant of alertness and performance. It is estimated that for every 24 hours of sleep deprivation there is a 25 percent drop in performance. Consequently, it is vital that the fatigue factors important to safe driving be addressed as much as possible through judicious work/rest regimes and countermeasures. These should allow performance to be maintained at safe levels on a daily basis and minimize cumulative deterioration from day to day. The daily regime should also be such that some buffer is built in to ensure that unusual or unplanned disturbances during one day can be counteracted as soon as possible after they occur, preferably no later than the next day.

Options for potential changes to the HOS, presented in this subsection, take human performance considerations into account, and aim to provide daily work/rest regimes that result in better management of fatigue levels. It is proposed that these options be considered under three categories, grouping elements that work together: Core Options, the most basic changes required to make the HOS regulations more closely reflect our understanding of the relationships between schedule-related fatigue factors and human performance; Recommended Options, which suggest additional improvements over the Core set; and, Special Circumstances. The options in this last category are akin to exemptions since, for practical and common-sense reasons associated with safe driving performance, they take into account – and provide remedies for – specific working environments and situations, including team drivers in sleeper cab operations and drivers who run out of available working hours close to their destination. The reader is referred to the report for a detailed explanation of each option, the associated positive and negative aspects and limitations, and pertinent references to the scientific literature.

Core Options

The core elements of a revised HOS regime are considered to include the following initiatives:

- ***Establish a 24-hour period as the basic daily cycle***

A 24-hour cycle should be established to encourage keeping shifts and the circadian rhythms of individuals synchronized to a 24-hour clock and to minimize the occurrence of phase-advancing routines promoted by the existing HOS regulations. Currently, a maximum of 13 hours of driving and a total of 15 hours on duty are permitted on a continuous basis. When combined with an 8-hour mandatory rest period, this yields either a 21-hour or a 23-hour cycle. The impairment in performance associated with such phase-advancing routines has been demonstrated by researchers.

- ***Decrease the maximum total on-duty time allowed in any consecutive 24 hours from 16 to 14 hours***

A number of studies have shown increased crash risk with hours of driving, well before hours of service are exceeded. The Canada/U.S. Driver Fatigue and Alertness Study (DFAS) showed that RVS test scores (i.e. a performance test that proved sensitive to vigilance and perceptual-motor speed changes typifying loss of alertness and fatigue) were lower at the end of trips than they were at the start. The DFAS also showed driver self-reports to have a strong relationship to elapsed time since trip start. Even though these self-reports differed sharply from the objective measures, it was concluded that they may have indicated increasing stress or the compensatory effort that signals fatigue or loss of alertness, and that the drivers had diminished motivation and abilities to remain alert by the end of their trips.

It is proposed that the driver's daily working hours be shortened from a maximum of 16 hours (of which 15 can be consecutive) to 14 hours. This is primarily based on the need to increase the hours available for sleep and rest (proposed in the following option), but also on the need to reduce fatigue effects associated with task duration.

- ***Increase the minimum total off-duty time required in any consecutive 24 hours from 8 to 10 hours***

Over the last few years, numerous studies have indicated the need to provide drivers with additional off-duty time to increase opportunities for sleep. With the driver's daily working hours shortened from 16 to 14 hours (proposed in the previous option), off-duty hours can be increased from 8 to 10 hours. This would also incorporate a 24-hour work/rest cycle into the HOS, which would encourage regular rather than phase-shifting work/rest schedules. Furthermore, these changes would accommodate a number of proposals (that follow) for additional fundamental improvements to the HOS.

- ***Require a minimum continuous off-duty period of 8 hours within any 24 consecutive hours***

A sufficiently long off-duty period must be made available so that drivers can obtain a continuous (anchor) sleep that is adequate for recovery on a daily basis. To minimize

the possibility that drivers shorten anchor sleep, the continuous length of this principal off-duty period must take into account time required for other daily driver needs. These include driving to and from home, taking care of personal needs (i.e., eating and grooming), and having some time for family-related activities, recreation and diversion away from work responsibilities.

The self-reported ideal sleep time of the 80 drivers who participated in the Canada/U.S. Driver Fatigue and Alertness Study was 7.2 hours, which is also the perceived nightly need for sleep of the general (U.S.) population of about 7.2 ± 1.2 hours. Eight hours is the minimum time during which a driver – who would immediately go to bed – could obtain about 7 hours of sleep. This option would also accommodate the following proposal for a 2-hour off-duty period between 0000 and 0600 for night drivers.

- ***Require a 2-hour off-duty period between 0000 and 0600 hours***

It has been repeatedly demonstrated that the potential for driver fatigue and accidents is increased markedly between 0000 and 0600, the exact time varying between individuals. A 2-hour off-duty period is intended to allow an opportunity for a nap and to shorten driving time during the most vulnerable time of day for a fatigue-related accident. The proposed duration is based on evidence that a 2-hour nap is sufficient to promote and maintain recovery for an extended period.

- ***Eliminate the split-rest provision in the HOS regulations, which accepts two short sleep periods as equally refreshing as one long period***

Research has shown that sleep accumulated in short time blocks is less refreshing than sleep accumulated in one long time period. Some studies have also linked split sleep to increased crash risk. Based on the human physiological need for a long continuous sleep to achieve full and fast recovery from fatigue, the split-sleep provision in the HOS regulations should be eliminated. The regulations should, for example, no longer accept two 4-hour periods of rest in a sleeper berth as being equivalent to 8 hours of rest.

- ***Do not distinguish between driving and non-driving work periods***

A number of studies have shown that driving duration is not a reliable indicator of decreased driving performance. Work duration is more important than driving duration. Work duration encompasses driving duration and directly affects the three other most important parameters from the driving fatigue perspective: the times of day at which work is performed and sleep is obtained, and the length of time awake since the last sleep. Note that driving time can occur at the end of an on-duty period, subsequent to hard physical work involving loading and unloading, for example, as often as it can occur at the beginning.

Recommended Options

- ***Increase by one hour (from 8 to 9 hours) the minimum duration of the continuous off-duty period required within any 24 consecutive hours***

Some studies have found that quick changeovers between shifts (usually allowing about 8 hours of free time) can lead to reduced sleep. The Canada/U.S. Driver Fatigue and Alertness Study and the U.S. National Transportation Safety Board among others have concluded that eight hours off duty between work periods might not provide enough time to obtain adequate sleep when all other driver daily needs are taken into account. Although a minimum of eight hours may be required to obtain adequate sleep on a daily basis under ideal circumstances, if this time is not all available for sleep and/or if sleep is less than optimal (such as sleep during the day), it may not be sufficient for recovery. This option of nine consecutive hours off duty would provide increased opportunity to obtain a long continuous sleep, while leaving a total of one hour off duty available to the driver during the rest of the day to attend to other driver-related needs.

The proposed one-hour increase may not, however, be necessary for solo drivers in sleeper cab operations. These drivers have their beds readily accessible – with little delay – at any time of the day. They are in a position to allocate a greater proportion of their off-duty period to getting adequate sleep. This also allows sleeper cab drivers to have an additional 2 hours off duty during the rest of the day, which is especially beneficial since they can more easily take advantage of the time for sleeping.

- ***Decrease by one hour (from 14 to 13 hours) the maximum total on-duty time allowed within any consecutive 24 hours that includes more than one hour on duty between 0000 and 0600***

A shorter on-duty period reduces performance deterioration. More importantly, the additional one hour off duty provides greater opportunity for increased sleep. It is well known that workers on night shifts, who sleep during the day, do not obtain as much sleep as those working days and sleeping nights. In a study of commercial vehicle drivers, this difference in sleep duration (between drivers who worked through the night and those who did not) was about 45.5 minutes. The additional hour off duty may also provide drivers who work through the night with some increased flex time for rest during the course of the work day.

- ***Require 30 minutes of rest from driving for every 5 hours on duty***

Some research (although not all) has shown that short breaks from driving (10 minutes or more) should be taken at least every 2 hours to avoid excessive accumulation of fatigue. The impact of short rest periods is particularly beneficial when fatigue is already evident. Rather than proposing regular breaks of short duration, it is proposed that rest breaks be at the discretion of the driver, such that they average about 10 minutes every

2 hours. Given that crash risk data based on time on task tends to suggest that risk increases somewhat after about 5 hours, 5 hours of duty time was chosen as the maximum period without a rest break.

Special Circumstances

- ***For team drivers in sleeper cab operations***

  - ***allow two periods of 4 continuous hours off duty to substitute for the minimum continuous off-duty period of 8 hours required within any 24 consecutive hours***
  - ***require a minimum continuous off-duty period of 4 hours after no more than 8 consecutive hours on duty***

Team drivers generally operate around the clock, with each driver sharing work and rest times equally over the course of a day. Sleep is usually taken in the moving vehicle. Although it has been proposed that the daily anchor sleep not be split, from the safety perspective, the circumstances of team driving may warrant an exception if this operating approach is to be maintained. Two safety considerations are that team drivers are in a better position to take a sleep break whenever they feel the need and that their sleep environment as well as work and partnering constraints do not favour long sleeps. There is little point in requiring a minimum of 8 hours if drivers cannot sleep that long, particularly since the resulting wake time while off duty would reduce their disposable off-duty time when they may be more inclined to sleep. It is also logical to conclude that the longer the required minimum off-duty period, the more reluctant the driver will be to use the bunk, unless he/she feels particularly fatigued (not a desirable result). The minimum proposed 4-hour off-duty period (rather than the 2-hour minimum allowed by existing regulations) is consistent with getting a basic amount of sleep that is known to be somewhat sustaining, at least for short periods. This would, for example, allow each driver 12 hours on duty/12 hours off duty during the course of a 24-hour day (including a possible three 4-hour off-duty periods), without locking drivers into such a schedule. To compensate for this shorter period for anchor sleep, it is also proposed that team drivers not be allowed more than 8 consecutive hours on duty, after which a 4-hour off-duty period would be required.

- ***For drivers who run out of available working hours close to their destination***

  - ***allow a 2-hour off-duty period as a sufficient condition for a subsequent 2-hour on-duty period***

Quite often a driver gets close to his or her destination but runs out of available hours and is required to take a period of prolonged rest/sleep. This can lead to safety violations involving speeding and/or excessive driving time without rest, both of which can increase the risk of crashes, as well as increase living costs for the driver and

service costs for the industry. Currently the regulations provide for a 4-hour rest period reduction (from the 8 consecutive hours off duty normally required before starting work in a day) that may occur once during 7 consecutive days. This provision should be replaced with a more conservative and flexible approach. Evidence indicates that a 2-hour nap promotes some degree of recovery and maintains performance at pre-nap levels for at least 2 hours, although it is unclear how long the recovery effects persist. Use of this on-duty period extension should be limited in certain cases; for example, it should not encompass the extremely vulnerable periods between midnight and 0600 hours. It should also be made up by adding the work extension to the subsequent principal rest period (of 8 or 9 hours – depending on the option selected), unless it is immediately followed by the required off-duty period for cumulative days.

OPTIONS FOR WORK/REST CYCLES OVER CUMULATIVE DAYS

Increasing the number of very long shifts (and hours worked) in a week can increase the sleep debt that accumulates over days while, at the same time, the number and duration of off-duty periods available for recovery sleep decreases. To maximize the recovery obtained from sleep, sleep periods should occur during the time of day when sleep is most consistent with human physiology and circadian rhythms. Two full nights of sleep appear to be required to allow near full recovery following protracted periods of sleep loss or sleep restriction. Given that better recovery sleep is achieved at night, the opportunity for night sleep becomes critical, especially for the more fatigued drivers. Furthermore, little scientific data can be found for drawing conclusions about the long-term effects of continuing long hours of work and high levels of sleep loss on driver performance and recovery. Consequently, it is prudent to provide, at the earliest possible opportunity, an off-duty period of sufficient duration to permit full recovery from fatigue accumulated over multiple days of work.

The proposals for changes to the HOS regulations that affect fatigue factors over cumulative days are intended to limit the number of hours worked, increase the number and duration of sleep opportunities, and promote availability of sleep opportunities at the most appropriate times of the day. In addition, the options take into account the time of day during which work hours are accumulated. Overall, they are intended to enhance operating flexibility, increase opportunities for drivers to spend more time at home with their families, and keep the regulations as simple as possible, while achieving the overall objective of reducing driver fatigue.

The options presented here, addressing work/rest cycles over cumulative days, are considered under the same three categories identified in the previous subsection (Core Options, Recommended Options, and Special Circumstances).

Core Options

- ***Promote work/rest cycle regularity***

A large body of research has firmly established that rotating shifts and irregular schedules lead to deterioration of driver performance due to shorter and poorer sleep as well as to circadian effects. Fatigue can be cumulative over the work week and extend into days off duty. Provisions of the HOS regulations that promote rotating and irregular schedules over multiple days should be removed. Additions should be made that encourage schedule regularity and incorporate remedial measures for particularly difficult periods. Incorporation of the proposals presented in this subsection would promote use of more regular schedules by industry, eliminate from the HOS regulations those aspects that promote rotating schedules and facilitate re-establishment of regular schedules subsequent to unforeseen perturbations. They include a daily work/rest cycle based on a 24-hour day, reasonable maximum cumulative weekly work hours based on a multiple of the daily work period, and a recovery period based on number of night sleeps rather than on total hours from the end of a work shift.

- ***Maintain the existing on-duty maximums at 60 hours in 7 days, 70 hours in 8 days and 120 hours in 14 days***

The scientific literature does not support any increase of current limits of 60 hours in 7 days, 70 hours in 8 days and 120 hours in 14 days. Until the industry and its stakeholders can develop ways of reducing weekly demands without severe economic repercussions, the weekly maximums can remain. However, every effort should be made to research the segments of the industry that regularly work these maximums. Alternative strategies should be identified to reduce the maximums in the future and/or to maximize rest opportunities.

- ***Treat off-duty recovery periods in terms of number of night sleeps (including the period between 0000 and 0600)***

Specifying the number of hours of off-duty time can force drivers to change shift during the next cycle; for example, day drivers may shift toward night operations to minimize the amount of time off duty. This can result from hours being counted starting from the end of a shift. This “hours” approach favours delays in one week’s work cycle being carried forward into the next week’s cycle, another negative feature. It is well established that day sleep is not as recuperative as night sleep, and that nighttime alertness and associated performance is reduced. It is also clear that virtually no one living in a normal social environment is a “night” person (in the sense that their circadian rhythm patterns are not substantially different from other individuals working day shifts). The implication is that off-duty recovery periods should promote sleeping at night rather than at any time of the day during which hours off duty happen to fall. By specifying an off-duty recovery period based on included nights of rest, work/rest cycles are maintained from week to week and unexpected schedule delays can be more easily accommodated within the

current cycle rather than the next. Drivers working through the night, who are of most concern, would have to switch to day cycles in the next period if they wished to minimize the length of their required off-duty recovery period. Or, if they wish to continue on night schedules during the next cycle, they would have to be off duty a longer number of hours. Both would be beneficial from the fatigue perspective.

- ***Require a 2-night off-duty period (including the intervening day) within any consecutive 7-day period having over 42 hours on duty***

It is proposed that the off-duty recovery period be considered in terms of night sleep opportunities. For both day and night drivers, the off-duty period should be of sufficient continuous duration to include 2 full nights, from 0000 to 0600 hours. Using this approach, off-duty time and night-sleep opportunities would be in accordance with the results of research for both day and night drivers. For day drivers, total hours off duty would stretch from a minimum of about 30 hours, if maintaining the same day schedule on the next cycle, up to a maximum of 48 hours, if switching to an exactly inverted schedule of night driving during the next cycle. For night drivers, total hours off duty would span a minimum of 48 hours, if shifting to an exactly inverted day schedule on the next cycle, up to a maximum of 58 hours, if maintaining exactly the same night schedule on the next cycle.

Currently, the HOS regulations do not include any requirement for off-duty time after reaching the cumulative days on-duty maximums. Thus, schedules that accumulate about 8½ hours or less per day can be conducted indefinitely over the course of the year. Although this amount of on-duty/driving time is not at the daily HOS maximum, it is not negligible and should not be ignored, particularly for night-shift drivers. It is proposed that a minimum 2-night off-duty period be required within each 7-day period incorporating over 42 hours of cumulative on-duty time.

- ***Require a 2-night off-duty period (including the intervening day) after 4 consecutive nights on duty***

While it is best for drivers to be driving at the same time of the day each day, whether that involves morning or afternoon starts, the same is not true of overnight driving. Driving a series of night shifts results in accumulating a significant sleep debt, as well as in sleep being taken at the time of day when it is least recuperative. Changes in the HOS regulations should deal with the greater risks from fatigue associated with night driving. It is proposed that a maximum of 4 nights of work (i.e. on-duty/driving between 0000 and 0600) in a row be allowed before requiring an off-duty period that provides the opportunity for 2 full nights of sleep that includes the hours between 0000 and 0600 (including the intervening day). This will guard against accumulating too great a sleep debt, with a consequent deterioration in performance. Although from a fatigue management perspective shifting work schedules should be avoided, it is a preferred alternative to working an excessive number of night shifts.

Recommended Options

- ***Modify the current 120-hour/14-day cycle to include the 2-night off-duty period (proposed under Core Options), and eliminate the 60-hour/7-day and 70-hour/8-day cycles***

The current maximum on-duty hours are 60 hours in 7 days, 70 hours in 8 days and 120 hours in 14 days. Drivers must conform to one of the three, rather than all 3 simultaneously, depending on the circumstances. Current regulations allowing 120 hours on-duty time within 14 days can result in a driver consecutively working, for example, ten 12-hour days (nights) and driving nine 13-hour days (nights). These potential work schedules are excessive by any standard, but especially for workers such as truckers in safety-sensitive positions. It is proposed that only the current 14-day/ 120-hour maximum be retained. This is, however, contingent on the integration of the recovery option of 2 nights off duty (including the intervening day) within every 7 consecutive days (over 42 hours on duty). Eliminating the 7- and 8-day options would simplify the regulations, record keeping (logbooks) and enforcement. Moreover, the 14-day cycle would encompass the operating possibilities offered by the other two cycles, except in very rare circumstances. This option may provide more flexible work/rest schedules that are more responsive to driver and motor carrier needs, as well as maintain an extended range of efficient operation, but with a more rested driver.

Special Circumstances

- ***For drivers who run out of available working hours close to their destinations***

  - ***allow an 8-hour off-duty period as a sufficient condition for a subsequent 8-hour on-duty period***

A 2-hour off-duty/2-hour on-duty option has already been proposed for the daily cycle to deal with the situation when drivers run out of hours close to their destinations. This proposal was made primarily for safety reasons, but also for practical and service considerations. Although the 2-hour period is considered adequate from the perspective of a daily cycle, delays can be cumulative over multiple days and exceed a driver's ability to compensate with the 2-hour rest/work option. For similar safety, practical, and service reasons cited earlier, consideration should be given to providing an option that drivers can use to safely compensate for longer delays that may have accumulated during the normal work cycle over multiple days. It is proposed that an 8-hour off-duty period allow a subsequent 8-hour (maximum) period of driving. The 8-hour off-duty period would allow a good principal sleep, rather than the truncated sleep allowed by the existing 4-hour rest reduction rule. This would then be followed by a relatively short period of work/driving (8 hours), which should be sufficient to get to the home terminal in the "close to home" situation. Since this on-duty extension would be allowed only once

at the end of the work cycle, a driver would subsequently obtain an off-duty period of normal duration (2 nights plus the intervening day) for recovery.

NATIONAL-REGIONAL CONSIDERATIONS

HOS regulations deal with specification of safe working limits related to fatigue. They should be determined by the limits of human physiology. In reality, however, difficulties arise because of unknowns in the relationships between fatigue, the control parameters specified by the HOS regulations (work and rest hours, break time, etc.) and road safety.

As a result of the considerable international research in the past 10 years, schedule-related factors affecting human performance are now much better understood. It should be possible to achieve a consensus on safe and acceptable working limits for Canadian commercial vehicle drivers. In matters that deal with shaping human behaviour, it is particularly important that rules be consistent and based on the most objective data possible. Only then can it be expected that the rules will be understood, respected, and adhered to by drivers, motor carriers and shippers, and that only moderate levels of enforcement will be necessary. However, local circumstances arising from particularities of geography and/or population characteristics may demand some adaptation for local carriers and drivers (such as extended periods of long days and long nights in the far north, short periods of terrain accessibility due to freezing or thawing, or immense distances with few inhabitants and amenities).

When weighing the significance of changes in HOS regulations, it may be useful to examine the residual time off available to drivers for diversionary activities away from work, as well as to compare this with different scenarios and other areas of economic activity. For illustrative purposes, Table 1 shows example residual time off calculations for:

- the existing federal HOS regulations, which allow 60 hours of work in 7 days, cycling 15 hours on duty/8 hours off duty

- a federal proposal for 70 hours of work in 7 days, cycling 14 hours on duty/10 hours off duty

- a proposal from provinces in Western Canada for 84 hours of work in 7 days, cycling 14 hours on duty/10 hours off duty

- the work hours of the average Canadian worker in the goods-producing industries of 39.3 hours in 7 days, cycling 7.9 hours on duty/16.1 hours off duty

Examining potential work/rest strategies available to drivers faced with, for example, an 84-hour work week may help us better understand possible work duration effects on the length of recovery sleep that may be feasible. A driver may choose to maintain the amount of sleep normally obtained over a 7-day period at 56 hours (Table 1) after switching to the new cycle of 84 hours on duty in 7 days. This would mean reducing the total time available for personal pursuits over 7 days (including the one off-duty day) to only 16 hours. This is 28 hours below the 44 hours that are available currently, and 46.7 hours less than the 62.7 hours available to the average Canadian worker in the goods-producing industries. However, most shiftworkers will trade off sleep for wakefulness to make more time available for attending to personal needs, being with spouses, children, extended families and friends, as well as for performing household and other chores of daily life. Moreover, many drivers must also make time available for tending to their vehicles and trucking businesses. Thus drivers may choose to maintain their available free time for personal, social and domestic activities at 44 hours. In this case, drivers would reduce their sleep to only 28 hours over a 7-day period. However, such extremely low levels of sleep would severely affect job performance, internal state of well being and safety, making this scenario much less likely. It is expected that most drivers would spend somewhere between 28 and 56 hours in bed. Considering night shiftworkers – who on average obtain about 5 hours of sleep per day, according to a number of studies, an 84-hour work week would leave only 37 hours of free time. These drivers have inadequate time to sleep and recover as well as inadequate time for a personal life. This would produce a fatigued driver who would be a danger to him/herself and to others, and who would be unable to reap the personal benefits of working long hours.

CANADA-U.S. RECIPROCITY

Currently the U.S. and Canadian HOS regulations are somewhat different. Changing Canadian (or U.S.) HOS regulations without mutual reciprocity or compatibility would have implications for international carriers. This would also be the case for the many Canadian carriers conducting their operations in Canada under U.S. rules, rather than Canadian. The greater the differences in HOS regulations between the two countries, the more difficult it will be to schedule drivers for transborder operations. These potential impacts must be considered and dealt with fully in advance of implementing any changes. Similar consideration should be given to any changes to U.S. HOS regulations.

IMPLEMENTATION OF HOS CHANGES

Prior to final implementation, a pilot demonstration and evaluation of selected HOS changes should be conducted, using a representative group of drivers and motor carriers. The pilot should provide enough information to establish objective conclusions concerning their effectiveness in reducing driver fatigue and increasing safety and driver

satisfaction, their practicality under operating conditions, and their overall efficiency and cost-effectiveness. Comparisons should be made with operations under existing regulations, by using control and test groups. In principle, the pilot demonstration should be carried out over a minimum one-year period to evaluate potential impacts of normal variations in circumstances and schedules.

Table 1
Comparison of residual time off available to drivers over seven days under various scenarios for total hours worked in a week

(Compares existing federal HOS regulations which allow 60 hours on-duty in 7 days, a federal proposal* for a 70-hour work week, a proposal from provinces in Western Canada* for an 84-hour work week, and work hours of the average Canadian worker in the goods-producing industries** of 39.3 hours)

Scenario	Total hrs. available in 7 days	Work hrs.	Work-related off-duty hrs.†	Drive hrs. to/from work††	Sleep hrs.	Net hrs. for personal life
Cdn. Goods-Producing Worker	168	39.3	5	5	56‡	62.7
Existing HOS: 60 hrs/7 days	168	60	4	4	56‡	44
Federal Proposal: 70 hrs/7 days	168	70	5	5	56‡	32
					44‡‡	44
Western Proposal: 84 hrs/7 days	168	84	6	6	56‡	16
					28‡‡	44

* Proposal tabled at a meeting of the Commercial Vehicle Driver Hours of Service Project Group (Canadian Council of Motor Transport Administrators, CCMTA), held on April 27-28, 1998, in Ottawa, Ontario.

** Statistics Canada, Catalogue No. 72F0002-XDE.

† For each workday, includes 0.5 hours for lunch and 0.5 hours for breaks. Numbers take into account a possible 4, 5, or 6 days in a work week as appropriate.

†† Assumes a driving time of 30 minutes each way. Numbers take into account a possible 4 or 5 day work week as appropriate.

‡ Assumes 8 hours in bed each 24 hours.

‡‡ Assumes drivers cut back on sleep time in order to maintain free time for personal life at the equivalent 44 hours available under the current 60 hours in 7 days HOS regime. (This is a plausible scenario presented for demonstration of potential sleep/free time tradeoffs.)

New HOS regulations and associated support programs for the trucking industry should be accompanied by research and evaluation to monitor their in-service effectiveness in reducing driver fatigue. This reflects the view that it is difficult to make unequivocal recommendations about actual day-to-day practice over the long term, particularly because of the diverse and complex nature of the trucking industry and the adaptability of human beings to changing environments. The adequacy of the revised regulations

and industry compliance levels should be monitored over a five-year review period, after which adjustments should be made if warranted.

In view of the importance of driver performance to road safety and the serious performance decrements that result from fatigue, vehicle monitoring should be considered for general implementation, as an objective method to assist in ensuring compliance with the HOS regulations (beyond the crude log-book information). This is proposed as an approach to achieving a required significant reduction in the substantial HOS violation rates reported by a number of studies. Because the HOS regulations are of major importance to the economics of trucking as well as to its competitive position vis-à-vis the other transportation modes, a level playing field must be established to ensure voluntary compliance by the vast majority of drivers and motor carriers.

SOMMAIRE – Options for Changes to Hours of Service for Commercial Vehicle Drivers

INTRODUCTION

En avril 1997, Transports Canada (TC) mettait sur pied un comité d'experts réunissant des spécialistes du travail par quarts, du sommeil et de la performance humaine qu'il chargeait d'élaborer une première série d'options en vue d'une modification éventuelle des règles sur les heures de service (HS) contenues dans le Règlement sur les heures de service des conducteurs de véhicules utilitaires (adopté par le gouvernement fédéral le 15 novembre 1994), et dans la norme n 9 du Code national de sécurité. Cette initiative découlait de la position prise par TC de fonder toute modification éventuelle aux règles sur les heures de service sur les connaissances scientifiques de pointe. Le comité n'avait pas pour mandat de proposer des options qui refléteraient des décisions de politique ou de gestion, ni de formuler des recommandations précises. Il lui incombait plutôt de présenter différentes façons d'incorporer les données scientifiques sur la fatigue à une réglementation sur les HS, et d'alimenter les discussions sur ces questions au sein du milieu. Le présent rapport rend compte des travaux de ce comité. Il présente :

- des options étayées scientifiquement pour la modification des règles sur les HS, et les contraintes opérationnelles qu'elles sont susceptibles d'engendrer;

- les enjeux nationaux et internationaux associés à la mise en oeuvre de modifications aux HS, sur lesquels il faudra préalablement se pencher;

- les règles de l'art concernant l'aménagement des horaires de travail et de repos des conducteurs de véhicules utilitaires, fondées sur l'état actuel des connaissances sur la physiologie humaine et la fatigue, et qui tiennent compte des impératifs opérationnels avec lesquels doivent composer les transporteurs routiers et les conducteurs de véhicules utilitaires.

En ce qui a trait aux options proposées, il convient de noter que les résultats des recherches scientifiques menées à ce jour permettent de bien comprendre (et de solidement étayer) certaines interactions entre les divers facteurs de fatigue et leurs effets sur la performance humaine. Mais d'autres interactions demeurent mal comprises. Aussi les options proposées se fondent-elles, autant que possible, sur les données d'études précises et, en l'absence de telles études ou de résultats probants, sur des principes fondamentaux déduits du corpus scientifique.

Le lecteur se rappellera également que le comité s'est servi des heures de service présentement en vigueur comme point de départ à ses discussions, plutôt que de partir de zéro et de tenter de «refaire le monde». Cette approche sage et prudente a pris en

considération les limites des connaissances scientifiques actuelles, la nature complexe des activités de camionnage et les répercussions imprévisibles de modifications majeures sur la sécurité routière et l'économie de l'industrie, ainsi que les contraintes imposées par les grandes distances qui séparent les villes jalonnant les grandes voies de communication canadiennes. Les changements proposés visent donc à accroître la sécurité en apportant des améliorations sensibles au régime actuel des heures de service, qui permettront de mieux faire échec à la fatigue et de disposer d'une plus grande souplesse en cas de perturbations des horaires.

OPTIONS TOUCHANT LES CYCLES JOURNALIERS DE TRAVAIL ET DE REPOS

L'apparition de la fatigue, la perte de vigilance et la dégradation de la performance chez les conducteurs sont inextricablement liées au sommeil et au rythme circadien, qui ont tous deux une périodicité journalière. Les effets du moment de la journée où a lieu la tâche ou le sommeil (rythme circadien) mènent à un sommeil moins réparateur le jour et à une performance moins bonne la nuit. En retour, un sommeil de mauvaise qualité accentue la dégradation normale de la performance associée aux «creux» du rythme circadien. Il s'ensuit qu'on ne peut mettre sur le même pied la conduite de nuit et la conduite de jour, que ce soit du point de vue de la performance ou du sommeil. Et si on réduit la quantité d'un sommeil qui est déjà de piètre qualité, on peut s'attendre à une détérioration encore plus accentuée de la performance. Le temps écoulé depuis la dernière période principale de sommeil est un autre facteur qui influe sur la vigilance et la performance. On estime que pour chaque période de 24 heures sans sommeil, la performance baisse de 25 p. cent. D'où l'importance de maîtriser le plus possible les facteurs de fatigue qui influent sur la sécurité de la conduite, en instaurant des régimes judicieux de travail et de repos et des mesures propres à prévenir la fatigue. Le but est de maintenir chez les conducteurs, jour après jour, des niveaux de performance qui favorisent la sécurité, et de prévenir la dégradation de la performance au fil des jours. Il importe également d'incorporer au régime de travail journalier une certaine marge de manoeuvre de sorte qu'en cas d'imprévus venant perturber l'horaire d'un jour de travail, des mesures puissent être prises pour rétablir la situation le plus tôt possible, de préférence pas plus tard que le lendemain.

Les options présentées dans la présente section sont centrées sur les questions de performance humaine. Elles visent l'aménagement de régimes travail/repos qui permettent de mieux gérer la fatigue. Ces options sont classées en trois catégories, elles-mêmes regroupées selon leurs liens fonctionnels : les options de base, correspondant aux changements fondamentaux à apporter pour que les règles sur les HS soient davantage le reflet de notre compréhension des rapports entre les facteurs de fatigue reliés à l'horaire de travail et la performance humaine; les options recommandées, qui proposent des améliorations complémentaires des options de base et les options reliées à des circonstances particulières. Les options de cette dernière catégorie, qui s'apparentent à des mesures d'exemption, proposent des solutions

pragmatiques pour garantir la sécurité de la conduite dans des circonstances et des contextes de travail particuliers (p. ex., conducteurs formant une équipe à bord d'un véhicule muni d'une couchette et conducteurs qui atteignent la limite des heures de service avant d'atteindre leur destination). Le lecteur se reportera à la version complète du rapport pour une présentation détaillée de chaque option, un survol des aspects positifs et négatifs et des limites de chacune, et pour une liste des références bibliographiques pertinentes.

Options de base

Voici les éléments essentiels d'une refonte du régime des heures de service :

- ***Établir un cycle journalier fondé sur une période de 24 heures***

En fondant les horaires sur un cycle de 24 heures, on peut mieux synchroniser les quarts de travail et les périodes de repos des conducteurs avec leur horloge interne de 24 heures, et prévenir les stratégies d'avance de phase que favorisent les règles actuelles. La réglementation en vigueur permet en effet un maximum de 13 heures de conduite et un total de 15 heures de service consécutives. En ajoutant à ces heures une période de repos obligatoire de 8 heures, on obtient un cycle de 21 heures ou de 23 heures. Or, les chercheurs ont mis en évidence la détérioration de la performance associée à l'avance de phase.

- ***Porter de 16 à 14 heures le nombre maximal d'heures de service permises pendant une période de 24 heures consécutives***

Certaines études ont démontré une corrélation entre le risque de collision et le nombre d'heures de conduite, même lorsque celles-ci sont bien en deçà des limites d'heures de service. L'Étude canado-américaine sur la fatigue et la vigilance chez les conducteurs (EFVC) a montré que les résultats RVS (réciproque de la latence médiane de réponse) obtenus à un test de vigilance simple (c.-à-d. un test de performance qui s'est révélé sensible à l'allongement du temps de réponse sensori-motrice associé à la perte de vigilance et à la fatigue) étaient plus faibles à la fin des trajets qu'au début. L'EFVC a également montré une forte corrélation entre les auto-diagnostics de fatigue des conducteurs et le temps écoulé depuis le début de leur voyage. Malgré des écarts considérables entre ces auto-diagnostics et les mesures objectives, il se peut que ces auto-diagnostics aient reflété un degré croissant de stress ou d'effort compensateur, indicateurs de fatigue ou de perte de vigilance, ainsi qu'une motivation et une capacité moindres de la part des conducteurs de demeurer vigilants alors qu'ils achevaient leur trajet.

Cette proposition de faire passer d'un maximum de 16 heures (dont 15 peuvent être consécutives) à 14 heures la durée de la journée de travail des conducteurs tient surtout à la nécessité de leur laisser plus de temps à consacrer au sommeil et au repos (voir la prochaine option), mais aussi à la nécessité d'atténuer la fatigue associée à la durée de la tâche.

- ***Porter de 8 à 10 heures le nombre minimal d'heures de repos pendant une période de 24 heures consécutives***

Plusieurs études réalisées au cours des dernières années ont mis en lumière la nécessité d'accorder davantage de temps de repos aux conducteurs pour qu'ils aient plus d'occasions de dormir. En faisant passer de 16 à 14 heures la période de travail journalière (voir l'option précédente), il est possible de porter de 8 à 10 heures la période de repos. Un tel réaménagement permet en outre d'établir un cycle de travail/repos d'une périodicité de 24 heures, ce qui facilite la confection d'horaires comportant une alternance régulière, plutôt qu'un déphasage, des périodes de travail et de repos. Aussi, cette modification prépare le terrain à d'autres propositions (voir plus loin) d'améliorations essentielles aux HS.

- ***Exiger un minimum de 8 heures de repos consécutives par période de 24 heures consécutives***

La période de repos journalière (sommeil principal) doit être suffisamment longue pour permettre aux conducteurs de dormir assez longtemps pour éliminer leur fatigue. Cette période de repos doit aussi permettre aux conducteurs de vaquer aux occupations de la vie quotidienne (transport entre le lieu de travail et la maison, repas, toilette, vie familiale, loisirs) sans rogner sur leur période de sommeil principal. Or, la durée de sommeil idéale, selon les 80 conducteurs qui ont participé à l'EFVC, est de 7,2 heures, ce qui coïncide avec la durée de sommeil nocturne perçue comme nécessaire par la population en général (aux États-Unis), de quelque 7,2 heures (±1,2). Une période de repos de 8 heures est le minimum nécessaire pour qu'un conducteur – en admettant qu'il se mette immédiatement au lit – puisse obtenir environ 7 heures de sommeil. Cette option est préalable à la proposition ci-après d'une période de repos de 2 heures entre minuit et 6 h, pour les conducteurs de nuit.

- ***Exiger une période de repos de 2 heures entre minuit et 6 h***

Il a été maintes fois démontré que le risque de fatigue chez les conducteurs et le risque d'accident augmentent de façon marquée entre minuit et 6 h. L'heure exacte à laquelle culminent ces risques varie d'un conducteur à l'autre. L'instauration d'une période de repos de 2 heures dans cet intervalle donnerait au conducteur l'occasion de dormir et de diminuer ses heures de conduite pendant la période du jour où les accidents reliés à la fatigue sont les plus probables. La durée de 2 heures proposée découle de résultats d'études qui ont montré qu'un somme de 2 heures est suffisant pour permettre une récupération aux effets durables.

- ***Éliminer la disposition du règlement sur les HS qui permet de fractionner la période de repos, comme si le pouvoir de récupération associé à deux courtes périodes de repos et à une seule période de repos de durée totale équivalente était le même***

La recherche a montré qu'un sommeil fractionné entre de courtes périodes n'entraîne pas une récupération équivalente à celle obtenue au cours d'une même période ininterrompue de sommeil. Certaines études ont également relié le sommeil fractionné à un risque accru de collision. Comme la physiologie humaine exige une longue période de sommeil continu pour une récupération rapide et complète, il y a lieu d'éliminer la disposition du règlement sur les HS qui permet le fractionnement des périodes de repos. Il ne devrait plus accepter, par exemple, l'équivalence entre deux périodes de repos de 4 heures prises dans une couchette et une période de repos de 8 heures.

- ***Éliminer la distinction «heures de conduite» - «heures de service»***

Selon certaines études, les heures de conduite ne constituent pas un indicateur fiable de la détérioration de la performance au volant. Les heures de service sont plus importantes à cet égard que les heures de conduite. Les heures de service, qui englobent les heures de conduite, influent directement sur les trois autres paramètres les plus importants du point de vue de la fatigue au volant, soit : le moment de la journée où s'effectue la conduite, le moment de la journée où est pris le sommeil, et le temps écoulé depuis la dernière période de sommeil. À noter aussi que la période de conduite peut avoir lieu aussi bien à la fin de la période de service, après des tâches exigeantes physiquement, comme le chargement et le déchargement, par exemple, qu'au début. Voilà qui renforce la nécessité d'éliminer cette distinction.

Options recommandées

- ***Augmenter d'une heure (de 8 heures à 9 heures) le minimum d'heures de repos consécutives exigées par période de 24 heures consécutives***

Certaines études ont montré un lien entre des changements de quart rapides (environ 8 heures de repos entre quarts différents) et une diminution de la durée du sommeil. L'étude canado-américaine sur la fatigue et la vigilance chez les conducteurs et le National Transportation Safety Board des États-Unis, entre autres, ont conclu qu'une période de repos de huit heures entre les périodes de travail ne laisse pas toujours suffisamment de temps au conducteur pour obtenir le sommeil nécessaire, compte tenu des autres besoins qu'il doit satisfaire. L'exigence d'un minimum de huit heures de repos peut permettre un sommeil quotidien suffisant dans des circonstances idéales. Mais s'il n'est pas possible de consacrer toute sa période de repos au sommeil et/ou si le sommeil n'est pas optimal (comme c'est le cas du sommeil diurne), une période de huit heures ne suffit pas toujours pour une récupération complète. Une période de neuf heures de repos consécutives accroîtrait les chances du conducteur d'obtenir une

longue période de sommeil ininterrompu, tout en lui laissant une autre heure de repos pour satisfaire à ses autres besoins.

Cette heure supplémentaire pourrait toutefois être superflue dans le cas des conducteurs qui sont seuls à bord d'un véhicule muni d'une couchette. Comme ils ont accès à un lit en permanence, ils peuvent se coucher à toute heure du jour. Ils sont donc en mesure de consacrer une plus grande proportion de leurs heures de repos au sommeil. Étant dispensés de cette heure de repos additionnelle, les conducteurs de véhicule avec couchette disposent de deux heures de repos de plus pendant le reste de la journée, ce qui est particulièrement avantageux pour eux, puisqu'ils peuvent plus facilement consacrer ce temps au sommeil.

- ***Diminuer d'une heure (de 14 à 13 heures) le maximum d'heures de service pendant une période de 24 heures consécutives, lorsque plus d'une heure de service est comprise entre minuit et 6 h***

Une période de service plus courte atténue la détérioration de la performance. Mais plus important encore, l'heure de repos supplémentaire permet au conducteur d'obtenir davantage de sommeil. Il est reconnu que les travailleurs de nuit, qui dorment le jour, n'obtiennent pas autant de sommeil que les travailleurs de jour. Une étude sur les conducteurs de véhicules utilitaires a révélé un écart d'environ 45,5 minutes entre la durée du sommeil des conducteurs de nuit et celle des conducteurs de jour. Cette heure de repos additionnelle peut également donner aux conducteurs de nuit plus de souplesse pour se reposer pendant le jour (avant et après leur quart de travail).

- ***Exiger 30 minutes de pause par période de 5 heures de service***

Certaines recherches (mais pas toutes) ont montré que de courtes pauses (d'au moins 10 minutes) au moins toutes les deux heures peuvent prévenir une accumulation excessive de fatigue. Ces pauses sont particulièrement bénéfiques lorsque la fatigue a fait son apparition. Plutôt que d'imposer des pauses à intervalles réguliers, il est proposé de laisser le conducteur les gérer à sa guise, pour peu qu'elles équivalent à 10 minutes toutes les 2 heures en moyenne. Les données sur les risques d'accident en fonction des heures de conduite laissent penser à une augmentation du risque après 5 heures au volant. C'est pourquoi la période maximale sans pause a été établie à 5 heures.

Options reliées à des circonstances particulières

- ***Conducteurs formant une équipe à bord d'un véhicule muni d'une couchette***

  - ***permettre deux périodes de 4 heures de repos consécutives au lieu de la période minimale de 8 heures de repos consécutives pendant une période de 24 heures consécutives***

- ***exiger une période de repos minimale de 4 heures consécutives après un maximum de 8 heures de service consécutives***

Les conducteurs qui se relaient au volant d'un véhicule travaillent généralement 24 heures sur 24, se partageant en parts égales les heures de conduite et de repos. Le sommeil est habituellement pris dans le véhicule en marche. Si l'on entend maintenir ce type d'exploitation, il peut être justifié d'exempter la conduite par équipe de la mesure proposée ci-dessus, à savoir l'interdiction de fractionner la période de sommeil principale, pour des raisons de sécurité. Eu égard à la sécurité, deux faits doivent être pris en considération : premièrement, les conducteurs jumelés peuvent à loisir faire un somme aussitôt qu'ils en sentent le besoin; deuxièmement, l'environnement dans lequel ils dorment, de même que les contraintes liées au travail et au fait d'appartenir à une équipe sont peu propices aux longues périodes de sommeil. Il ne sert donc à rien d'exiger un minimum de 8 heures de repos lorsque les conducteurs ne peuvent pas dormir tout ce temps. Surtout que pour ces heures de repos «excédentaires» pourraient être sacrifiées d'autres heures plus propices au sommeil. Aussi, il est logique de conclure que plus la période minimale de repos sera longue, plus le conducteur sera réticent à utiliser la couchette, à moins qu'il se sente particulièrement fatigué (ce qui n'est pas un résultat souhaitable). La période de repos minimale de 4 heures qui est proposée (plutôt que les 2 heures minimales présentement autorisées) rejoint ce que l'on sait sur la quantité de sommeil minimale nécessaire pour récupérer, au moins pour une courte période. Cela permettrait aux chauffeurs, par exemple, d'aménager leur horaire selon une alternance de 12 heures de service/12 heures de repos (soit, p. ex., trois périodes de repos de 4 heures) pendant une journée de 24 heures, sans toutefois qu'ils soient contraints à un tel horaire. Pour compenser la durée plus courte de la période de sommeil principale, il est également proposé de limiter à 8 heures consécutives les heures de service des conducteurs jumelés, après quoi ils devraient obligatoirement prendre une période de repos de 4 heures.

- ***Conducteurs qui ont atteint la limite d'heures de service avant de terminer leur trajet***

  - ***autoriser une prolongation de 2 heures des heures de service après une période de repos de 2 heures***

Il est assez fréquent qu'un conducteur atteigne la limite d'heures de conduite et d'heures de service avant d'avoir atteint sa destination, et qu'il soit alors forcé de prendre plusieurs heures de repos/sommeil. Une telle exigence peut avoir des effets néfastes sur la sécurité (dépassement des limites de vitesse et/ou de la limite des heures de conduite consécutives, deux infractions qui accentuent le risque d'accident), sans parler des frais de subsistance que doit assumer le conducteur et de la hausse des coûts des services pour l'industrie. La réglementation actuelle permet de réduire jusqu'à un minimum de 4 heures la période de repos (par rapport aux 8 heures de repos normalement exigées avant de commencer ses heures de service), une fois pendant

une période de sept jours consécutifs. Cette disposition doit être remplacée par une approche à la fois plus souple et plus prudente. Des recherches ont en effet montré qu'un somme de 2 heures permet une certaine récupération et maintient la performance aux niveaux antérieurs au somme pendant au moins 2 heures; on ne sait pas, toutefois, pendant combien de temps la récupération produit ses effets. La prolongation des heures de service doit être limitée à certains cas; par exemple, les heures extrêmement critiques entre minuit et 6 h devraient être exclues. Cette prolongation doit être compensée par une prolongation équivalente de la période de repos principale subséquente (de 8 ou 9 heures – selon l'option choisie), à moins que les heures de service soient immédiatement suivies de la période de repos obligatoire à la suite de plusieurs jours de travail.

OPTIONS TOUCHANT LES CYCLES DE TRAVAIL ET DE REPOS S'ÉTALANT SUR PLUSIEURS JOURS

Le fait d'accroître le nombre des très longs quarts de travail (et des heures travaillées) au cours d'une semaine peut accentuer le déficit de sommeil accumulé au fil des jours et en même temps diminuer le nombre et la durée des périodes de repos propices à un sommeil réparateur. Pour maximiser le pouvoir de récupération associé au sommeil, les périodes de repos doivent coïncider avec les moments de la journée les plus favorables au sommeil, compte tenu de la physiologie humaine et du rythme circadien. Il semble que deux nuits complètes de sommeil soient nécessaires pour permettre une récupération quasi complète à la suite d'une série de périodes de sommeil écourté ou de piètre qualité. Comme le sommeil pris la nuit est le plus réparateur, il devient essentiel que les conducteurs, et en particulier les conducteurs les plus fatigués, puissent dormir la nuit. De plus, la documentation scientifique contient peu de données permettant de tirer des conclusions concernant les effets à long terme de périodes prolongées de longues heures de travail conjuguées à de lourds déficits de sommeil sur la performance au volant et la récupération. Il est donc prudent de prévoir une période de repos suffisamment longue pour permettre au conducteur de se remettre complètement, et à la première occasion, de la fatigue accumulée au cours de plusieurs jours de travail.

Les propositions touchant les facteurs de fatigue associés à plusieurs jours de travail visent à limiter le nombre d'heures travaillées, à augmenter le nombre et la durée des périodes de repos, et à faire coïncider les périodes de repos avec les moments de la journée les plus propices au sommeil. De plus, ces options prennent en compte le moment du jour où sont effectuées les heures de travail. De façon plus globale, elles visent à accroître la souplesse des opérations, à accorder aux conducteurs plus de temps à passer chez eux avec leur famille, et à garder les règles le plus simples possible dans la poursuite de l'objectif ultime : réduire la fatigue des conducteurs.

Les options présentées ci-après touchant les cycles de travail et de repos s'étalant sur plusieurs jours sont elles aussi regroupées selon les catégories de la section

précédente (options de base, options recommandées et options reliées à des circonstances particulières).

Options de base

- ***Favoriser la régularité des cycles de travail et de repos***

De multiples recherches ont fermement établi que les postes tournants et les horaires irréguliers conduisent à une détérioration de la performance des conducteurs, en raison de la baisse de la qualité et de la quantité du sommeil, et des effets circadiens. La fatigue peut s'accumuler au cours de la semaine de travail et persister pendant les jours de repos. Il y a lieu d'éliminer du règlement sur les HS les dispositions qui favorisent les postes tournants et les horaires irréguliers s'étalant sur plusieurs jours, d'ajouter des dispositions qui favorisent l'aménagement d'horaires réguliers et d'instaurer des mesures compensatoires pour les périodes particulièrement difficiles. L'application des options ci-après amènerait l'industrie à confectionner des horaires de travail plus réguliers, éliminerait de la réglementation sur les HS les dispositions qui favorisent les postes tournants, et faciliterait le retour à un horaire régulier à la suite de perturbations d'horaires. Il est notamment proposé d'établir des cycles de travail/repos basés sur une journée de 24 heures, de fixer une limite raisonnable d'heures de travail hebdomadaires (correspondant à un multiple de la limite des heures de travail quotidiennes) et d'instaurer une période de repos dite «de récupération», fondée sur le nombre de périodes de sommeil nocturne plutôt que sur le nombre total d'heures de repos à partir de la fin d'un quart de travail.

- ***Maintenir les limites actuelles d'heures de service de 60 heures en 7 jours, 70 heures en 8 jours, et 120 heures en 14 jours***

Les rapports de recherche consultés n'appuient aucune hausse des limites d'heures de service actuellement établies à 60 heures pendant une période de 7 jours consécutifs, à 70 heures en 8 jours et à 120 heures en 14 jours. D'ici à ce que l'industrie et ses partenaires puissent penser à des façons de réduire le nombre d'heures de travail hebdomadaires sans que cela entraîne des répercussions économiques graves, le comité ne voit pas d'objection à maintenir le statu quo. Il y aurait lieu, toutefois, de se pencher sur les secteurs de l'industrie qui atteignent régulièrement ces maximums. Des stratégies devraient être élaborées pour permettre une réduction des maximums dans l'avenir et/ou pour maximiser les périodes de repos.

- ***Considérer les périodes de repos «de récupération» sous l'angle du nombre de périodes de sommeil nocturne (comprises entre minuit et 6 h)***

Des prescriptions fondées sur le nombre d'heures de repos peuvent inciter les conducteurs à changer de quart, d'un cycle de travail à l'autre; par exemple, le fait pour un conducteur de passer d'un horaire de jour à un horaire de nuit lui permettrait de réduire au minimum sa période de repos. Cela est possible parce que les heures de

congé sont comptées à partir de la fin d'un quart de travail. Autre conséquence néfaste de cette approche fondée sur les heures, elle permet de reporter à la semaine suivante les heures excédentaires effectuées lors d'un retard. Il est bien établi que le sommeil pris le jour n'est pas aussi réparateur que le sommeil pris la nuit, et que la vigilance et la performance au volant qui s'ensuit sont réduites la nuit. Il est également clair que personne, ou presque, vivant dans un environnement social normal n'est du type «de nuit» (le rythme circadien de l'être humain diffère peu, qu'il travaille de jour ou de nuit). Cela signifie que les périodes de repos dites «de récupération» doivent permettre au conducteur de prendre son sommeil la nuit et non pas n'importe quand, au moment où tombent ses heures de repos. Le fait de prescrire une période de récupération fondée sur le nombre de nuits de repos fait en sorte de maintenir les mêmes cycles de travail/repos d'une semaine à l'autre et permet d'absorber les retards pendant le cycle en cours plutôt que de les imputer au cycle suivant. Les conducteurs qui travaillent de nuit, les plus préoccupants, devraient, s'ils veulent réduire au minimum la durée de leur période de récupération, passer à un horaire de jour pour leur prochain cycle de travail. Ou, s'ils souhaitent garder un horaire de nuit, ils devraient demeurer en congé un plus grand nombre d'heures. Or, ces éventualités sont toutes deux souhaitables du point de vue d'une réduction de la fatigue.

- ***Exiger une période de repos comportant 2 nuits (et le jour intermédiaire) pendant une période de 7 jours consécutifs comportant plus de 42 heures de service***

Il est proposé que la période de récupération soit fondée sur le nombre de périodes de sommeil nocturne. Tant pour les conducteurs de jour que pour les conducteurs de nuit, la période de récupération devrait être suffisamment longue pour englober 2 nuits complètes, c'est-à-dire deux périodes de minuit à 6 h. Les heures de repos et les occasions de sommeil nocturne préconisées par cette approche sont appuyées par les résultats de recherches touchant à la fois les conducteurs de jour et les conducteurs de nuit. En effet, le nombre total d'heures de repos des conducteurs de jour passerait d'un minimum d'environ 30 heures, s'ils gardaient le même horaire de jour au cours du cycle suivant, à un maximum de 48 heures, s'ils passaient à l'horaire de nuit inverse pour le cycle suivant. Quant aux conducteurs de nuit, leur période de repos compterait au moins 48 heures, s'ils choisissaient l'horaire de jour inverse pour leur prochain cycle, et pourrait atteindre un maximum de 58 heures, s'ils maintenaient exactement le même horaire de nuit.

La réglementation actuelle sur les HS n'exige pas des conducteurs qu'ils prennent des heures de repos après avoir atteint la limite des heures de service accumulées sur plusieurs jours. Ainsi, les horaires qui comportent environ 8 ½ heures ou moins de conduite par jour peuvent se perpétuer indéfiniment au cours de l'année. Même si ces heures de conduite et ces heures de service sont en deçà de la limite journalière d'HS, elles ne sont pas négligeables et doivent être prises en compte, surtout dans le cas des conducteurs de nuit. C'est pourquoi il est proposé de prescrire une période de repos

comprenant au moins 2 nuits pendant une période de 7 jours comportant 42 heures de service accumulées.

- ***Exiger une période de repos comportant 2 nuits (et le jour intermédiaire) après 4 quarts de nuit consécutifs***

Même s'il faut privilégier un horaire régulier (dont les quarts de travail coïncident toujours avec le même moment du jour) pour les conducteurs qui commencent leur période de service le matin ou l'après-midi, tel n'est pas le cas pour les conducteurs de nuit. Le fait de conduire pendant plusieurs cycles de quarts de nuit entraîne l'accumulation d'un lourd déficit de sommeil, sans compter que le sommeil est pris pendant le jour, alors qu'il est le moins régénérateur. Les modifications de la réglementation sur les HS doivent prendre en compte le risque plus élevé que représente la fatigue associée à la conduite de nuit. Il est proposé d'établir un maximum de 4 nuits de travail (c.-à-d. d'heures de service et d'heures de conduite entre minuit et 6 h) consécutives, après quoi doit être exigée une période de repos permettant de prendre 2 nuits complètes de sommeil, c'est-à-dire qui couvre deux périodes comprises entre minuit et 6 h (ainsi que le jour intermédiaire). Une telle disposition préviendra l'accumulation d'un trop lourd déficit de sommeil, et la détérioration de la performance qui s'ensuit. Même si, du strict point de vue de la gestion de la fatigue, les changements d'horaire de travail devraient être évités, cette stratégie est opportune en ce qu'elle prévient l'accumulation d'un nombre excessif de quarts de nuit.

Options recommandées

- ***Modifier le cycle actuel de 120 heures de service en 14 jours pour y incorporer une période de repos comportant 2 nuits (proposition figurant parmi les options de base) et éliminer les cycles de 60 heures en 7 jours et de 70 heures en 8 jours***

La réglementation actuelle fixe à 60 heures en 7 jours, 70 heures en 8 jours et 120 heures en 14 jours les limites des heures de service. Les conducteurs sont tenus de respecter une des trois limites (non les trois en même temps), selon les circonstances. La disposition qui permet d'effectuer 120 heures de service en 14 jours peut entraîner des cas où un conducteur effectuerait, par exemple, dix périodes (nuits) de 12 heures et neuf périodes (nuits) de 13 heures, toutes à la suite. Ces horaires de travail sont excessifs, de quelque point de vue que l'on se place, mais ils le sont particulièrement pour les travailleurs qui occupent des postes critiques pour la sécurité, comme les camionneurs. Il est proposé de ne retenir que la limite actuelle de 120 heures de service pendant une période de 14 jours, sous réserve toutefois de l'instauration de l'option relative à la période de récupération de 2 nuits (y compris le jour intermédiaire) pendant une période de 7 jours consécutifs comportant plus de 42 heures de service. L'élimination des dispositions touchant les périodes de 7 jours et de 8 jours simplifierait le règlement, la tenue des dossiers (carnets de route) et l'application de la réglementation. De plus, le cycle de 14 jours ne donnerait pas moins

de souplesse que les deux autres cycles, sauf en de très rares circonstances. Cette option permet l'aménagement d'horaires de travail/repos plus flexibles qui répondent mieux aux besoins des conducteurs et des transporteurs, en même temps qu'elle autorise une gamme étendue de modalités d'exploitation, mais avec des conducteurs mieux reposés.

Options reliées à des circonstances particulières

- ***Conducteurs qui ont atteint la limite d'heures de service avant de terminer leur trajet***

  - ***autoriser une prolongation de 8 heures des heures de service après une période de repos de 8 heures***

Une option semblable de 2 heures de repos/2 heures de service a déjà été proposée pour le cycle journalier, afin de parer aux situations dans lesquelles les conducteurs atteignent la limite d'heures de service avant de terminer leur trajet. La présente proposition tient avant tout à des motifs de sécurité, mais elle tient aussi à des considérations pratiques et de qualité du service. Même si la période de 2 heures est considérée suffisante pour la gestion des cycles journaliers, si des retards se répètent jour après jour, des mini-cycles de travail/repos de 2 heures ne permettront pas au conducteur de récupérer. Il est donc nécessaire, pour les mêmes raisons de sécurité, de commodité et de qualité du service mentionnées plus tôt, d'envisager une option à laquelle les conducteurs pourraient recourir pour compenser les retards qui auraient pu s'accumuler au cours d'un cycle normal de jours de travail. Il est proposé qu'un conducteur puisse reprendre la route pour une période maximale de 8 heures, après avoir pris une période de repos 8 heures. La période de repos de 8 heures permettrait un bon sommeil, plutôt qu'un sommeil tronqué, auquel mène la disposition actuelle qui permet de réduire le repos à 4 heures. Ce repos serait alors suivi d'une période relativement courte de travail/conduite (8 heures), qui devrait être suffisante pour permettre au conducteur d'atteindre son terminus d'attache, lorsqu'il se trouve à proximité de celui-ci. Comme cette prolongation de la période de service ne serait permise qu'une fois à la fin du cycle de travail, le conducteur aurait par la suite une période de repos d'une durée normale (2 nuits plus le jour intermédiaire) pour récupérer.

ENJEUX NATIONAUX-RÉGIONAUX

Le règlement sur les HS établit des limites de sécurité reliées à la fatigue. Celles-ci devraient être déterminées à la lumière des limites imposées par la physiologie humaine. Mais il est difficile, dans la réalité, de respecter ce principe, en raison des rapports qui demeurent inconnus entre la fatigue, les paramètres visés par le règlement sur les HS (cycles de travail et de repos, heures de repos, etc.) et la sécurité routière.

Grâce aux vastes recherches menées au cours des dix dernières années par plusieurs pays, on comprend beaucoup mieux maintenant l'influence des horaires de travail sur la performance humaine. Il devrait être possible d'atteindre un consensus sur des limites d'heures de service sûres et acceptables pour les conducteurs canadiens de véhicules utilitaires. Pour ce qui a trait au modelage du comportement humain, il est particulièrement important que les règles soient cohérentes et qu'elles se fondent sur les données les plus objectives possibles. Alors seulement pourront-elles être comprises et respectées et emporteront-elles l'adhésion des conducteurs, des transporteurs et des expéditeurs, de sorte que des mesures minimales de surveillance suffiront à les faire appliquer. Mais des contextes géographiques et/ou démographiques particuliers peuvent justifier des aménagements spéciaux applicables à des transporteurs ou des conducteurs desservant certains marchés (comme le Grand Nord caractérisé par des périodes prolongées de jours très longs ou très courts, de courtes périodes d'accessibilité du terrain, en raison du gel ou du dégel, des distances immenses à parcourir dans des zones peu habitées et offrant peu de commodités).

Dans l'évaluation des changements à apporter à la réglementation sur les HS, il peut être utile d'examiner les heures résiduelles que les conducteurs peuvent consacrer à des activités autres que le travail et le sommeil, et de faire des comparaisons avec différents scénarios et d'autres secteurs d'activité économique. Le tableau 1 donne des exemples de calcul des heures résiduelles, compte tenu des régimes suivants :

- le règlement fédéral en vigueur sur les HS, qui permet 60 heures de service pendant une période de 7 jours consécutifs, selon des cycles de 15 heures de service et de 8 heures de repos;

- une proposition du gouvernement fédéral qui prévoit un maximum de 70 heures de service pendant une période de 7 jours consécutifs, selon des cycles de 14 heures de service et de 10 heures de repos;

- une proposition des provinces de l'Ouest du Canada qui prévoit 84 heures de service pendant une période de 7 jours consécutifs, selon des cycles de 14 heures de service et de 10 heures de repos;

- les heures de travail du travailleur canadien moyen dans les industries de production de biens, soit 39,3 heures pendant une période de 7 jours consécutifs, selon des cycles de 7,9 heures de service et de 16,1 heures de repos.

L'étude des stratégies de travail/repos accessibles aux conducteurs affectés à une semaine de travail de 84 heures, par exemple, peut aider à mieux comprendre les effets potentiels du nombre d'heures de travail sur la quantité de sommeil de récupération possible. Le conducteur qui entreprend un nouveau cycle de travail de 84 heures en 7 jours peut décider de continuer de dormir le même nombre d'heures que pendant une période de 7 jours normale, soit 56 heures (tableau 1). Il ne disposerait alors, en 7 jours

Tableau 1
Comparaison du temps de repos résiduel des conducteurs affectés à un horaire sur 7 jours aménagé selon divers scénarios concernant les limites d'heures de service hebdomadaires

(Comparaison entre les règles fédérales en vigueur concernant les HS, qui autorisent 60 heures de service en 7 jours, une proposition du gouvernement fédéral* comportant une semaine de 70 heures de service, une proposition des provinces de l'Ouest du Canada* comportant une semaine de travail de 84 heures, et les heures de travail du travailleur canadien moyen dans les industries de production de biens**, de 39,3 heures)

Scénario	N total d'heures libres en 7 jours	Hres de travail	Heures de repos reliées au travail†	Heures déplace-ment maison/ travail††	Heures de sommeil	N net d'heures pour la vie personnelle
Trav. can., ind. production de biens	168	39,3	5	5	56‡	62,7
HS en vigueur : 60 hres/7 jours	168	60	4	4	56‡	44
Prop. fédérale : 70 hres/7 jours	168	70	5	5	56‡	32
					44‡‡	44
Prop. prov. de l'Ouest : 84 hres/7 jours	168	84	6	6	56‡	16
					28‡‡	44

* Proposition déposée à une rencontre du Groupe de travail sur les heures de service des conducteurs de véhicules utilitaires (Conseil canadien des administrateurs en transport motorisé, CCATM), tenue les 27 et 28 avril 1998 à Ottawa, Ontario.

** Statistique Canada, n cat. 72F0002-XDE.

† Pour chaque jour de travail, comprend 0,5 heure pour le dîner et 0,5 heure pour les pauses. Les chiffres tiennent compte d'une semaine de travail de 4, 5, ou 6 jours, selon le cas.

†† On suppose un déplacement de 30 minutes dans chaque direction. Les chiffres tiennent compte d'une semaine de travail de 4 ou 5 jours, selon le cas.

‡ On suppose une période de 8 heures au lit pendant une période de 24 heures.

‡‡ On suppose que les conducteurs empiètent sur leur temps de sommeil pour ne pas avoir à diminuer le temps libre qu'ils peuvent consacrer à leur vie personnelle à moins de 44 heures, selon le régime actuel des 60 HS en 7 jours. (Il s'agit d'un scénario vraisemblable présenté pour démontrer la stratégie possible d'échange de temps de sommeil contre du temps libre.)

(dont un jour de repos), que de 16 heures au total pour ses autres activités personnelles. C'est 28 heures de moins que les 44 heures dont il dispose présentement, et 46,7 heures de moins que les 62,7 heures dont dispose le travailleur canadien moyen dans les industries de production de biens. Toutefois, la plupart des travailleurs par poste sont prêts à sacrifier des heures de sommeil au profit de temps plus long à consacrer à leurs besoins personnels, c'est-à-dire des activités avec leur conjoint, leurs enfants, leur famille élargie et leurs amis, de même que pour vaquer aux soins du ménage et aux autres occupations de la vie quotidienne. De plus, nombre de

conducteurs sont tenus d'accomplir des tâches reliées à l'entretien de leur véhicule et des tâches connexes. Ils pourraient donc choisir de se garder 44 heures de temps libre pour leurs activités personnelles, sociales et domestiques. Il ne leur resterait plus alors que 28 heures de sommeil sur 7 jours. Mais une quantité aussi faible de sommeil dégraderait gravement leur performance au volant et les priverait du sentiment de bien-être et de sécurité. D'où la faible probabilité d'un tel scénario. On peut s'attendre à ce que la plupart des conducteurs passeront entre 28 et 56 heures au lit. Si on considère les travailleurs par poste affectés à l'horaire de nuit – qui, selon certaines études, dorment en moyenne 5 heures par jour –, une semaine de travail de 84 heures ne laisserait que 37 heures de temps libre. Ces conducteurs n'auraient assez de temps ni pour dormir et éliminer leur fatigue ni pour leur vie personnelle. On aurait ainsi un conducteur fatigué qui serait un danger pour lui-même et pour les autres, et qui ne serait pas en mesure de jouir des avantages personnels associés aux longues heures de travail.

RÉCIPROCITÉ CANADA-ÉTATS-UNIS

À l'heure actuelle, les réglementations canadienne et américaine concernant les HS diffèrent quelque peu. Toute modification des règles canadiennes (ou américaines) qui ne serait pas assortie d'une entente de réciprocité ou de compatibilité aurait des incidences sur les transporteurs internationaux. Sans parler des nombreux transporteurs canadiens qui exercent leurs activités au Canada en vertu des règles américaines plutôt que canadiennes. Plus l'écart sera grand entre les réglementations sur les HS des deux pays, plus il sera difficile d'aménager l'horaire des conducteurs affectés au transport transfrontalier. Il faut prendre en compte ces répercussions possibles avant d'instaurer un changement quel qu'il soit. Il en va ainsi de toute modification éventuelle des règles américaines en matière d'heures de service.

MISE EN OEUVRE DES MODIFICATIONS AUX HEURES DE SERVICE

Avant de mettre en oeuvre de façon définitive de nouvelles règles sur les heures de service, il faudra mener une étude pilote de démonstration et d'évaluation des modifications, faisant appel à un groupe représentatif de conducteurs et de transporteurs routiers. Cette étude devrait livrer suffisamment d'informations pour mener à des conclusions objectives concernant l'efficacité des nouvelles dispositions en regard de la diminution de la fatigue et de l'augmentation de la sécurité et de la satisfaction des conducteurs, de leur applicabilité à un contexte opérationnel, ainsi que de leur efficience et de leur rapport coût-efficacité. Il sera également intéressant de comparer les opérations menées en vertu des «anciennes» et des «nouvelles» règles, au moyen de groupes expérimentaux et de groupes témoins. En principe, l'étude pilote devrait s'étaler sur au moins une année, afin que l'on puisse évaluer les effets d'un degré normal de variabilité dans les circonstances et les horaires.

Les nouvelles règles sur les HS et les programmes de soutien connexes destinés à l'industrie du camionnage doivent s'accompagner d'études et de mesures permettant d'évaluer leur rôle dans la diminution de la fatigue des conducteurs en service. C'est qu'il est difficile de formuler des recommandations non équivoques concernant les pratiques à adopter au jour le jour et à long terme, surtout si l'on pense à la nature diversifiée et complexe de l'industrie du camionnage et à la capacité de l'être humain de s'adapter à un environnement changeant. Il y a donc lieu de surveiller, pendant cinq ans, l'adéquation des règles révisées et le degré de conformité de l'industrie à ces règles, après quoi des rajustements pourront être faits, au besoin.

Compte tenu de l'importance de la performance des conducteurs pour la sécurité routière et de la dégradation grave de la performance qui résulte de la fatigue, on devrait envisager l'implantation généralisée d'une méthode de surveillance qui viserait le véhicule, pour avoir ainsi des données objectives de conformité aux règles sur les HS (en plus des données brutes figurant sur les carnets de route). Il faut voir cette proposition comme une façon d'abaisser radicalement les taux élevés d'infraction au règlement sur les HS signalés par certaines études. Vu l'importance capitale de la réglementation sur les HS pour l'économie du secteur du camionnage de même que pour la capacité de ce dernier de livrer concurrence aux autres modes de transport, des règles du jeu équitables doivent être établies pour susciter l'adhésion volontaire à la réglementation par la vaste majorité des conducteurs et des transporteurs routiers.

TABLE OF CONTENTS

LIST OF TABLES

1. INTRODUCTION

1.1 Background

Driver fatigue has long been recognized as a major risk factor for commercial drivers. Estimates of the percentage of crashes that are partially or completely attributable to fatigue range from 1 to 56 percent (Mitler et al., 1997), depending on the database examined, the level of detail gathered from crash investigations, and the study methodology employed. For over 60 years, governments around the world have instituted a variety of regulations stipulating the maximum number of hours that commercial vehicle drivers are allowed to work, in an attempt to limit the development of fatigue and minimize its negative effects on driving performance. In one of the first scientific studies (1938) to address fatigue relating to hours of service (HOS), the United States Public Health Service found that (Jones et al., 1941; Wylie et al., 1996) "it would… appear that a reasonable limitation of the HOS would, at the very least, reduce the number of drivers on the road with very low functional efficiency. This, it might reasonably be inferred, would act in the interest of highway safety".

During the last two decades, major changes have occurred in the way the trucking industry conducts its business. The competitiveness of truck transport has stretched to much longer distances, increased economic competition from deregulation has led to structural changes as well as to much leaner organizations and just-in-time delivery required by manufacturers and consumers has placed much greater pressures on reliably achieving the shortest delivery schedules possible. These changes in the competitive factors of the industry have all led to increased demands on drivers (Vespa, 1997). At the same time, scientific knowledge concerning fatigue has advanced, particularly in the relationships between sleep, circadian rhythms and alertness. Current regulations seek to limit driver fatigue by specifying maximum daily, weekly and biweekly on-duty/driving hours as well minimum off-duty periods. It is evident that this approach does not incorporate findings from the scientific literature concerning those additional factors – other than task duration – that have been associated with fatigue-related accidents (Wylie et al., 1996 and 1997). In addition, awareness that driver fatigue continues to be a significant safety problem is growing (NTSB, 1995). These concurrent developments have led Transport Canada (TC), the U.S. Federal Highway Administration (FHWA) and the Australian National Road Transport Commission (NRTC) in Australia to re-examine the adequacy of current HOS regulations and related management practices, with a view to enhancing their operational effectiveness and further reducing the incidence of fatigue in road crashes.

1.2 Transport Canada Approach

Transport Canada has taken the position that any changes to the HOS regulations should be guided by the currently available scientific knowledge. In line with this

approach, it constituted an expert panel that includes TC personnel and external experts in shiftwork, sleep and human performance to develop an initial set of options for potential changes to the HOS regulations. These options could be used to animate discussions with stakeholders. These options were not intended to reflect TC policy or management decisions, nor to present a recommended course of action. Rather, they were to illustrate potential approaches to incorporating current scientific knowledge on sleep and circadian rhythms into an HOS regulatory framework.

An initial meeting of the expert panel was convened on 18 April 1997. The group reviewed currently available scientific knowledge of human physiology, sleep and performance and evaluated the impact of fatigue factors on driving performance in the context of current HOS regulations. A further meeting was held in March 1998 to review research developments over the previous year and the results of a recent conference on Fatigue in Transportation held in Fremantle, Australia (Vespa, 1998). This report incorporates results from the review meetings as well as subsequent discussions and deliberations. It presents "work in progress" that could be further developed and refined through discussions with stakeholders. It is not a final document intended to present formal recommendations to alter the current regulations.

1.3 Objectives

- To present a taxonomy of "good" practice for work and rest scheduling of commercial drivers based on what is known about human physiology and fatigue, while being mindful of motor carrier and driver operational considerations; and, following from this,

- To propose an initial set of options for potential changes to the HOS regulations, as well as to consider related implementation issues that would be useful in animating discussions with stakeholders.

1.4 Observations from the Scientific Literature

1.4.1 Circadian rhythm, sleep and performance

A number of studies have attempted to evaluate how driver fatigue and driving performance are affected by on-duty and driving time (Harris et al., 1972; Mackie and Miller, 1978 Jones and Stein, 1987; Jovanis and Kaneko, 1990; Hartley et al., 1994; Wylie et al., 1996). The findings from Harris and Mackie (1972), Mackie and Miller (1978) and Wylie et al. (1996) indicate that time-of-day, or more correctly, our circadian rhythm, which varies across the 24-hour day, is a major determinant of driving alertness and performance. It has been shown that driving 13 hours as compared to 10 hours in a 24-hour period contributes less to driver drowsiness than does the time of day during

which the driving occurs (Wylie et al., 1996), i.e., driving at night affects driving performance to a far greater extent that the length of time driving.

Driver alertness and performance not only vary across the 24-hour day, with alertness being markedly reduced between midnight and 0600, but are also reduced as a result of reduced sleep. Findings from NTSB (1995), Hertz (1988), and Mackie and Miller (1978) demonstrate the importance of sleep loss in determining fatigue and crash rate. While sleep loss can occur for many reasons, one of the primary causes of chronic sleep loss is sleeping at the wrong time of day relative to our circadian rhythms. Many studies of shiftworkers have linked sleep loss with the time of day that sleep is taken (Lille, 1967; Kogi, 1985), the major finding being that both the length and quality of sleep taken during the day are reduced when compared with sleep taken at night.

Time of day (circadian rhythm) effects are thus incontrovertibly linked to poorer night performance and day sleeping. In turn, poor sleep (both quality and quantity) exacerbates the normal drop in performance found at circadian low points of the day (NTSB, 1995). Consequently, night driving cannot be treated as equivalent to day driving (Wylie et al., 1996), from either performance or sleep perspectives.

1.4.2 Cumulative fatigue and crash risk

With respect to number of hours of work/driving, the scientific literature does not support any extension of the current limits. A number of studies have shown increased crash risk with hours of driving, well before hours of service are exceeded (Harris and Mackie, 1972: after 3 - 6 hours; Bureau of Motor Carrier Safety, 1974: after 5 hours; Jones and Stein, 1987: twice the risk after 8 hours; Mackie and Miller, 1978, Jovanis et al., 1991, and Saccomano et al., 1996: increased risk for over 9.5 hours as compared to under 9.5 hours). In the Wylie et al. (1996) study, cumulative number of trips was neither a strong nor a consistent predictor of fatigue across different measures, but there was some evidence of cumulative fatigue across days of driving. For example, performance on the Simple Response Vigilance Test declined during the last days of a 4-5 day cycle. Also, drivers tended to rate themselves as more fatigued across multiple trips; however, this tendency was not consistent across all observational schedules. It was concluded that these self-reports may have indicated the increasing stress or compensatory effort that signals fatigue or loss of alertness, and that the drivers had diminished motivation and abilities to remain alert by the end of their trips (Wylie et al., 1996 and 1997; Brown, 1994; Dinges et al., 1994).

Studies show that hours worked and time of day interact, so that time of day effects are more pronounced the longer the hours worked (Hildebrandt et al., 1974) and the greater the number of cumulative days on task (Mackie and Miller, 1978; Jovanis and Kaneko, 1991).

Other effects of driving for long periods that impact driver behaviour and performance may exist, but have not been measured by studies done to date. Researchers are

currently investigating the effects of driving for long periods on specific measures of performance such as how well drivers manage the space around their vehicle. These studies are also looking at changes in the drivers' levels of tolerance for other drivers, their moods and mental states. These studies are on-going and the results have not yet been released.

1.4.3 Night versus day driving

Both driver performance and crash risk studies suggest that night driving is particularly risky from a fatigue perspective. The Bureau of Motor Carrier Safety (1974) showed that accidents involving sleepy drivers were 7 times more likely to occur between midnight and 0800 than at other hours of the day. The NTSB (1995) study of single-vehicle truck accidents that were likely to have been fatigue-related (limited further to those in which the driver survived and in which the previous 96 hours could be reconstructed) found a total of 62 out of 107 accidents that were fatigue-related, of which 52 (83.9%) occurred at night (i.e., between 2200 and 0800) and 10 occurred by day, a ratio of 5.2:1 for the observed number of night versus day fatigue-related accidents. The Wylie et al. (1996) study showed that there was an eight-fold increase in the prevalence of drowsiness observed during driving periods between 2200 and 0600 hours compared with daytime levels. Australian and European studies have estimated the crash risk of night driving at levels between 22.8 and 50 times higher than that of day driving (Di Milia, 1998). That drowsiness is much more pronounced in night driving has been shown by both simulator (Gillberg et al., 1996) and on-road studies (Mackie and Miller, 1978; Wylie et al., 1996). Furthermore, risk increases with cumulative shifts at night. Jovanis and Kaneko (1991) showed that drivers who begin their trips near midnight and typically end them around 1000 hours face a particularly increased crash risk after driving for several consecutive days. In contrast, drivers who typically drive a regular daytime schedule (1000 to 1800) showed little evidence of any effect associated with consecutive days of driving.

The large increase in accident risk seen at night, and the current equal treatment of night and day driving in the regulations, suggests that changes to deal with night driving are necessary. This is reinforced by the emerging understanding that almost no one in our society is a "night person", although individual differences in tolerance to night driving appear substantial. However, care is required in determining the precise measures to apply to night drivers, primarily because the safety impacts of shifting a significant percentage of night trips to day trips (relative risk factors) are not well known. There are also issues relating to effects on daytime traffic congestion and infrastructure use, particularly in urban centres, as well as service delivery constraints from around-the-clock operations. Although night operations cannot – and, perhaps, should not – be eliminated, measures can be taken to ensure that they are as safe as possible.

1.4.4 Other fatigue factors

Although sleep loss and circadian variations in alertness and performance are of primary concern in driving safety from a fatigue perspective, it should be noted that a number of other factors appear to also have significant impacts. Brown (1994) provides a thorough discussion of the complex interplay between many important factors affecting fatigue and driver performance, such as rest breaks, sleep breaks, duty periods, motivation and mental state.

1.4.5 Fatigue recovery periods

The scientific community worldwide appears to be reaching a consensus that two full nights of sleep may be required to allow near full recovery following protracted periods of sleep loss or sleep restriction (Johnson and Naitoh, 1974; Smiley and Heslegrave, 1997; Dinges et al., 1997; Vespa et al., 1998; Vespa, 1998), and that a daily irreducible period of sleep is necessary to maintain performance on an on-going basis. Most shift workers, in another study, reported needing at least two days (with normal sleep episodes) to recover after a period of night work involving three shifts in a row, and the need for recovery increased by one day when the period of night work increased to seven shifts in a row (Kecklund et al., 1994; Akerstedt, 1997).

1.5 Development of Options for Potential Changes to HOS Regulations

The options developed and presented in this report deal with potential changes to the HOS regulations from a prescriptive rather than a performance-based perspective. Although a performance-based approach to managing driver fatigue may be possible in the not too distant future, with the development and maturing of driver fitness for duty and unobtrusive on-board driver monitoring technologies, the current state of the art is not adequate to this end. While a fatigue management program (FMP) approach such as that being instituted in Australia (Vespa, 1998) may incorporate a variety of additional fatigue elements beyond those that can be addressed by prescriptive HOS regulations – and thus allow some measure of additional operational flexibility – a good set of prescriptive rules should serve as a code of good practice, which should also benefit the FMP approach. Furthermore, for the foreseeable future, the prescriptive approach is expected to be the only approach that is accessible and utilizable by the vast majority of drivers, especially considering the large number of Canadian owner-operators and small-scale motor carriers who generally have few administrative resources.

It is hoped that the change options presented in this report will provide some ideas for remedying a variety of deficiencies associated with how current regulations address (or do not address) those driver fatigue factors generally accepted as being the most significant. At least, it is hoped that this objective can be accomplished to a reasonable extent, considering the severe limitations resulting from the necessity of instituting rules that must apply equally to everyone, in a trucking industry that is far from homogeneous.

The proposals are fashioned to accommodate some of the operational and economic constraints on the industry, to make them institutionally “adoptable”.

When considering the proposed options, the reader should note that the scientific body of evidence concerning the various fatigue factors and their related impacts on human performance is such that some interactions are well understood (and backed up by convincing data) while others are less so. Thus, the proposals presented are based on the results of specific studies to the extent possible and, where these are lacking or less convincing, on basic principles derived from the scientific body of knowledge.

The reader should also be aware that these deliberations took the existing hours of service as the starting position, rather than using a blank sheet approach that sought to make sweeping changes. This was a carefully considered and conservative approach that took into account the limitations of current scientific knowledge, the complex nature of the trucking industry and the unforeseeable impacts of major changes on road safety and industry economics, as well as constraints imposed by long distances between cities in the major Canadian transportation corridors. Thus, the proposed changes to the HOS are designed to increase safety by ensuring substantial improvements over the existing situation, in terms of enhanced fatigue management and increased operational flexibility in the event of schedule perturbations.

The proposed options are intended to accomplish several objectives: maintain driver alertness by allowing sufficient time for sleep; allow time for sleep during particularly vulnerable periods of the day (the lowest point in the circadian cycle); reduce the impact of chronic sleep debt and cumulative fatigue; and, maximize recovery opportunities to provide for restoration of full driver alertness at the earliest possible opportunity. The daily and cumulative work/sleep schedules seek to incorporate potential countermeasures that consider the impacts of circadian factors on fatigue, namely that the needs of day and night driving lead to different schedules and work/sleep patterns. While each of the proposals have individual merit, taken together they have the added advantage of fashioning the HOS regulations to facilitate rather than impede the use of regular daily, weekly or biweekly cycles, since regularity is known to be beneficial from a fatigue and alertness perspective. It should be noted that perceived operational needs of the industry have also been taken into account, to make the proposals as operationally useful as possible.

To this point, implementation and international considerations have not been discussed; nor have the support structures needed to ensure successful implementation of significant HOS changes. Although important, they are not the primary thrust of this document. They will, however, be discussed briefly in the body of this report.

2 GOOD PRACTICE TAXONOMY

This section provides an overview of some current work/rest scheduling problems faced by commercial drivers and motor carriers, as well as general principles and potential remedial measures available from the scientific literature that can be used for guidance in reducing the negative effects of these problems.

Table 2.1 lists many current commercial driver practices that are considered poor from the fatigue perspective, and describes the psychophysiological concern and consequences on driving safety associated with each. Superior practices are recommended together with their rationale and associated references from the scientific literature.

Table 2.1
Good practice taxonomy based on some currently observed poor practices

Poor Practice	Physiological/ Psychological Concern	Consequences	Recommended Good Practice	References
Driving overnight (midnight - 0600)	Working at a time of day when the body is prepared for sleep	Drowsiness during driving Significantly increased crash risk	Limit driving during the vulnerable midnight to 0600 period	Bureau of Motor Carrier Safety, 1974 Mackie and Miller, 1978 Jovanis and Kaneko, 1991 NTSB, 1995 Saccomano, Shortreed and Yu, 1996 Wylie et al., 1996
Long shifts into the night	Long hours that are fatiguing combined with working at a circadian low point	Interaction between long hours and low point in the day leads to poorer performance, especially in the midnight to 0600 period	Do not extend day/evening shifts into the night (without a rest period) Provide a 2-hour sleep opportunity during the night driving period (midnight to 0600), depending on prior breaks and rest periods	Mackie & Miller, 1978 Angus et al., 1987 Dinges, 1989 Wylie et al., 1996
Driving many night shifts in a sequence	Sleep debt accumulates with each successive night	Interaction between accumulated sleep debt and low point in the day leads to poorer performance and increased crash risk	Limit the number of consecutive night shifts to 3 or 4 in a row	Vidacek et al., 1986 Jovanis and Kaneko, 1991
Driving longer than maximum HOS limits	Driving abilities decline after 8 hours on regular schedules, sooner on irregular schedules	Degraded performance Increased crash risk	If driving exceeds 8 hours, manage fatigue by starting in well-rested state and avoid finishing the run in the midnight to 0600 time period If not possible to avoid midnight to 0600, then take a 2-hour nap during this period	Mackie and Miller, 1978 Harris & Mackie, 1978 Jones and Stein, 1987 Williamson et al., 1994

Table 2.1
Good practice taxonomy based on some currently observed poor practices (cont'd)

Poor Practice	Physiological/ Psychological Concern	Consequences	Recommended Good Practice	References
Driving longer than maximum HOS limits	Driving abilities decline after 8 hours on regular schedules, sooner on irregular schedules	Degraded performance Increased crash risk	If driving exceeds 8 hours, manage fatigue by starting in well-rested state and avoid finishing the run in the midnight to 0600 time period If not possible to avoid midnight to 0600, then take a 2-hour nap during this period	Mackie and Miller, 1978 Harris & Mackie, 1978 Jones and Stein, 1987 Williamson et al., 1994
Early shift starts	Starting the shift before 0600 usually results in a shortened sleep period, and includes a portion of the time when the circadian rhythms are at their lowest	Degraded performance (sleep loss) and increased sleep debt	Start day shifts after 0600	Folkard, 1996
Initiating main sleep between 1100 and 1700	The most sleep is obtained when initiated between 1900 and 0900.	Poor quality sleep and significant sleep loss	Begin afternoon sleep periods before 1400 if afternoon sleep is all that can be obtained – better to not plan late afternoon/early evening sleeping periods	Kogi, 1985
Starting a day sleep period too late in the morning	The body begins its ascent in its circadian rhythm at about 0600, while daylight levels are increasing – both of these factors influence the body to be more awake	Body becomes more resistant to sleep Sleep loss and degraded quality of sleep	If working overnight, get to bed before 0900, and avoid bright light (wear dark glasses or newly developed sunglasses designed to filter out alerting components of the light spectrum, keep home dark during the sleep period)	Kogi, 1985

Table 2.1
Good practice taxonomy based on some currently observed poor practices (cont'd)

Poor Practice	Physiological/ Psychological Concern	Consequences	Recommended Good Practice	References
Sleeping less than the daily minimum sleep required	An accumulated sleep debt will occur if adequate levels of sleep are not obtained, resulting in significant declines in mental and physical performance – the average requirement for sleep is 7.5 hours	Sleep loss and a building sleep debt if continued throughout the shift cycle Increased drowsiness Poor cognitive performance	Determine usual amount of sleep required (daily sleep obtained towards end of a vacation period can be a useful guide)	Dement, 1992
Splitting the main sleep period into two or more sleep periods	The normal sleep pattern is that three to four normal cycles of nonREM and REM sleep occur	Splitting the sleep will usually result in reduced REM sleep, and disruption of the normal sleep cycles Split sleep leads to increased crash risk	Try to obtain all main sleep during a single sleep period	Mackie & Miller, 1978 Hertz, 1988 NTSB, 1995
Driving without a rest break	Maximum length of time that an individual can sustain monitoring behaviour effectively is 2 hours or less. When driving long hours monitoring ability degrades over time, rapidly falling off nearing the eighth hour.	Degraded vigilance and monitoring abilities – alertness declines rapidly after prolonged hours of driving (8 hours or more)	Take scheduled rest/food breaks (30 minutes every 5 hours)	Heslegrave and Angus, 1985 Parasuraman, 1986
Limiting off-duty time to less than 8 hours	The required amount of recovery sleep may not be possible due to too little available opportunity for sleep	Sleep loss may result	Provide 10 hours between shifts for recovery time, commuting, eating, hygiene, chores, etc.	Dinges, 1989 Wylie et al., 1996

Table 2.1
Good practice taxonomy based on some currently observed poor practices (cont'd)

Poor Practice	Physiological/ Psychological Concern	Consequences	Recommended Good Practice	References
Driving while very sleepy	Humans are poor judges of their level of sleepiness, usually underestimating it	Microsleeps and falling asleep (while driving) without realizing it, when fatigued	Take a nap – scheduled or opportunistic	Dinges, 1989 Wylie et al., 1996
Working a day shift 8 hours after completing a series of night shifts	Consecutive night shifts, and shifts that extend into the night, will disrupt the circadian rhythm enough to cause some dysrhythmia	Sleep loss and poor cognitive performance on the day shift as a result of dysrhythmia	Provide at least two nights and a day for rest/recovery time after all work cycles	Smiley and Heslegrave, 1997
Coming to work in a fatigued state	Fatigue that is already present at the start of the shift will increase fatigue experienced during the shift	Any performance deficits due to hours worked or time of day will be exacerbated	Obtain adequate sleep (7-8 hours) before starting work	Williamson et al., 1994

3. OPTIONS FOR DAILY WORK/REST CYCLES

The development of driver fatigue, loss of alertness and performance is tied inextricably to sleep and circadian rhythms, both of which have a daily periodicity. Time of day (circadian rhythm) effects lead to poorer night performance and day sleeping. In turn, poor sleep exacerbates the normal drop in performance found at circadian low points of the day. As a result, night driving cannot be treated as equivalent to day driving, from either performance or sleep perspectives. Moreover, reduced quantity and quality of sleep will result in increasingly poor performance. Length of time awake since the last principal sleep is another important determinant of alertness and performance. It is estimated that for every 24 hours of sleep deprivation there is a 25 percent drop in performance (Belenky, 1998). Consequently, it is vital that the fatigue factors important to safe driving be addressed as much as possible through judicious work/rest regimes and countermeasures that allow performance to be maintained at safe levels on a daily basis and that minimize a cumulative deterioration from day to day. The daily regime should also provide some built-in buffer to ensure that unusual or unplanned disturbances during one day can be counteracted as soon as possible after they occur, and preferably no later than the next day.

The options for potential changes to the HOS regulations presented in this section take human performance considerations into account and aim to provide daily work/rest regimes that result in better management of fatigue levels. It is proposed that these options be considered under three categories grouping elements that work together: Core Options, the most basic changes required to make the HOS regulations more closely reflect our understanding of the relationships between schedule-related fatigue factors and human performance; Recommended Options, which suggest additional improvements over the Core set; and, options for Special Circumstances. Special Circumstances are akin to exemptions since, for practical and common-sense reasons associated with safe driving performance, they take into account – and provide remedies for – specific working environments and situations, including team drivers in sleeper cab operations and drivers who run out of available working hours close to their destination.

3.1 Core Options

The core elements of a revised HOS regime are considered to include the following initiatives.

- ***Establish a 24-hour period as the basic daily cycle***

A 24-hour cycle should be established to encourage keeping shifts and the circadian rhythms of individuals synchronized to a 24-hour clock. This would minimize the phase-advancing routines, promoted by the current HOS regulations, which contribute to fatigue. Currently, a maximum of 13 hours of driving and a total of 15 hours on duty are

permitted on a continuous basis. When combined with an 8-hour mandatory rest period, this yields either a 21-hour or a 23-hour cycle. Of course, any shorter work periods combined with a minimum rest period of 8 hours would create a more problematic and fatigue-inducing phase-advancing routine, which would compromise the performance of drivers as well as their ability to obtain adequate sleep during the rest period. For example, working a 10-hour period and obtaining an 8-hour rest/sleep would result in an 18-hour cycle. This would compromise both driver performance and potential recovery associated with sleep, since, within only a day, both waking and sleeping times would be inconsistent with normal circadian rhythms.

The performance deficits associated with such phase-advancing routines have been repeatedly demonstrated by researchers (e.g., Czeisler et al., 1982). Although the design of the HOS regulations should be modified so that they do not promote – as a standard –the use of phase advancing schedules, this will not be the total solution, because of the variety of schedules required in day-to-day operations. However, it is expected that drivers, dispatchers and company managers will come to accept the value of operating on the basis of a 24-hour cycle and minimize others as much as possible.

- ***Decrease the maximum total on-duty time allowed in any consecutive 24 hours from 16 to 14 hours***

Partly based on the need to increase the hours available for sleep and rest to 10 hours and to maintain a 24-hour work/rest schedule to eliminate circadian phase-shifting, it is proposed that the driver's daily working hours should be shortened from a maximum of 16 hours (of which 15 can be consecutive) to 14 hours. This would reduce fatigue effects and make the HOS operate on the basis of a 24-hour day. Thus, in a 24-hour cycle, the on-duty/off-duty period would consist of 14 hours on duty and 10 hours off duty. Such a proposal is consistent with recommendations made by a number of jurisdictions, including Australia.

A number of studies have shown increased crash risk with hours of driving, well before hours of service are exceeded (Harris and Mackie, 1972: after 3 - 6 hours; Bureau of Motor Carrier Safety, 1974: after 5 hours; Jones and Stein, 1987: twice the risk after 8 hours; Mackie and Miller, 1978, Jovanis et al., 1991, and Saccomano et al., 1996: increased risk for over 9.5 hours as compared to under 9.5 hours). The DFAS study showed that RVS test scores (i.e., a performance test that proved sensitive to vigilance and perceptual-motor speed changes typifying loss of alertness and fatigue) were lower at the end of trips than they were at the start. The DFAS also showed driver self-reports to have a strong relationship to elapsed time since trip start. Even though these self-reports differed sharply from the objective measures, it was concluded that they may have indicated increasing stress or the compensatory effort that signals fatigue or loss of alertness, and that the drivers had diminished motivation and abilities to remain alert by the end of their trips (Wylie et al., 1996; Brown, 1994; Dinges et al., 1994).

- ***Increase the minimum total off-duty time required in any consecutive 24 hours from 8 to 10 hours***

The conclusions of the Canada/U.S. Driver Fatigue and Alertness Study (Wylie et al., 1996) and the NTSB (1995) among others stated that 8 hours off between duty periods might not provide enough time to obtain adequate sleep when all daily driver needs are taken into account. It is proposed that the daily off-duty time be extended from 8 to 10 hours. This provision would accommodate, as one option, the need for a minimum continuous 8-hour off-duty period for sleep, and would allow up to 2 hours of the mandatory off-duty period to be taken as meal, rest or nap breaks interspersed throughout the on-duty period according to the driver's choice. It would also accommodate other proposals in this report for increased off-duty time between work shifts in order to obtain a good daily anchor sleep, and for a 2-hour compensatory off-duty period between midnight and 0600 for night driving.

- ***Require a minimum continuous off-duty period of 8 hours within any 24 consecutive hours***

Many recent studies (Hertz, 1988, Dinges, 1989, Mitler et al., 1988) have shown that the recuperative effect of fragmented sleep is less than that of continuous sleep. A sufficiently long block of off-duty time must be made available so that the driver can obtain adequate continuous (anchor) sleep on a daily basis to avoid accumulating a sleep debt, which is a primary cause of drowsiness and loss of alertness. To reduce the possibility of drivers shortening anchor sleep, this time block must take into account time required for other daily driver needs, such as driving to/from home, taking care of personal needs (i.e., eating and grooming), and time for family-related activities, recreation and diversion away from work responsibilities.

The self-reported ideal sleep time of the 80 drivers who participated in the Canada/U.S. Driver Fatigue and Alertness Study was 7.2 hours, which is also the perceived nightly need for sleep of the general (i.e., U.S.) population of about 7.2 ± 1.2 hours. Eight hours is the minimum time during which a driver – who would immediately go to bed – could obtain about 7 hours of sleep. This option would also accommodate the following proposal for a 2-hour off-duty period for night drivers between 0000 and 0600.

- ***Require a 2-hour off-duty period between 0000 and 0600 hours***

The HOS regulations should be consistent with human psycho-physiological needs and circadian rhythms, which have a primary effect on daily variations in driver alertness and performance. It has been well documented that the potential for driver fatigue and accidents is increased markedly between midnight and 0600, the exact time varying between individuals, and, to a lesser extent, in the afternoon between 1300 and 1600 hours. It is proposed that a mandatory 2-hour off-duty period be introduced during the midnight - 0600 period. This off-duty period is intended to allow an opportunity for a

nap and to shorten driving time during the most vulnerable time of day for a fatigue-related accident.

Among others, McDonald (1984) argues that work/rest patterns that are inverted vis-à-vis circadian rhythms should incorporate a compensatory rest period. The scientific data is still not clear over whether a 30- to 40-minute nap period is sufficient to promote and maintain recovery. In fact, Gillberg et al. (1996) show that a 30-minute nap is ineffective in preventing performance deterioration in simulated truck driving at night. The duration proposed here is based on evidence that a 2-hour nap is sufficient to promote and maintain recovery for an extended period of time (Dinges, 1989; Angus et al., 1987). It is therefore proposed that a 2-hour off-duty period be required between midnight and 0600. This 2-hour period can count toward the recommended daily rest requirement of 10 hours. While it is important that split sleeps be eliminated, the mandatory 2-hour rest overnight allows some sleep to be taken when it is needed most, yet leaves sufficient other time to obtain a reasonable anchor sleep.

The time at which the 2-hour period is taken between 0000 and 0600 hours can be selected according to individual needs and practical considerations, such as taking advantage of optimal traffic conditions. Such a mandatory time-out period is long enough to encourage sleep. Sleep could average over 90 minutes assuming 10 minutes for driving to/from the rest location, 10 minutes to fall asleep, and 10 minutes at the end of the sleep period for the dissipation of sleep inertia effects. A requirement for a 2-hour nap will perhaps necessitate greater planning on the part of drivers, dispatchers, companies and shippers, but improved safety and driver performance should result.

What may need to be considered further prior to adoption of this proposed countermeasure is its potential impact on driver behaviour from the perspective of pre-shift sleep time. What is not known is whether drivers would reduce their sleep time prior to starting their shift knowing that they would be required to take the 2-hour off-duty period later (potentially negating the benefits of the proposal). Additionally, sufficient rest spaces and locations with adequate facilities would need to be made available to accommodate the increased demand generated by instituting this requirement. It is also proposed that the efficacy of shorter napping strategies be investigated to ascertain their effectiveness at promoting recovery.

- ***Eliminate the split-rest provision in the HOS regulations, which accepts two short sleep periods as equally refreshing as one long period***

Based on the human physiological need for a long continuous sleep to achieve full and fast recovery from fatigue, the split-sleep provision in the HOS regulations should be eliminated. The regulations should, for example, no longer accept two 4-hour periods of rest in a sleeper berth as being equivalent to 8 hours of rest (NTSB, 1995). Recent research has shown that sleep accumulated in short time blocks is less refreshing than sleep accumulated in one long time period (NTSB, 1995; Dinges, 1989; Mitler et al., 1988; Hertz, 1988). In one study (Hertz, 1988), for example, use of sleeper berths was

found to increase crash risk by a factor of 3. This did not appear to arise because of the disturbance of sleep from the motion of the truck, but rather because of the splitting of sleep into two periods. Contrary to expectation, then, two drivers who are able to relieve each other after a stint of driving tend to experience disrupted sleep and show deterioration in driving performance, particularly if they have to drive during periods of low physiological arousal.

- ***Do not distinguish between driving and non-driving work periods***

Recent research indicates that there should be no distinction between driving and non-driving work periods. Kecklund and Akerstedt (1993) showed that physiological manifestations of drowsiness correlated with duration of work previously performed and not with driving time or other driver activities. Van Ouwerkerk (1988) concluded from a survey of 650 international truck drivers from six EEC countries and from a review of the research that changes in the EEC regulations should concentrate on limiting the working hours per day and per week rather than on limiting the driving hours. Wylie et al. (1996) showed that driving duration was not a strong or consistent predictor of observed fatigue.

The conclusion from these results and others is that, from the fatigue perspective, the more important parameter to address is work duration rather than driving duration. Work duration encompasses driving duration and directly affects the three other most important parameters from the driving fatigue perspective: the time of day at which work is performed and sleep is obtained, and length of time awake since the last sleep. It should also be noted that driving time can occur at the end of an on-duty period, subsequent to, for example, hard physical work involving loading and unloading, as much as it can occur at the beginning.

This proposal may also promote some reduction in the amount of physical work performed by drivers, such as loading and unloading – as a trade-off between working and driving time, which may be additionally beneficial from the driver fatigue perspective.

3.2 Recommended Options

- ***Increase by one hour (from 8 to 9 hours) the minimum duration of the continuous off-duty period required within any 24 consecutive hours***

Some studies have found that quick changeovers between shifts, usually allowing about 8 hours of free time, can lead to reduced sleep. When a morning shift or a day shift is followed by a night shift (with less than 6 hours of free time in between), sleep duration can be less than 3 hours (Knauth et al., 1983; Totterdell and Folkard, 1990; Kurumatami et al., 1994; Akerstedt, 1997). The Canada/U.S. Driver Fatigue and Alertness Study (DFAS) (Wylie et al., 1996) and the NTSB (1995) among others concluded that 8 hours

off between duty periods might not provide enough time to obtain adequate sleep when all daily driver needs are taken into account. While a minimum of 8 hours may be required to obtain adequate sleep on a daily basis under ideal circumstances, when this time is not all available for sleep and when sleep is less than optimal (such as sleep during the day), it may not be sufficient for recovery. To partially address this problem, the daily minimum rest requirement should be lengthened from 8 to 9 hours.

Many recent studies (Hertz, 1988; Dinges, 1989; Mitler et al., 1988) have shown that the recuperative effect of fragmented sleep is less than that of continuous sleep. A sufficiently long block of off-duty time must be made available such that the driver can obtain adequate continuous sleep on a daily basis to avoid accumulating a sleep debt, which is a primary cause of drowsiness and loss of alertness. Considering sleep time, the reported ideal sleep duration of the overall group of 80 DFAS drivers was 7.2 hours, which is consistent with the perceived nightly need for sleep of the general (i.e., U.S.) population of about 7.2 ± 1.2 hours (Mitler et al., 1997). In addition to sleep time, this time block must take into account time required for other daily driver needs such as driving to/from home, taking care of personal needs (i.e., eating and grooming), and time for family-related activities, recreation and diversion away from work responsibilities. Adding one hour to the off-duty period between shifts responds to this observed need for more time off to provide adequate sleep opportunity.

The proposed one-hour increase may not, however, be necessary for solo drivers in sleeper cab operations. While a minimum of 8 hours may be considered sufficient to obtain adequate sleep on a daily basis, this requires the assumption that all this time will be made available for sleep. In today's living and driving environment, it is not unreasonable to assume that commuting between home and work terminal can easily consume an hour for a return journey. Solo drivers in sleeper cab operations have their beds readily accessible – with little delay – at any time of the day. They are generally on the road and away from the usual distractions and requirements of home and family life. They are thus in a position to allocate a greater proportion of their off-duty period to getting adequate sleep. Therefore, solo sleeper cab drivers on the road may have an equivalent opportunity for sleep within 8 hours off-duty when compared with other drivers getting nine hours. This also allows sleeper cab drivers to have an additional 2 hours off-duty during the rest of the day, which is especially beneficial since they can more easily take advantage of the time for sleeping.

- ***Decrease by one hour (from 14 to 13 hours) the maximum total on-duty time allowed within any consecutive 24 hours that includes more than one hour on duty between 0000 and 0600***

It is proposed that one hour be subtracted from the maximum on-duty time allowed in a day that includes night work. Conversely this requires that the minimum off-duty time be increased by one hour. Thus, while the additional one-hour off-duty allows greater opportunity for increased sleep and a reduced sleep debt, a shorter on-duty period reduces the level of performance deterioration reached from continuing accumulation of

time on task. This would also lower – to some extent – the probability of working through the 0000 to 0600 period of low performance.

It is well known that workers on night shifts, who sleep during the day, do not obtain as much sleep as those working days and sleeping nights. In a study of commercial vehicle drivers (Vespa et al., 1998), the sleep gap between drivers who worked through the night and those who did not was about 45.5 minutes, which translated into about 49 minutes of time in bed. Providing drivers who work at nights with an additional hour of time off provides them with additional sleep opportunity to more closely approach sleep times of day shift drivers. The offset may be more important for drivers than for most other shift workers, because the free time available to commercial drivers as a whole is very short. This already predisposes them to obtaining a relatively short anchor sleep. Most shift schedules have 16 hours of free time between consecutive shifts (compared with 8 hours), and some researchers have concluded that at least this amount is needed for a sleep duration of 7 or 8 hours (Kurumatani et al., 1994; Akerstedt, 1997). In the case of the Driver Fatigue and Alertness Study (Wylie et al., 1996), drivers working through the night had an average daily sleep shortfall of about 2.3 hours compared with their self-reported ideal sleep time of 7.2 hours. The perceived nightly need for sleep of the general (U.S.) population is also about 7.2 ± 1.2 hours (Mitler et al., 1997). It should be noted, however, that shift workers in other fields also show substantially reduced sleep duration during duty days (Donderi et al., 1995; Rhodes et al., 1994; Rhodes et al., 1996; Comstock, 1997).

Incorporating into the HOS regulations this requirement for a reduced work cycle for drivers working nights would also highlight, on an on-going basis, the additional human and physiological demands placed on night drivers. In addition, it may encourage drivers, the companies they work for and their families to take a more careful approach to their situation.

- ***Require 30 minutes of rest from driving for every 5 hours on duty***

It is well-known that inattention and fatigue accumulate as the time on task becomes longer (though such fatigue effects are smaller than those resulting from sleep loss and circadian rhythm factors). For this reason some limit should be set on continuous performance, but such limits should attempt to achieve maximum flexibility.

Some research has shown that short breaks from driving (10 minutes or more) should be taken at least every 2 hours to avoid excessive accumulation of fatigue. Cognitive performance and vigilance appeared to be able to be sustained for long periods (e.g., 18 hours)with such a schedule (Heslegrave and Angus, 1985). In addition, the impact of short rest periods is particularly beneficial under conditions where fatigue is already evident (Heslegrave and Angus, 1985). However, for practical reasons, the flexibility for taking breaks must be as great as possible. Hence, rather than proposing regular breaks of short duration (such as 10 minutes), it is proposed that rest breaks be at the discretion of the driver, such that they average about 10 minutes every 2 hours. It is

proposed that drivers accumulate 30 minutes of rest for every 5 hours of on-duty time. Given that the crash risk data based on time on task, cited earlier, tends to suggest that risk increases somewhat after about 5 hours, 5 hours of duty time was chosen as the maximum period without a rest break.

Although some studies have shown the benefits of rest breaks, at the recent Third International Conference on Fatigue and Transportation held 9-13 February 1998 in Fremantle, Australia, the effects of short breaks were not addressed in any substantive way, and no research was presented in support of such breaks (Vespa, 1998). Wylie et al. (1996) summarize their literature review of the effects of breaks as follows "…breaks allow some recovery when taken early in the drive, but after six or seven hours of driving, two studies show that breaks become ineffective in preventing performance decline and drowsiness". In a paper that also reviewed the literature concerning the impact of breaks on fatigue, Vincent et al. (1998) concluded that most studies have reported little benefit of breaks in reducing drowsiness levels in drivers. From the results of their own study, they concluded that 30-minute breaks are an ineffective drowsiness countermeasure. Such breaks had a minor impact on decreasing driver fatigue and the effects were short lived, lasting only about 12 minutes.

Since drivers are required to stop for short periods for a variety of reasons (personal needs, safety and fuel checks, etc.), the need for additional stops that would be required by this potential regulation needs to be further considered. It must also be determined that sufficient rest spaces and locations with adequate facilities are available to accommodate the increased demand generated by instituting this requirement.

3.3 Special Circumstances

- ***For team drivers in sleeper cab operations***

  - ***allow two periods of 4 continuous hours off-duty to substitute for the minimum continuous off-duty period of 8 hours required within any 24 consecutive hours***

  - ***require a minimum continuous off-duty period of 4 hours after no more than 8 consecutive hours on duty***

Study findings indicate that use of sleeper berths increases crash risk by a factor of 3. This increased risk due to sleeper berth use did not appear to arise because of the disturbance of sleep from the motion of the truck, but rather because of the splitting of sleep into two periods (Hertz, 1988). Contrary to expectation, then, two drivers who are able to relieve each other after a stint of driving tend to experience disrupted sleep and show deterioration in driving performance, particularly if they have to drive during periods of low physiological arousal (Wylie et al., 1996). Other studies have found team versus single driving to be a very important issue for drivers regarding quality of sleep.

Many who do not like team driving say that they cannot sleep in a moving truck. A common reason for not being able to sleep was lack of confidence in the partner's driving ability and/or willingness to stop driving if too fatigued, partner's inability to drive smoothly or lack of partner courtesy (radio/CB volume, heater/cooler settings (Neale et al., 1998).

Although team and solo drivers in sleeper cab operations face a somewhat similar situation from the sleep accommodation point of view, team drivers adhere to very different work/rest patterns and must sleep in the environment of a moving vehicle. Team drivers generally operate around the clock, with each driver equally sharing work and rest times over the course of a day. By most reports, sleeping in a moving vehicle is difficult because of motion and noise disturbances, as well as concern about potential road mishaps. These elements set team drivers apart from all other drivers from the fatigue management perspective. For example, either driver can be first on-duty after days off, which provides the opportunity for the first-up driver to be the one who is more rested (either planned as a result of prior agreement or by on-the-spot assessment). This can reduce first trip fatigue effects experienced by the first-up driver, particularly for a first night shift (because of prior long wake time and short shift changeover sleep).

Although team drivers are in a better position to take a sleep break whenever they feel the need, their sleep environment as well as work and partnering constraints do not favour sleeps of long duration. These operational realities need to be taken into account if HOS regulations aimed at their situation are to be effective, beneficial and economically practical.

The requirement for a minimum 4-hour off-duty period between shifts, although much less than the 8-hour minimum cited for solo sleeper cab drivers, seeks to adapt to – and shape – the reality of team driving operations. It is double the duration of the minimum 2 hours permitted under current HOS regulations. It allows teams more freedom to set work/rest hours that are in tune with their specific needs, and allows more flexibility to get sleep when and to the extent that they are able to sleep. There is little point in requiring a minimum of 8 hours if drivers cannot sleep that long, particularly since the resulting wake time while off-duty would reduce their disposable off-duty time when they may be more inclined to sleep. It is also logical to conclude that the longer the required minimum off-duty period, the more reluctant the driver will be to use the bunk unless he/she feels particularly fatigued (which is not a desirable result). The 4-hour off-duty period is consistent with getting a basic amount of sleep that is known to be somewhat sustaining, at least for short periods. In the Driver Fatigue and Alertness Study (Wylie et al., 1996, 1997), the least sleep was obtained by night drivers, who averaged 4.4 hours in bed and 3.8 hours asleep. In the case of team drivers, they would be in the advantageous position of having 3 such sleep opportunities during the course of the day if, for example, a 4 hours on-duty/4 hours off-duty work/rest schedule were used. This would also allow each driver 12 hours on-duty/12 hours off-duty during the course of a 24 hour day, without locking them into such a schedule. On the other hand, the 4-hour minimum ensures that drivers are not disturbed on a whim from the other driver,

requires the team to do some minimal planning and empowers each driver to defend his/her interests, using the letter of the law.

To compensate for this short sleep period, it is also proposed that team drivers not be allowed more than eight consecutive hours of driving, after which a 4-hour off-duty period would be required. It should be noted that this minimum 4-hour rule should be reviewed if, and when, sleeper cabs become substantially better than current models, such that improved noise and vibration isolation will allow longer and more restful sleep.

Team drivers tend to have split sleeps as well as disrupted and poor quality sleep, all of which lead to poor recovery, increased fatigue and lower alertness on the subsequent work shift. Additionally, each partner in a team must usually do the inverse of the other to equalize work/rest times and maximize distance covered. Thus, long periods of driving by one partner will require long off-duty and driving periods by the other, irrespective of whether the other partner is able to make use of the off-duty opportunities for sleep or whether his/her condition and individual characteristics are suitable for a subsequent long period of sustained driving. This would also reduce the off-duty time available in subsequent periods when the driver may be in a better position to sleep. Limiting the continuous on-duty (driving) period to 8 hours is a more conservative approach to team drivers, in comparison with other drivers. It maintains the productivity benefits of team driving, while also serving as a countermeasure to the increased accident risk seemingly apparent after 8 hours, the more difficult sleeping conditions and split sleep, individual differences that may make one driver less suited to long hours of driving than the other and limitations on the variety of off-duty activities available for rest and relaxation.

- ***For drivers who run out of available working hours close to their destination***

  - ***allow a 2-hour off-duty period as a sufficient condition for a subsequent 2-hour on-duty period***

Quite often a driver gets close to home or some termination point in a trip, but runs out of available hours and is required to enter a period of prolonged rest/sleep. This situation can lead to HOS violations involving excessive driving time without rest and/or speeding, both of which can increase the risk of crashes, as well as increase living costs for the driver and service costs for the industry (Neale et al., 1998).

Currently, the regulations provide for a 4-hour rest period reduction (from the 8 consecutive hours off-duty normally required before starting work in a day) that may occur once during 7 consecutive days. This provision should be replaced with a more conservative approach that does not reduce the main sleep period in a day, but provides for a 2-hour off-duty period (intended for sleep) followed by a maximum 2-hour period of driving. Evidence indicates that a 2-hour nap will promote some degree of recovery and maintain performance at pre-nap levels for at least 2 hours, although it is unclear how long the recovery effects will persist.

If drivers are fatigued (either by sleep deprivation or circadian rhythms) prior to this 2-hour rest, it can be expected that the recovery following a 2-hour sleep period will be less complete and that declines in performance will occur earlier than if the driver is not fatigued. Moreover, if the 2-hour work period following this proposed 2-hour sleep represents a more fatigue-inducing time of day based on circadian rhythms, the 2-hour sleep period may be insufficient to maintain driver alertness over the 2-hour extended driving period. To minimize the potential for fatigue in this extended 2-hour on-duty scenario, the following three restrictions are proposed:

- The 2-hour period should be viewed as a sleep period and not just a rest period. It is well known that rest alone does not promote recovery in the fatigued driver; sleep is required.

- The driver should have had at least 6 hours of continuous (uninterrupted) sleep in the last 24 hours and 14 hours in the last 48 hours.

- The on-duty extension will not include any of the period of lowest performance due to circadian effects, which is between 0000 and 0600.

This option would permit only one extension period per day. If the on-duty period extension occurred on the last shift and immediately before taking the required off-duty recovery period for cumulative days of work, the extension need not be added to the next work shift.

4 OPTIONS FOR WORK/REST CYCLES OVER CUMULATIVE DAYS

Recovery from cumulative fatigue and sleep debt requires adequate sleep in terms of both quantity and quality. Increasing the number of very long shifts (and hours worked) in a week can increase the sleep debt that accumulates over days; at the same time, the number and duration of off-duty periods available for recovery sleep decreases. To maximize the recovery obtained from sleep, sleep periods should occur during the time of day when sleep is most consistent with human physiology and circadian rhythms. Two full nights of sleep appear to be required to allow near full recovery following protracted periods of sleep loss or sleep restriction. Given that better recovery sleep is achieved at night, the opportunity for night sleep becomes critical, especially for the more fatigued drivers.

Little scientific data can be found for drawing conclusions about the long-term effects of continuing long hours of work and high levels of sleep loss on driver performance and recovery. One of the most pertinent – but limited – studies was undertaken by Transport Canada (Wylie et al., 1997; Vespa et al., 1998). It spanned two work cycles over 10 days (using a provision of existing Canadian HOS regulations that allows a maximum of 120 hours in 14 days). This study also allowed a recovery period of 36 hours after the initial 60 hours of work, which were completed in just under four days. It indicated that it is prudent to provide, at the earliest possible opportunity, an off-duty period of sufficient duration to permit full recovery from fatigue accumulated over multiple days of work.

The proposals for changes to the HOS regulations that affect fatigue factors over cumulative days are intended to limit the number of hours worked, increase the number and duration of sleep opportunities and promote availability of sleep opportunities at the most appropriate times of the day. In addition, the options take into account the time of day during which work hours are accumulated. Overall, they are intended to enhance operating flexibility, increase opportunities for drivers to spend more time at home with their families and keep the regulations as simple as possible, while achieving the overall objective of reducing driver fatigue.

The options presented here, addressing work/rest cycles over cumulative days, are considered under the same three categories identified in the previous section (Core Options, Recommended Options and Special Circumstances).

4.1 Core Options

- ***Promote work/rest cycle regularity***

A large body of research has firmly established that rotating shifts and irregular schedules lead to deterioration of driver performance due to shorter and poorer sleep as

well as to circadian effects. Fatigue can be cumulative over the work week and extend into days off-duty. Provisions of the HOS regulations that promote rotating and irregular schedules over multiple days should be removed. Additions should be made that encourage schedule regularity and incorporate remedial measures for particularly difficult periods. Incorporation of the proposals presented in this section would promote use of more regular schedules by industry, eliminate from the HOS regulations those aspects that promote rotating schedules and facilitate re-establishment of regular schedules subsequent to unforeseen perturbations. They include a daily work/rest cycle based on a 24-hour day, reasonable maximum cumulative weekly work hours based on a multiple of the daily work period, and a recovery period based on number of night sleeps rather than total hours from the end of a work shift.

- ***Maintain the existing on-duty maximums at 60 hours in 7 days, 70 hours in 8 days and 120 hours in 14 days***

The scientific literature does not support any increase of the current limits of 60 hours in 7 days, 70 hours in 8 days and 120 hours in 14 days. Until the industry and its stakeholders can develop ways of reducing weekly demands without severe economic repercussions, the weekly maximums can remain. However, every effort should be made to research the segments of the industry that regularly work these maximums. Alternative strategies should be identified to reduce these maximums in the future and/or maximize rest opportunities.

- ***Treat off-duty recovery periods in terms of number of night sleeps (including the period between 0000 and 0600)***

Specifying the number of hours of off-duty time can force drivers to change shift during the next cycle; for example, day drivers may shift toward night operations to minimize the amount of time off duty. This can result from hours being counted starting from the end of a shift. This “hours” approach favours delays in one week’s work cycle being carried forward into the next week’s cycle, another negative feature. It is well established that day sleep is not as recuperative as night sleep, and that nighttime alertness and associated performance is reduced. It is also clear that virtually no one living in a normal social environment is a “night” person (in the sense that their circadian rhythm patterns are not substantially different from other individuals working day shifts). The implication is that off-duty recovery periods should promote sleeping at night rather than at any time of the day during which hours off duty happen to fall. By specifying an off-duty recovery period based on included nights of rest, work/rest cycles are maintained from week to week and unexpected schedule delays can be more easily accommodated within the current cycle rather than the next. Drivers working through the night, who are of most concern, would have to switch to day cycles in the next period if they wished to minimize the length of their required off-duty recovery period. Or, if they wish to continue on night schedules during the next cycle, they would have to be off duty a longer number of hours. Both would be beneficial from the fatigue perspective (Gander et al., 1998; Vespa et al., 1998).

- ***Require a 2-night off-duty period (including the intervening day) within any consecutive 7-day period having over 42 hours on duty***

The technical literature clearly shows that day sleeping does not promote as much recovery as night sleeping. If a significant sleep debt has accumulated, evidence shows that a 36-hour off-duty period may be insufficient to promote full recovery (Wylie et al., 1997; Vespa et al., 1998). A 48-hour period allows night drivers to obtain at least 2 night sleep opportunities (Smiley and Heslegrave, 1996). While a shorter reset period may be tolerable for day drivers, this option is in need of further research. McDonald (1984) argues that work/rest patterns that are inverted vis-à-vis circadian rhythms should incorporate a compensatory rest period.

It is proposed that the off-duty recovery period be considered in terms of night sleep opportunities. For both day and night drivers, sleep should be of sufficient continuous duration to include 2 full nights, from 0000 to 0600 hours (Gander et al., 1998; Vespa et al., 1998). Using this approach, off-duty time and night-sleep opportunities would be in accordance with the results of research for both day and night drivers.

Currently, the HOS regulations do not include any requirement for off-duty time after accumulating the multi-day on-duty maximums. Thus, schedules that accumulate about 8 ½ hours or less per day can be conducted indefinitely over the course of the year. Although this amount of on-duty/driving time is not at the daily HOS maximum, it is not negligible and should not be ignored, particularly for night-shift drivers. It is proposed that a minimum 2-night off-duty period be required within each 7-day period incorporating over 42 hours of cumulative on-duty time. (These total hours represent approximately a normal work week in an industrial context.) This provision would come into play when more than the equivalent of three 14-hour days are worked within 7 days. Thus, for example, drivers now working on average between 6 and 8.5 hours over 7 shifts would be required to incorporate the night-day-night (2 nights) off-duty period provision under the 60 hours in 7 days cycle.

For day drivers under the 2-night off-duty recovery provision, total hours off duty would stretch from a minimum of about 30 hours, if maintaining the same day schedule on the next cycle (for example, drivers completing their shift at exactly 2359 and maintaining the same day shift on the next cycle would start the next cycle's first shift at 0601) up to a maximum of 48 hours for day drivers switching to an exactly inverted schedule of night driving during the next cycle (for example, completing shift at 2359 and starting next cycle at 2359).

For night drivers, total hours off-duty would span a minimum of 48 hours if shifting to an exactly inverted day schedule on the next cycle (for example, completing shift at 0601 and staring next cycle at 0601) up to a maximum of 58 hours, if maintaining exactly the same night schedule on the next cycle (for example, completing shift at 0601 and starting next cycle on same schedule as previously, at about 1600).

- ***Require a 2-night off-duty period (including the intervening day) after 4 consecutive nights on duty***

While it is best for drivers to be driving at the same time of the day each day, whether that involves morning or afternoon starts, the same is not true of overnight driving. Driving a series of night shifts results in accumulating a significant sleep debt, as well as sleep being taken at the time of day when it is least recuperative.

Changes in HOS regulations should deal with the greater risks from fatigue associated with night driving. It is known from the scientific literature that a sleep debt of about 1½ hours accumulates with each night worked and is paid off in longer sleep on rest days. Furthermore, a study of productivity of shift workers suggested that circadian adjustment to night work is the dominant alertness factor for the first 3 to 4 successive night shifts, while sleep deprivation due to working nights predominated on subsequent nights (Vidacek et al., 1986). It is proposed that a maximum of 4 nights of work (i.e., on-duty/driving between 0000 and 0600) in a row be allowed before requiring an off-duty period that provides the opportunity for 2 full nights of sleep that include the hours between 0000 and 0600. This will guard against accumulating too great a sleep debt, with a consequent deterioration in performance. Of course, this rest period (of 2 nights of sleep as well as the intervening day off) could occur earlier (say after 3 nights).

The requirement to limit night driving to 4 nights would reduce the maximum attainable weekly hours to 56 from the current 60 hour maximum, because of the daily 14-hour limit. This is not a negative factor from the fatigue perspective. Nonetheless, 60 hours can be achieved if an additional 4 hours are worked on the subsequent shift. Over the 14-day period, 120 hours of maximum on-duty time could be maintained with adequate rest and recovery time. Of course, working less on-duty time would result in less than the maximum hours, as it would with current work schedules, depending on the number of hours worked daily. If drivers change work schedules from night to day shifts after 3 nights to avoid this proposed 4-night regulation, more hours of work may be attainable. However, logistically a night's sleep would be obtained between shifting from night work to day work, thereby promoting greater recovery, while day work would result in less fatigue. Although shifting work schedules should be avoided from a fatigue management perspective, it may be a preferred alternative to working an excessive number of night shifts. Long distance drivers would thus be able to accumulate their full week's hours (i.e., 60 hours in 7 days) on a regular day to day basis, in one block of time, and then have time off for recovery prior to the next week's cycle.

4.2 Recommended Options

- ***Modify the current 120-hour/14-day cycle to include the 2-night off-duty period (proposed under Core Options), and eliminate the 60-hour/7-day and 70-hour/8-day cycles***

The current maximum on-duty hours are 60 hours in 7 days, 70 hours in 8 days and 120 hours in 14 days. Drivers must conform to one of the three, rather than all 3 simultaneously, depending upon the circumstances. Current regulations allowing 120 hours on-duty time within 14 days can result in a driver consecutively working, for example, ten 12-hour days (nights) and driving nine 13-hour days (nights). These potential work schedules are excessive by any standard, but especially for workers such as truckers in safety-sensitive positions. It is proposed that only the current 14-day/ 120-hour maximum be retained. This is, however, contingent on the integration of the recovery option of 2-nights off-duty within every seven consecutive days of over 42 hours on duty. By eliminating the 7- and 8-day options from the current regime, the regulations, record keeping (logbooks), and enforcement become simplified. Moreover, the 14-day cycle would encompass the operating possibilities offered by the other two cycles, except in very rare circumstances. This option may provide work/rest schedules which are more flexible in response to driver and motor carrier needs, as well as maintain an extended range of efficient operation but with a more rested driver.

4.3 Special Circumstances

- ***For drivers who run out of available working hours close to their destination***

  - ***allow an 8-hour off-duty period as a sufficient condition for a subsequent 8-hour on-duty period***

A 2-hour off-duty/2-hour on-duty option has already been proposed for the daily cycle to deal with the situation when drivers run out of hours close to their destination. This proposal was made primarily for safety reasons, but also for practical and service considerations. Although the 2-hour period is considered adequate from the perspective of a daily cycle, delays can be cumulative over multiple days and exceed a driver's ability to compensate with the 2-hour rest/work option. For similar safety, practical and service reasons cited earlier, consideration should be given to providing an option that drivers can use to safely compensate for longer delays that may have accumulated during the normal work cycle over multiple days. It is proposed that an 8-hour off-duty period allow a subsequent 8-hour (maximum) period of driving. The 8-hour off-duty period would allow a good principal sleep, rather than the truncated sleep allowed by the existing 4-hour rest reduction rule. This would then be followed by a relatively short period of work/driving (8 hours), which should be sufficient time to get to the home terminal in the "close to home" situation. Since this on-duty extension would be allowed only once at the end of the work cycle, a driver would subsequently obtain an off-duty period of normal duration (2 nights plus the intervening day) for recovery.

5 INSTITUTIONAL AND INTERNATIONAL CONSIDERATIONS

5.1 National-Regional Considerations

HOS regulations deal with specification of safe working limits related to fatigue. They should be determined by the limits of human physiology. In reality, however, difficulties arise because of unknowns in the relationships between fatigue, the control parameters specified by the HOS regulations (work and rest hours, break time, etc.) and road safety.

As a result of the considerable international research in the past 10 years, schedule-related factors affecting human performance are now much better understood. It should be possible to achieve a consensus on safe and acceptable working limits for Canadian commercial vehicle drivers. In matters that deal with shaping human behaviour, it is particularly important that rules be consistent and based on the most objective data possible. Only then can it be expected that the rules will be understood, respected, and adhered to by drivers, motor carriers and shippers, and that only moderate levels of enforcement will be necessary. However, local circumstances arising from particularities of geography and/or population characteristics may demand some adaptation for local carriers and drivers (such as extended periods of long days and long nights in the far north, short periods of terrain accessibility due to freezing or thawing, or immense distances with few inhabitants and amenities). Table 5.1 provides a comparison of existing federal regulations, provincial HOS proposals and several options presented in this report.

When weighing the significance of changes in HOS regulations, it may be useful to examine the residual time off available to drivers for diversionary activities away from work, as well as to compare this with different scenarios and other areas of economic activity. For illustrative purposes, Table 5.2 shows example residual time off calculations for:

- the existing federal HOS regulations, which allow 60 hours of work in 7 days, cycling 15 hours on duty/8 hours off duty

- a federal proposal for 70 hours of work in 7 days, cycling 14 hours on duty/10 hours off duty)

- a proposal from provinces in Western Canada for 84 hours of work in 7 days, cycling 14 hours on duty /10 hours off duty

- the work hours of the average Canadian worker in the goods-producing industries of 39.3 hours in 7 days, cycling 7.9 hours on duty/16.1 hours off duty

Table 5.1
Provincial HOS proposals compared with existing federal regulations and several options presented in this report

Existing Federal HOS Regulations	Ontario Proposed HOS Regulations*	Alberta Proposed HOS Regulations**	Expert Panel Proposed HOS Regulations	Implications
DAILY DRIVING TIME 13 consecutive hrs 16 hrs/ 24-hr period	13 consecutive hrs 15 hrs/ 24-hr period	14 consecutive hrs 14 hrs/ 24-hr period	14 consecutive hrs 14 hrs/ 24-hr period	Change to 14-hr combined driving/duty maximum eliminates the distinction between driving and duty time. This move would limit long duty times and allow more rest time.
DAILY ON-DUTY TIME 15 consecutive hrs 16 hrs/ 24-hr period	15 consecutive hrs 15 hrs/ 24-hr period	14 consecutive hrs 14 hrs/ 24-hr period	14 consecutive hrs 14 hrs/ 24-hr period	
ON-DUTY CYCLE MAXIMUMS 60 hrs per 7 days 70 hrs per 8 days 120 hrs per 14 days	60 hrs per 7 days 70 hrs per 8 days no 14 days	84 hrs per 7 days no 8 days no 14 days	120 hrs per 14 days Eliminate 7- and 8-day cycle option	The present 7- and 8-day cycles do not have the flexibility to accommodate adequate periods for recovery. The 14-day cycle with the planned recovery periods will provide a healthier and safer alternative compared to the 7- and 8-day cycles.
14-DAY CYCLE 120 hrs per 14 days	Eliminated	No provision	Modified 120 hrs per 14 days (see Section 4)	The present 14-day cycle does not allow for a rest/recovery period.

* Recommendations in report of Ontario Target '97 Task Force on Truck Safety
** Alberta Trucking Association's response to the proposed changes to the federal HOS regulations, December 1997

Table 5.1
Provincial HOS proposals compared with existing federal regulations and several options presented in this report (cont'd)

Existing Federal HOS Regulations	Ontario Proposed HOS Regulations*	Alberta Proposed HOS Regulations**	Expert Panel Proposed HOS Regulations	Implications
DAILY OFF-DUTY TIME 8 consecutive hrs	9 consecutive hrs	10 total hrs 7 consecutive hrs 3 hrs at driver's discretion	10 total hrs 8/9 consecutive hrs 2/1 hrs at driver's discretion (see Section 4)	Cost-benefit of increased off-duty time to carriers and independents
WEEKLY REST/ RECOVERY PERIOD None	36-hour rest/recovery period Elimination of 14-day cycle	24-hour rest/recovery period within 7-day cycle	Two nights-one-day rest/recovery period including two night sleeps within every 7-day period of over 42 hours, and after 4 consecutive nights (See Section 4)	The rest/recovery period will allow drivers to get two full nights of sleep and a day off to recover from any sleep debt accumulated within a 7-day period or after 4 nights of the 14-day cycle.
BREAKS None	30 minutes anytime during driving period	15 minutes every 5 continuous hours of driving	30 minutes anytime during or immediately after the first 5 hours of the duty time	It is recognised that working continuously over 7-8 hours will result in increasingly degraded performance (OHSA). One proposal is for a 30-minute break to provide relief on longer shifts, consistent with the OHSA. Fifteen minutes is inadequate to secure a rest stop and provide for proper recovery.

Table 5.1
Provincial HOS proposals compared with existing federal regulations and several options presented in this report (cont'd)

Existing Federal HOS Regulations	Ontario Proposed HOS Regulations*	Alberta Proposed HOS Regulations**	Expert Panel Proposed HOS Regulations	Implications
REST AREAS No provision	Proposal for developing rest areas	No provision	Adequacy of existing rest areas should be reviewed	Rest areas may need to be developed in remote parts of Canada. The present situation may be inadequate.
4-HOUR REST REDUCTION Rest can be reduced by 4 hours – 13 hrs. max driving can follow	Rest reduced by 4 hours – 4 hrs. max driving follows	No provision	No provision	
2-HOUR EXTENSION Emergency or adverse weather – 2 hours additional driving	Emergency or adverse weather – 2 hours additional driving	Emergency or adverse weather – 2 hours additional driving twice in any 7-day period to be added to the following off-duty period or subtracted from the next duty cycle	Emergency, adverse weather, scheduling anomalies – 2 hours additional driving after having a 2-hour sleep.	This situation should be uncommon and planning should be such that it only occurs under emergency and adverse conditions. The inclusion of a 2-hour sleep period just prior to making the 2-hour additional driving will ensure that driving performance will be maintained.
LOG-BOOK EXEMPTION 160 km from home terminal	160 km from home terminal	160 km from home terminal	No provision	There is no acceptable rationale for exemptions from log-books. Since most terminal areas have more dense traffic congestion, traffic congestion requires greater vigilance on the part of the driver.

Examining potential work/rest strategies available to drivers faced with, for example, an 84-hour work week may help us better understand possible work duration effects on the length of recovery sleep that may be feasible. A driver may choose to maintain the amount of sleep normally obtained over a 7-day period at 56 hours (Table 5.2) after switching to the new cycle of 84 hours on duty in 7 days. This would mean reducing the total time available for personal pursuits over 7 days (including the one off-duty day) to only 16 hours. This is 28 hours below the 44 hours that are available currently, and 46.7 hours less than the 62.7 hours available to the average Canadian worker in the goods-producing industries. However, most shiftworkers will trade off sleep for wakefulness to make more time available for attending to personal needs, being with spouses, children, extended families and friends, as well as for performing household and other chores of daily life. Moreover, many drivers must also make time available for tending to their vehicles and trucking businesses. Thus drivers may choose to maintain their available free time for personal, social and domestic activities at 44 hours. In this case, drivers would reduce their sleep to only 28 hours over a 7-day period. However, such extremely low levels of sleep would severely affect job performance, internal state of well being and safety, making this scenario much less likely. It is expected that most drivers would spend somewhere between 28 and 56 hours in bed. Considering night shiftworkers – who on average normally obtain about 5 hours of sleep per day, according to a number of studies, an 84-hour work week would leave only 37 hours of free time. These drivers have inadequate time to sleep and recover as well as inadequate time for a personal life. This would produce a fatigued driver who would be a danger to him/her and to others, and who would be unable to reap the personal benefits of working long hours.

5.2 Canada-U.S. Reciprocity

Currently the U.S. and Canadian HOS regulations are somewhat different. The U.S. regulations set the maximum number of hours of driving at 10, rather than 13, before an 8-hour rest period is required. The maximum number of on-duty hours allowed in both countries is set at 15. Specific regulations are also included for Alaska and Hawaii, not linked to the main territory of the U.S. These are designed to accommodate the special driving environments in those States. In Alaska, longer driving and duty times are allowed because – among other reasons – days with long hours of ambient light in summer can allow longer trips, and few way-stations and facilities are available. In Hawaii, distances are very short and operations are intense, requiring HOS regulations that are more appropriate to in-city driving conditions.

Changing Canadian (or U.S.) HOS regulations without mutual reciprocity or compatibility would have implications for international carriers. This would also be the case for the many carriers conducting their operations in Canada under U.S. rules, rather than Canadian, in order to simplify their combined U.S. and Canadian operations. The greater the differences in HOS regulations between the two countries, the more difficult it will be to schedule drivers for transborder operations. These potential impacts must be

considered and dealt with fully in advance of implementing any changes. Similar consideration should be given to any changes to U.S. HOS regulations.

Table 5.2
Comparison of residual time off available to drivers over seven days under various scenarios for total hours worked in a week

(Compares existing federal HOS regulations which allow 60 hours on-duty in 7 days, a federal proposal* for a 70-hour work week, a proposal from provinces in Western Canada* for an 84-hour work week, and work hours of the average Canadian worker in the goods-producing industries** of 39.3 hours)

Scenario	Total hrs. available in 7 days	Work hrs.	Work-related off-duty hrs.†	Drive hrs. to/from work††	Sleep hrs.	Net hrs. for personal life
Cdn. Goods-Producing Worker	168	39.3	5	5	56‡	62.7
Existing HOS: 60 hrs/7 days	168	60	4	4	56‡	44
Federal Proposal: 70 hrs/7 days	168	70	5	5	56‡	32
					44‡‡	44
Western Proposal: 84 hrs/7 days	168	84	6	6	56‡	16
					28‡‡	44

* Proposal tabled at a meeting of the Commercial Vehicle Driver Hours of Service Project Group (Canadian Council of Motor Transport Administrators, CCMTA), held on April 27-28, 1998, in Ottawa, Ontario.

** Statistics Canada, Catalogue No. 72F0002-XDE.

† For each workday, includes 0.5 hours for lunch and 0.5 hours for breaks. Numbers take into account a possible 4, 5, or 6 days in a work week as appropriate.

†† Assumes a driving time of 30 minutes each way. Numbers take into account a possible 4 or 5 day work week as appropriate.

‡ Assumes 8 hours in bed each 24 hours.

‡‡ Assumes drivers cut back on sleep time in order to maintain free time for personal life at the equivalent 44 hours available under the current 60 hours in 7 days HOS regime. (This is a plausible scenario presented for demonstration of potential sleep/free time tradeoffs.)

Table 5.3 compares a number of current U.S. and Canadian HOS regulations and identifies some international considerations associated with certain HOS changes proposed in this report.

Cross-border travel can result in fatigue-related problems caused by the differences between U.S. and Canadian HOS regulations. U.S. drivers who are less than 10 hours away from their U.S.-Canada border crossing point can cross the border just prior to their daily maximum driving time, and drive for another 3 hours before they must stop to rest for at least 4 hours (according to the 4-hour rest reduction rule). Of course,

Canadian drivers crossing back into Canada can do this as well. However, since U.S. drivers are conditioned to drive maximum periods of 10 hours, the extra 3 hours added on to the last portion of their trip may cause increased levels of fatigue. Then by only getting 4 hours of sleep, and driving another 13 hours the next day, a U.S. driver may find that fatigue becomes too great to continue safely. On the other hand, such a scenario may be familiar to the U.S. drivers who regularly make this type of trip and they may have developed coping mechanisms.

The main concern is that this kind of scenario often includes nighttime driving. Cumulative sleep loss and circadian rhythms can lead to serious declines in performance during the nighttime portion of the trip. It is now well known that driving performance is significantly degraded between 0000 and 0600 hours, when compared with daytime hours, and that sleep loss makes this situation worse. Both Canadian and U.S. drivers would benefit from a change in the HOS regulations that would eliminate the opportunity for a 4-hour rest period between shifts once every cycle, and from the adoption of a combined 14-hour driving/duty-time. Increasing the rest period to 10 hours allows these drivers to plan naps, and get 7-8 hours of sleep each day, thereby minimizing the accumulation of significant sleep debt over time. Although driving time could increase by 1 hour (from 13 to 14), this would apply only to daytime driving. Night driving would require that the driver take a 2-hour break to sleep (or on-duty hours could be reduced by one hour, depending on the option selected), effectively reducing the overall driving/working time in many scenarios.

5.3 Economic Considerations

Driver hours of service and vehicle weights and dimensions are, without doubt, the two most important factors determining the economics of trucking and its competitive position vis-à-vis the other modes. Motor carriers should take a comprehensive view of the costs and benefits of specific changes to the HOS regulations. They must consider the savings they may obtain in reduced insurance premiums, reduced losses resulting from accidents (less damaged equipment, fewer fines due to damage to highway structures, lower costs of injury to personnel, lower costs of replacing personnel, etc.), increased driver efficiency (fewer missed positions in lines at terminals and customer docks, improved performance in unloading and loading, fewer missed turns and other navigational mistakes and likely reduced maintenance and repair costs associated with more reliable and alert drivers), reduced driver absenteeism and increased working lives of drivers (e.g., less premature retirement). Increased schedule reliability and reduced away-from-home time and expenses are also possible. The costs will include reduced duty time, and potentially, reduced driving time, although this is likely to be marginal, if any.

Table 5.3
Existing U.S. HOS regulations compared with Canadian regulations and several options presented in this report

Canadian HOS Regulations	U.S. HOS Regulations	Expert Panel Proposed HOS Regulations	Implications
DAILY DRIVING TIME 13 consecutive hrs 16 hrs/24-hr period	10 consecutive hrs 16 hrs/24-hr period	14 consecutive hrs 14 hrs/24-hr period	Change to 14-hr combined driving/duty maximums eliminates the distinction between driving and duty time. This move would limit long duty times and allow more rest time
DAILY ON-DUTY TIME 15 consecutive hrs 16 hrs/24-hr period	15 consecutive hrs 16 hrs/24-hr period	14 consecutive hrs 14 hrs/24-hr period	
ON-DUTY CYCLE MAXIMUMS 60 hours per 7 days 70 hours per 8 days 120 hours per 14 days	60 hours per 7 days 70 hours per 8 days no 14-day cycle	120 hours per 14-day cycle Eliminate 7- and 8-day cycle option	The inclusion of a rest/recovery period within a 14-day cycle allows drivers to pay back accumulated sleep debt and keep a regular routine to maintain their circadian rhythms. U.S. drivers do not have this option at the moment. Paper work associated with cycle adjustments will need to be done at border crossings.
OFF-DUTY TIME 8 consecutive hours	8 consecutive hours	10 total hours 8/9 consecutive hours 2/1 hours at driver's discretion	Cost-benefit of increased off-duty time to carriers and independents needs to be examined. Increased driving time may offset costs of increased off-duty time. Paper work associated with cycle adjustments will need to be done at border crossings.
REST/ RECOVERY PERIOD None	None	Two nights plus intervening day (2-night) rest/recovery period within every 7-day period of over 42 hours, and after 4 consecutive nights	The inclusion of a rest/recovery period within a 14-day cycle allows drivers to pay back accumulated sleep debt and to regularize their circadian rhythms. Less accumulated driving time is allowed for night driving in order to offset the increased sleep debt due to working nights and sleeping days. Paper work associated with cycle adjustments will need to be done at border crossings.

Table 5.3
Existing U.S. HOS regulations compared with Canadian regulations and several options presented in this report (cont'd)

Canadian HOS Regulations	U.S. HOS Regulations	Expert Panel Proposed HOS Regulations	Implications
BREAKS None	None	30 minutes anytime during a driving period up to a maximum of 5 hours.	U.S. drivers will benefit from the breaks, but the carriers may find a slight reduction in efficiency. This reduction may be offset by the increased driving efficiency of the driver. This may not cause much change since many drivers currently stop for coffee, personal needs, safety checks, etc.
REST AREAS No provision	No provision	Recommendation for review of existing rest areas	The U.S. is presently investigating expansion of rest areas for drivers. Adequacy of rest areas in Canada should be examined.
SLEEPER CAB – SPLIT SLEEPS 8 hours off duty can be split into 2 periods with neither under 2 hours Aggregate 13 hours max driving immediately preceding and following rest	8 hours off duty can be split into 2 periods with neither under 2 hours Aggregate 10 hours max driving immediately preceding and following rest	8 hours can be split into 2 periods with neither under 4 hours 4 hours off duty required after 8 hours on duty	In Canada, U.S. drivers can take a 2-hour sleep in the sleeper of their cab, then drive 13 hours before finishing the rest of their 8-hour sleep period. This may have more road safety implications for American drivers who are potentially less habituated to the longer driving times in Canada. Eliminating split sleeps would be the ideal.
4-HOUR REST REDUCTION Rest can be reduced by 4 hours – 13 hrs. max driving can follow	No provision	No provision	This regulation was designed to allow drivers to add 2 hours to their driving to arrive at a destination late (emergency, adverse weather, etc.). Unfortunately, the present regulations allow drivers to do 18 hours of driving in a 24-hour period. The acute sleep loss from a shortened sleep period will result in degraded driving performance.

Table 5.3
Existing U.S. HOS regulations compared with Canadian regulations and several options presented in this report (cont'd)

Canadian HOS Regulations	U.S. HOS Regulations	Expert Panel Proposed HOS Regulations	Implications
2-HOUR EXTENSION Emergency or adverse weather – 2 hours additional driving	Emergency or adverse weather – 2 hours additional driving	Emergency, adverse weather, or scheduling difficulties – 2 hours additional driving following a 2-hour sleep opportunity	An extension on a already long 15-hour duty cycle will result in the driver risking severely degraded driving performance. The driver would benefit from a 2-hour sleep opportunity that would allow maintenance of driving performance. This would be particularly useful for U.S. drivers who are more accustomed to 10-hour driving times. Requiring that the driver must abstain from driving for two hours prior to completion of the trip would provide an additional incentive to respect the regulation.
LOG-BOOK EXEMPTION 160 km radius from home terminal	100 air miles radius from home terminal	No provision	

6 IMPLEMENTATION OF HOS CHANGES

6.1 Pilot Evaluation

Prior to final implementation, a pilot demonstration and evaluation of selected HOS changes should be conducted, using a representative group of drivers and motor carriers. The pilot should provide enough information to establish objective conclusions concerning their effectiveness in reducing driver fatigue and increasing safety and driver satisfaction, their practicality under operating conditions, and their overall efficiency and cost-effectiveness. Comparisons should be made with operations under existing regulations, by using control and test groups. In principle, the pilot demonstration should be carried out over a minimum one-year period to evaluate potential impacts of normal variations in circumstances and schedules.

The pilot should be stratified to include different types of operations and routes. For example, long-haul trucking with limited rest stops should be included as well as rapid turn-around local trips. Schedules should include the proposed daily and cumulative-days limits, the mandatory 2 nights of rest, as well as the 4 consecutive night shifts prior to the 2 nights of rest. Much less intense schedules should also be evaluated to estimate the impacts of such schedule reductions on economic factors vital to the industry.

The pilot should use subjective tools such as surveys, activity logs, and self-evaluation tools (mood, sleepiness, performance, workload, alertness, etc.), generic types of performance assessment based on individual performance levels, and vehicle monitoring such as lane-tracking. In addition, on-board monitoring of vehicle movement should be carried out with appropriately reliable devices to objectively estimate rest opportunities.

Sleep should be monitored, ideally through the use of on-driver physiological measures but more likely through indirect, unobtrusive measures such as wrist-worn actigraphs. Subjective and, to the extent possible, objective measures of recovery of function following sleep should be assessed.

6.2 Fatigue Countermeasures Program and Training

The increased flexibility offered to industry by the proposed set of options should be used to encourage industry to adopt a package of fatigue countermeasures. These would ensure that drivers understand the impacts of the proposed changes and that they benefit from the proposals. Moreover, the application of fatigue management principles should provide drivers with tools and techniques to better manage driver fatigue. Industry-wide adoption of fatigue management principles may also result in all

industry stakeholders, including the industry itself, as well as shippers, receivers, and insurers, sharing responsibility for managing driver fatigue and alertness.

6.3 Compliance Monitoring

In view of the importance of driver performance to road safety and the serious performance decrements that result from fatigue, vehicle monitoring should be considered for general implementation, as an objective method to assist in ensuring compliance with the HOS regulations (beyond the crude log-book information). This is proposed as an approach to achieving a required significant reduction in the substantial HOS violation rates reported by a number of studies (Hertz, 1991; Braver et al., 1992; Williamson et al., 1992). Because the HOS regulations are of major importance to the economics of trucking as well as to its competitive position vis-à-vis the other transportation modes, a level playing field must be established to ensure voluntary compliance by the vast majority of drivers and motor carriers.

Monitoring vehicle movement can at best provide only a crude measure of driver sleep opportunities, which is only one parameter of interest. To properly monitor driver condition, direct objective monitoring of the driver should be undertaken although this is not recommended at present, since current relatively unobtrusive techniques are unreliable (Dinges, 1998).

6.4 Five-Year Review Period

New HOS regulations and associated support programs for the trucking industry should be accompanied by research and evaluation to monitor their in-service effectiveness in reducing driver fatigue. This reflects the view that it is difficult to make unequivocal recommendations about actual day-to-day practice over the long term, particularly in view of the diverse and complex nature of the trucking industry and the adaptability of human beings to changing environments. Education and awareness training programs should be noted and company records audited to ensure compliance with the new regulations. The adequacy of the revised regulations and industry compliance levels should be monitored over a five-year review period, after which adjustments should be made if warranted.

6.5 Enhancement to Prescriptive HOS Approach

Fatigue Management Programs of the type implemented in Australia (Moore, 1998; Goodwin, 1998; Transport, 1998), but adapted to Canadian conditions, should be introduced to provide industry with the awareness, education, and incentive to adopt effective strategies to promote driver alertness and minimize driver fatigue. It is

expected that fatigue management programs will take advantage of current scientific knowledge and promote schedules that respond better to driver needs and limitations. The program must ensure that drivers' working conditions and fatigue factors are managed in a way that achieves real overall improvement in driver alertness, performance and satisfaction. Related paperwork should be kept to a minimum (Vespa, 1998). By working under better designed and more flexible schedules, drivers should be more rested and more alert. These changes should lead to improved employee well-being and morale, as well as to greater productivity and fewer accidents, all of which could yield an improved financial picture for participating companies.

The key to the success of any Fatigue Management Program is in the meticulous planning of all driver trips. This process must be well developed by management and drivers, together, to arrive at a schedule that respects the driver's human capabilities (physical and mental), but still allows the company to operate effectively. Planning must be as long term as feasible, and must be discussed and approved by the driver and management. Another important element necessary to success is a well-developed motor carrier training and education program delivered to all members of the organization who have an impact on driver schedules.

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