

Commercial Truck and Bus Safety

Synthesis 7

Motorcoach Industry Hours of Service and Fatigue Management Techniques

A Synthesis of Safety Practice

Sponsored by the
Federal Motor Carrier
Safety Administration

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Synthesis 7

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COMMERCIAL TRUCK AND BUS SAFETY SYNTHESIS PROGRAM

Safety is a principal focus of government agencies and private-sector organizations concerned with transportation. The Federal Motor Carrier Safety Administration (FMCSA) was established within the Department of Transportation on January 1, 2000, pursuant to the Motor Carrier Safety Improvement Act of 1999. Formerly a part of the Federal Highway Administration, the FMCSA's primary mission is to prevent commercial motor vehicle-related fatalities and injuries. Administration activities contribute to ensuring safety in motor carrier operations through strong enforcement of safety regulations, targeting high-risk carriers and commercial motor vehicle drivers; improving safety information systems and commercial motor vehicle technologies; strengthening commercial motor vehicle equipment and operating standards; and increasing safety awareness. To accomplish these activities, the Administration works with federal, state, and local enforcement agencies, the motor carrier industry, labor, safety interest groups, and others. In addition to safety, security-related issues are also receiving significant attention in light of the terrorist events of September 11, 2001.

Administrators, commercial truck and bus carriers, government regulators, and researchers often face problems for which information already exists, either in documented form or as undocumented experience and practice. This information may be fragmented, scattered, and undervalued. As a consequence, full knowledge of what has been learned about a problem may not be brought to bear on its solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem.

There is information available on nearly every subject of concern to commercial truck and bus safety. Much of it derives from research or from the work of practitioners faced with problems in their day-to-day work. To provide a systematic means for assembling and evaluating such useful information and to make it available to the commercial truck and bus industry, the Commercial Truck and Bus Safety Synthesis Program (CTBSSP) was established by the FMCSA to undertake a series of studies to search out and synthesize useful knowledge from all available sources and to prepare documented reports on current practices in the subject areas of concern. Reports from this endeavor constitute the CTBSSP Synthesis series, which collects and assembles the various forms of information into single concise documents pertaining to specific commercial truck and bus safety problems or sets of closely related problems.

The CTBSSP, administered by the Transportation Research Board, began in early 2002 in support of the FMCSA's safety research programs. The program initiates three to four synthesis studies annually that address concerns in the area of commercial truck and bus safety. A synthesis report is a document that summarizes existing practice in a specific technical area based typically on a literature search and a survey of relevant organizations (e.g., state DOTs, enforcement agencies, commercial truck and bus companies, or other organizations appropriate for the specific topic). The primary users of the syntheses are practitioners who work on issues or problems using diverse approaches in their individual settings. The program is modeled after the successful synthesis programs currently operated as part of the National Cooperative Highway Research Program (NCHRP) and the Transit Cooperative Research Program (TCRP).

This synthesis series reports on various practices, making recommendations where appropriate. Each document is a compendium of the best knowledge available on measures found to be successful in resolving specific problems. To develop these syntheses in a comprehensive manner and to ensure inclusion of significant knowledge, available information assembled from numerous sources, including a large number of relevant organizations, is analyzed.

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FOREWORD

*By Christopher W. Jenks
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This synthesis will be useful to commercial motorcoach companies, state agencies, and others interested in improving commercial motorcoach safety. The report identifies and documents the unique features of the extended workday that typifies motorcoach operations and identifies techniques that motorcoach managers, front-line employees, and drivers use to reduce fatigue-related incidents resulting from the irregular on-duty conditions facing the motorcoach driver. The synthesis also identifies current and emerging technologies that may be appropriate for motorcoach operations to offset the effects of the extended workday and fatigue-inducing environment. The synthesis is based on a review of relevant literature and a survey of selected motorcoach companies, industry associations, motorcoach insurers, state driver licensing agencies, private driving schools, and other relevant organizations.

Administrators, commercial truck and bus carriers, government regulators, and researchers often face problems for which information already exists, either in documented form or as undocumented experience and practice. This information may be fragmented, scattered, and underevaluated. As a consequence, full knowledge of what has been learned about a problem may not be brought to bear on its solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem.

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MOTORCOACH INDUSTRY HOURS OF SERVICE AND FATIGUE MANAGEMENT TECHNIQUES

SUMMARY

The effects of fatigue on human behavior have been well researched. These effects are of particular interest to all transportation modes. In fact, government and private organizations with transportation missions have been major supporters of fatigue research. Although motorcoach operations have not been extensively studied, operations similar to the motorcoach community (e.g., commercial trucking and transit) have recently participated in major fatigue studies.

One unique area of motorcoach operations is the extended workday many motorcoach operators face. Current Federal Hours of Service (HOS) regulations require 8 hours off duty before driving again after a 15-hour duty period. However, because many motorcoach operations include extended non-driving and non-working periods, operators are off duty intermittently so that the 15-hour duty period may stretch over significantly longer periods.

The Federal Motor Carrier Safety Administration (FMCSA) has continued to sponsor numerous research projects related to driver fatigue since the mid-1990s. The FMCSA considered the science-based findings in formulating the new HOS regulations for truck drivers. The new HOS regulations apply to property-carrying motor carriers; bus and motorcoach drivers (carrying passengers in interstate commerce) will continue to adhere to the HOS regulations in effect in October 2002. Much of the driver fatigue/workload/rest research is relevant to this synthesis.

An important factor setting motorcoach operations apart from other commercial driving operations is the passenger. Motorcoach operators are in direct, lengthy contact with the traveling public. Passengers concerned about getting across the country, making a connection to get to work, or visiting the local zoo or tourist site are unlikely to be informed or concerned about driver fatigue or HOS regulations.

Most charter and tour drivers usually sleep in hotel beds. Inverted duty/sleep cycles (i.e., a night trip followed by a day of rest may be followed by a day trip and a night of rest so that the body never adjusts to a single schedule) can occur because of group itineraries. Itineraries may be altered in real time, disrupting the driver's planned schedule. Extended duty days can result in long layovers at destinations (e.g., casinos). Drivers must also tend to passengers' luggage needs, take tickets, and perform other tasks that add to their work time and possible stress. Having numerous people observing driving behavior may produce an incentive for more diligence and professionalism on the part of a driver, but may also cause stress and fatigue.

Extensive research has been conducted regarding in-vehicle fatigue countermeasure technologies for truckers, and in some cases this work has been taken onwards toward commercialization. These systems may be equally applicable to motorcoach drivers. Systems have been developed that monitor and measure eye closures. Additionally, head movement monitoring has shown very good results, and commercially available products are now being offered to commercial drivers and being marketed to automotive original equipment manufacturers (OEMs). A lane departure warning system offers feedback regarding levels of driver fatigue; although not scientifically validated, this type of feedback is seen as valuable by drivers who have experienced it. Companies in Japan have had success in monitoring driver inputs (i.e., steering, brakes, and throttle) to assess fatigue. Essentially, a major portion of research and development has been completed and now the focus is on commercialization issues, such as driver-vehicle interface, packaging, and generating cost/benefit data that are compelling to fleet buyers.

Thus there was a clear opportunity to synthesize these various driver-related research approaches and countermeasures and to identify both commonalities and differences between trucking and motorcoach operations. This opportunity set the stage for this synthesis study.

The primary objective of this research is to identify and document the fatigue effects of the extended workday that typifies motorcoach operations. The researchers also sought to identify any techniques that motorcoach managers, front-line employees, and drivers use to reduce fatigue-related incidences resulting from the irregular on-duty conditions facing the motorcoach operator. A final objective is to identify any current or on-the-horizon technologies that may be appropriate for motorcoach operations to offset the effects of the extended workday and fatigue-inducing environment. All of this was done within the context of normal best of practice approaches to countering driver fatigue whether the workday is extended or not.

The scope of the study included a literature review complemented by a survey of selected motorcoach bus companies, industry associations, insurers of motorcoach companies, state driver licensing agencies, private driving schools, and other organizations. The information sought in the literature review and survey permitted the research team to identify and examine: (1) HOS issues in the motorcoach industry, particularly the effects of countermeasures to the extended workday; (2) similarities and differences in the approach of the trucking and motorcoach industries in complying with HOS regulations; and (3) current or on-the-horizon technologies that could assist motorcoach operators in combating fatigue.

The challenge of this synthesis was the limited availability of empirical research in the domain of motorcoach operator fatigue effects. The literature review and discussion of the current state of the art in fatigue research and countermeasures depended to a great extent on a 1999 study that included focus groups and telephone surveys with over-the-road bus company managers and research scientists (Arrowhead Space & Telecommunications, Inc., 1999). By the same token, much of the background on the scientific foundation for the general discussion on fatigue and fatigue countermeasures came from a major 2003 study funded by the U.S. Department of Transportation Research and Special Programs Administration (McCallum et al., 2003). A third report produced by the TCRP (Gertler et al., 2002) was a valuable source of specific countermeasures to bus operator fatigue.

In terms of research findings and support, this synthesis does not break new ground. It does put in one document the research findings of fatigue in transportation studies in general and bus operator fatigue studies in particular. Its major contribution is the results of recent and current surveys of over-the-road bus company managers and the relevant research community. Again, the results of these surveys do not contain many surprises. But they do represent a snapshot of current over-the-road bus company practices and options as regards bus operator fatigue.

Given that empirical research into the specific problems facing over-the-road bus operators is limited, this subject appears to be a natural candidate for a major research study.

Bus transportation is often the first choice of seniors looking for tours and destinations in their retirement years. As the number of such people grows, the need for safe bus operators will grow as well. Bus companies and drivers could use a set of guidelines and aids, based on scientific research, to combat motorcoach operator fatigue effects. This research and its products could be major contributors to over-the-road bus safety.

FINDINGS

Although major research studies into operator fatigue have been reported, motorcoach operators have not been included in these studies. Although the similarities between over-the-road truck drivers and over-the-road bus drivers are many, the latter also have unique situations that may either increase or decrease incidences of fatigue.

Managers surveyed for this and other studies reported very few bus crashes associated with bus operator fatigue. The research personnel responding to the survey believe that bus operator fatigue may be a significant contributor to over-the-road safety incidents. However, there is little statistical support for that belief.

Bus company managers identified operator training as a major countermeasure to bus operator fatigue. The researchers also identified rest and regular schedules as key features of any fatigue countermeasure program.

Managers reported significant pressure from passengers to have bus operators drive for longer periods. They also reported that as many as 75% of bus operators also handle passenger luggage.

Both drivers and managers believe that nearly all bus operators are familiar with current Federal HOS regulations.

CONCLUSIONS

There is no evidence that over-the-road bus operators are any more susceptible to fatigue than other commercial drivers or other transportation operators.

There has been very little objective research conducted on over-the-road bus operators and this is particularly true when it comes to fatigue research.

Fatigue countermeasures that work for over-the-road truck operators should work for over-the-road bus operators as well. Both bus and truck operators drive large vehicles on long, over-the-road routes. There is no evidence that bus and truck operators are drawn from different workforce populations; they are also subject to the same work related pressures, schedules, and challenges.

The effects that passengers have on either combating or amplifying fatigue in bus operators have not been well documented.

RECOMMENDATIONS

A research study on the specific effects of fatigue on over-the-road bus operators should be conducted.

Any research into either causes of fatigue or fatigue countermeasures should include over-the-road bus drivers as part of the subject pool.

Over-the-road bus companies and associations should be encouraged to provide counter-fatigue products, training on fatigue effects, and combating fatigue information and support to all bus operators, even when those products and materials may have been developed for the trucking industry.

A research program on the effects of passengers on bus operator fatigue (including the effects of non-driving tasks) should be instituted.

CHAPTER 1

INTRODUCTION

BACKGROUND

Operator fatigue is a critical issue that applies to all modes of commercial transportation. Fatigue can induce sleepiness and drowsiness, decrease alertness, degrade the ability of workers to operate vehicles safely, and thereby increase the risk of crashes, injuries, or even fatalities.

In 2003, the U.S. Department of Transportation's Research and Special Programs Administration (RSPA) published a major reference document on commercial transportation operator fatigue management (McCallum et al., 2003). Although this all-purpose guidance document was intended to address operator fatigue in all transportation modes, commercial over-the-road bus and motorcoach operators were not specifically mentioned.

The National Transportation Safety Board (NTSB, 1990) determined that the incidence of operator fatigue is underestimated in virtually every transportation mode, because it is so hard to quantify and measure. Many accident investigations do not obtain the information necessary to address the contribution of fatigue: namely, the condition of the operators, the extent to which they have been deprived of sleep, and their state of alertness. Therefore, it is likely, most transportation accident and crash records do not adequately account for fatigue-related factors that might have played a significant part of the investigative report.

Available analyses of crash reports and accident and incident data suggest that operator fatigue may contribute to between 20% and 40% of commercial transportation accidents. A 1996 U.S. Coast Guard study (McCallum, Raby, and Rothblum, 1996) reports the results of analyzing 297 commercial marine casualty investigations, using procedures specially developed to identify the contribution of fatigue to the accidents. Analysis of these reports indicated that fatigue was a contributing factor in 16% of vessel casualties and in 33% of the personnel injuries investigated.

Managing the fatigue of commercial transportation operators requires an understanding of the practical implications of fatigue research, coupled with the application of appropriate fatigue management practices. Fatigue research has been conducted to address a wide range of issues and operational settings. A number of operator fatigue management training workshops, guidelines, and handbooks have been developed to aid in the development of individual fatigue management programs.

Fatigue management program elements and fatigue research findings can be extracted from earlier efforts that have general applicability across a range of commercial transportation modes (McCallum et al., 2003, p. 1-1).

Hours of Service Regulations

The original hours of service (HOS) regulations prescribed for commercial drivers were promulgated in 1939. Since then, as the FMCSA discusses on its Internet web site: "Our roads are better designed, constructed, and maintained in a nationwide network to provide greater mobility, accessibility, and safety for all highway users. Vehicles have been dramatically improved in terms of design, construction, safety, comfort, efficiency, emissions, technology, and ergonomics. These factors, combined with years of driver fatigue and sleep disorder research, have led to a revision of the hours-of-service regulations for drivers, the most important component of trucks operating on the highway" (FMCSA, 2004; www.fmcsa.dot.gov).

Recently revised FMCSA truck driver HOS regulations (placed into effect on 4 January 2004) only apply to property carriers and drivers. Currently, these truck driver HOS regulations are under judicial and administrative review. Commercial passenger carriers and drivers will continue operating under the previously existing rules while fatigue issues specific to the passenger carrier industry (bus and motorcoach drivers) are assessed. As of this writing, then, all bus and motorcoach operators may not drive

- More than 10 hours, following 8 hours off-duty,
- After 15 hours on-duty, following 8 hours off-duty, and
- After 60/70 hours on-duty in 7/8 consecutive days.

Over-the-Road Bus Operators

Buses of all kinds (e.g., over-the-road, transit, and school) make up about 6% of the vehicles over 10,000 pounds gross vehicle weight rating (GVWR); and they account for less than 1% of all vehicles involved in fatal accidents. Over-the-road buses represented 11% of all bus accidents from 1995 through 1999 (Putch, Blower, and Campbell, 2002).

By far, the buses most involved in recordable accidents are school buses. Transit buses also represent a large percentage of bus crashes. The low percentage of fatal accidents for

over-the-road buses reflects to a large extent the proportion of miles driven by the various bus types.

A recent study (Crum, Morrow, and Daecher, 2002) used a Commercial Motor Vehicle (CMV) Driver Fatigue Model to analyze the influence of carrier scheduling practices on motorcoach driver fatigue. However, the study identifies some clear differences between commercial truck operators and commercial motorcoach operators:

- Motorcoach seats do not provide comfortable areas for sleeping. Unlike many tractor trailer trucks, buses rarely have sleeper berth areas for drivers. On the other hand, many motorcoach operators have the opportunity to sleep in hotel rooms while transporting tour groups.
- Motorcoach drivers are in constant contact with their passengers. There are only marginal physical separations between the driver and his or her passengers' activities.
- Whereas commercial truck drivers can often drive the same hours every day or night, motorcoach drivers are tied to various tour or commercial schedules. Inverted duty/sleep cycles (i.e., driving during the day followed by a 24-hour break and then driving at night) can occur "because of group itineraries; also, itineraries may be spontaneously altered, disrupting the driver's planned schedule" (Crum, Morrow, and Daecher, 2002, p. 327).
- Drivers have the additional responsibility of helping with luggage, taking tickets, and generally looking after their passengers.
- Passengers provide an incentive for drivers to be professional and diligent, but may also provide an additional source of fatiguing stress.
- Within the tour bus operator population, peak-season demands may reduce opportunities for extended rest periods.

Although over-the-road bus operators and transit bus operators drive similar vehicles, the operations of the two groups differ. Nonetheless, research sponsored by the TCRP into bus operator fatigue (Gertler et al., 2002) reports on fatigue countermeasures that are also relevant to this report.

Bus and Motorcoach Operator Fatigue Issues

One of the first research studies to address bus driver fatigue was the October 1978 report prepared for the National Highway Traffic Safety Administration, *Effects of Hours of Service, Regularity of Schedules, and Cargo Loading on Truck and Bus Driver Fatigue* (Mackie and Miller, 1978). The most significant finding of this report was that bus and truck drivers operating on irregular schedules suffer greater subjective fatigue and physiological stress than drivers operating on a regular schedule.

Partly in response to NTSB urgings to address issues of transportation operator fatigue, three national meetings were convened in 1995 to address various issues related to

commercial vehicle operator fatigue and alertness. The first National Truck and Bus Safety Summit sponsored by the Federal Highway Administration was held March 12–15, 1995, in Kansas City, Missouri. More than 200 experts from all modes of the motor carrier community met to share their views and identify top truck and bus safety issues. Most of the discussion over this 3-day Safety Summit addressed issues concerning commercial trucking, but the commercial driver issues of concern were almost identical for bus and motorcoach drivers. In identifying the top Truck and Bus Safety Issues facing the nation, the Summit Participants listed as priority number one, a concern about CMV *driver fatigue* (Reagle, 1995).

In preparation for the Summit, focus group sessions were conducted to obtain information about highway safety issues relating to commercial motor carriers (i.e., trucks and buses). Eighteen focus groups were conducted at the request of what was then the Federal Highway Administration Office of Motor Carriers (OMC). The focus groups were held in three regions of the country: the Southeast, the Midwest, and the Northwest.

The participants were representatives of three populations that have an interest in commercial vehicle safety: commercial drivers (a total of 60 truck and bus drivers), police officers who deal in part with traffic enforcement, and the general public or non-commercial drivers (adults who drive passenger cars, light trucks, etc.).

The outcomes of group opinions about commercial buses were summarized as follows:

Very few people express any concern about buses in relation to safety. Some note that intercity buses often speed on the highway, but the drivers are generally regarded as competent and careful. Most comments about city bus drivers are unrelated to safety. Special concerns are expressed about school bus drivers, who are seen as more likely than others to receive insufficient training and monitoring (Reagle, 1995, p. D-3).

Also in 1995, a bus conference sponsored by OMC was held in Tyson's Corner, Virginia. This conference brought together leaders throughout the interstate bus industry to define and prioritize issues of importance to the industry's future vitality and safety. Hours of service/fatigue was rated as one of the highest priority issues by the industry. In November 1995, a symposium on managing human fatigue in transportation was held in Tyson's Corner, Virginia. Irregular duty/sleep patterns and inverted duty/sleep patterns were identified as major contributors to driver fatigue and therefore to commercial motor vehicle accidents.

The three 1995 national meetings led to the next major study on bus operator fatigue, sponsored by the Federal Motor Carrier Safety Administration (FMCSA) in 1999 (Arrowhead Space & Telecommunications, Inc., 1999). The Arrowhead study included a series of focus groups and phone surveys held with managers, supervisors, and drivers from over-the-road bus companies and organizations. In their bibliographical review, the authors of that report found no

research beyond Mackie and Miller (1978) specifically addressing bus drivers. A similar study in Great Britain (ROSPA, 2001) also reported a lack of reported research on motorcoach operators and fatigue effects.

Putch, Blower, and Campbell (2002) examined the records of the FARS (Federal Accident Reporting System, a census file with data on fatal accidents on U.S. public roads) looking for data on fatal accident in which bus drivers were involved during the period 1995–1999.

... the FARS file identifies the contribution of driver-related factors in an accident. Drowsy, asleep or fatigued is coded as a contributing factor for five bus drivers out of a total of 1,483 buses involved in fatal accidents over the five year period, 1995–1999, for an average of one per year. There is only one case in five years involving a school bus in a fatal accident where the driver condition was coded as drowsy, fatigued, or asleep, and no transit bus drivers were coded as fatigued. The remaining four fatigued bus drivers were split evenly between over-the-road and “other” buses. Overall, 0.3 percent of bus drivers that are involved in fatal accidents are coded as drowsy, fatigued or asleep (Putch, Blower, and Campbell et al., 2002, p. 269).

Many of the findings from these activities served as the basis for the survey questions developed for the current Synthesis study as well as the focus of the current literature review. These findings are reviewed in detail in the Results section of this synthesis.

OBJECTIVES AND SCOPE

The primary objective of this Synthesis was to identify and document the unique features of the extended workday that typifies motorcoach operations. As a second objective, the researchers reported on industry approaches to increasing the probability that the industry’s customers understand both

HOS regulations and driver rest and fatigue issues. The research team also identified any techniques that motorcoach managers, front-line employees, and drivers use to reduce fatigue-related incidences resulting from the irregular on-duty conditions facing the bus operator. A final objective was to identify any current or on-the-horizon technologies that may be appropriate for motorcoach operations to offset the effects of the extended workday and fatigue-inducing environment.

The scope of the study included a literature review complemented by a survey of selected motorcoach companies, industry associations, insurers of motorcoach companies, state driver licensing agencies, private driving schools, and other organizations. The information sought in the literature review and survey permitted the research team to identify and examine: (1) HOS issues in the motorcoach industry, particularly the effects of and countermeasures to the extended workday; (2) similarities and differences in the approach of the trucking and motorcoach industries in complying with HOS regulations; and (3) current or on-the-horizon fatigue management technologies that could assist motorcoach operators in combating driver fatigue.

The approach of the literature review has been to survey the large body of fatigue research and then, based on the results of the surveys and other source documents, apply that research to motorcoach operations and operators.

At the end of this synthesis report is a list of the references specifically identified in the report text. However, the authors reviewed many more articles, books, book chapters, technical reports, and presentations than are cited. Many of these lacked the specific kinds of information about either fatigue or motorcoach operations necessary to meet directly the objectives of this Synthesis. These documents provide general information about human fatigue and sleep research, and a rich history of fatigue-related history. Appendix C to this Synthesis contains a bibliographical listing of all these documents.

CHAPTER 2

STATEMENT OF THE PROBLEM: FATIGUE AND TRANSPORTATION EQUIPMENT OPERATORS

In the United States, in recent years several studies (NCSDR/NHTSA, 1998; Johnson, 1998; Reissman, 1996) produced various estimates of the level of sleep-related road accidents. The National Highway Traffic Safety Administration (NHTSA) estimates that there are 56,000 sleep-related road crashes annually in the United States, resulting in 40,000 injuries and 1,550 fatalities (NCSDR/NHTSA, 1998). However, specific motorcoach data are not identified in these studies.

Studies in Great Britain (Horne and Reyner, 2000), Australia (Fell, 1994), Germany (Hell, 1997), New Zealand (Land Transport Safety Authority, 1998), Norway (Sagberg, 1999), and Israel (Zomer, 1990) all identified vehicle operator fatigue as a significant contributor to road crashes. Even in such overviews of the international driver safety research community, no specific data about motorcoach operators were found.

The Department of Transportation/Research and Special Programs Administration (McCallum et al., 2003) sponsored a report that associated many factors with transportation operator fatigue. The RSPA report describes several general operational fatigue risk factors identified during structured interviews with representatives from the airline, railroad, maritime, and trucking industries. When these risk factors are present, there is an increased likelihood that operators are working with compromised alertness and possibly even in a state of fatigue. The McCallum et al. (2003) report is the primary source document for the following discussion of many factors that contribute to transportation operator fatigue; many of these pertain to commercial bus and motorcoach operators as well.

EXTENDED WORK AND COMMUTING PERIODS

Most commercial transportation operator work hours are regulated by Federal HOS rules. Therefore, long work hours seldom—independently—result in operator fatigue. Rather, it is the combination of long work periods and other non-duty factors that contribute to on-the-job fatigue, by limiting the available time for recreation, rest, and sleep. Over extended working periods, repeated inadequate sleep periods can result in accumulated sleep debt and associated operator fatigue. Among the primary aspects of extended work and/or commuting periods that have been cited as contributing to operator fatigue are

- Long commutes to or from work on a daily basis,
- Long waits after reporting for work before duty begins,
- Forced interruptions in work that extend the duty day, and
- Long commutes from home to report for work prior to beginning a multi-day work period.

WORK SCHEDULES

Split-Shifts

Split-shift work can increase the likelihood of operator fatigue, by resulting in schedules that are not conducive to obtaining adequate sleep. Among the primary factors that commonly occur in conjunction with split-shift schedules contributing to operator fatigue are

- Early morning start of shift;
- Late evening end of shift;
- High-paced operations during the work period;
- Limited time at home during the awake period;
- Difficulty in taking advantage of mid-day sleep opportunities; and
- Sleep/work periods conflicting with circadian rhythm.

When work schedules require people to obtain their sleep during times that are normally awake periods, the quality and quantity of sleep suffers. Work during “low” periods of the circadian rhythm (roughly 1 a.m. to 4 a.m. and 1 p.m. to 4 p.m.) can be associated with drowsiness and a low level of alertness.

Inappropriate times to obtain sleep include

- Late morning (for those adjusted to a nighttime sleep schedule);
- Afternoon (for those adjusted to a nighttime sleep schedule);
- Early evening (for those adjusted to a nighttime sleep schedule); and
- Any shift in sleep time due to time zone travel that requires sleep during the day at the origin of travel (i.e., the jet lag phenomenon).

Local night routes and cross-country routes often involve nighttime driving and daytime sleeping. Night drivers commonly shift to daytime schedules on weekends or days off, resulting in weekly disruption of their usual sleeping period. HOS rules can require an off-duty period that is not conducive to sleep (e.g., 4 p.m. to 2 a.m.), resulting in low-quality sleep immediately followed by a driving period beginning during a “low” circadian period (i.e., 2 a.m.).

Changing or Rotating Work Schedules

Many commercial transportation operations require frequent changes or rotations in schedule. These schedule shifts lead to relatively quick changes in the time of day at which operators can obtain sleep, generally resulting in inadequate levels of rest. Changing or rotating work schedules can be characterized as follows:

- Changes in work and rest schedules that do not have a fixed pattern and thereby result in fatigue management challenges that are extremely difficult to address, and
- Rotating schedules that have fairly systematic shifts in the work start and stop times.

Unpredictable Work Schedules

The amount of advance notice commercial transportation operators receive regarding their work schedule varies substantially. An unpredictable schedule can lead to forced changes in sleep times and therefore to low-quality sleep. Unpredictable schedules can also cause workers to wake sooner than necessary in order to check in with dispatchers. Conditions commonly associated with unpredictable work schedules include

- Being “on call” for work without a fixed schedule;
- First-in, first-out work pool scheduling; and
- Schedule delays resulting from equipment, weather, or traffic problems.

LACK OF REST OR NAP PERIODS DURING WORK

Taking a brief rest or nap during a work period is a controversial topic in some transportation settings, while it is considered the procedural norm in others. Research has demonstrated the value of planned napping to supplement main sleep obtained and to temporarily restore alertness on the job. Lack of rest or nap periods can result from

- Company policies that restrict or prohibit napping, and
- Unwillingness of operators to take naps.

SLEEP DISRUPTION

Interruptions to or disturbed sleep can make returning to sleep more difficult. It has been shown that both the number and timing of disruptions can adversely affect daytime alertness. Some general factors that disrupt sleep in commercial transportation operations include

- Noise, vibration, movement, uncomfortable temperature, and poor air quality in sleeping quarters;
- Unfamiliar environments away from home with less than optimal conditions; and
- Attempting to sleep at an inappropriate time for one’s circadian rhythm.

INADEQUATE EXERCISE OPPORTUNITIES

People who exercise regularly have fewer episodes of sleeplessness. Isolated exercise, while not an effective countermeasure for immediate fatigue, can improve sleep quality by promoting smoother, more-regular transitions between the cycles and phases of sleep. Moderate exercise lasting 20 to 30 minutes, three or four times a week, promotes sleep. Exercise in the morning or afternoon is preferred, because exercise close to evening bedtime can disrupt the onset of sleep. A brisk walk can be very beneficial, although more vigorous exercise has been shown to provide increased health benefits. Even exercises designed for environments with restricted space (e.g., inside a truck sleeper berth) have also been shown to be beneficial. Factors that may limit exercise opportunities include

- Personal habits that might need to be overcome in initiating an exercise program,
- Work schedules that might need to be adjusted to include appropriate exercise opportunities, and
- Travel or living conditions that can limit access to exercise equipment or space.

POOR DIET

What one eats can be a determining factor in sleep quality and duration. Some dietary behaviors that can disrupt sleep include

- Eating heavy or spicy foods just prior to bedtime, which can interfere with sleep by causing heartburn;
- Consuming alcohol just prior to bedtime can induce sleep initially, but tends to lead to fragmented sleep; and
- Consuming caffeine within 4 to 6 hours before bedtime can delay the onset of sleep as well as disrupt sleep.

ENVIRONMENTAL STRESSORS

Several environmental factors can adversely affect a commercial transportation operator’s level of alertness. These

include environmental aspects related to heat, humidity, cold, altitude, vibration, and noise.

Heat and Humidity

Generally, one experiences high ambient temperatures as dry heat (temperature above 85°F, humidity less than 50%) or wet heat (temperature above 85°F, humidity above 80%). All excessively hot conditions make operators feel less alert and generally more fatigued. Hot-wet working conditions can be significantly more detrimental to worker performance than can hot-dry conditions and will usually make one feel “fatigued” much sooner than will temperatures less than 75°F.

Cold

Cold weather can indirectly contribute to operator fatigue. Operators often wear several layers of clothing during cold weather, which can make using restroom facilities more difficult, which in turn can lead operators to reduce the amount of liquids they consume. Reduced liquid consumption can then lead to dehydration, which can cause operators to become fatigued more quickly than usual.

High Terrestrial Altitude

Driving at altitudes in excess of 5,000 feet can increase a driver’s respiration and heart rate; and sleeping at high altitude can result in blood pooling in the arms and legs. Spending even a few hours at high terrestrial altitude (e.g., mountainous passes) can cause the general malaise and discomfort that accompanies Acute Mountain Sickness (AMS). These effects dissipate as one acclimates to a higher altitude, usually in a matter of a few days.

Drivers should be aware of the effects of high altitude, and, if at all possible, should avoid sleeping at high altitudes (e.g., above 5,000 feet).

Whole Body Vibration

Whole-body vibration and acceleration accompany operation of several types of transportation vehicles, including aircraft, helicopters, large trucks, buses, trains, ships, and small vessels. Operation of helicopters, automobiles, trucks, and buses exposes operators to increasing acceleration magnitudes, with a frequency range extending up to 100 Hz, depending on the roughness of the air/road/seas and the vehicle speed. Although most operators consider these to be lower-level fatiguing effects, they can add to operators’ general feeling of fatigue, thereby compromising their alertness while operating equipment, especially if they are exposed to these effects over long duty days.

Acoustical Noise

Operators are exposed to engine noises in all transportation vehicles, as well as related noises emanating from controls, transmissions, braking systems, and wind streams. Some of these noises present more of a hearing-conservation issue than a driver fatigue issue. In fact, wearing ear protection in the presence of these noises is often called for; however, these noises can also contribute to an operator’s level of fatigue. The continuous “hum” and other intermittent noises of most running engines, especially in hot and stuffy crew compartments, can contribute to sleepiness on lengthy trips. Being aware that noise can contribute to one’s overall feeling of operator fatigue is an important step toward ensuring that operators take rest breaks.

CHAPTER 3

STRATEGIES AND TECHNIQUES TO COUNTER FATIGUE

Transportation industries of all modes continue to search for ways to prevent or counter the effects of operator fatigue. Fatigue countermeasures are identified in one of three general approaches: (1) individual personal actions (e.g., carefully monitoring one's diet, obtaining plenty of rest, and avoiding some medications), (2) managerial (e.g., scheduling and assignments and company policies), and (3) technological (e.g., in-vehicle operator monitoring devices and road and highway design features). A fourth approach, of course, is regulatory and pertains mostly to HOS considerations as briefly described earlier in this report.

The McCallum et al. (2003) report addresses 20 fatigue countermeasures. The authors organized the 20 countermeasures into four categories based on the results of varied amounts of research. Some of the countermeasures are known to be effective; some might be effective but are still being studied; others require medical or other professional supervision; and some simply do not work or may even have harmful health effects. A second major information source for this discussion is *TCRP Report 81: Toolbox for Transit Operator Fatigue* (Gertler et al., 2002).

COUNTERMEASURES THAT CLEARLY WORK

The countermeasures described in this category are effective as shown by research data and operational experience. They encompass both the *prevention* of fatigue by getting enough sleep and the *mitigation* of fatigue through countermeasures applied when one is getting tired. Individual countermeasures may need to be combined, based on specific operational circumstances. Countermeasures included in this category are as follows:

- Obtaining adequate sleep,
- Napping,
- Anchor sleep,
- Caffeine,
- Trip planning, and
- Good sleeping environment.

Obtaining Adequate Sleep

Historically, the medical community believed the brain was inactive during sleep, but research over the past half century demonstrated sleep actually consists of several stages

and, in some of the stages, the brain is often very active. A typical night's sleep consists of cyclic sleep stages. The only way that the different stages are easily recognizable is through the use of electroencephalography (EEG), a physiological recording means that measures changes in the electrical brainwave potentials on the surface of the scalp. With the possible exception of rapid eye movement (REM) sleep, merely observing an individual asleep will not identify the various sleep stages. Lengthy bouts of human sleep consist of several 90-minute cycles of brainwave stages. Each sleep cycle consists of several sleep stages, some deeper than others and not all of them conducive to dreaming. The basic stages of sleep are as follows:

- Stage 1 occurs as we drift off to sleep. This is a relaxed, half-awake state of "falling asleep" or light sleep.
- Stage 2 sleep begins as relaxation proceeds and the heart rate slows. During this period, body movement ceases and muscle tension eases.
- Stages 3 and 4, often referred to as slow-wave sleep, are characterized by different brain activity levels. These are deep states of sleep, which are more difficult to awaken from and, along with sleep, constitute the stages of sleep that are truly restful and restorative.
- REM sleep, usually occurs last after a cycle or two of Stages 1 through 4 sleep have been obtained. REM sleep, as the name suggests, is characterized by rapid eye movements and generally occurs at the end of each 90-minute cycle. This part of the sleep cycle is characterized by significant brain activity, electrophysiologically, almost as if the brain were actively awake, but only the eyes are moving behind the eyelids. During REM sleep there is a lack of muscle tone, thus preventing the individual from "acting out" dreams.

During the night, sleep behavior may systematically alternate between the slow wave and REM stages. As the night progresses, REM periods lengthen so that sometimes the last one before awakening may comprise almost one-half of the sleep cycle. Sleep specialists agree that adults need an average of 7.5 to 8 hours of sleep every night to perform in a maximally alert fashion on the job. However, there are exceptions. Some individuals can function normally on as little as 6 hours of sleep, while others require 9 hours. To be most restful and recuperative, sleep stages should proceed through all the sleep cycles.

This is why eight 1-hour naps do not provide the restorative rest of a longer continuous sleep period.

Understanding one's individual sleep pattern is crucial for taking the steps to ensure sufficient restorative sleep. People can determine their optimum sleep amount by recording their sleep start and stop times on their third consecutive day off when they are not using an alarm clock to wake up.

The amount of sleep needed should be enough to feel refreshed and healthy the next day, but not more—this will usually be between 7.5 and 8.5 hours. Based on the amount of sleep needed, people should establish a habitual time for going to sleep and waking up, and then maintain this schedule whether or not it is a workday. Additionally, daily exercise helps to promote sounder sleep.

Getting good sleep depends on knowing what to avoid prior to sleeping. It is especially important to avoid caffeine, a widely used stimulant compound—it should be avoided within 4 to 6 hours of going to sleep, since caffeine effects can last that long. It is also important to avoid drinking alcohol within 3 hours of bedtime, because alcohol fragments sleep and makes it less restorative. Cutting down or eliminating nicotine is important for promoting good sleep. Drinking fewer fluids before going to sleep will reduce awakenings to use the bathroom.

Napping

Napping is one of the most popular coping mechanisms for those working nontraditional hours. Although science is split as to the benefits and consequences of napping, there is significant evidence of the value of supplementing the primary sleep period with a nap. In recent years both railroads and airlines have instituted policies that permit napping during work hours. An excellent description of the value and strategy of napping can be found in Gertler et al. (2002) and is quoted below.

Research has shown that subjective sleepiness and sleep quality seem to be a function of the total sleep over the course of the day, and not a function of the number or lengths of the naps. In other words, napping can be effective for meeting the daily sleep requirements, but the length of the nap determines whether or not it significantly adds to a short main sleep period.

A nap of less than 90 minutes, or one that does not go through an entire sleep cycle of slow wave and REM sleep, will not significantly add to a short main sleep period and may not prevent the onset of fatigue. While a nap of up to 20 minutes may not compensate for inadequate daily sleep, it may eliminate the performance manifestations of fatigue for a short period of time. This type of nap is usually unscheduled and results from an uncontrollable sleep pressure or need to sleep. As such, this "emergency" nap should be reserved for infrequent use and not be a regular component of an individual's sleep schedule. Scheduled naps of appropriate timing and duration, well integrated into the worker's sleep management program are a better course of action. With all naps the issue of sleep inertia or hangover is a factor, just as it is with main sleep periods.

Nap placement may be key to the consequences of napping. The timing of a nap rather than its length has more of an effect on an individual's alertness or performance fol-

lowing the nap. Research showing a benefit to napping placed the nap right before the work start time while research reporting a performance decrement due to napping allowed napping to occur throughout the day as desired. This illustrates the complexity of napping. Both the length and timing of a nap are co-dependent on each other and may affect one's performance and alertness differently depending upon their level.

While many research questions still remain with regard to naps, when used appropriately napping is a viable strategy for supplementing an inadequate main sleep period and as such can improve on-the-job alertness. Since napping is a primary self-prescribed fatigue countermeasure, often without regard to appropriate usage and potential negative consequences, providing information on effective napping strategies can help the workforce to be more alert on the job. (Gertler et al., 2002, pp. 22–23)

Anchor Sleep

Anchor sleep refers to a regular sleep period of at least 4 hours' duration, obtained at the same time each day. The anchor sleep period is supplemented by additional sleep periods (e.g., naps) taken when the schedule allows.

Employing an anchor sleep and taking supplemental naps should be used as a coping mechanism for situations where one cannot get a full continuous eight hours of normal sleep. While split sleep periods may give one a sufficient amount of sleep on a short-term basis, getting a full sleep allotment in a single episode is preferred.

Anchor sleep periods have the advantage of stabilizing a person's circadian physiological rhythm to a 24-hour period, so that a motorcoach operator does not constantly feel "out of synch" with the clock. He or she can time the anchor sleep period so that the circadian rhythm high and low points correspond to work and sleep periods. Research data indicate that it is important to have the anchor sleep period occur at a constant time every day. If a driver is going to use anchor sleep, the driver and the company must make sure his or her schedule allows this. (Minors and Waterhouse, 1981, 1983)

Anchor sleep is not a substitute for getting a full 8 hours' sleep during any 24-hour period. Instead, it is a coping mechanism meant to keep one's circadian rhythm synchronized to a daily schedule. It is important to supplement anchor sleep with naps that are sufficient to provide the complete sleep allotment that we need on a daily basis. This countermeasure anchors the sleep cycle.

Caffeine

Our bodies gradually build up a tolerance to repeated consumption of high levels of caffeine (e.g., 5+ cups of coffee per day). A frequent coffee drinker may need a higher dose of caffeine to obtain the same "boost" effect of the more casual coffee drinker. Therefore, workers who wish to benefit from the alerting effects of caffeine should consume caffeine sparingly and "save the boost effect" until they really need it (e.g., during

two known physiological lull points of every day: 1–4 PM and 1–4 AM).

Caffeine, a mild stimulant, is one of the most commonly used fatigue countermeasures, usually through drinking coffee. Other popular drinks and foods contain a lot of caffeine, including cola drinks, chocolate, and tea. Caffeine is widely available and can have the advantage of breaking up a fatiguing work routine (e.g., a long, monotonous drive). Caffeine affects the nervous system within 15 to 20 minutes.

The effects include a more rapid heartbeat and increased alertness that may last for 4 to 5 hours. In especially sensitive individuals the effects may last up to 10 hours (De Valck and Cluydts, 2001).

Coffee has the highest caffeine level, followed by tea, cola drinks, and chocolate. Over-the-counter cold medications also contain caffeine, as do “alertness aids” such as NoDoz and Vivarin. The caffeine content of coffee may vary substantially depending on preparation. The irony of caffeine is that although it can aid alertness when a motorcoach driver is on duty, it may hinder his or her ability to sleep once off duty. And large amounts of caffeine raise one’s blood pressure for the period of time the caffeine is still in the bloodstream.

Trip Planning

Trip planning is using knowledge of the length and structure of a trip to plan rest intervals at particular times and places en route. The limitations on trip planning involve factors that are often outside of a driver’s immediate control, such as when his or her work shift starts, the availability of rest areas, and the pace of operations.

In general, trip planning is an effective approach to starting work more refreshed, and alleviating fatigue while on the job. The primary advantage of trip planning is that motorcoach operators can *anticipate* those times at which they will be feeling fatigued and do something about it before it lowers performance to unsafe levels. It also provides some structure along the route so drivers will be less likely to overextend themselves. Proper use of trip planning and the associated rest intervals will keep drivers from getting dangerously fatigued and also allow them to plan where and when to sleep for their main sleep period during multiple-day trips. Trip planning can be considered both a *preventive* countermeasure, as well as an *operational* approach (Rosekind et al., 1995).

The difficulty of trip planning for motorcoach operators lies in the pre-determined schedules within which they must operate. Itineraries are seldom built with the coach driver in mind. Passenger needs, whether individuals traveling point to point or tour groups, determine the basic schedule for the motorcoach operator. He or she must be able to identify places to rest and break while meeting the scheduling demands of the passengers. Motorcoach company managers should be

encouraged to fold the resting needs of their drivers into the scheduling equation.

Good Sleeping Environment

The sleep environment should be quiet and dark, using room-darkening shades if necessary. Earplugs can be helpful if there is noise. The temperature of the sleeping room should be around 65°F, and the bed should be used only for sleeping—not for activities such as reading or television watching (Zarcone, 2000).

One clear advantage for motorcoach operators in combating fatigue is their access to hotel and motel rooms on a regular basis.

The McCallum et al. (2003) report makes the following recommendations to drivers seeking restful sleep:

To ensure quiet, you should remove any noise sources, especially those that are unpredictable (e.g., pets in the bedroom). Use of earplugs to reduce traffic noise or other external sounds helps many people, as does use of a constant low-level noise source such as a fan. Reducing the amount of light in your sleeping area can be done by using black out shades over windows, heavy dark fabric for curtains, or “hurricane shutters” over windows. Some people also use eye shades in areas where there is substantial light leakage (p. 4–14).

COUNTERMEASURES IN THE RESEARCH PHASE

The countermeasures described in this category show promise for reducing fatigue, but generally they are some distance from practical application and are not available for implementation without the assistance of fatigue research professionals. The countermeasures included in this category are, for the most part, technological or medical.

Carroll (2004) reports on an FMCSA-sponsored fatigue management technology (FMT) pilot study conducted in partnership with Transport Canada and the American Transportation Research Institute. Although the study focused on the operators of commercial trucks, the findings could reasonably be applied to motorcoach operations as well.

This most recent study looked at a combination of four different technologies that tested four different kinds of fatigue management. One device was a wristwatch activity monitor that, based on objective information regarding the driver’s recent sleep history, informs him or her of his or her state of readiness to continue to perform well before requiring additional sleep.

The second device, called PERCLOS (PERcent of the Time Eyelids are CLOSed), is a system for infrared camera monitoring of driver drowsiness. The study was to determine if providing objective information about the amount of eyelid drooping could improve driver alertness (Dinges and Mallis, 1998).

The third device, a lane-tracking device, provided a second measure that presumably also measured driver alertness by monitoring the driver's performance in keeping the vehicle in the center of the driving lane. The fourth technology was a power steering system for reducing driver workload in controlling the truck in tough driving circumstances such as driving in cross winds.

The results of the study indicate that drivers who are informed frequently about their sleep status will take steps to get more sleep; in the study, those drivers who were provided with feedback from the wristwatch device increased their sleep duration by 26 minutes a day. The FMCSA study elicited encouragement from the drivers for researchers and engineers to continue development of such technologies; and the drivers recommended many improvements to the design of the prototype devices tested to make them more user-friendly.

At least two viable lane-tracking systems designed to monitor and inform drivers about their driving performance are being offered to commercial drivers and marketed to automotive original equipment manufacturers (OEMs). Additionally, in other exploratory research, technologies such as driver head movement monitoring have also shown promising results. Companies in Japan have had success in monitoring driver inputs (i.e., steering, brakes, and throttle) to assess fatigue. Much R&D has been accomplished and now selecting which driver monitoring technologies to employ and further developing them begins to focus on driver-vehicle interface, packaging, and generating cost/benefit data that are compelling to fleet buyers.

COUNTERMEASURES THAT REQUIRE SUPERVISION

The countermeasures described in this section either require a prescription by a physician (e.g., drugs such as stimulants or hypnotics) or require guidance by a person trained in circadian physiology for best application (e.g., melatonin). Drivers must be careful about countermeasures in this category, because side effects and dependencies can develop from the use of many chemical substances. The countermeasures included in this category are

- Stimulants,
- Sedatives/hypnotics,
- Melatonin, and
- Bright light.

Stimulants

Stimulants exert a physiological effect on the nervous system so that the effects of sleep loss can be temporarily reduced. Caffeine (discussed in a separate entry) is an example of a stimulant—one that does not require a prescription and that

does not have adverse side effects unless consumed in very large quantities (Babkoff and Krueger, 1992).

Even under the guidance of a physician, many stimulant compounds can have unwanted and even dangerous side effects that can affect one's performance and health. These effects may include changes in blood pressure and pulse, headaches, irritability, appetite loss, insomnia, nervousness, talkativeness, and sweating. Herbal stimulants are unregulated, and the effects of many are unknown because of lack of proper evaluation. However, it is known that ephedra in particular is associated with heart attack and stroke and is likely to soon be controlled (Gyllenhaal et al., 2000).

Most stimulants, except caffeine, are not permitted in operation of public transportation vehicles in the United States and many other industrialized nations. Many stimulants have a high potential for addiction and abuse because of the rapid euphoria that results from high doses. The use of stimulants can lead to a cycle of bingeing and crashing, and long-term abuse can lead to mental and behavioral disorders. Possession and use of controlled substances without a proper physician's prescription is illegal and can result in fines and jail time.

All motorcoach operators are subject to regulations banning use of illegal substances while operating a motor vehicle. Random drug testing is regularly carried out to cut down on the use of most known stimulants.

Sedatives/Hypnotics

Depending on the specific type of drug class, sedatives can cause changes in the nature of a person's sleep. Generally, the use of sedatives does not change the overall amount of sleep for an individual. Although some sleeping pills (used only while under a physician's prescription) can help a driver to obtain needed sleep, they often are accompanied by unwanted side effects.

Sedatives and hypnotics have the advantage of being applicable to a number of situations that might interfere with sleep, such as shift changes, jet lag, or stress-related short-term insomnia. The drugs can help to alleviate these short-term problems and be discontinued to preclude the risk of dependency. Under no circumstances should anyone use these medications without the close supervision of a physician.

If hypnotics are used for a long period of time, the user may develop a dependence on them, and there often is a "rebound insomnia" in which sleep is slightly worse for 1 or 2 nights after discontinuing the drug even if it was used for only short periods of time. If the drug is a particularly long-acting one, or if the user has high sensitivity, there may be a sleep inertia "hangover" effect the next day in which a person will feel sluggish after awakening from the drug-induced sleep (Roehrs and Roth, 2000).

Herbal remedies such as Valerian root, chamomile, kava, and lavender are promoted as sleep aids, but the evidence for their effectiveness is much less clear.

The significance of the physiological changes associated with sleeping pills make it difficult to recommend use of most commercially available pharmaceutical products at this time.

Melatonin

Melatonin is a natural sleep sedative hormone produced by the pineal gland in the brain. Melatonin levels increase in the blood stream during hours of darkness. Commercially available synthetic melatonin sold in health food stores is often used in attempts to induce sleepiness and to help one adjust the circadian rhythm to new schedules (e.g., to overcome jet lag after transmeridian travel). However, the production of synthetic melatonin is not regulated by the Food and Drug Administration, so the quality and purity of individual packages of the product is inconsistent.

If one can obtain good quality synthetic melatonin and a proper use regimen can be worked out, use of melatonin offers good promise to assist drivers in stabilizing their sleep schedules. Because melatonin naturally dissipates in the blood stream in bright light, its use as a sleep sedative is effective only in a darkened room, or a blackened-out truck sleeper berth. Many drivers report successfully using melatonin to induce sleep during their required down time when they ordinarily might not have gotten to sleep without it.

The sleep inducing properties of synthetic melatonin are short term. Although potentially helping an individual fall asleep more quickly, the use of melatonin will not necessarily lead to longer sleep periods. Those who successfully use melatonin as a sedative take it in a pill form in hopes it will help them fall asleep quickly at times when they might otherwise have trouble sleeping (e.g., during daylight hours). Individual experiences with commercially sold synthetic melatonin vary widely, perhaps partly because the actual contents of pill form melatonin are not clearly identified by the manufacturers and very likely because no recommended plan of use regimens have been succinctly worked out as of yet. Medical research continues in numerous government and university research laboratories to determine the potentially promising use of synthetic melatonin as a sedative and to identify any as-yet-unknown side effects.

If commercial drivers plan to use synthetic melatonin over a period of time, it is recommended they consult with a physician to determine what the latest research findings are on repeated use (National Sleep Foundation, 1997).

Bright Light

The use of bright light as an operational fatigue countermeasure refers to timing the exposure to outside or bright indoor light in order to shift the circadian rhythm to correspond to a new work schedule or to enhance alertness. Use of light exposure for resetting the circadian rhythm is a

complex undertaking and should be guided by a person knowledgeable in circadian physiology. Additionally, the benefits of resetting the circadian rhythm can be maintained only through fairly rigid adherence to the procedure and ensuring that other time cues (e.g., daylight) are minimized (McCallum et al., 2003).

The idea is to use bright light exposure to shift circadian rhythm toward work schedule requirements, so that the operator will obtain more sleep and be more alert when on the job. The required light is in the range of 3000 to 10000 lux—much beyond that obtained simply from indoor lights.

Special equipment is required to generate this level of illumination, and some evidence suggests that the green wavelength is especially effective. Using light exposure for several hours over a several-day period is usually most effective in shifting the circadian rhythm, although periods as short as 30 minutes have been shown to have an effect (Wright and Lack, 2001).

This countermeasure has been particularly useful for pilots and other transport workers who either rapidly shift through multiple time zones or who work on a forward rotating schedule that changes by one shift each rotation (e.g., day shift, afternoon, night). Given that motorcoach operators do not quickly transit across multiple time zones, it is unlikely that they will find this countermeasure to be very practical in their work situation.

COUNTERMEASURES THAT HAVE MINIMAL EFFECTS OR MAY CAUSE HEALTH PROBLEMS

The following fatigue countermeasures are not supported sufficiently by scientific data demonstrating their effectiveness (e.g., diet or aromatherapy) or they may cause health problems (use of tobacco and/or nicotine).

Other countermeasures that have been commonly reported, such as exercise, diet, or listening to the radio have minimal or no lasting impact on driver fatigue, even though people think they do. The countermeasures included in this category are as follows:

- Nicotine (not an effective stimulant for maintaining alertness);
- Ventilation and temperature (effects are fleeting and temporary);
- Exercise (taking rest breaks and exercising energizes one for a short while, but then onset of driver drowsiness returns quickly);
- Diet (longer term solution to health, wellness, and fitness helps to a point);
- Sound (noise-induced alertness gets old and tends to be aggravating to a tired driver); and
- Odor/Fragrance (fleeting effects are not very helpful in maintaining alertness).

**COUNTERMEASURES SPECIFICALLY USED
BY THE OVER-THE-ROAD BUS INDUSTRY**

The focus groups from the 1999 study (Arrowhead Space & Telecommunications, Inc., 1999) also recommended a set of countermeasures specifically to offset bus operator fatigue. The study report lists the following countermeasures:

1. Increase minimum off-duty time for drivers to at least 10 hours between trips and improve opportunities for drivers to get better rest during long and overnight trips.
 2. Minimize inverted duty sleep cycles for drivers during extended tours and trips.
 3. Establish "first in/first out" dispatch protocols to minimize stress and fatigue-producing situations associated with dispatch.
 4. Enhance total compensation packages for drivers to attract more quality drivers to the motorcoach industry and to retain them.
 5. Provide training on fatigue causes and countermeasures for bus drivers on a regular basis.
 6. Provide bus drivers with skill training in areas such as passenger management and conflict resolution to reduce daily stress factors.
 7. Provide effective outreach and education for tour group organizations and the general bus riding public regarding regulatory and operational limitations and bus driver fatigue.
 8. Encourage the federal government to regulate the motorcoach industry as a separate entity in terms of operations and situations related to driver fatigue.
 9. Compile relevant data specific to the motorcoach industry determining the number of units in operation, miles driven, accidents, and so forth.
 10. Increase and enhance motorcoach federal regulation enforcement.
 11. Include tour group operators as responsible parties for compliance with regulations by motorcoach operators and drivers.
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CHAPTER 4

SURVEY METHODOLOGY AND RESULTS

Based on the literature review of fatigue issues facing motorcoach operators, it was apparent that a number of circumstances these drivers encountered are unique to their industry and profession. These factors include the following:

- Time with passengers—drivers can spend days (or weeks) with a tour/charter group; the interaction between the two can lead to unrealistic demands by the passengers.
- An extended workday—tour and charter groups' itineraries typically include stops at tourist attractions, leading to longer days (though usually shorter hours of driving).
- Multiple roles of the driver—sometimes, because of the amount of time spent with the passengers, drivers assume several different functions such as tour guide or even trip counselors.
- Company representative—while hired only to drive, some drivers may become the onsite spokesperson for the company's charter and route policies, pricing, etc.
- Strict scheduling—extended trips with scheduled stops at different attractions can lead to unrealistic timetables when factoring in weather, traffic conditions, construction, and other unforeseen delays.

SURVEY PARTICIPANTS

In order to determine the effect of the aforementioned factors, two constituencies were identified as representative and knowledgeable of motorcoach operators' activities. The first group consisted of motorcoach company representatives who were primarily operational and safety managers. These individuals were seen as having direct experience with both day-to-day and extended motorcoach operations. Emails were sent out requesting participation in the survey. The second group was composed of research scientists and other transportation specialists who are active in TRB commercial vehicle and bus operations committees and subcommittees. These individuals were seen as having first-hand knowledge regarding the processes, technologies, and interventions that affect motorcoach drivers.

SURVEY SCOPE

To assess the effects of fatigue and its countermeasures, two surveys were developed, one for each of the surveyed groups. The first survey, sent to motorcoach company man-

agers and supervisors, was more comprehensive about the policies and procedures of motorcoach companies. This survey, provided as Appendix A, addressed the following issues:

- Company processes and strategies used to address and combat fatigue (e.g., company training, scheduling, flexibility, and driver schedules);
- Perceived effects of passengers (e.g., requests for slower or faster driving, staying on schedules, and luggage handling);
- Typical work/rest cycles and sleeping arrangements for extended charter/tour trips; and
- Specific countermeasures drivers and companies may employ and foster to combat fatigue (e.g., using caffeine, listening to the radio, and using advanced technology devices).

The second survey, provided as Appendix B, addressed the research scientist group. Questions in this survey focused on countermeasures and their effectiveness and on company training issues.

SURVEY PROCESS

The surveys were developed using a commercial, online survey development and processing system. Each survey respondent group member was contacted via email and informed of the survey's intent and the URL where the survey could be viewed and completed.

The first respondent group consisted of members of the Motorcoach Industry Operators and were identified by and coordinated with the American Bus Association, based in Washington, DC. This organization sent an email to all members and advertised the survey in its weekly online newsletter. The potential respondents included all companies in the United States with fleets ranging from just a few motorcoaches to hundreds as well as companies whose buses are driven both regionally and nationally.

The second respondent group was composed of members of TRB committees. Respondents were identified and contacted using a listserv maintained by TRB and represents researchers, academics, and government employees. Twenty-two respondents were in this group.

Because the response rate of the survey of bus company managers was low, the research team merged the results of

that survey with the results of a series of focus groups of the same constituency reported in 1999 (Arrowhead Space and Telecommunications, Inc., 1999). The results of the survey and the Arrowhead focus groups (described below) are remarkably similar and reflect the general practices and perceptions of motorcoach industry management and supervisors.

The focus group sessions were designed to determine the issues and operating situations that are unique within the motorcoach industry and which contribute to driver fatigue. The focus groups of particular interest to this synthesis were made up of owners, operation managers, safety directors, and drivers. A series of five focus group sessions were convened by Arrowhead Space and Telecommunications, Inc. An additional focus group session was conducted by an operator for its drivers. One hundred and twenty-five people participated in the focus groups. A complete description of this process can be found in the Arrowhead (1999) report.

RESULTS OF INDUSTRY SURVEY

All of the survey respondents reported that their companies' primary business is charters/tours. The average age of vehicles for these companies is 5 to 7 years with a range of 5 years to 11 years. The average vehicle fleet for the respondent's companies is 48 vehicles with a range of 10 to 170 vehicles.

Training and Education

Respondents and participants all reported that they included fatigue and fatigue countermeasure information in their driver educational materials and as part of their regular training programs. In terms of frequency, survey respondents reported that they sometimes distributed materials and always conducted training. The focus groups also recommended that anyone in a

motorcoach company who works with drivers (e.g., dispatchers and tour group planners) should be trained on driver fatigue issues. All groups also identified training as one of the most important activities in alerting drivers to the effects of and countermeasures to fatigue.

Both the survey groups and the focus groups believe that motorcoach operators are aware of and understand current Federal HOS regulations. The survey group agreed that *all* motorcoach operators know these regulations.

Scheduling

The single most frequent method for addressing motorcoach operator fatigue is local scheduling. Somewhat contradictory, neither the survey nor focus group ranked local scheduling as significantly important. In companies with multiple locations, centralized scheduling systems are sometimes used but are not viewed as particularly effective for addressing fatigue issues. However, managers did say their companies were often flexible in scheduling and that schedule flexibility is moderately important in dealing with motorcoach driver fatigue. The focus groups also identified scheduling as a good way to control the fatigue of drivers.

Figures 1 and 2 show the survey response distribution for the series of questions probing the topics discussed above.

Passengers

Although passengers on motorcoaches are seen as problems, their effects on fatigue are not well known. Both the survey and focus group members identified passengers as creating stress, but neither group was very specific about what passengers do that is stressful. Instances of passengers specifically giving driving directions (e.g., drive faster) to motorcoach drivers were cited as rare or an event that occurs

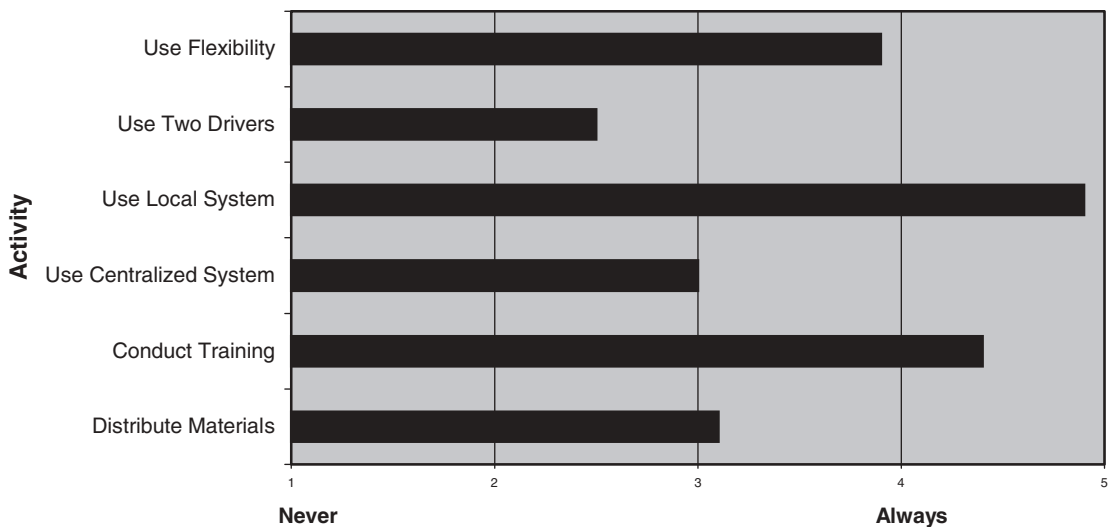


Figure 1. Industry representatives' perception of how often their companies perform activities.

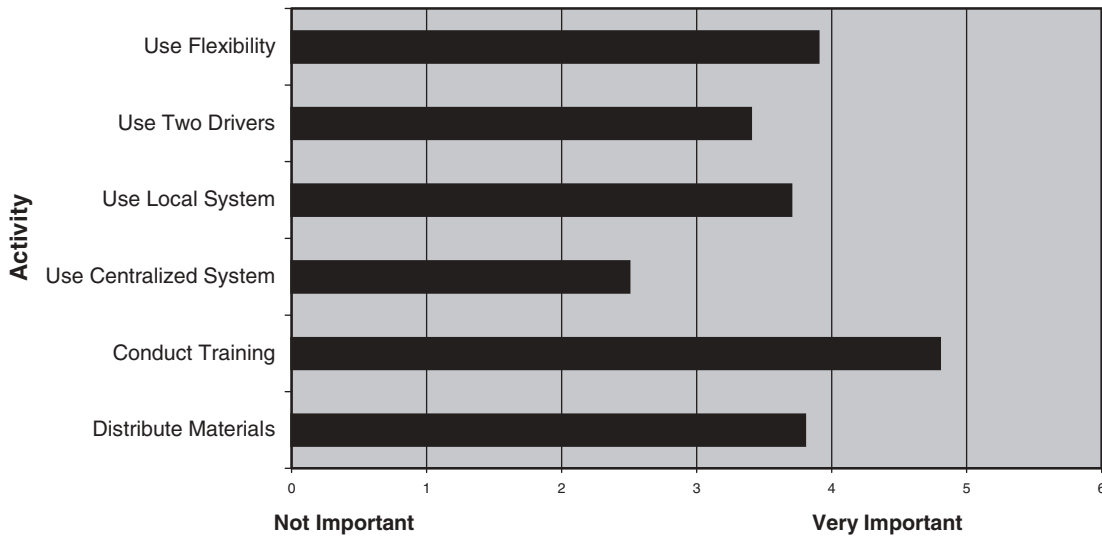


Figure 2. Importance rating for each activity for preventing fatigue.

only sometimes. Passenger requests to ignore the HOS regulations were mentioned only slightly more frequently.

All groups described the non-driving interactions with passengers to be serious problems leading to fatigue. Loading and unloading luggage, passenger assistance, and ticket handing were all identified as both fatigue inducing and as limiting opportunities to rest.

An indirect result of transporting passengers is the opportunity for motorcoach operators to sleep in hotel or motel beds. The survey group reported that 100% of their drivers sleep in hotels (90% in the same hotel as where the passengers are lodged). The focus groups also identified this as the motorcoach operator’s major defense against fatigue.

Figure 3 shows the survey response distribution for the series of questions probing passengers’ interactions with drivers.

Significance of Fatigue

There was general agreement among the managers and supervisors in both the survey and focus groups that fatigue affects motorcoach driving performance. One-half of the survey group identified it as having a significant effect. Yet 75% of this same group reported zero crashes in their companies attributed to driver fatigue in the past 2 years. One-half did not even know of a near-miss where fatigue might have been a factor. The focus groups also reported very few fatigue-related crashes.

Strategies for Combating Fatigue

The survey asked how effective were several methods of fighting fatigue and also how often each of these methods

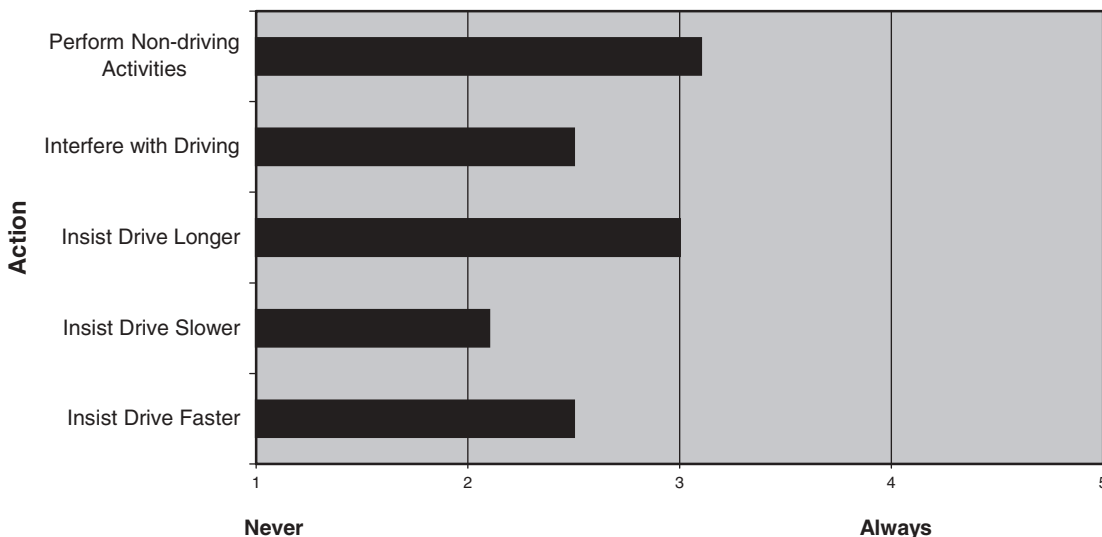


Figure 3. Frequency of requests that passengers make of drivers.

were used. The highest rated management method to countering fatigue was scheduling a full block of rest. This was also the most highly reported technique actually being used. Not surprisingly, the focus groups also strongly supported uninterrupted sleep as a key feature of any fatigue management program.

The method that was judged second most effective was providing regular schedules to the motorcoach operators. Yet when asked how often such regular schedules were provided, the answers split between “sometimes” and “often.” “Always” was not selected by any of the respondents. Although the focus groups were not asked specific questions about scheduling, the need for regular scheduling was identified as another key to combating driver fatigue.

Managers expressed skepticism about caffeine as an effective fatigue fighter, but also reported that caffeine is either often or always used by the motorcoach operators to overcome fatigue. Managers expressed some interest in technological interventions, but this interest was tinged with skepticism. There were no reported instances of a company actually using any of these new technologies. Table 1 shows the distribution of responses across the motorcoach manager and supervisor survey for the countermeasure questions.

RESULTS OF RESEARCH SCIENTIST SURVEY

The members of the research community who responded to the synthesis survey averaged 13 years’ conducting transportation research and more than 8 years’ conducting fatigue research. Slightly over 70 research scientists were contacted for the survey and 22 responded. The entire survey is in Appendix B.

Training and Education

Respondents expressed their views of the approaches motorcoach companies take to managing the fatigue of the motorcoach operators. They identified the distribution of safety literature and safety training as two common company activ-

ities. They reported fewer instances of safety training than the company managers reported. However, all groups identified safety training as the single most important intervention to manage driver fatigue.

Scheduling

The responses about scheduling also matched those of motorcoach company managers and supervisors. Both centralized and local scheduling were seen as often being used; local scheduling was seen as a more important contributor to fatigue management. Flexible scheduling was seen as an important tool but not used as often as it could be.

Figures 4 and 5 show the survey response distribution for the series of questions probing the topics discussed above.

The research community responses to the survey indicate a strong belief that fatigue has a significant effect on motorcoach operator performance. However, even among this group, more than one-half expressed a belief that there were no crashes of motorcoaches in the last 2 years caused by fatigue. They did, however, attribute from 25% to 75% of near misses and other incidents to fatigue. Although the opinion on the degree of effect of fatigue on motorcoach operator performance varied from minimal to significant, no respondent believed it had no effect at all.

Strategies for Combating Fatigue

The survey of the research group also asked how effective were several methods of fighting fatigue and also how often each of these methods was used. The highest rated method to countering fatigue was scheduling a full block of rest, although this group ranked regular scheduling as equally important. These two methods were also the most highly reported techniques actually being used. For this group, these two methods were much more effective than caffeine.

The research group was more skeptical than the industry professionals of the effectiveness of caffeine, sleeping aids, or listening to the radio to manage fatigue. They did state a

TABLE 1 Motorcoach company managers and supervisors perceived effectiveness and frequency of use mean responses for fatigue countermeasures (N=8)

	EFFECTIVENESS 1=Not at all, 5=Very	FREQUENCY 1=Never, 5=Always
Caffeine	2.5	4.3
Sleeping aids	1.5	1.8
Full block of rest	4.8	3.8
Regular schedule	4.4	3.6
Talking with others	2.8	3.0
Listening to the radio	2.5	3.0
Using 2 drivers	3.5	2.7
Technologies	2.6	1.0

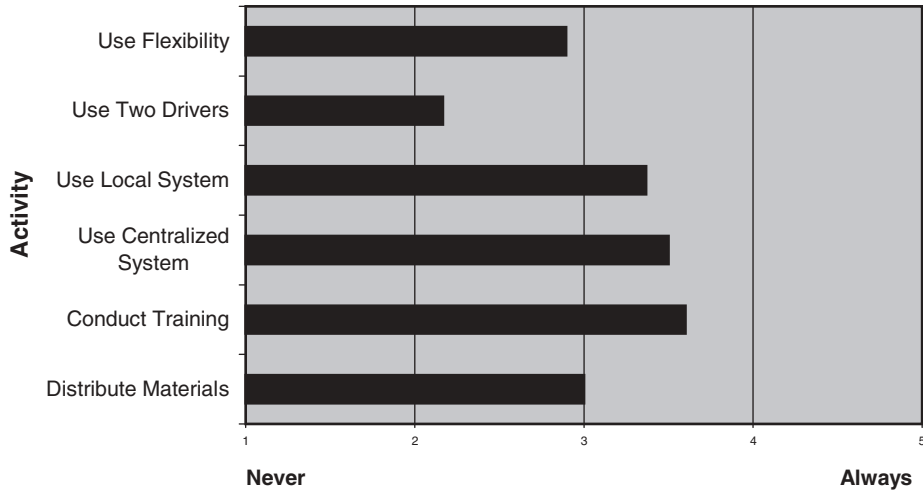


Figure 4. Researchers' perception of how often motorcoach companies perform activities.

belief that in-vehicle technologies showed promise of becoming somewhat effective in combating the driving performance decrements stemming from fatigue.

The research scientists also judged that companies were relying on caffeine and listening to the radio. They are aware that, currently, companies are not using technological interventions to counter motorcoach operator fatigue.

Table 2 shows the distribution of responses across the research scientist survey for the countermeasure questions.

The results of the two surveys plus the earlier focus groups reveal consistent points of view about motorcoach operators and fatigue. Fatigue does not appear to be a major contributor

to crashes (a supposition supported by traffic crash data) but is seen as a problem to be addressed, nonetheless. The best current approaches to managing driver fatigue do not require major investments but do require management commitment: opportunities for good sleep, regular schedules that provide adequate rest periods, and access to caffeinated beverages.

The skepticism about new fatigue management technologies by motorcoach company managers is not shared by the research community. As much as anything this skepticism reflects the stage of development of those technologies. The lack of skepticism may also reflect a better understanding of driver fatigue on the part of the research group.

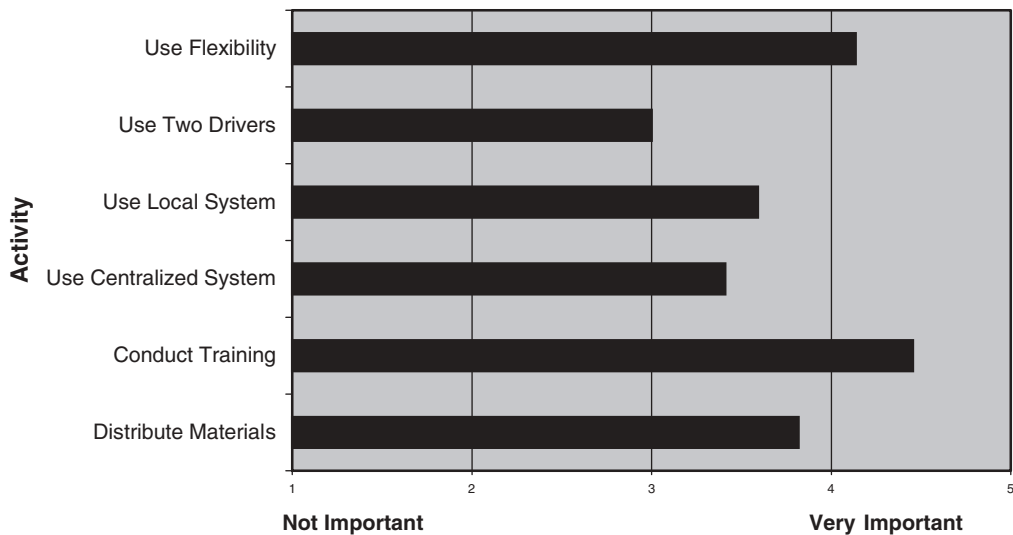


Figure 5. Importance rating for each activity for preventing fatigue.

TABLE 2 Transportation and fatigue research scientists perceived effectiveness and frequency of use mean responses for fatigue countermeasures (N=22)

	Effectiveness 1 = not at all, 5 = very	Frequency 1 = never, 5 = always
Caffeine	2.3	3.5
Sleeping aids	2.0	2.1
Full block of rest	4.4	3.5
Regular schedule	4.8	3.5
Talking with others	2.8	2.5
Listening to the radio	2.0	2.8
Using 2 drivers	3.3	2.2
Technologies	3.0	1.3

CHAPTER 5

FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

FINDINGS

Although major research studies into operator fatigue have been reported, motorcoach operators have not been included in those studies. Although the similarities between over-the-road truck drivers and over-the-road bus drivers are many, the latter also have unique situations that may either increase or decrease incidences of fatigue.

Managers surveyed for this and other studies reported very few bus crashes associated with bus operator fatigue. The research personnel responding to the survey believe that bus operator fatigue may be a significant contributor to over-the-road safety incidents. However, there is little statistical support for that belief.

Bus company managers identified operator training as a major countermeasure to bus operator fatigue. The researchers also identified rest and regular schedules as key features of any fatigue countermeasure program.

Managers reported significant pressure from passengers to have bus operator's drive for longer periods. They also reported that as many as 75% of bus operators also handle passenger luggage.

Both drivers and managers believe that nearly all bus operators are familiar with current Federal HOS regulations.

CONCLUSIONS

- There is no evidence that over-the-road bus operators are any more susceptible to fatigue than other commercial drivers or other transportation operators.

- There has been very little objective research conducted on over-the-road bus operators and this is particularly true when it comes to fatigue research.
- Fatigue countermeasures that work for over-the-road truck operators should work for over-the-road bus operators as well. Both bus and truck operators drive large vehicles on long, over-the-road routes. There is no evidence that bus and truck operators are drawn from different workforce populations; they are also subject to the same work related pressures, schedules, and challenges.
- The effects that passengers have on either combating or amplifying fatigue in bus operators have not been well documented.

RECOMMENDATIONS

- A research study on the specific effects of fatigue on over-the-road bus operators should be conducted.
 - Any research into either causes of fatigue or fatigue countermeasures should include over-the-road bus drivers as part of the subject pool.
 - Over-the-road bus companies and associations should be encouraged to provide counter-fatigue products, training on fatigue effects, and combating fatigue information and support to all bus operators, even when those products and materials may have been developed for the trucking industry.
 - A research program on the effects of passengers on bus operator fatigue (including the effects of non-driving tasks) should be instituted.
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APPENDIX A

OPERATION MANAGER SURVEY

Bus and Motorcoach Fatigue Countermeasures – OPERATION MANAGERS



RESPONDENT / ORGANIZATION INFORMATION



1

How many years have you been at your company?



2

What is your position title?



3

How many years have you been in this position?



4

How old are the vehicles in your fleet?



5

Please describe your company's primary business.



6

Approximately how many vehicles does your company have?



ATTITUDES AND PROCESSES REGARDING FATIGUE



7

How Frequently Does Your Organization Engage in the Following Activities?

1 Never 2 Rarely 3 Sometimes 4 Often 5 Always N/A

a) Distribute Educational Materials and Activities to Alert Drivers to Fatigue Issues

1 2 3 4 5 N/A

b) Conduct Safety Training

1 2 3 4 5 N/A

c) Use a Centralized Scheduling System

1 2 3 4 5 N/A

d) Use a Local Scheduling System

1 2 3 4 5 N/A

e) Use Two Drivers for One Vehicle

1 2 3 4 5 N/A

f) Use Flexibility in Scheduling (e.g., changes due to weather, traffic, etc.)

1 2 3 4 5 N/A



8

How Important Are Each of the Following Activities in Preventing Fatigue?

1 Not Important At All 2 Slightly Important 3 Somewhat Important 4 Moderately Important 5 Very Important

a) Distributing Educational Materials and Activities to Alert Drivers to Fatigue Issues

1 2 3 4 5

b) Conducting Safety Training

1 2 3 4 5

c) Using a Centralized Scheduling System

1 2 3 4 5

d) Using a Local Scheduling System

1 2 3 4 5

e) Using Two Drivers for One Vehicle

1 2 3 4 5

f) Using Flexibility in Scheduling (e.g., changes due to weather, traffic, etc.)

1 2 3 4 5

9

To the best of your knowledge, how often do motorcoach drivers report that passengers ...

1 Never 2 Rarely 3 Sometimes 4 Often 5 Always

a) Insist they drive faster?

1 2 3 4 5

b) Insist they drive slower?

1 2 3 4 5

c) Insist they drive longer than the hours of service rules?

1 2 3 4 5

d) Interfere with their driving?

1 2 3 4 5

e) Insist they perform non-driving duties?

1 2 3 4 5



10

About what proportion of your drivers are aware of the Hours of Service regulations?

Less than 10% About 25% About 50% About 75% All the drivers

1 2 3 4 5



11

How long do drivers typically wait in charter-type stopovers?

Drivers don't wait 1-2 hours 3-5 hours 6-8 hours Over 8 hours

1 2 3 4 5



12

On how many trips (approximately) do drivers handle passengers' luggage?

Less than 10% About 25% About 50% About 75% All trips

1 2 3 4 5



13

Where do drivers usually sleep if en-route with passengers? (please check only

one)

- On the bus
- At a company facility
- At the same hotel as the passengers
- At a different hotel than the passengers
- Other, Please Specify



14

To what degree do you think fatigue impacts drivers' performance at your organization?

No Impact	A Minimal Impact	A Moderate Impact	A Significant Impact
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



15

How many CRASHES have your company's drivers had in the past 2 years DUE TO FATIGUE?

None	1 or 2	3 to 5	6 to 10	Over 10
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



16

How many NEAR MISSES OR INCIDENTS have your company's drivers had in the past 2 years DUE TO FATIGUE?

None	1 or 2	3 to 5	6 to 10	Over 10
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

METHODS TO FIGHT FATIGUE

Motorcoach companies and their drivers typically use a number of different methods to help keep drivers alert and fight fatigue. Please review each of the following methods and rate each on 1) how EFFECTIVE you think each is to fight fatigue and 2) how FREQUENTLY your company uses each method.

17

How EFFECTIVE is Each Method to Fight Fatigue?

1 2 3 4 5
Not Effective at All Slightly Effective Somewhat Effective Moderately Effective Very Effective

Using Caffeine to Maintain Alertness

1 2 3 4 5

Using Sleeping Aids (melatonin, Sominex) to Help Initiate Sleep

1 2 3 4 5

Scheduling a Full Block of Rest (7 to 8 hours)

1 2 3 4 5

Scheduling Routes/Trips to Follow a Regular Schedule

1 2 3 4 5

Talking with Others

1 2 3 4 5

Listening to the Radio

1 2 3 4 5

Using 2 Drivers on Selected Routes

1 2 3 4 5

An "Alert Indicator" Such as Offered by Assistware that Monitors Driving Performance

1 2 3 4 5

The "Co-Pilot" System, that Detects How Often and Long Drivers' Eyes are Closed

1 2 3 4 5

A System to Detect Lane Departures and Alerting the Driver, Such as the Iteris AutoVue System

1 2 3 4 5

A Sleep Detection System that Monitors a Driver's Head Position ("bobbing") Such as "HeadTrak"

1 2 3 4 5



18

How FREQUENTLY Do Your Company's Drivers Use Each of the Following Methods to Fight Fatigue?

1 2 3 4 5
Never Rarely Sometimes Often Always

Using Caffeine to Maintain Alertness

1 2 3 4 5

Using Sleeping Aids (melatonin, Sominex) to Help Initiate Sleep

1 2 3 4 5

Scheduling a Full Block of Rest (7 to 8 hours)

1 2 3 4 5

Scheduling Routes/Trips to Follow a Regular Schedule

1 2 3 4 5

Talking with Others

1 2 3 4 5

Listening to the Radio

1 2 3 4 5

Using 2 Drivers on Selected Routes

1 2 3 4 5

An "Alert Indicator" Such as Offered by Assistware that Monitors Driving Performance

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The "Co-Pilot" System, that Detects How Often and Long Drivers' Eyes are Closed

1 2 3 4 5

A System to Detect Lane Departures and Alerting the Driver, Such as the Iteris AutoVue System

1 2 3 4 5

A Sleep Detection System that Monitors a Driver's Head Position ("bobbing") Such as "HeadTrak"

1 2 3 4 5



RECOMMENDATIONS



19

Please provide descriptions of any strategies, activities, or devices that you think would help motorcoach drivers prevent fatigue or detect fatigue when they are driving.



FOLLOW-UP



If you would like an electronic copy of this survey's results, please provide us with your Name, Company, and E-mail address.



20

Name



21

Company



22

Email Address



APPENDIX B

RESEARCHER SURVEY

Bus and Motorcoach Fatigue Countermeasures – RESEARCHER / TRB



RESPONDENT INFORMATION



1

How many years have you been conducting research in transportation?

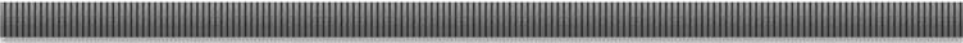


2

How many years have you been conducting research in the area of fatigue?



ATTITUDES AND PROCESSES REGARDING FATIGUE



3

How Often Do You Believe Motorcoach Companies Perform the Following Activities?

1 2 3 4 5 N/A
Never Rarely Sometimes Often Always

a) Distribute Educational Materials and Activities to Alert Drivers to Fatigue Issues

1 2 3 4 5 N/A

b) Conduct Safety Training

1 2 3 4 5 N/A



c) Use a Centralized Scheduling System

1 2 3 4 5

d) Use a Local Scheduling System

1 2 3 4 5

e) Use Two Drivers for One Vehicle

1 2 3 4 5

f) Use Flexibility in Scheduling (e.g., changes due to weather, traffic, etc.)

1 2 3 4 5



4

How Important Are Each of the Following Activities in Preventing Fatigue for Motorcoach Drivers?

1 2 3 4 5
Not Important At All Slightly Important Somewhat Moderately Important Very Important

a) Distributing Educational Materials and Activities to Alert Drivers to Fatigue Issues

1 2 3 4 5

b) Conducting Safety Training

1 2 3 4 5

c) Using a Centralized Scheduling System

1 2 3 4 5

d) Using a Local Scheduling System

1 2 3 4 5

e) Using Two Drivers for One Vehicle

1 2 3 4 5

f) Using Flexibility in Scheduling (e.g., changes due to weather, traffic, etc.)

1 2 3 4 5



5

In general, to what degree do you think fatigue impacts motorcoach drivers' performance?

No Impact	A Minimal Impact	A Moderate Impact	A Significant Impact
1	2	3	4



6

In your opinion, approximately what percentage of motorcoach CRASHES that occurred in the United States in the past 2 years are DUE TO FATIGUE?

0	25%	50%	75%	100%
1	2	3	4	5



7

In your opinion, approximately what percentage of motorcoach NEAR MISSES OR INCIDENTS that occurred in the United States in the past 2 years were DUE TO FATIGUE?

0	25%	50%	75%	100%
1	2	3	4	5



METHODS TO FIGHT FATIGUE



Motorcoach companies and their drivers typically use a number of different methods to

help keep drivers alert and fight fatigue. Please review each of the following methods and rate each on 1) how EFFECTIVE you think each is help motorcoach drivers fight fatigue and 2) how FREQUENTLY you believe motorcoach companies use these methods.



8

How EFFECTIVE is Each Method to Fight Fatigue?

1 2 3 4 5
Not Effective at All Slightly Effective Somewhat Effective Moderately Effective Very Effective

Using Caffeine to Maintain Alertness

1 2 3 4 5

Using Sleeping Aids (melatonin, Sominex) to Help Initiate Sleep

1 2 3 4 5

Scheduling a Full Block of Rest (7 to 8 hours)

1 2 3 4 5

Scheduling Routes/Trips to Follow a Regular Schedule

1 2 3 4 5

Talking with Others

1 2 3 4 5

Listening to the Radio

1 2 3 4 5

Using 2 Drivers on Selected Routes

1 2 3 4 5

An "Alert Indicator" Such as Offered by Assistware that Monitors Driving Performance

1 2 3 4 5

The "Co-Pilot" System, that Detects How Often and Long Drivers' Eyes are Closed

1 2 3 4 5

A System to Detect Lane Departures and Alerting the Driver, Such as the Iteris AutoVue System

1 2 3 4 5

A Sleep Detection System that Monitors a Driver's Head Position ("bobbing") Such as "HeadTrak"

1 2 3 4 5



9

How FREQUENTLY Do Motorcoach Companies Use Each of the Following Methods to Fight Fatigue?

1 2 3 4 5
Never Rarely Sometimes Often Always

Using Caffeine to Maintain Alertness

1 2 3 4 5

Using Sleeping Aids (melatonin, Sominex) to Initiate Sleep

1 2 3 4 5

Scheduling a Full Block of Rest (7 to 8 hours)

1 2 3 4 5

Scheduling Routes/Trips to Follow a Regular Schedule

1 2 3 4 5

Talking with Others

1 2 3 4 5

Listening to the Radio

1 2 3 4 5

Using 2 Drivers on Selected Routes

1 2 3 4 5

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A Sleep Detection System that Monitors a Driver's Head Position ("bobbing") Such as HeadTrak

1 2 3 4 5



RECOMMENDATIONS



10

Please provide descriptions of any strategies, activities, or devices that you think would help motorcoach drivers prevent fatigue or detect fatigue when they are driving.



FOLLOW-UP

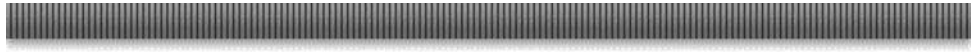


If you would like an electronic copy of this survey's results, please provide us with your Name, Organization, and E-mail address.



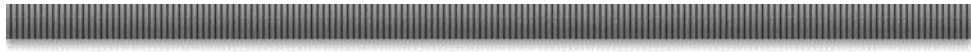
11

Name



12

Organization



13

Email Address



APPENDIX C

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Abbreviations used without definitions in TRB publications:

AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
IEEE	Institute of Electrical and Electronics Engineers
ITE	Institute of Transportation Engineers
NCHRP	National Cooperative Highway Research Program
NCTRP	National Cooperative Transit Research and Development Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
SAE	Society of Automotive Engineers
TCRP	Transit Cooperative Research Program
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation