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Motor Carrier Scheduling Practices and Their Influence on Driver Fatigue

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Abstract
The primary objective of this report is to develop a better understanding of how the scheduling practices of motor carrier firms affect driver fatigue. The basis of this empirical research is a commercial driver fatigue model that includes driving environment (i.e., regularity of time, trip control, and quality of rest), economic pressures exerted on drivers (from customers, carriers, and the drivers themselves) and company safety practices as key factors in explaining driver fatigue. The model utilizes two measures of fatigue: frequency of close calls due to fatigue and driver perceptions of fatigue as a problem. Crash involvement is used to evaluate general safety performance.

Three separate studies were conducted. First, the influence of driving environments alone on fatigue among over-the-road truck drivers was tested through a survey of 502 drivers at five geographically dispersed truck stops. A typology of driving environments was developed and the percent of drivers in each category was determined. It was found that a large number of drivers are in the "high fatigue risk" categories. Regression analysis identified starting the work week tired and longer than expected loading and unloading time as significantly related to both measures of fatigue. Regularity of time, regularity of route, and hours of uninterrupted sleep were each statistically significant factors for one fatigue measure.

Next, the complete model was tested on a random sample of 279 drivers at 116 trucking companies and 122 drivers at 66 motor coach companies, which was then stratified on the basis of safety performance (i.e., SAFESTAT ratings). Data for these two studies were generated from surveys of drivers, safety directors, dispatchers, and top management at the sample firms. In the truck company study, starting the workweek tired was the single most significant factor related to fatigue. Other significant fatigue-influencing factors were difficulty in finding a place to rest and shippers' and receivers' scheduling requirements (including loading and unloading). Company safety practices that mitigated driver fatigue were carrier assistance with loading and unloading, carrier efforts to minimize nighttime driving, and driver voluntary attendance at corporate safety and training meetings.

In the motor coach company study, the most significant factors related to driver fatigue were starting the work week tired, driving tired to make a good income, and pressure on drivers to accept trips. Two safety measures – drivers' perceptions of their company's safe drivingculture and policies, or attempts to minimize nighttime driving – mitigated some of the factors that adversely affect driver fatigue.

Keywords
carrier safety practices, dispatcher, driver, driver fatigue, driving environments, economic pressures, motor carrier, motor coach, safety director, scheduling practices, truck

Disciplines
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FINAL REPORT

FMCSA
Federal Motor Carrier Safety Administration

October 2002

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Foreword

The purpose of this report is to develop a better understanding of how the scheduling practices of motor carrier firms affect driver fatigue. Three separate studies were conducted. First, the influence of driving environments alone on fatigue among over-the-road truck drivers was tested through a survey of 502 drivers at five geographically dispersed truck stops. A typology of driving environments was developed and the percent of drivers in each category was determined.

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Members of the general public will find this report interesting and informative, as will anyone interested in the study of commercial motor vehicle scheduling practices, and how they may relate to drive fatigue. This report is considered final, in that it fully documents the results of the aforementioned study, and that the information provided herein is not superceded by other research.

Notice

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yards	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	ml
gal	gallons	3.785	liters	l
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lbs)	0.907	megagrams	Mg
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5(F-32)/9 or (F-32)/1.8	Celsius temperature	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m2	cd/m2
		FORCE and PRESSURE or STRESS		
lbf	pound-force	4.45	newtons	N
psi	pound-force per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	Yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
ml	milliliters	0.034	fluid ounces	fl oz
l	liters	0.264	gallons	gal
m^3	cubic meters	35.71	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg	megagrams	1.103	short tons (2000 lbs)	T
		TEMPERATURE (exact)		
°C	Celsius temperature	1.8 C + 32	Fahrenheit temperature	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m2	candela/m2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	pound-force	lbf
kPa	kilopascals	0.145	pound-force per square inch	psi

* SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.

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EXECUTIVE SUMMARY

INTRODUCTION

"Motor Carrier Scheduling Practices and Their Influence on Driver Fatigue" was a collaborative research project funded by the Department of Transportation Federal Motor Carrier Safety Administration (FMCSA). The research team consisted of Iowa State University, Daecher & Associates, the Trucking Research Institute of the American Trucking Associations (ATA), and the Private Fleet Management Institute of the National Private Truck Council (NPTC). The project had three main objectives:

1. to develop a definition or typology of truck driving environments and determine the percentage of over-the-road drivers that fall within each type of environment,
2. to identify the operational scheduling requirements of truck and motor coach carriers that affect driver fatigue, and
3. to assess truck and motor coach carrier scheduling and related safety practices that influence driver fatigue and driver safety performance.

The foundation of the project is the Commercial Motor Vehicle (CMV) Driver Fatigue Model, which provides a conceptual framework delineating the hypothesized operational scheduling requirements and related safety practices that influence truck and motor coach driver fatigue. The model is based on a thorough review of the literature on CMV driver fatigue, focus group discussions involving industry personnel, and company site visits and interviews.

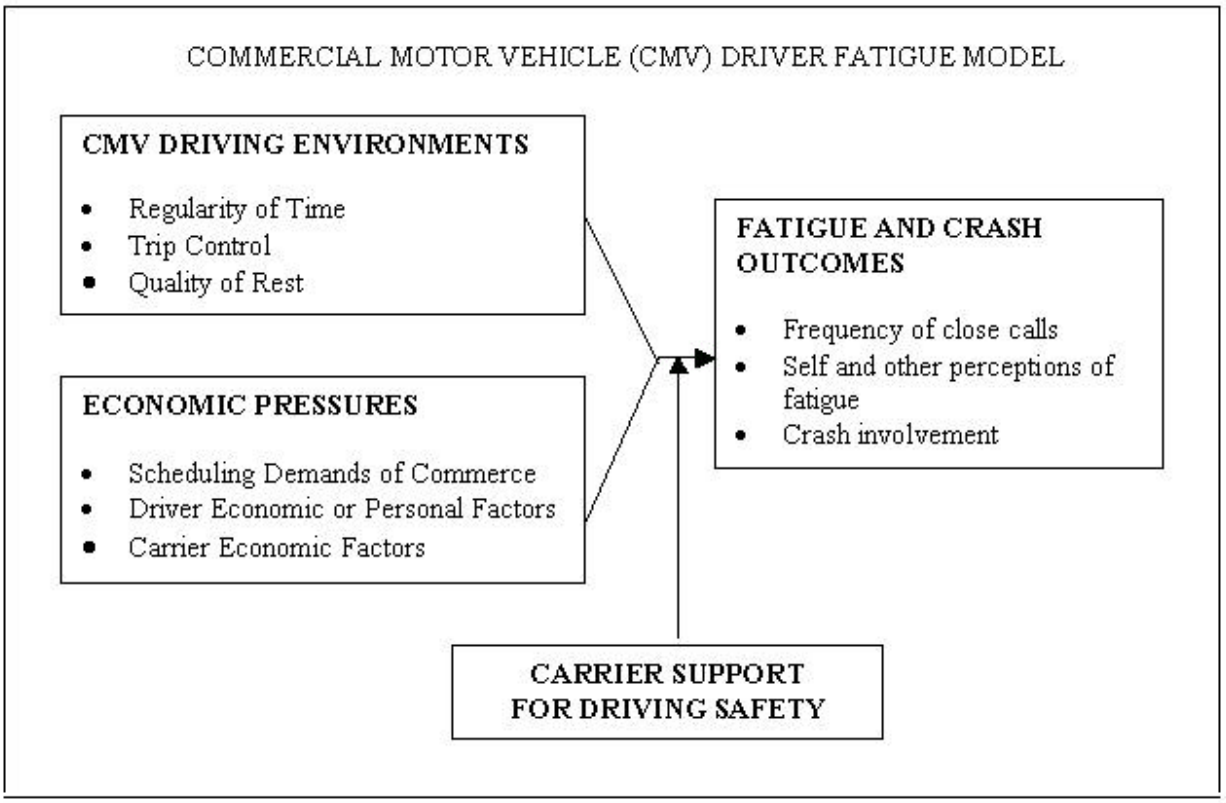
Three separate studies and data collection efforts were required to achieve the project's objectives. First, a random survey of over-the-road truck drivers provided the necessary data for the development of a typology of truck driving environments based on driving environment factors that influence driver fatigue. Second, the identification and assessment of operational scheduling requirements and related safety practices that influence truck and motor coach driver fatigue required survey research targeted at multiple organizational levels within companies in each of these industries. The hypothesized fatigue-influencing factors in the CMV Driver Fatigue Model were analyzed, and a number of them were found to be significantly related to driver fatigue.

THE COMMERCIAL MOTOR VEHICLE (CMV) DRIVER FATIGUE MODEL

The CMV Driver Fatigue Model identifies various scheduling-related factors that may influence driver fatigue, non-scheduling factors that may also have an effect on driver fatigue, and measures of driver fatigue. The model was based on an extensive review of the literature, focus group sessions with personnel from truck and motor coach firms, and company site visits. The key fatigue-influencing factors in the model are:

- CMV Driving Environments (Regularity of Time, Trip Control, and Quality of Rest),
- Economic Pressures (Scheduling Demands of Commerce, Carrier Economic Factors, and Driver Economic or Personal Factors), and
- Carrier Support for Driving Safety.

The model includes two measures of fatigue, Frequency of Close Calls Due to Fatigue and Driver Perceptions of Fatigue as a Problem, and one measure of general safety performance, Crash Involvement.



RESEARCH DESIGN

The first study, the "truck stop study," utilized the CMV driving environments component of the model to develop a driving environment typology for over-the-road truck drivers. Survey data were collected from a random sample of 502 truck drivers at five geographically dispersed truck stops.

The other two studies utilized the complete CMV Driver Fatigue Model to identify the significant fatigue-influencing factors in the trucking and motor coach industries. Potential trucking and motor coach sample firms were stratified on the basis of safety performance using FMCSA SafeStat performance categories. An effort was made to sample an equal number of carriers from each safety performance rating category. However, the percentages of firms agreeing to participate more closely approximated a

normal distribution, with nearly equal numbers of top and poor performers. Data were collected from four different levels of the firm (i.e., top management, safety director, dispatchers, and drivers) at 116 truck companies and 66 motor coach companies. A total of 279 truck drivers and 122 motor coach drivers provided usable responses.

RESULTS AND IMPLICATIONS

Overall, the CMV Driver Fatigue Model did a good job of explaining driver fatigue in both the trucking and motor coach industries, although the R^2 values (i.e., the percentage of the fatigue measures' variability explained by the model) were lower for close calls due to fatigue. The model performed less well in explaining crash involvement. Crashes have a low base rate relative to the driving exposure of the CMV driver population (i.e., there is restriction in range in the crash data). Additionally, it is worth noting that many non-scheduling factors influence driver fatigue and crash rates, and these were, of course, beyond the scope of this study. Key results and implications of the three studies follow.

Truck Stop Study

Twelve driving environment indicators collectively explain only 5 percent of the variability in close calls due to fatigue. However, they explain 23 percent of the variability in driver perceptions of fatigue. Two indicators, starting the workweek tired and longer than expected loading/unloading times, had a statistically significant relationship with both close calls due to fatigue and driver perceptions that fatigue is a problem. Driving the same hours each day, route regularity, and the number of hours of uninterrupted sleep were significantly related to driver perceptions of fatigue.

Elements from each of the three CMV Driving Environment characteristics specified in the model were used to develop a 2 x 2 x 2 typology of driving environments. In general, both the frequency of close calls due to fatigue and the drivers' perceptions of fatigue being a problem were captured by the typology, but crash involvement was not. Sample drivers report wide variability in the driving environments they experience. In the tests we ran, the percentage of drivers operating in the environment least likely to induce fatigue ranged from 12.6 to 22.7. The percentage of drivers operating in the environment most conducive to creating fatigue ranged from 11.5 to 16.5. Clearly, a large number of drivers are at high risk of experiencing fatigue on the job.

The following recommendations and findings emerged from the truck stop study:

- Carriers should focus on providing adequate recovery time for drivers between driving stints.
- Drivers should utilize the provided recovery time to obtain adequate rest.
- Shippers and carriers need to work together to improve the scheduling and performance of loading and unloading activities.

- To the extent possible, carriers should have their drivers drive the same hours on a regular basis. Also, having drivers run the same routes on a regular basis appears to diminish fatigue.
- Drivers who, on average, got more than the average number of hours of uninterrupted sleep during a 24-hour period while working perceived fatigue to be less of a problem than drivers who got less uninterrupted sleep.

Trucking Company Study

Sixteen trucking operational scheduling requirements and four indicators of trucking company support for safety explained 20% and 34% of the variability in close calls due to fatigue and drivers' perceptions of fatigue as a problem, respectively. The trucking company study supported many of the truck stop study findings, but also yielded some unique conclusions and implications. Key findings include:

- Starting the workweek tired was the single most statistically significant factor in both studies, indicating the importance of adequate recovery time and effective use of that time to obtain rest.
- Difficulty in finding a place to rest surfaced as statistically significant explanatory factor in the truck company study.
- Shippers' and receivers' scheduling practices and requirements play a very important role in driver fatigue – particularly size of delivery window.
- The physical interface between carriers and shippers/receivers potentially exerts a significant influence on driver fatigue.
- Pressures exerted by the trucking company on drivers and dispatchers have a significant influence on driver fatigue.
- Attendance at corporate safety and training meetings is significantly related to driver fatigue.
- In this study, carrier assistance with loading/unloading mitigated driver perceptions that fatigue is a problem.
- Similarly, trucking company policies to minimize nighttime driving also lessened driver perceptions that fatigue is a problem.
- Carrier support for driving safety significantly contributed to mitigating perceptions of fatigue as a problem when viewed in combination with driving environment and economic pressure factors.

Motor Coach Study

Ten motor coach operational scheduling requirements and two indicators of motor coach company support for safety explained 22% and 57% of the variability in close calls due to fatigue and drivers' perceptions of fatigue as a problem, respectively. Key findings include:

- Regularity of time worked was found to be significantly related to drivers' perceptions of fatigue as a problem.
- Starting the workweek tired was significantly related to drivers' perceptions of fatigue as a problem, indicating the importance of adequate recovery time and effective use of that time

to obtain rest.

- Driving tired to make a good income was a statistically significant factor for drivers' perceptions of fatigue as a problem. Importantly, there is a perception that it is necessary to drive tired in order to earn the desired income.
- Driver perception of pressure by dispatchers or others to accept trips was a statistically significant factor for both close calls due to fatigue and drivers' perceptions of fatigue as a problem.
- Driver perception of pressure from dispatchers and others to bend rules is also a significant factor regarding driver fatigue. It is primarily related to the pressures of meeting customer demands.
- While two elements of carrier support for driving safety were included in the final version of the model, carrier support did not significantly contribute to mitigating the fatigue or crash outcomes when viewed in combination with driving environment and economic pressure factors.

CONCLUSIONS

This research represents the first empirical assessment of how scheduling and scheduling-related work practices affect CMV driver fatigue and safety performance. A model identifying the primary determinants of fatigue and safety performance was formulated and tested using the perceptions and experiences of drivers, dispatchers, safety directors, and management personnel. This model received considerable support and was observed to be robust across two industries (trucking and motor coach). Pivotal factors affecting fatigue and safety were the extent to which drivers were able to drive at regular times (i.e., the same hours), experience adequate rest and recovery time, and resist economic pressures to continue driving when tired, in order to meet customer demands. Carrier support for driving safety (e.g., help with loading and unloading, establishment of an organizational culture valuing safety, minimal use of nighttime driving) was also found to be significantly related to truck driver fatigue. In addition, the scheduling practices of shippers, receivers, tour organizers, and the carriers themselves were significantly related to fatigue.

While the model certainly warrants further investigation, certain implications seem assured. The model suggests that many parties bear responsibility for achieving CMV safety. Personnel in CMV firms, especially drivers, represent the first line of responsibility for safety. Drivers must stop driving when they are fatigued (or otherwise impaired) and assume responsibility for using their recovery time wisely. Other carrier personnel have equally important roles to play. They must strive to create work cultures, incentive systems, training opportunities, etc. that underscore the importance of minimizing driver fatigue, not only to drivers and other carrier personnel but to external customers as well (e.g., shippers, receivers, tour operators). Indeed, one valuable contribution of this research is its empirical support for the argument that

customer groups are important parties that should be included in CMV safety efforts. Working cooperatively with customers to make scheduling activities less fatigue-invoking could have significant benefits for all.

PROJECT OVERVIEW

An understanding of motor carrier operational scheduling requirements and practices is fundamental to any attempt to improve government safety policies and regulations pertaining to commercial motor vehicle (i.e., truck and motor coach) driver fatigue. Such an understanding is essential to the establishment of regulations that are effective in promoting safety, enforceable, and operationally practical from the carriers' perspective. Carrier firms, too, should benefit from the knowledge gained from a thorough, scientific analysis of how they schedule truck drivers and how various scheduling-related factors influence driver fatigue.

The Trucking Research Institute of the American Trucking Associations (ATA), the Private Fleet Management Institute of the National Private Truck Council (NPTC), Iowa State University, and Daecher & Associates collaborated on a research project to evaluate the role of carrier scheduling practices in truck and motor coach driver fatigue. Funding for and oversight of the study was provided by the Federal Motor Carrier Safety Administration (FMCSA). The purpose of the project was threefold:

1. to develop a definition or typology of truck driving environments and determine the percentage of over-the-road drivers that fall within each type of environment,
2. to assess the operational scheduling requirements of truck and motor coach carriers that affect driver fatigue, and
3. to identify truck and motor coach carrier scheduling and related safety practices which have a positive effect on driver fatigue and driver safety performance.

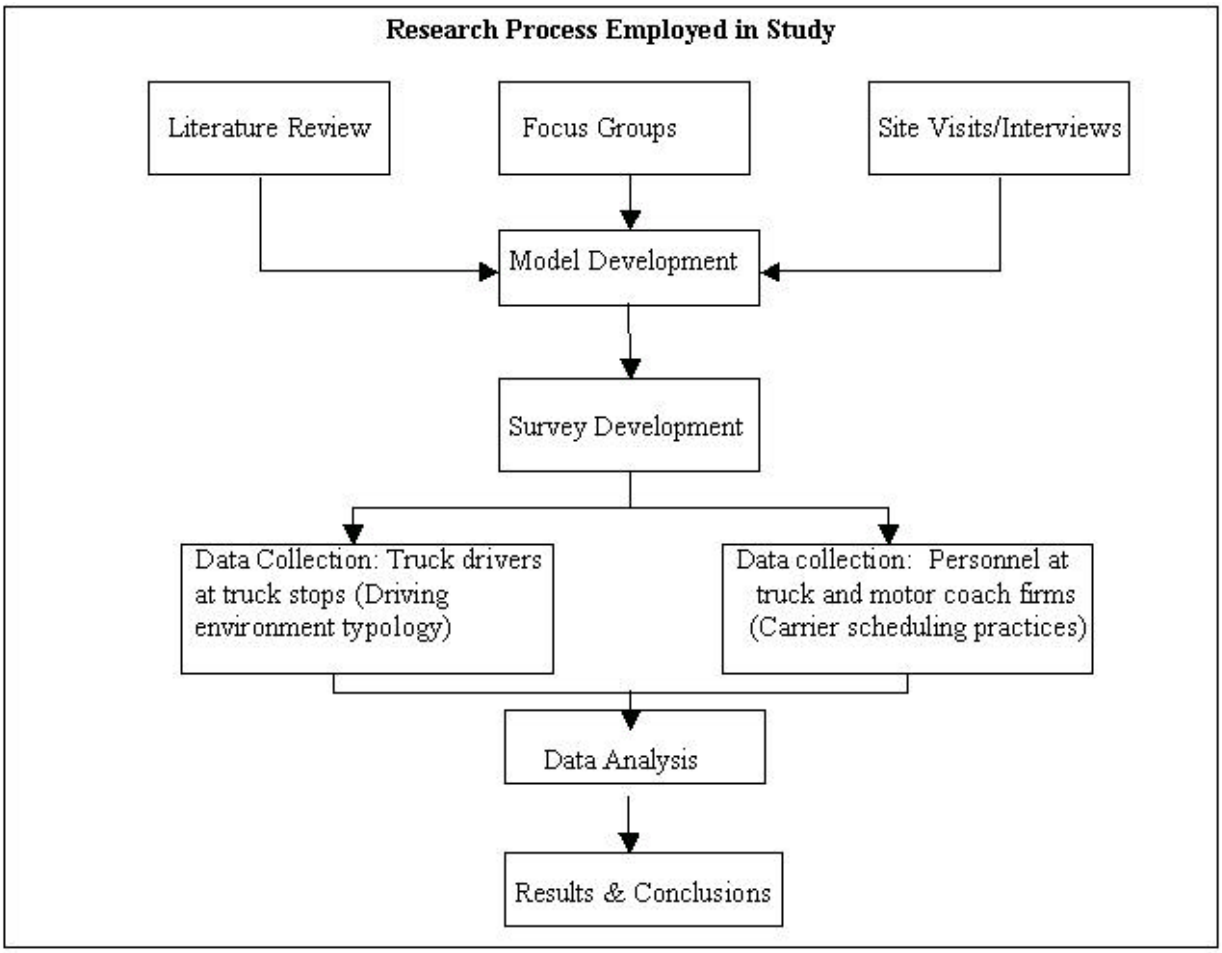
The study was conducted with a "regulation neutral" approach because the existing hours of service regulations (HOS) were undergoing review and were expected to be changed by the year 2001. Thus, the study investigated scheduling practices that are independent of HOS; i.e., the focus of the study is on the management processes and activities associated with driver scheduling and on driving environments, and not on how current HOS regulations influence carrier scheduling.

The research methodology utilized to accomplish the project was multi-faceted. The required information and data came from:

1. an extensive review of the driver fatigue literature,
2. carrier firm site visits and interviews,
3. discussions with carefully selected focus groups comprised of different carrier personnel involved in driver scheduling (i.e., drivers, dispatchers, safety managers, and upper management),
4. mailed surveys to each of these carrier personnel groups at a stratified, random sample of truck and motor coach companies, and
5. truck driver surveys distributed at truck stops.

The survey method of research was necessary to generate the data that allowed the researchers to determine the actual nature and extent of the operational requirements and various scheduling and other safety-related practices. These data were then analyzed to develop causal inferences concerning how scheduling and related practices influence driver fatigue and safety performance. The knowledge gained from the literature, site visits, and focus groups was instrumental to the development of a model that postulates the causes of driver fatigue as well as the survey instruments that allowed the model to be tested.

The study may be depicted as a five-step process: (1) model development, (2) survey development, (3) data collection, (4) data analysis, and (5) interpretation and presentation of results. The diagram below illustrates this process.



The remainder of this report is organized in the following manner:

Part 1 discusses the development of the Commercial Motor Vehicle (CMV) Driver Fatigue Model, which provides a conceptual framework delineating the hypothesized operational scheduling

requirements and related safety practices that influence truck and motor coach driver fatigue. The model is derived from a thorough literature review, focus group meetings, and company site visits. This model provided the basis for the research conducted in pursuit of the study's objectives. Part 1 also discusses the development of the survey instruments utilized for data collection.

Part 2 presents a study of over-the-road truck drivers. This study employed a random survey of more than 500 truck drivers at five geographically-dispersed truck stops to develop a typology of truck driving environments based on driving environment factors that influence driver fatigue. The percentage of over-the-road drivers operating within each type of driving environment was determined, and the predictive power of the typology with respect to fatigue was assessed.

Part 3 presents a study of drivers at trucking firms stratified on the basis of safety performance using FMCSA SafeStat performance categories. Top level management, safety directors, dispatchers, and drivers at good, average, and poor safety performance companies were surveyed. The proposed CMV Driver Fatigue Model was refined utilizing data from these surveys, and the hypothesized fatigue-influencing factors were tested.

Part 4 presents a study of drivers at motor coach firms stratified on the basis of safety performance using FMCSA SafeStat performance categories. Top level management, safety directors, dispatchers, and drivers at good, average, and poor safety performance companies were surveyed. The hypothesized fatigue-influencing factors were tested using the refined CMV Driver Fatigue Model.

Part 5 summarizes the findings and discusses implications for carrier management and safety regulation policy.

PART 1. MODEL DEVELOPMENT

The foundation of the study is the Commercial Motor Vehicle (CMV) Driver Fatigue Model that identifies the various scheduling-related factors that influence driver fatigue, non-scheduling factors that may also have an effect on driver fatigue, and measures of driver fatigue. The model reflects previous research discovered through the literature review process and the knowledge and experience base of a number of individuals and organizations discovered through focus groups and company site visits.

Literature Review

Appendix A contains the bibliography of 149 research articles, government reports, and trade articles that were reviewed. The bibliography includes publications that address a variety of driver fatigue and general safety issues in both the United States and other countries. From this literature review, 55 studies were found to be exceptionally informative and directly relevant to the project at hand. These studies were then subdivided into two groups, those which focused only on CMV fatigue and safety issues in general terms (n=16) and those which attempted to identify causes and antecedents of CMV fatigue (n=39). These latter 39 studies provided a starting point for organizing the wide range of factors thought to influence driver fatigue. A bibliography of the 55 project-relevant studies is provided in Appendix B.

It should be noted that the overwhelming majority of the driver fatigue research to date is focused on the trucking industry. The motor coach industry has received very little attention from researchers, though a number of articles and reports acknowledge the importance of the driver fatigue issue to this industry. The factors hypothesized to influence driver fatigue and their sources will be discussed later when the CMV Driver Fatigue Model is presented.

Focus Groups

Carefully selected focus groups were convened to elicit the experiences, thoughts, and opinions of motor carrier personnel who play a significant role in driver scheduling and overall company safety performance. Specifically, dispatchers, drivers, safety directors, and top level managers or executives from both for-hire and private motor carrier operations comprised the focus groups. The knowledge of these industry professionals served two essential purposes: (1) to validate the findings from (and provide a "reality check" on) the literature review and (2) to provide operational and organizational examples and experiences that would aid in the development of the survey instruments.

Truck Industry Focus Groups

Four separate trucking focus groups were convened between November 1997 and February 1998. Three of the focus group meetings occurred in conjunction with conferences or meetings of professional

organizations. Information about the trucking focus group dates, locations, participants, and organizations is provided in Table 1.1.

Two focus groups comprised of safety directors were convened at conferences sponsored by the National Private Truck Council (NPTC) in Dallas, Texas and the Iowa Motor Truck Association (IMTA) in Des Moines, Iowa. A focus group of senior motor carrier executives met at the annual conference of the Western Highway Institute in San Francisco, California. A focus group of CMV drivers and safety directors was organized by the ATA Foundation and convened in Denver, Colorado. The meetings ranged from one- and-one-half hours to two-and-one-half hours in duration.

Table 1.1
Summary of Truck Focus Groups

Date and Location	Number & Types of Participants	Organizations
11-11-97 Des Moines	13 Safety Directors/Risk Managers For-hire carriers	Iowa Motor Truck Association Mastering Fatigue Seminar
12-7-97 San Francisco	8 Executives For-hire carriers	Western Highway Institute Annual Conference
2-11-98 Dallas	29 Safety Directors Private carriers	National Private Truck Council Annual Meeting
2-24-98 Denver	1 Vice President 4 Safety Directors 4 Drivers For-hire carriers	Western Highway Institute Annual Conference

Structured questions and exercises were employed by the researchers to facilitate the Dallas and Denver focus group discussions. The five question sets utilized in each discussion were:

- What factors most influence driver alertness/drowsiness? Please rank order these in terms of importance.
- How do you address driver fatigue in your company? What practices seem most effective?
- How does the dispatching process affect driver fatigue? How do the dispatcher behavior/driver interactions affect driver fatigue?
- What sorts of things limit your ability to schedule drivers in a way that reduces the likelihood of fatigue? How do you deal with these limitations?

- Do some shippers' (carriers/brokers, receivers) commodities tend to put more pressure on carriers/drivers to not adhere to hours-of-service regulations? What characteristics do these shippers or commodities have in common?

The Des Moines and San Francisco focus group meetings were less structured because of the venue and time allotted for the discussions. However, the same general questions and topics were addressed.

The focus group responses to the first question were most germane to the development of the CMV driver fatigue model. The private fleet safety directors at the Dallas focus group identified several factors that influence driver fatigue. They selected the following five factors as the most influential:

- quality of rest/off-duty time
- physical condition of the driver
- job responsibilities in addition to driving
- type of driving environment and conditions
- irregular schedules.

The for-hire carrier drivers and safety directors at the Denver focus group each independently identified factors that they thought influenced fatigue, and their perceptions were nearly identical. The drivers listed the following six factors as most influential:

- scheduling (times of pickups and deliveries)
- personal habits of driver
- equipment quality
- time of day (circadian rhythm)
- driving conditions
- shipper/consignee demand

The safety directors came up with the following five factors:

- time of day
- physical condition of driver
- stress (family and work induced)
- road/weather conditions
- off-duty hours

Motor Coach Industry Focus Groups

For this study, we used input obtained through focus group sessions conducted for the Bus Driver Fatigue and Stress Issues Study. This study was conducted for the U. S. Department of Transportation during 1999.

The focus group sessions were designed to develop the issues and operating situations that are unique within the motor coach industry and which contribute to driver fatigue. This direct interaction with the people currently involved in the industry was crucial to produce a study that is relevant to today's drivers, particularly in light of the scarcity of literature on the issue. The strategy in scheduling focus groups was to gain as wide a geographical representation as possible and to obtain input from the five relevant operational areas within motor coach organizations: namely, owners, operation managers, safety directors, drivers, and travel/tour planners and coordinators.

To accomplish this, a series of eight focus group sessions were conducted. One hundred and fifty-four (154) people participated in the focus groups. Additionally, telephone surveys were conducted with four individuals who could not attend a focus group session, but wanted to participate. One motor coach driver provided written input which was incorporated into the study. Focus group sessions, locations, and targeted organizational areas are indicated in Table 1.2.

Table 1.2
Summary of Motor Coach Focus Groups

Date & Location	Number and Types of Participants
6-17-99 Biloxi, MS	Motor Coach Drivers – 28 participants
8-30-99 Chicago, IL	Motor Coach Operation Managers – 14 participants
9-10-99 Falls Church, VA	Motor Coach Industry Cross-section – 16 participants Owners, Operations Managers, Safety Directors, Drivers, Tour Associations, and Government Representatives
9-16-99 Ontario, CA	Motor Coach Company Owners – 27 participants
10-5-99 Sweetwater, NJ (2)	Motor Coach Safety Directors – 20 participants Motor Coach Drivers – 16 participants
9- 20-99 San Diego, CA	Motor Coach Drivers – 20 participants
11-10-99 Nashville, TN	Travel and Tour Planners & Coordinators – 13 participants

Our objective was to facilitate a lively candid discussion around the relevant topics to produce meaningful input within a 2-hour time interval. The major areas around which Focus Group discussions were facilitated are as follows:

- Does the motor coach driver in your company have the opportunity to get at least 8 hours of sleep on a daily basis during his/her workweek?
- What operational situations/issues can lead to motor coach driver stress and fatigue?
- What operational situations/issues which can lead to motor coach driver stress and fatigue are unique to the motor coach industry?
- What situations can be applied to minimize/eliminate these driver stress and fatigue producing situations/issues?

Motor coach driver's stress and fatigue issues, the unique aspects related to the motor coach industry, and solutions that were identified at each of the focus group sessions and through the phone surveys were consistent and similar. They are summarized below.

Driver Issues

- Wellness and lifestyle - a driver's physical fitness, diet, and personal living habits; family matters, state of health, and sense of self-worth.
- Personal accountability - a driver's level of personal accountability for his or her actions; holding one's self to a personal and professional standard.
- Exceeding one's limits - usually related to economic opportunities; economic need, company demand, or both, may cause a driver to accept work, delaying or ignoring the physiological need for rest.

Vehicle Issues

- Driver comfort - the modern motor coach offers comfort and ergonomic efficiency for the coach operator, a positive aspect towards combating or reducing fatigue; on the other hand, the comfort of the driver in combination with the monotony of the driving task can result in a loss of attention and alertness.
- Motor coach seats do not accommodate comfortable positions for quality rest or sleep, and motor coaches do not easily accommodate acceptable "sleeper berth" areas for drivers. With most charter and tour trips, however, drivers almost always sleep in hotel beds.
- Driver/passenger interface - the driving area is not physically isolated from the passenger area, and may result in passenger conversation with drivers and driver distraction because of passenger activities.

Operations

- Driver shortage/lack of quality drivers - currently employed drivers must drive more to meet operating schedules and customer demands, possibly resulting in less cumulative off-duty rest time.
- Pay - the relatively small compensation packages for charter/tour operators may force them to work more hours; hourly compensation for regular scheduled drivers is higher and has a positive affect on hours worked as well as availability of drivers.
- Dispatch protocol - can increase driver stress because of communication issues between

dispatchers and drivers (e.g., authoritative and confrontational communication styles), the dispatcher's motivation simply to move buses without sensitivity to driver needs, and the influence of seniority/extra boards and some dispatchers "playing favorites."

- Schedules and itineraries - inverted duty/sleep cycles can occur because of group itineraries; also, groups sometimes wish to "spontaneously" do things during trips that are not part of the original itinerary, disrupting the driver's planned schedule.
- Non-driving work - drivers must tend to passenger's needs (e.g., luggage), take tickets, and perform other tasks, adding to their work time and possibly increasing stress.
- Having numerous people observing driver behavior may produce an incentive for more diligence and professionalism on the part of a driver, but may also cause stress and fatigue.
- Lack of organizational coordination - many times sales people, who accept group itineraries, may not be aware of driver needs and requirements or of competing trips and demands; this may lead to pressure upon dispatch for scheduling of drivers.
- Seasonality - during the peak seasons, the need for driver services increases and there are fewer extended rest periods for drivers.

Unique Aspects of the Motor Coach Industry

Overwhelmingly, the unique aspect of motor coach operations which can lead to driver stress and fatigue that was identified and discussed at length at all focus groups is the presence of passengers on the vehicle. This uniqueness presents itself in many ways:

- The "customer" is on board, watching the driver's activities. This puts pressure on the driver at all times.
- Passengers have questions, requests, and demands. These occur spontaneously and frequently throughout a driver's day. These interactions may cause stress.
- With passengers on board, schedules and itineraries must be kept. If a driver feels fatigued, he or she cannot simply pull over and take a nap. When trips are running late, the driver must deal with the pressure of dissatisfied passengers.
- Drivers must ensure that passengers know where to meet and when to board, and must attend to their accommodations in hotels, at attractions, etc. They also must handle luggage. All of these situations extend the driver's day and cause stress and possible fatigue.
- Passengers will also make requests for unscheduled activities to the driver during trips. When this occurs, the driver must find a way to politely refuse passenger requests or agree to them, many times knowing that it will infringe upon his or her off duty and rest time.

In summary, drivers must attend to passenger requests, needs, and safety throughout their workday. In the case of tour groups, itineraries are in place that will cause the driver to have extended days and work at various hours during successive days. These demands are truly unique to the motor coach industry. However, they do not have only negative impacts. As mentioned before, drivers are more aware of their behavior behind the wheel because of passengers on board. Moreover, companies

must train drivers to be sensitive to customer relations in addition to defensive driving. Hence company policies and procedures revolve around the transport of passengers.

Truck Company Site Visits

In addition to focus groups, a series of site visits and personnel interviews at thirteen (13) different for-hire and private truck carrier facilities generated further valuable input for the development of the model. The site visits allowed the researchers to observe driver scheduling in practice and to obtain a better understanding of the carriers' operating processes and systems. Companies were selected to provide diversity with respect to fleet size, equipment types (e.g., dry vans, flatbeds, tankers), geographic coverage (e.g., local, regional, national), and nature of operations and requirements (e.g., dedicated routes, irregular routes, just-in-time requirements, multiple drops, hazardous materials, driver time away from home, team driving). The duration of the site visits ranged from a couple of hours to a full day. Information about the company interview dates, locations, personnel participants, and types of organizations is provided in Table 1.3.

Table 1.3
Summary of Truck Company Site Visits and Interviews

Date(s) & Location	Types of Participants	Type of Organization
2-17-98 and 3-3-98 Central Iowa	1 Safety Director 2 Fleet Managers (Dispatchers) 1 Human Resources Manager 2 Load Coordinators 5 Drivers (4-company, 1-owner/operator)	2 General freight truckload carriers Both for-hire
5-27-98 and 6-9-98 Central Iowa	2 Safety Directors 1 Operations Manager	2 Flatbed carriers Both for-hire
7-27-98 – 7-30-98 Indiana	2 Trucking Executives 3 Safety Directors 3 Dispatchers 4 Drivers	4 Private carriers
8-17-98 – 8-19-98 North Carolina and South Carolina	2 Trucking Executives 2 Safety Directors 3 Fleet Managers 2 Dispatchers 2 Traffic Coordinators 4 Drivers 1 Truck Maintenance	5 Private carriers

Additionally, the Project Steering Committee reviewed and provided input to the model at its meeting in October 1998. A list of steering committee members is provided in Appendix C. The authors also conducted ad hoc interviews with several shipper and carrier attendees at two transportation conferences in April 1998 – the Indiana Transportation Conference held at Indiana University's Bloomington campus and the National Private Truck Council Education/Management Conference held in Chicago.

The knowledge gained from the literature review, focus group meetings, and site visits and interviews is reflected in the resulting driver fatigue research model that is discussed in the next section.

The Commercial Motor Vehicle Driver Fatigue Model

Two categories of dependent variables are included in the model, measures of driver fatigue and measures of safety performance (i.e., crash rates). Three general categories of fatigue antecedents, or factors that are hypothesized to affect driver fatigue emerged from the literature review and focus groups and are delineated in the CMV Driver Fatigue Model: CMV Driving Environments, Economic Pressures, and Support for Driving Safety. CMV Driving Environments and Economic Pressures are hypothesized to exert a direct influence on driver fatigue, and each of these factors, in turn, is comprised of three constructs. Carrier Support for Driving Safety is a driver fatigue moderating factor and a "stand-alone" construct. The dependent and independent variables are discussed below. The model is depicted in Figure 1.1.

Fatigue and Safety Outcome Measures

There is little consensus in the literature regarding how driver fatigue should be viewed and measured. Numerous indicators of perceived driver fatigue are possible, although care must be taken to obtain these estimates in ways that minimize self-incrimination and elicit accurate responses. Williamson, et. al.[1] note that while many drivers will acknowledge that fatigue is an industry-wide problem, fewer may admit that fatigue is a problem for them personally. Accordingly, a broad array of direct and indirect fatigue indicators were included.

Frequency of driving "tired" is the first indicator and it has been used in prior research by Williamson, et.al. (1994)[2], Harris and Mackie (1972)[3], and Mackie and Miller (1978)[4]. Harris and Mackie (1972)[5] utilized other fatigue indicators germane to this study including the number of close calls experienced by the driver because of less-than-full alertness and an estimate of the frequency other company drivers drive when they are tired.

At the individual driver level, crash rate indicators of safety performance include the number of reportable crashes and the number of chargeable crashes a driver has had over some defined time/mileage

period. Harris and Mackie (1972)[6] and Mackie and Miller (1978)[7] were successful in acquiring such data via surveys.

CMV Driving Environments

The three hypothesized constructs comprising CMV Driving Environments are: (1) regularity of time, (2) quality of rest, and (3) trip control. In total, the model proposes 25 individual measures or indicators within these constructs.

Regularity of time is concerned with the opportunity for drivers to establish a routine and with schedules that run counter to the natural circadian rhythms of drivers. Indicators that reflect drivers' regularity of time include the percent of time normally driven the same daily hours, how driving time is distributed over the 24-hour day, variability of driving work, and maximum hours driven in a given week. Quality of rest captures when and where drivers are able to obtain uninterrupted sleep and the duration of such sleep. The eight items in the model reflect when and where drivers get sleep, the level of difficulty in finding a place to rest, how much sleep, and the amount and effectiveness of recovery time between runs.

Trip control measures reflect the ability of drivers to plan their trips and how closely their trips conform to what they expected. They also assess the percentage of time drivers spend performing job-related activities other than driving. Measures formulated to capture trip control include the regularity of drivers' routes, drivers' control over routes and schedule including rest stops, dispatcher assistance in determining the best routes to drive, and the number of stops per day. Additionally, the model includes non-driving factors such as the percent of time spent waiting and loading or unloading, the percent of time spent on other non-driving activities while working (e.g., paperwork), and perceived pressure to be "on-time".

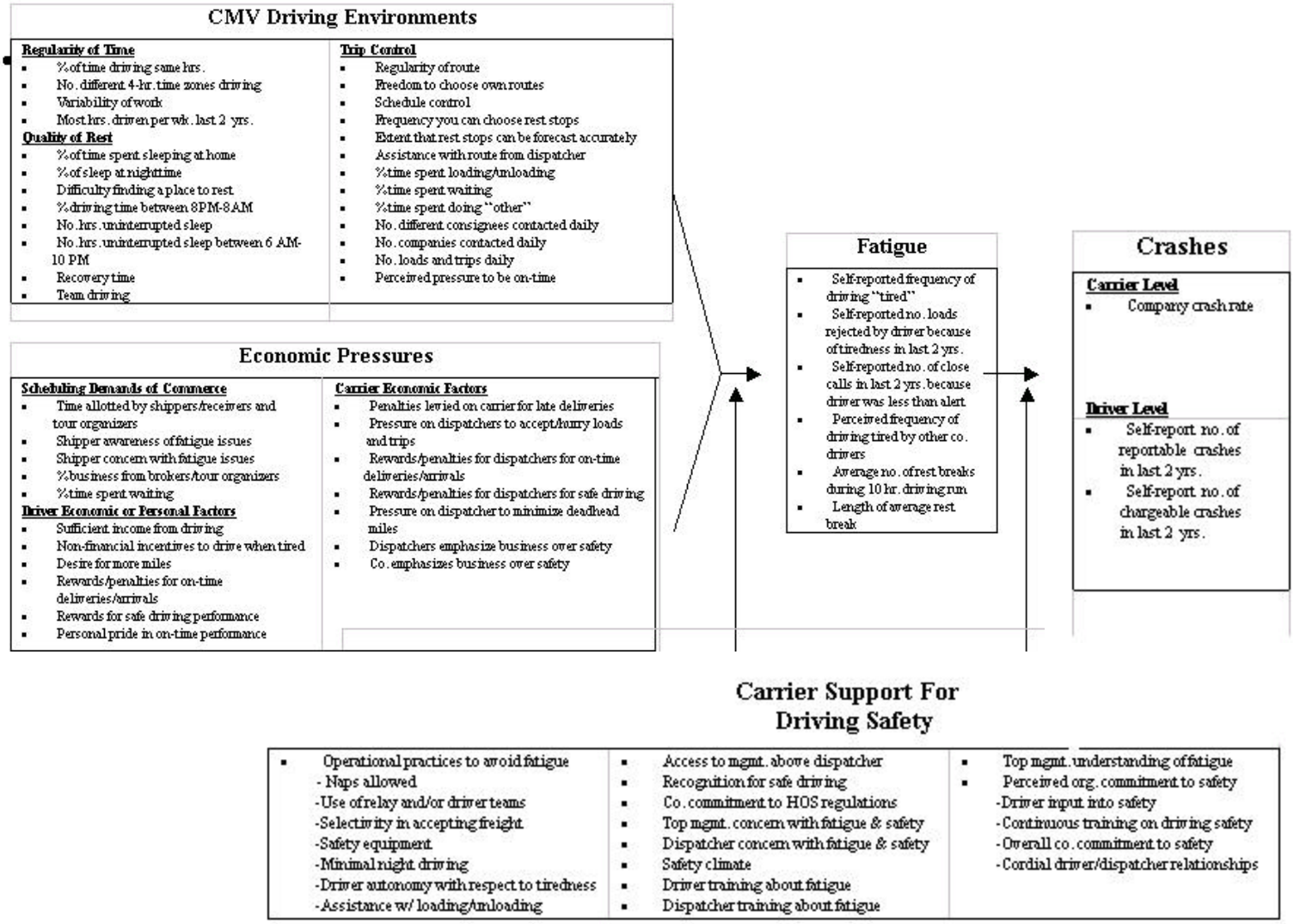
Economic Pressures

The second category of antecedents found in the literature review involves the Economic Pressures associated with the running of commercial vehicle operations and/or making a living as a driver. In total, the model proposes 18 individual measures or indicators within the three constructs comprising Economic Pressures.

The first of three hypothesized constructs comprising Economic Pressures concerns the external economic pressures that can arise from the scheduling demands of commerce (e.g., time pressures from shippers and receivers and tour bus groups). Scheduling pressures, while always inherent to the trucking business, have increased considerably in recent years with the advent of just-in-time production processes and the increased emphasis on customer service. The motor coach business continues to experience demand for drivers to drive all night, resulting in inverted duty/rest cycles for many drivers.

Drivers working in these environments may be asked to drive when they are tired in order to satisfy the demands of shippers, receivers, and tour organizers. The model includes five potential measures indicative of the scheduling demands of commerce. Among these are adequate/inadequate time for pick-ups and deliveries of freight and passengers, the extent to which shippers and tour organizers demonstrate awareness of fatigue and hours of service issues, and the percent of a carrier's business that

Figure 1.1
Proposed Commercial Motor Vehicle (CMV) Driver Fatigue Model



comes from third party transportation companies. With respect to the latter, some trucking carriers have indicated that loads from brokers, for example, are typically more difficult to schedule in advance.

The second construct identified as an economic pressure is also external in nature and is termed "carrier economic factors". This construct entails the economic penalties and rewards realized by drivers, dispatchers, and the company as a whole in the course of conducting business. The construct is intended to identify pressures that may exist which encourage carrier personnel to reward drivers for driving when they are tired, or to "look the other way" when drivers continue driving when they are fatigued. Among the six potential measures of this construct are the extent to which customers penalize carriers for late deliveries or arrivals, the extent to which dispatchers perceive pressure to accept or hurry loads and trips, and the relative importance of business versus safety concerns when scheduling drivers.

The last economic pressure can be viewed as internal to the driver. It reflects the economic pressure and/or personal characteristics of drivers that make them want to continue driving even when they are fatigued (i.e., financial and non-financial incentives to drive when tired). The model proposes seven potential indicators of the economic pressures and personal factors that might be experienced by drivers. They include items such as drivers' perceptions of adequate income from their driving work, non-financial reasons to continue driving when tired (e.g., to get home, see friends), and the extent to which drivers take personal pride in on-time deliveries/arrivals.

Company Support for Driving Safety

The third and final category of antecedents to emerge from the literature entailed company support for driving safety. The Support for Driving Safety factor includes carrier operational practices that are perceived to be directly linked to driver fatigue. It also includes both general safety measures and fatigue-specific safety measures that are designed to gauge the organizational safety climate and commitment to safe operations.

Sources for Model Constructs

Table 1.4 summarizes the number of sources from the literature that address each of the constructs and the number of focus groups that considered each construct to be important. With respect to Driving Environments, ten studies[8] were identified that discussed how drivers' irregular work schedules are related to fatigue while seventeen studies[9] emphasized how drivers' difficulties in getting adequate rest while working leads to fatigue. Seventeen studies[10] discussed how drivers seldom have the ability to control elements of their work (e.g., routes to be driven, frequency and location of rest breaks, waiting time) and how such a lack of control contributes to fatigue.

As Table 1.4 reveals, Economic Pressures was not as well represented in the literature review, but was generally viewed by the focus groups as equally important as Driving Environments. Seven studies[11] illustrated how scheduling demands of shippers, carriers, and passengers can invoke driver

fatigue. More extensive information (i.e., 12 studies[12]) was available on economic and personal motives for drivers to continue working or driving, even when tired. Similarly, five studies[13] showed how commercial carriers can exert pressure on drivers through rewards and penalties that have a bearing on driver fatigue (e.g., rewards/penalties for safe/unsafe driving, or on-time deliveries and arrivals). Finally, Table 1.4 reports that twenty studies discussed company practices directly or indirectly related to fatigue (e.g., minimal night driving, top management concern with safety).

Table 1.4
Number of source references to fatigue-inducing factors included in CMV Driver Fatigue Model

	Possible Antecedents of CMV Driver Fatigue						
	Driving Environments			**Economic Pressures**			
Source of References	Regularity of Time	Quality of Rest	Trip Control	Scheduling Demands of Commerce	Driver Economic & Personal Factors	Carrier Economic Factors	**Support for Safety**
Literature (39 sources total)	10	17	17	7	12	5	20
Focus Groups (4 groups)	3	3	4	4	3	3	4

Survey Development

The measures of the various factors and constructs in the CMV Driver Fatigue Model require data and information from a number of organizational levels and individuals within the truck and motor coach companies. Since these data are not available from published sources, nine different survey instruments were developed to collect the necessary data to accomplish the objectives of the study. The survey instruments are presented in Appendix D.

The Survey Instruments

Eight survey instruments were utilized in the studies of drivers at truck and motor coach firms reported in Parts 3 and 4 of this report. A different questionnaire was developed for each of four organizational levels for both truck and motor coach firms: upper management, safety directors, dispatchers, and drivers. The two questionnaires for each organizational level were very similar to one another, but each was customized to reflect unique operational requirements and practices in the truck and motor coach industries.

The ninth survey instrument was utilized to gather data from over-the-road truck drivers to develop the typology of driving environments. The "truck stop survey" contained a subset of questions and items from the driver survey utilized in the study of drivers at truck firms – that is, it included only

those items addressing driving environment and fatigue and safety outcomes.

Developing and Pre-testing the Surveys

As noted earlier, the focus groups and company site visits were most helpful in developing the questionnaires. Additionally, the questionnaires were reviewed by members of the Project Steering Committee and representatives from the ATA Foundation, National Private Truck Council, and Federal Motor Carrier Safety Administration. After revisions resulting from comments and suggestions from these individuals, a pretest with representatives of the target populations (e.g., carrier executives, safety directors, dispatchers, and drivers) was conducted.

Nine motor coach drivers, nine truck drivers, two truck dispatchers, two motor coach dispatchers, two truck company safety directors, two motor coach safety directors, two truck company executives, and two motor coach executives participated in the pretest of the company-based survey collection. Four truck drivers pre-tested the truck stop survey. Pretest respondents were asked to review and comment on both the questions and the survey distribution process. Further refinements based on these comments were incorporated. The pretests also provided an estimate of the average times for completion of the questionnaires.

The remainder of this report focuses on the three major research efforts comprising this project. Part 2 describes the methodology utilized to develop a typology of driving environments for over-the-road truck drivers and presents key findings.

ENDNOTES

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PART 2. THE INFLUENCE OF DRIVING ENVIRONMENT ON FATIGUE AMONG OVER-THE-ROAD TRUCK DRIVERS

One task assigned to this project was the development of a definition or typology of truck driving environments and determination of the percentage of over-the-road drivers that operate within each type of environment. Toward this end, a survey instrument addressing the Driving Environment constructs from the CMV Driver Fatigue Model was developed and distributed to a random sample of over-the-road truck drivers. This section of the report is organized in this manner: first, the sampling and data collection effort is described; second, the method for selecting the driving environment indicators is presented; third, the method for refining the dependent or outcome variables is discussed; fourth, the development of the typology reflecting different driving environments is presented; and finally, an assessment of the predictive power of the driving environment indicators is reported.

Sample and Data Collection

The study sought to be representative of all over-the-road commercial truck drivers. However, the population of such drivers cannot be specified (i.e., there is no directory of all truck drivers). Consequently, sampling was conducted in a manner to avoid systematic bias in the selection of drivers.

Data Collection

With the assistance of the National Association of Truck Stop Operators, the NATSO Foundation, four large, geographically dispersed truck stops/plazas were identified. These facilities are located near major intersections of interstate highways and are not dominated by any client, commodity or product group. They are located in Maryland, Georgia, California, and Iowa. A fifth truck stop in Colorado was added to reach the target sample size of 500 drivers. The data collection occurred between October and December 1999.

Based on traffic flow through the facility, project staff exercised judgment regarding the frequency with which they randomly asked a driver to participate and how long to remain at a facility. Data collection took place throughout the 24-hour day. Drivers were offered $10 cash inducement to participate. Tracking non-respondent bias would have interfered with the individuals' rights not to participate and was not attempted.

Response rates from the various truck stops were as follows: Maryland -- 103, Georgia -- 149, California -- 128, Iowa -- 95, and Colorado -- 31. In all, 506 truck drivers participated in the survey and 502 of these drivers provided usable responses (i.e., few omitted survey items).

Sample

The composition of the sample can be described in several ways. Demographically, it was overwhelmingly male (89 percent) and ranged in age from 21 to 72 years, with an average age of 41. The

average driver had 11.67 years of driving experience and had worked for one or two companies during the previous two years.

Sample drivers can also be characterized according to driving characteristics. Most drivers worked for for-hire carriers (86 percent) rather than private fleets. Company drivers comprised 60 percent of the sample, while just over a third (34 percent) were owner-operators. The remainder were temporary, casual, or leased drivers. The overwhelming majority of the drivers (95 percent) drove tractor-trailers with about a quarter (29 percent) indicating that they typically drove double-combination vehicles. Only 4 percent reported driving longer combinations (e.g., Rocky Mountain doubles/triples). Sleeper berths were available to half (53 percent) of the drivers. A majority (65 percent) said that they never engaged in team driving. However, 18 percent said they always worked in a team-driving configuration, and 17 percent engaged in team driving sometimes. Nearly all (93 percent) of the respondents described their runs as primarily interstate. The average number of miles driven per week was estimated to be 2848. The average number of stops for pick-ups or deliveries was 2.39 per day.

Finally, with respect to crash behavior, 80 percent reported they had not had a reportable crash and 93 percent had not had a chargeable crash in the previous two years. The raw data on crash rates were normalized to account for the amount of crash risk exposure a driver experiences. Crash rates were normalized by dividing the number of crashes by the average number of miles driven, and expressed on a per 100,000 miles basis. The normalized distribution of crash rates was essentially equivalent to the unadjusted distribution. The 20 percent acknowledging reportable crashes had between .17 to 2.75 crashes per 100,000 miles. The 7 percent reporting chargeable crashes had between .20 to 2.75 chargeable crashes per 100,000 miles.

Selecting Indicators for Driving Environment Characteristics

Each of the twenty-five possible indicators was first evaluated to assure that it yielded sufficient variability among the drivers to be of interest. Beyond this, however, no assumptions could be made regarding how indicators of a given construct would be related to each other. The relative independence of the indicators precluded the use of standard data reduction techniques like factor analysis. An indicator's association with fatigue and crash behavior was thus utilized to select those indicators to be further investigated.

The survey contained 15 items related to fatigue and crash behavior:

- close calls ("near accidents') because of a lack of alertness at four fixed locations,
- close calls ("near accidents') because of a lack of alertness at two driving locations,
- five assessments of fatigue and alertness while driving,

- two perceptions of the extensiveness of the fatigue problem among other drivers, and
- two crash involvement indicators.

The ability of each environmental indicator to account for variation in the fatigue and crash measures was ascertained via regression analysis, and indicators failing to account for a statistically significant (at $p \leq .05$) amount of variation in at least two outcomes were eliminated from further consideration. The significance standard was relaxed to $p \leq .10$ twice to allow retention of two measures that are uniquely descriptive of driving behavior (i.e., the number of different 6-hour time zones driven daily and route regularity). Following this procedure, indicators were evaluated for excessive multicollinearity (i.e., >.4). However, no indicators were eliminated based on this criterion. These procedures yielded a much more efficient model consisting of twelve indicators, as described next.

Regularity of Time Indicators

Regularity of Time refers to the extent to which drivers can achieve a set pattern of driving behavior. The literature and industry experts suggest that drivers who can regularize their time behind the wheel should be able to drive more safely. The first indicator, a subjective estimate of how often they drive the same hours, revealed that just over a third (38.8 percent) of the sample was "never" or "rarely" able to start and stop driving the same time each day. The remaining 61.2 percent said they were able to do this at least "sometimes", "frequently" or "always".

Regularity of Time can also be viewed in terms of the variability of the driving experience. Four daily work time zones were created by dividing the workday into four six-hour periods (starting at 6 AM). A driver was considered to drive regularly during a given time zone if more than 10 percent of his/her driving time occurred during that time zone. The vast majority of drivers reported driving in three times zones: 6 AM to Noon (73.3 percent), Noon to 6 PM (73.0 percent), and 6 PM to Midnight (69.3 percent). The only time zone with a different utilization pattern was Midnight to 6 AM. Just under half (45.7 percent) reported that they normally did not drive these hours while just over half (54.3 percent) said that they did drive during these hours. The variability of the driving experience was measured simply by counting the number of time zones reported by each driver (i.e., 1 to 4 zones). Very few drivers (10.9 percent) drove during only one time zone. A quarter of the drivers (25.3 percent) reported extensive variability in their driving behavior by reporting that they normally drove during all four time zones.

These two indicators were regressed against the fatigue and crash outcome measures and found to be significantly related to four of them (at $p \leq .05$), explaining between 2 percent and 4 percent of the variation in these measures. Driving the same hours was a stronger individual predictor than the number of time zones. As expected, routinely driving the same hours was negatively related to perceptions of fatigue, continuing to drive when less than alert, and perceptions that fatigue is a company-wide problem for drivers.

Trip Control Indicators

Trip Control entails the amount of discretion and flexibility drivers have while engaged in driving. Six indicators emerged as useful predictors of fatigue and crash outcomes.

The first indicator was regularity of route, the extent to which drivers drive the same routes frequently. About half (45.9 percent) of the study drivers fell into this first category, while the remaining 54.1 percent were classified as driving a wide variety of routes. Freedom to choose own routes was the second indicator. Sample drivers appeared to be afforded more latitude in this area of work, as a large majority (84.4 percent) reported high levels of flexibility.

The third indicator was the number of loads taking longer than expected to load or unload. Loading and unloading are integral parts of the driving environment. There is debate as to whether these activities increase fatigue emanating from the physical work or offset fatigue induced by otherwise long periods of driving. Additionally, not being able to accurately forecast the amount of time loading/unloading will take is thought to contribute to fatigue and stress. It makes arriving on time for the next pick-up/delivery problematic and can lead to perceived pressure to "make-up time" by driving faster or longer. Longer than anticipated load times also makes planning for rest stop times and locations exceedingly difficult. Thus this trip control indicator focuses on the number of loads where waiting time is longer than forecast by the driver. Operationally, drivers who wait longer than anticipated for 30 percent or more of their loads were deemed to have less trip control. More than half (52.6 percent) were in this grouping.

Difficulty in finding a place to rest was the fourth indicator of Trip Control. It is intuitive that not being able to stop when tired could be a major determinant of fatigue and crashes. The extent to which drivers experience this problem was measured by classifying drivers into two groups: those who "never" "rarely", or "sometimes" have difficulty finding a place to rest (51.3 percent) and those who "frequently" or "always" report this to be a problem (48.7 percent).

The fifth indicator, schedule delays, consisted of the percent of work time spent in traffic delays or waiting to make a pick-up or delivery. Like the experience of long load times, schedule delays contribute to fatigue and the potential for crashes by initiating a sequence of events that can occur when a driver is behind schedule (e.g., pressure to make–up time, delaying rest, and forgoing planned rest locations). Drivers reported that between 0 to 90 percent of their work time was consumed by scheduling delays, with an average of 18.3 percent.

The final indicator of Trip Control was the average number of stops a driver made each day. Again there is debate about the effect stops have on fatigue. Stops can break the monotony of driving, but they provide more opportunity for unanticipated delays. About half of the sample (51.4 percent) reported making one or fewer stops per day on average while 48.6 percent reported making two or more.

Trip Control was significantly related (at $p \leq .05$) to 10 fatigue and crash outcomes, explaining between 4.5 percent and 9.3 percent of the variation in these outcome variables. Five of the six Trip Control indicators were significant predictors for at least one of the outcome measures. Longer than anticipated loading times was the single best predictor for four of the outcome measures. Average number of stops per day was the single best predictor for three measures. Difficulty in finding a place to rest was the single best predictor for two measures.

Quality of Rest

Quality of Rest pertains to a driver's ability to obtain good quality sleep and rest while working. Quality of Rest is especially important in truck driving work given the need for alertness, the long hours it can entail, the frequent requirement to sleep away from home, and the need to sometimes drive during hours that are counter to circadian rhythms. Four indicators are examined.

The frequency with which drivers are able to get their sleep at nighttime is the first indicator. A majority of the sample drivers (60.9 percent) reported that they were able to sleep at night "never", "rarely", or "sometimes". The remaining drivers indicated that they were able to sleep at night "frequently" or "always".

The second indicator was the amount of uninterrupted sleep that drivers were typically able to get during a 24-hour period when working. About a third (35.3 percent) said they were able to get five or less hours of sleep while nearly two-thirds (64.7 percent) were able to get more than five hours.

The extent to which drivers are able to get home was the third indicator of Quality of Rest. The sample was nearly equally divided, with 52.6 percent away from home more than two weeks at a time and 47.4 percent able to get home at least once every two weeks.

The final indicator was the frequency with which the driver reported starting the workweek tired. Approximately a third (38.0 percent) indicated that they "never" or "rarely" started tired while almost two-thirds (62.0 percent) indicated that they "sometimes", "frequently", or "always" started tired.

Quality of Rest was significantly related to eight fatigue and crash outcomes, explaining between 2.1 percent and 15.2 percent of the variation. Furthermore, each of the four indicators was a significant predictor for at least one outcome measure.

The most pervasive finding was the predictive strength of starting the workweek tired. It was significantly related to eight outcomes and the only significant predictor for three of the outcomes. For example, starting tired, alone explained 12 percent of the variation in self-reported feelings of fatigue.

The frequency with which the driver gets home was a significant predictor for three outcome measures. Interestingly, getting home more often was associated with more close calls, a higher frequency of nodding off while driving, and more reportable crashes.

Refinement of Fatigue and Crash Outcomes

The 15 fatigue and crash indicators specified in the model have, thus far, been treated as single item outcomes. This was useful for a very in-depth understanding and for refining the independent variables, but rather tedious in presentation. As in the case of the driving environment indicators, a reduction in the number of dependent variables would result in a more efficient model. Unlike the independent variables, however, an examination of the 15 outcome indicators suggests some natural groupings may exist. Conceptually, the "close call" items seemed to be a logical grouping while the two crash items (i.e., reportable and chargeable) seemed to be a second logical grouping. The remaining items, reflective of perceptions of personal and others' fatigue constituted a third possibility. Accordingly factor analysis was employed.

Table 2.1 shows the results of the factor analysis of the dependent variables. The close calls items were, in fact, unidimensional. The Crombach alpha associated with the 6 items (α=.81) further

Table 2.1
Results of Factor Analysis of Fatigue Outcome Measures

Frequency of Close Call Items	**Factor**
At a terminal	.69
At a weigh station	.65
At a truck stop	.78
At a shipper/receiver facility	.76
While driving in urban area or secondary road	.75
While driving on interstate	.66
Eigenvalue/Percent of Variance Explained	51.38
Perceptions of Fatigue as Problem Items	**Factor**
Near misses because of fatigue	.63
Nod-off while driving	.79
Think fatigue is a problem	.76
Continue to drive when tired	.77
Fatigue a company problem	.64
Fatigue an industry problem	.66
Eigenvalue/Percent of Variance Explained	50.67

supported the unidimensionality of the measure. This newly formed measure was name Frequency of Close Calls.

Table 2.1 also shows that the perceptions of fatigue items have a unidimensional factor structure. These six items also yielded a Cronbach alpha (α=.80). Cronbach's alpha is a coefficient of reliability or consistency that measures how well a set of items measures a single unidimensional latent construct. The generally accepted cut-off for unidimensionality is an alpha value of 0.70 or larger. Accordingly, these six items were combined to form a Self and Others' Perceptions of Fatigue measure.

The results of the factor analysis for the two crash involvement indicators yielded a single factor solution. The two items were then combined to form a single measure. The Cronbach alpha associated with the new Crash Involvement measure was .76.

Figure 2.1 illustrates the driving environment model with the reduced number of driving environment indicators and the revised fatigue and crash outcome indicators. In addition, Table 2.2 reports the descriptive statistics for all the variables included in this model. Table 2.2 indicates that nearly all of the variables were characterized by reasonable dispersion relative to their range. Only Crash Involvement appeared to suffer from restriction in range. This restriction in range indicates that it will be difficult to achieve statistically significant findings for analyses involving Crash Involvement. In other words, the relative infrequency of crashes makes the prediction of this outcome very difficult. However, given the criticality of crash involvement, it was retained.

Typology of Work Environments

The three primary characteristics of driving environments and their underlying indicators provide the basis for a typology of driving environments. At present, little is known about the proportions of drivers that work under conditions that are favorable in terms of avoiding fatigue and crashes (i.e., enjoy regularity of time, high levels of trip control, and allow for high quality of rest) and under unfavorable conditions (i.e., poor regularity of time, low levels of trip control, and poor quality of rest).

Drawing on the preceding analysis, the single best predictor of fatigue and crash outcomes for each characteristic was identified. The best indicator of Regularity of Time was the estimate of time driving the same hours. For Trip Control, the number of loads taking longer than expected to load or unload was observed to be the strongest predictor. Quality of Rest was best represented by the frequency with which drivers start their workweek tired. By dividing each indicator into unfavorable and favorable levels, a 2 x 2 x 2 typology containing 8 driving environment "cells" was formulated and is presented in Table 2.3. Each of these environmental cells can be viewed as a way to describe various CMV drivers' work environments. The typology depicted in Table 2.3 is one of 48 that could be formulated using the three driving environment characteristics and their 12 underlying indicators (i.e., 2 x 6 x 4).

Figure 2.1
CMV Driving Environments And Fatigue And Crash Outcomes Of Over-The-Road Truck Drivers

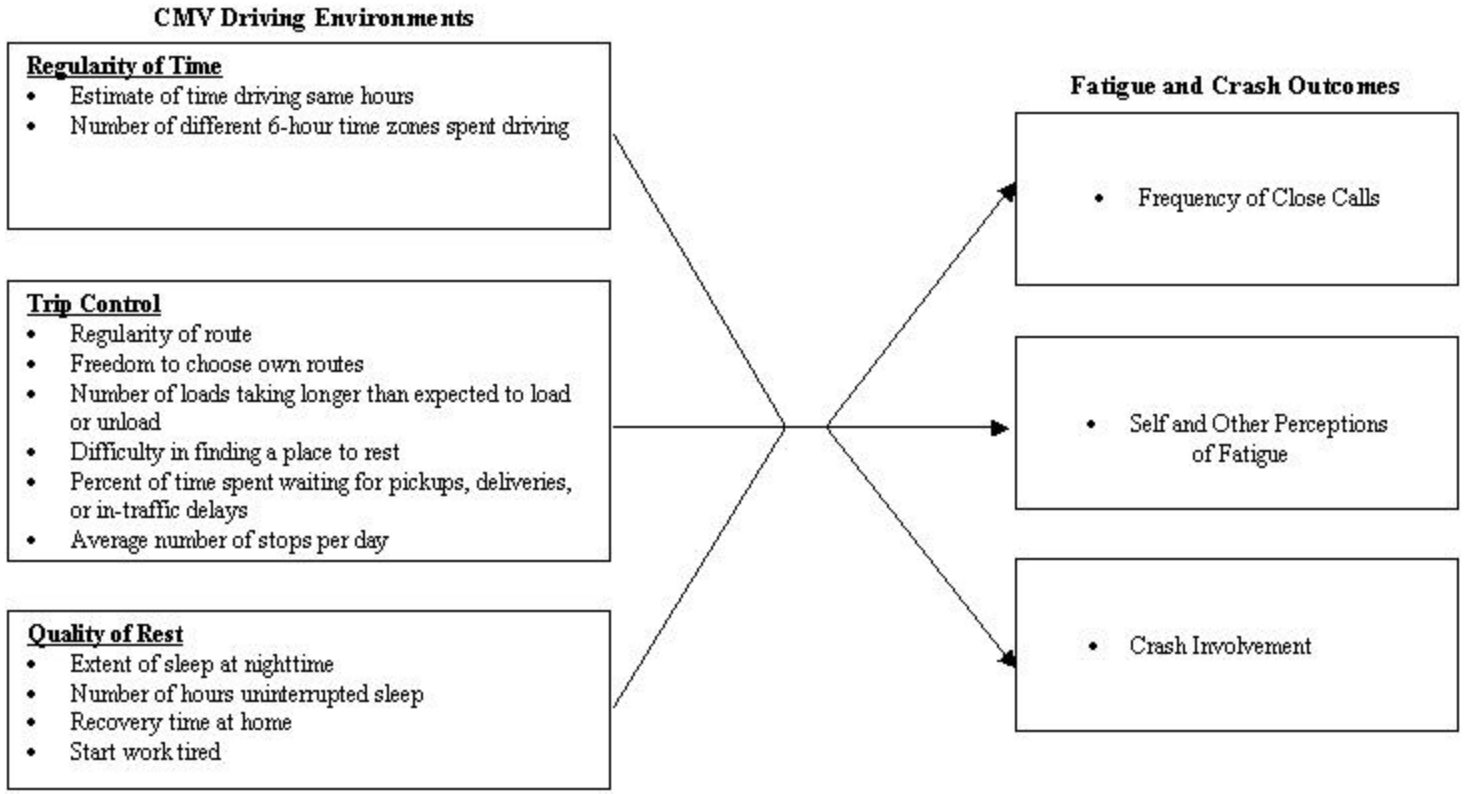


Table 2.2
Descriptive Statistics for Variables Specified in CMV Driving Environments and Fatigue Outcomes Model

Variable	Range	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Driving same hours	1,2	1.62	.49															
2. Number of time zones	1-4	2.70	.98	-.11														
3. Regularity of route	1,2	1.54	.50	-.15	.06													
4. Choose own routes	1,2	1.84	.36	.01	-.00	.02												
5. Long load time	1,2	1.53	.50	-.06	.05	.01	-.05											
6. Difficulty in rest place	1,2	1.49	.50	-.16	.07	.07	-.01	.15										
7. Schedule delays	0-90	18.31	11.54	-.04	.07	.00	.01	.16	.02									
8. Avg. stops per day	1,2	1.49	.50	-.05	-.00	-.14	.04	.05	.00	.00								
9. Sleep at night	1,2	1.39	.49	.29	-.13	-.02	.06	-.15	-.23	-.07	-.06							
10. Uninterrupted sleep	1,2	1.65	.48	.20	-.05	-.01	.02	-.09	-.10	-.09	-.01	.30						
11. Frequency at home	1,2	1.47	.50	.06	-.03	-.26	.11	-.08	-.09	-.10	.27	.09	.01					
12. Start work week tired	1,2	1.62	.49	-.08	.02	-.04	-.13	.18	.15	.07	.04	.28	-.18	-.08				
13. Close calls	6-28	11.60	3.90	-.08	-.09	-.06	.07	.16	.11	-.00	.02	.07	-.02	-.02	.18	(.81)		
14. Fatigue	6-26	14.80	4.24	-.17	.02	-.09	-.05	.29	.17	.11	.09	.26	-.22	-.04	.40	.43	(.80)	
15. Crash involvement	0-5.49	.13	.36	.02	.02	-.07	-.04	.07	-.01	-.02	.13	-.08	-.05	.07	.12	.06	.12	(.77)

Notes: (1) Ns ranged from 468 to 502 due to missing data
(2) Cronbach alphas for multi-item scales are on diagonal
(3) Correlations $\geq \pm .09$ are statistically significant at $p \leq .05$ (2-tailed); correlations $\geq \pm .13$ are statistically significant at $p \leq .01$ (2-tailed).
(4) Complete descriptions of each variable, including the scoring system used, are available in Appendix E, "Definitions of Model Variables."

As shown in Table 2.3, all eight driving environments were represented in the sample. The environment with the largest proportion of drivers (20.1 percent, N=100) was #4, an environment characterized by regular driving time but more loads with longer load times than expected and a high frequency of starting the workweek tired. The next most common environment (16.5 percent of the drivers, N=82) was the least favorable. These drivers report driving irregular times, waiting for more loads to be loaded or unloaded much longer than they planned, and a high frequency of starting the work week tired. Collectively, this distribution of drivers in all eight environments suggests that CMV work environments are highly variable and that there is no such thing as a "typical" work environment.

Table 2.3
Distribution of Drivers by Driving Environment
(Driving the Same Hours, Longer Than Expected Load Times, Starting Workweek Tired)

Driving Environment	Frequency	Percent
1. Drive regular time, low load wait time, do not start workweek tired	72	14.5
2. Drive regular time, low load wait time, start workweek tired	79	15.9
3. Drive regular time, high load wait time, do not start workweek tired	53	10.7
4. Drive regular time, high load wait time, start workweek tired	100	20.1
5. Drive irregular time, low load wait time, do not start workweek tired	39	7.8
6. Drive irregular time, low load wait time, start workweek tired	46	9.3
7. Drive irregular time, high load wait time, do not start workweek tired	26	5.2
8. Drive irregular time, high load wait time, start workweek tired	82	16.5
Total	497	100 %

Note: Complete descriptions of each variable are available in Appendix E, "Definitions of Model Variables".

One-way analyses of variance (ANOVA) were completed using these eight environments to predict each of the 3 fatigue and crash outcomes (see Table 2.4). Work environment was found to be a statistically significant ($p \leq .001$) predictor for 2 outcomes, the frequency of close calls and perceptions of fatigue. A visual inspection of the means indicates that these outcomes were higher in the higher

numbered work environments. It appears that the eight driving environments may be viewed somewhat in a continuum fashion with the first environment as the most favorable and the eighth environment as least favorable.

Though not reported here, several additional combinations of the dichotomous driving environment variables (i.e., different typologies) were formulated and analyzed with similar results. One combination merits special comment because of its ability to explain variation in crash involvement. The environment defined by driving regularity, number of loads taking longer than expected, and number of hours of uninterrupted sleep, was significantly related ($p \leq .05$) to all three outcome measures. As before, there was a general increased trend toward more undesirable outcomes in the higher-numbered environments. Interestingly, however, the absolute worst scenario for crash involvement (M=.29) occurred in the environment characterized by higher than anticipated waiting times for loads and five or fewer hours of sleep but regular driving times. Fortunately, the percentage of drivers working in this environment (9.1 percent) was relatively small.

Table 2.4
Driving Environment
(Driving the Same Hours, Longer Than Expected Load Times, Starting Workweek Tired)
as Predictors of Close Calls, Self and Others' Perception of Fatigue, and Crash Involvement

Fatigue and Crash Outcome		**Driving Environment Means**								
	Range	1	2	3	4	5	6	7	8	F
Close Calls	6-28	10.06	11.09	11.78	12.18	9.97	12.89	11.27	12.67	4.62*
Self & Others' Perceptions of Fatigue	6-26	11.55	14.65	13.33	16.32	12.15	15.76	14.96	17.43	18.17*
Crash Involvement	0-5.49	.00	.11	.00	.21	.00	.16	.00	.14	1.55

*$p \leq .001$

Note: Complete descriptions of each variable are available in Appendix E, "Definitions of Model Variables".

Determining How Driving Environment Indicators Affect Fatigue and Crashes

Testing the Driving Environment component of the CMV Driver Fatigue Model is somewhat premature because many elements known to affect fatigue and crashes are not included in Figure 2.1 (i.e., Economic Pressures and Carrier Support for Driving Safety). Still, insights may be gleaned by examining how driving environment indicators affect fatigue and crash outcomes independent of any specific driving environment typology.

Results of Model Tests

Regression analysis was used to test whether the CMV Driving Environment factors were related to fatigue and crash outcomes. The results are presented in Table 2.5.

Close Calls

The 12 indicators of driving environment explained 5 percent ($F=2.95$, $p \leq .001$) of the variability of close calls due to fatigue. Three indicators, one from each environmental factor, emerged as useful predictors of close calls. The number of different 6-hour time zones a driver worked in during a given workweek ($\beta = -.11$, $p \leq .05$) was negatively related to close calls, a rather counterintuitive finding. One would expect more time zones to be associated with a greater frequency of close calls. The results associated with the other two indicators were in the expected direction. The experience of more than 30 percent of one's loads taking longer than expected to load or unload, a Trip Control indicator, was positively related ($\beta = .12$, $p \leq .05$), to close calls. Finally, Quality of Rest, as reflected in sometimes, frequently or always starting the workweek tired ($\beta = .18$, $p \leq .001$), was also positively related to close calls. Thus, while the total amount of explained variation was modest (5 percent), there is evidence that elements representative of each environmental factor play a role in the frequency of close calls.

Self and Others' Perceptions of Fatigue

Driving environment factors accounted for 23 percent ($F=11.41$, $p \leq .001$) of the variation in fatigue perceptions. As in the case of Close Calls, factors from each environmental set played a role. With respect to Regularity of Time, drivers who never or rarely drive the same hours had higher perceptions of fatigue ($\beta = -.10$, $p \leq .05$). Trip Control yielded two useful predictors. The extent to which drivers experience regularity in the routes they drive was linked to fatigue, with less regularity associated with more fatigue ($\beta = -.09$, $p \leq .05$). More loads with longer than expected load times ($\beta = .18$, $p \leq .001$) was also associated with more fatigue. Quality of Rest also produced two predictors of fatigue. Drivers who reported getting 5 or more hours of uninterrupted sleep while working ($\beta = -.09$, $p \leq .05$) were significantly less likely to report higher levels of fatigue in others or themselves, while drivers who started the workweek tired ($\beta = .29$, $p \leq .001$) were significantly more likely to report higher levels of fatigue in others or themeselves.

Table 2.5
Results of Regression Analysis Testing Driving Environment Indicators of Fatigue

Driving Environment Indicators	Close Calls	Self and Others' Perceptions of Fatigue	Crash Involvement
Regularity of Time			
Driving the same hours	-.06	-.10*	.03
Number of time zones	-.11*	-.03	.02
Trip Control			
Regularity of route	-.07	-.09*	-.04
Can choose own routes	.08	.03	-.02
Long load time	.12*	.18***	.05
Difficulty in rest place	.06	.07	-.05
Schedule delays	-.04	.06	-.03
Average stops per day	-.02	.04	.10[a]
Quality of Rest			
Extent of sleep at night	.01	-.08	-.05
Uninterrupted hours of sleep	.03	-.09*	-.04
Frequency at home	-.01	-.01	.07
Start workweek tired	.18***	.29***	.09 [a]
F	2.95***	11.41***	1.67 [a]
Adjusted R^2	.05	.23	.02

*$p \leq .05$ **$p \leq .01$ ***$p \leq .001$ [a] $p \leq .10$

Note: Complete descriptions of each variable are available in Appendix E, "Definitions of Model Variables".

Crash Involvement

The ability of the three environmental factors to account for variation in actual crash involvement was small and only marginally statistically significant (i.e., 2 percent, $p \leq .07$). Recall, however, that achieving statistical significance was predetermined to be difficult, given the low base rate of crashes (i.e., the restriction in range association with the crash involvement measure). The two predictors of crashes came from the Trip Control and Quality of Rest categories. The average number of stops per day (as measured by one or less versus two or more) was positively ($\beta = .10$, $p \leq .10$) related to the number of crashes, and starting the workweek tired also contributed to the explanation of crashes ($\beta = .09$, $p \leq .10$).

Summary

The primary objectives of this part of the project were to develop a typology of driving environments, estimate the percent of over-the-road drivers working in each type of driving environment, and to describe how driving environment affects fatigue and crash rates. The literature review and focus groups of industry professionals led to the development of 25 potential indicators of truck driving environments. A survey of randomly selected truck drivers provided the required data.

Twelve driving environment indicators were found to be meaningfully related to fifteen fatigue and crash outcome measures: two Regularity of Time items, six measures of Trip Control, and four items indicating Quality of Rest. Factor analysis identified three constructs underlying the fifteen fatigue and crash measures: close calls due to fatigue, the perception of fatigue as a problem for self and other drivers, and crashes (reportable and chargeable).

All three hypothesized driving environment characteristics were good predictors of fatigue, and the typology developed from them does a good job of predicting the frequency of close calls due to fatigue and drivers' perceptions of fatigue being a problem for themselves and other drivers. Thus, the results of the truck stop study indicate that the driving environment plays a key role in driver fatigue. Management and safety regulation implications drawn from this study will be discussed at greater length in Part 5.

Parts 3 and 4 of this report investigate the complete CMV Driver Fatigue Model which includes two hypothesized fatigue-influencing factors that were not investigated in the truck stop study – economic pressures and company practices and programs that promote safety. While the truck stop study identifies the salient measures of driving environment that will be utilized to test the CMV Driver Fatigue Model, the assessment of economic pressures and company practices requires input beyond that which can be provided by drivers alone. Hence, the samples employed in Parts 3 and 4 include other individuals (in addition to drivers) from trucking companies and motor coach companies, respectively, that could provide information related to operational requirements.

PART 3. TESTING THE CMV DRIVER FATIGUE MODEL IN TRUCKING COMPANIES

Part 2 of this report focused on the formation of definitions (typologies) of driving environments and deriving estimates of how many interstate commercial vehicle drivers within the trucking industry fall into each type of driving environment. In addition, an analysis of how CMV Driving Environments are related to Fatigue and Crash Outcomes was presented. Part 3 of this report replicates and extends this model by (1) assessing the role of CMV Driving Environments on Fatigue and Crash Outcomes in a different trucking sample and (2) evaluating additional factors which may have a bearing on Fatigue and Crash Outcomes. Specifically, the role of Economic Pressures and Carrier Support for Driving Safety are assessed. Hypothesized components of these two factors are shown in Figure 3.1 that presents a revised CMV Driver Fatigue Model. Item level indicators in this figure have been condensed into fewer, more logical, groupings than shown in some previous CMV Driver Fatigue Model figures. These editorial changes also correspond more closely to survey content.

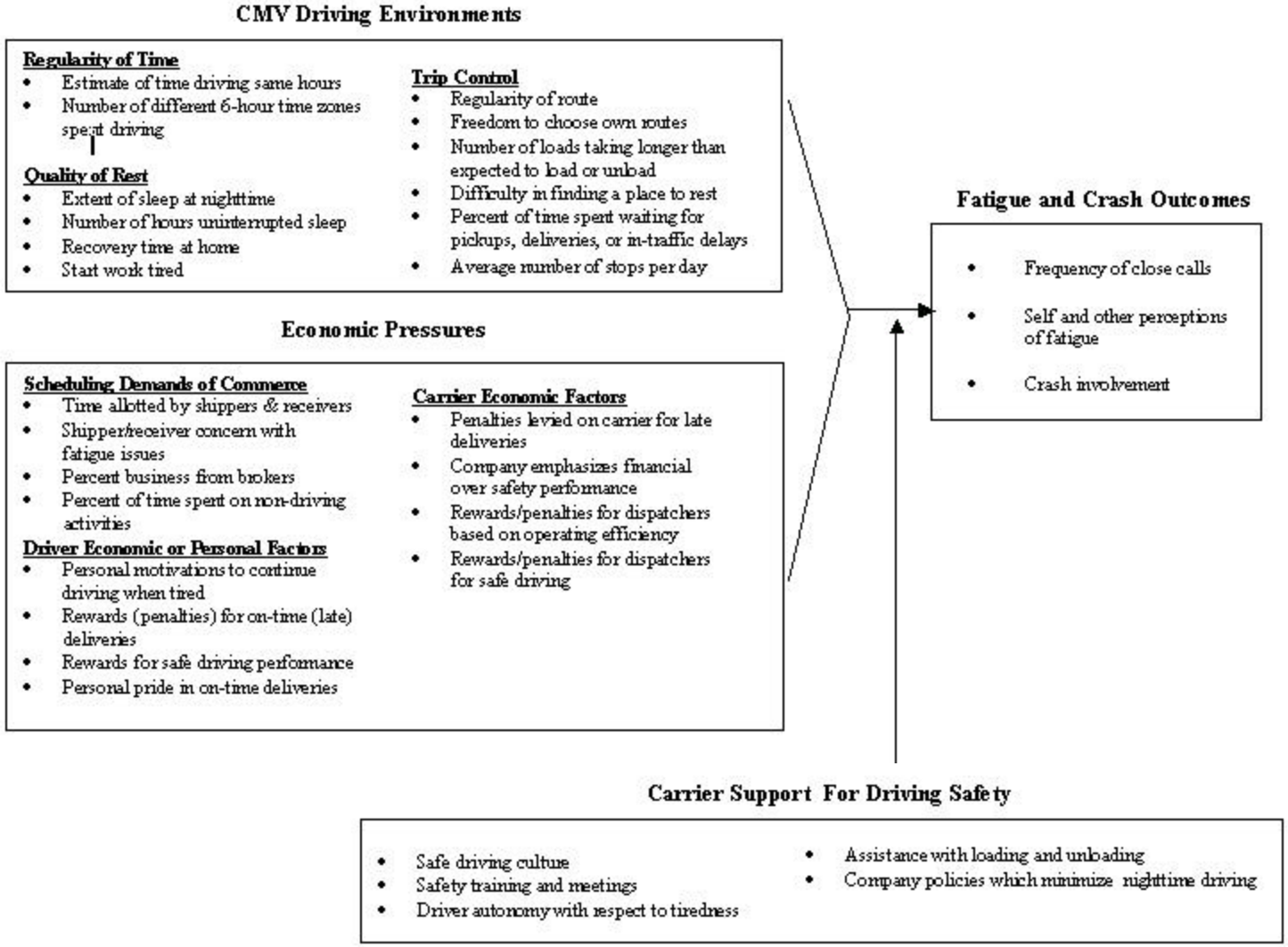
The inclusion of these two additional broad factors facilitates the completion of two project research objectives: (1) to assess the operational scheduling requirements of carriers and (2) to identify carrier scheduling requirements that have a positive effect on safety performance. Part 4 will evaluate this model among motor coach firms.

Sample and Data Collection

This segment of the study sought to be representative of drivers working for carriers with three distinct safety performance levels, as reflected in judgments made within the SafeStat, the FMCSA's Motor Carrier Safety Status Measurement System (SafeStat, Version 6.1) data base. SafeStat is a compilation of performance-based variables for each known motor carrier. The variables used for comparison purposes are: power units; number of roadside inspections; number of out-of-service violations for vehicles; number of out-of-service violations for drivers; out-of-service violations related to the transport of hazardous materials; and accidents. These variables are used to develop frequencies over and within three (3) year periods that are used to assess the performance of each motor carrier against standards developed by the Department of Transportation. Typically, combined out-of-service rates that are greater than 34 percent indicate less than acceptable performance. Accident frequencies of 1.4 per million miles or greater also indicate unacceptable performance.

These data are weighted by the Federal Motor Carrier Safety Administration based upon their relative importance. Accident data carry twice as much weight as any other data contained in SafeStat. The Federal Motor Carrier Safety Administration accesses these data through an algorithm that results in overall performance indicators for each carrier. Carriers are then placed within different groups based

Figure 3.1
Commercial Motor Vehicle (CMV) Driver Fatigue Model



upon these performance indicators. These groupings constitute top performers, average performers, and poor performers.

Data Collection

A multi-step data collection effort was employed. The SafeStat database was first used to obtain a stratified population of carrier firms. Next, a sample of firms from each performance category was randomly selected. Given the fact that some carriers would not choose to participate, a strategy for selecting potential replacement carriers was also formulated. The next step was to contact the carriers identified to be in the sample by telephone and secure their agreement to participate. Each of these steps in data collection is described in more detail below.

Identification of carriers. Candidate firms for inclusion in this study had to have accurate census data detailing their location, safety performance record, and a sufficient number of drivers (i.e., 4) to provide a reliable driver perspective. Carrier census data and safety performance data, specifically driver inspection and accident data, were available in FMCSA's Motor Carrier Safety Status Measurement System (SafeStat, Version 6.1). SafeStat has safety data for 136,745 firms. Census data could be matched with 78,621 CMV firms in the SafeStat database. Of these 78,621 firms, 77,216 carried only freight. Another 207 engaged in both freight and passenger transport, and were excluded from the sample. Since the survey methodology required three truck driver respondents from each sample firm in order to get a reliable representation of the driver perspective, firms with three or fewer truck drivers were thus excluded from consideration. Accordingly, the universe consisted of 21,292 trucking firms. More generally it could be defined as all interstate motor carriers in the United States registered with the FMCSA for which safety information is readily available and who employ at least four truck drivers.

This universe was stratified on the basis of safety performance prior to drawing the sample, in order to assure sufficient variation among the sample carriers on the dependent variables specified in the model (i.e., there needs to be some variance in safety performance and the frequency of driver fatigue occurrences). Consequently, universe carriers were grouped into three safety performance rating categories (i.e., first quartile, middle two quartiles, and fourth quartile), and sample carriers were selected randomly from within each category. An effort was made to sample an equal number of carriers from each safety performance rating category. However, the percentages of firms agreeing to participate more closely approximated a normal distribution, with nearly equal numbers of top and poor performers.

The poor safety performers (first quartile) were those carriers that had a SafeStat category rating of A or a rating of B and an Accident SEA. The average safety performers (middle two quartiles) were those carriers that had a SafeStat category rating of H and at least two crashes. The top safety

performers were those carriers that had a SafeStat category rating of H and fewer than two crashes. Figure 3.2 describes the universe of trucking firms from SafeStat and the stratification of these firms based on safety performance.

Data collection methodology. The data collection methodology involved telephone calls to the safety director at each of the selected carriers to solicit her or his firm's voluntary participation in the study. Carriers that chose not to participate were replaced with firms selected at random from the appropriate safety performance group. Sampling continued until the data collection time deadline was reached.

At each trucking company, the safety director was sent a packet of seven (7) surveys -- one each for the executive and safety director, two for dispatchers, and three for drivers. The safety director was instructed to complete the appropriate survey and to distribute the remainder to a top executive, two dispatchers and three drivers. The safety director was instructed to select "typical" dispatchers and drivers; that is, neither the best nor the worst. An envelope was provided for each survey. Each respondent was instructed to put her/his completed survey into the envelope, seal it, and return it to the safety director who would return the entire packet to the researchers.

Response rates. Tables 3.1 and 3.2 summarize the response rate from the trucking companies in the aggregate and by the safety performance stratification. The response rates are described at two stages of the data collection process: (1) the telephone calling stage where voluntary participation was sought (Table 3.1) and (2) for the data return stage where companies that had agreed to participate did or did not complete and return surveys (Table 3.2).

As Table 3.1 shows, 374 (66.1 percent) of the 566 companies contacted agreed to participate in the project (i.e., agreed to participate). The percentage of companies agreeing to participate by company performance level ranged from 47.5 percent (top performers) to 80.6 percent (average performers). Table 3.2 indicates that 116 (31.0 percent) of the 374 companies who agreed to participate in the study returned usable survey sets. This response rate is typical for mailed surveys and perhaps even higher than one might expect given that the methodology asked for surveys from four different occupational categories within each company. Response rates by company performance level ranged from 24.8 percent (poor performers) to 38.7 percent (average performers).

Sample

The composition of the sample can be described in various ways (e.g., company characteristics can be described, demographic attributes of respondent groups such as drivers or dispatchers can be summarized). In this section we describe some of the characteristics of the companies who participated in the study and describe the driver respondents.

Figure 3.2
Sampling Flowchart of Trucking Firms

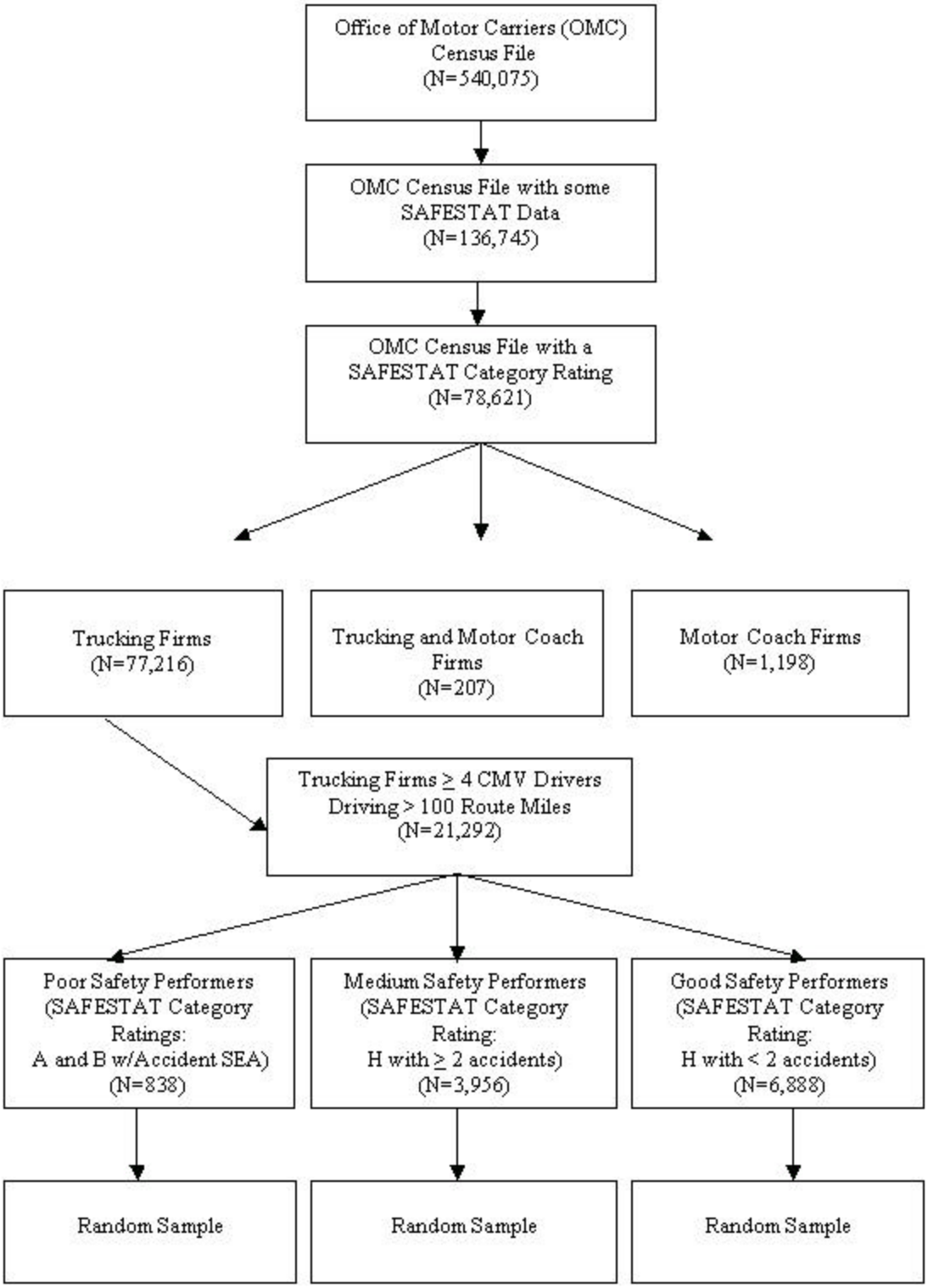


Table 3.1
Response Rates Associated with Telephone Calling Stage of Data Collection

	Performance Level of Trucking Company			
Companies Successfully Contacted	Top	Average	Poor	Total
Agreed	112 (47.5%)	137 (80.6%)	125 (78.1%)	374 (66.1%)
Refused	124 (52.5%)	33 (19.4%)	35 (21.9%)	192 (33.9%)
Contacted	236 (100%)	170 (100%)	160 (100%)	566 (100%)

Table 3.2
Response Rates Associated with Company Return Stage of Data Collection

	Performance Level of Trucking Company			
Returns Based On Telephone Agreements	Top	Average	Poor	Total
Did not return	80 (71.4%)	78 (56.9%)	92 (73.6%)	250 (66.8%)
Non-usable	0 (0.0%)	6 (4.4%)	2 (1.6%)	8 (2.1%)
Usable	32 (28.6%)	53 (38.7%)	31 (24.8%)	116 (31.0%)
Sent out	112 (100%)	137 (100%)	125 (100%)	374 (100%)

For the most part, safety directors were asked to provide the company background information. Not quite half of the 116 firms (44.8 percent) were described as "for-hire" companies, 21.6 percent described themselves as private carriers, and 4.3 percent indicated they functioned in both capacities. The remaining firms' safety directors (29.3 percent) elected not to specify their operations using these descriptors. Since carriers can be involved in numerous types of freight operations, safety directors were also asked to describe their carriers' dominant activity. Slightly over half (55.2 percent) described their firms as truckload carriers while 15.5 percent described their firms as a less-than-truckload carriers. Perhaps surprisingly, 29.3 percent characterized their firms as specialized commodity carriers. The average haul distance ranged from 20 to 3000 miles, with a mean haul length of 531 miles. While some companies relied exclusively on brokers, others did not use brokers at all. The average percent of business coming from brokers was 13.39 percent.

Equipment and staffing patterns were also quite variable. The average truck fleet size for the 116 respondent firms was 146.23, with a range of 3 to 4002. The average number of trailers was 650.57, with a range of 3 to 22,040. The average number of drivers per company was 127.86, assisted by an average of 5.75 dispatchers. The average number of miles driven per driver per week was estimated to be 1982.16 miles, with an average range of driving miles between 100 and 3000 miles.

The majority of companies relied upon company drivers. Safety directors reported an average of 76.03 percent of their drivers to be company drivers and 18.40 percent as owner operators. Relatively few drivers (5.54 percent) were unionized. As might be expected, turnover rates were high with an annual average turnover rate of 72.64 percent reported.

Nearly three-quarters (72.4 percent) of the companies responding indicated that they retained a safety director, but only a fifth (21.6 percent) employed that individual full-time (i.e., most safety directors had additional duties other than safety).

A total of 279 drivers also provided valuable information through their survey responses. One to three drivers represented each company and thus the following statistics differ from some those reported using a company perspective.

The sample was overwhelmingly male (96 percent) and ranged in age from 22 to 65 years, with an average age of 43. The average driver had 15.8 years of driving experience. Seven (2.6 percent) reported that they had a sleep disorder. The drivers were nearly equally divided between for-hire carriers (47.6 percent), and private fleet carriers (52.4 percent). Eighty-six percent of the sample classified themselves as company drivers while just over ten percent (11.6 percent) were owner-operators. Only 2.1 percent were temporary, casual, or leased drivers. The overwhelming majority of the drivers (86.6 percent) drove tractor-trailers, with only a few (5.1 percent) indicating that they typically drove double-combination vehicles. Sleeper berths were available to half (48.4 percent) of the drivers. Team driving was not all that common. Seventy-two percent of the drivers said that they never engaged in team driving, while 1.5 percent said that they always worked in a team-driving configuration. The remaining 26.5 percent engaged in team driving sometimes.

With respect to driving behavior, drivers estimated their average number of miles driven per week to be 1966 with a range of 20 to 4000 miles per week. The average number of stops for pick-ups or deliveries was 4.98 per day. Finally, with respect to crash behavior, 77.7 percent reported that they had not had a reportable crash in the previous two years and 90.9 percent reported that they had not had a chargeable crash during this same time period.

While a comparison between the truck stop drivers and the drivers from the trucking companies is not a purpose of this study, several differences between the two samples should be noted. Drivers in the present study were far less likely to drive double-combination vehicles than the truck stop respondents were. In addition, 86 percent of the truck stop drivers were for-hire, as compared to the 47.6 percent observed here. The drivers from the trucking companies appear to drive less than their truck stop counterparts. The average number of miles driven reported by truck stop drivers was 2848, considerably

more than the 1966 reported in this sample. Perhaps the most instructive difference, however, was in the average number of daily stops made by drivers. This sample averaged nearly 5 per day while the truck stop sample indicated an average of only 2.39 stops per day. Collectively, these differences suggest that a larger proportion of drivers in the present study is engaged in shorter runs with more frequent stops. This may also be a function of the greater representation of private carrier drivers in the present study.

Formation of the CMV Driver Fatigue Model

The formation of the CMV Driver Fatigue Model, as has been described in Part 1, was initially derived from a literature review and numerous focus groups and interviews. Two parts of this model, CMV Driving Environments and the Fatigue and Crash Outcomes, were refined using a nationwide sample of over-the-road drivers, as described in Part 2 -- the truck stop component of this study. The following three sections describe (1) a replication of the CMV Driving Environments and the Fatigue and Crash Outcomes analysis of indicators in the present sample, (2) the development of indicators for Economic Pressures, and (3) the development of indicators for Carrier Support for Driving Safety.

Replication of CMV Driving Environments and Fatigue and Crash Outcomes

Building on the results of the truck stop component of this study, the same measures used to operationalize CMV Driving Environments and Fatigue and Crash Outcomes were employed here (see Figure 3.1). The results of the replication of the dependent outcome variables are described first, followed by the results of the independent, driving environment variables.

Fatigue and Crash Outcomes

Three fatigue and crash outcomes were replicated from the truck stop study: frequency of close calls at six locations (e.g., terminals, weigh stations), self and others' perceptions of truck driver fatigue, and crash involvement (normalized for exposure). As shown in Table 3.3, the first two indicators demonstrated adequate variability while crash involvement was again marked by restriction in range. The normalized crash involvement measure range is slightly inflated by the inclusion of a driver reporting 15.18 crashes per 100,000 miles. The next highest number of crashes was 6.41. The internal consistency of each indicator was more than adequate as all had αs greater than 0.7.

CMV Driving Environments

The three dimensions of CMV driving environments were regularity of time, trip control, and quality of rest. Regularity of time, the extent to which drivers can achieve a set pattern of driving behavior during a 24-hour period, was measured via two indicators: (a) drivers' estimates of how often they drive the same hours and (b) the number of different 6-hour time zones spent driving. For the exact wording and measurement of each indicator, see Part 2. These single-item measures exhibited adequate dispersion relative to their range and were relatively independent (i.e., r = -.19, see Table 3.3). Six single-item indicators measured trip control, the amount of discretion and flexibility drivers' experience while engaged in driving. They were: (a) frequency of route (i.e., the extent to which a driver drives the same routes frequently), (b), freedom to choose one's routes, (c) long load time (i.e., the extent to which drivers have to wait longer than they estimated for loading or unloading), (d) difficulty in finding a place to rest, (e) amount of work time consumed by scheduling delays, and (f) the average number of stops made daily for pick-ups or deliveries. Again, adequate dispersion was observed and the intercorrelations among the six indicators ranged from r = .00 to r = .25, suggesting relative independence among the indicators.

Table 3.3
Descriptive Statistics for Variables Specified in CMV Driving Environments and Fatigue Outcome Indicators

Variable	Range	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Driving same hours	1,2	1.74	.44															
2. Number of time zones	1-4	2.63	.80	-.19														
3. Regularity of route	1,2	1.27	.45	-.19	.04													
4. Choose own routes	1,2	1.83	.38	.09	.16	-.01												
5. Long load time	1,2	1.42	.49	-.18	.15	.02	-.07											
6. Difficulty in finding place to rest	1,2	1.33	.47	-.16	.22	.00	.14	.07										
7. Schedule delays	0-90	16.84	11.60	.01	.05	-.04	-.14	.25	.00									
8. Avg. stops per day	1,2	1.78	.41	.10	-.14	-.06	-.16	-.02	-.22	.07								
9. Sleep at night	1,2	1.66	.47	.29	-.30	-.08	-.08	-.14	-.16	-.06	.06							
10. Uninterrupted sleep	1,2	1.66	.47	.04	.10	.01	.08	-.15	.00	-.02	.01	.17						
11. Frequency at home	1,2	1.95	.23	.09	-.10	-.22	-.07	.05	-.03	.06	.27	.10	.10					
12. Start workweek tired	1,2	1.47	.50	.06	.02	-.07	.02	.17	-.01	.04	.06	-.11	-.10	-.03				
13. Close calls	7-33	12.04	3.80	.08	.11	.04	.06	.10	.13	-.02	-.01	-.06	.05	.05	.15	(.80)		
14. Fatigue	6-27	13.92	3.75	-.01	.15	-.01	-.04	.13	.06	.01	.12	-.13	-.13	-.01	.42	.43	(.78)	
15. Crash involvement	0-15.18	.30	1.16	.09	-.11	-.05	-.10	-.08	-.11	-.08	.08	.10	.04	.03	-.02	.04	.03	(.85)

Notes: (1) Ns ranged from 256 to 279 due to missing data
(2) Cronbach alphas for multi-item scales are on diagonal
(3) Correlations (r's) ≥ ± .12 are statistically significant at $p \leq .05$ (2-tailed); correlations ≥ ± .16 are statistically significant at $p \leq .01$ (2-tailed).
(4) Complete descriptions of each variable, including the scoring system used, are available in Appendix F, "Definitions of Model Variables."

Quality of rest was captured by four indicators: (a) the extent to which drivers get their sleep at night-time, (b) the amount of uninterrupted sleep a driver was able to get within a 24-hour period when working, (c) the frequency with which drivers get home, and (d) frequency of starting the workweek tired. These were all measured by single items and demonstrated adequate variation. The intercorrelations among these four indicators ranged from r = .01 to r = .27, supporting independence.

In order to determine whether these indicators should be retained in this study, all twelve indicators were regressed on each of the three fatigue and crash outcome indicators (see Table 3.4). With the expectation that each indicator should exhibit a statistically significant relationship ($p \leq .10$) with at least one indicator, five indicators appear worthy of retention. From regularity of time, driving the same hours ($\beta = .14$, $p \leq .10$) was associated with close calls while the number of time zones ($\beta = .15$, $p \leq .05$) was related to fatigue perceptions. The positive relationship observed between regularity of time and close calls is surprising and counterintuitive. The indicator of difficulty in finding a place to rest ($\beta = .12$, $p \leq .10$) was predictive of close calls and the average number of stops per day indicator ($\beta = .13$, $p \leq .05$) was predictive of fatigue perceptions. Both of these indicators are from the trip control category. Lastly, from quality of rest, starting the workweek tired was associated with both close calls ($\beta = .11$, $p \leq .10$) and fatigue perceptions ($\beta = .39$, $p \leq .001$). These five indicators will be used to operationalize CMV driving environments (see Figure 3.3).

Evolution of Indicators for Economic Pressures and Carrier Support for Driving Safety

A broad list of possible indicators for the Economic Pressures and Carrier Support for Driving Safety "boxes" were devised, as specified in the proposed model. Note that Economic Pressures, like CMV Driving Environments, is comprised of three components: scheduling demands of commerce, driver economic or personal factors, and carrier economic factors. Carrier Support for Driving Safety does not have internal, logically grouped components. Rather, a large set of possible safety practices that might have a bearing on fatigue and crash outcomes was identified. Questions intended to measure each of these broad constructs were then developed and included on various surveys. The processes by which indicators of the broad constructs were refined and reduced in number is similar to the procedure used in the truck stop part of this study and are described below.

Table 3.4
Results of Regression Analysis of CMV Driving Environments and Fatigue and Crash Outcomes

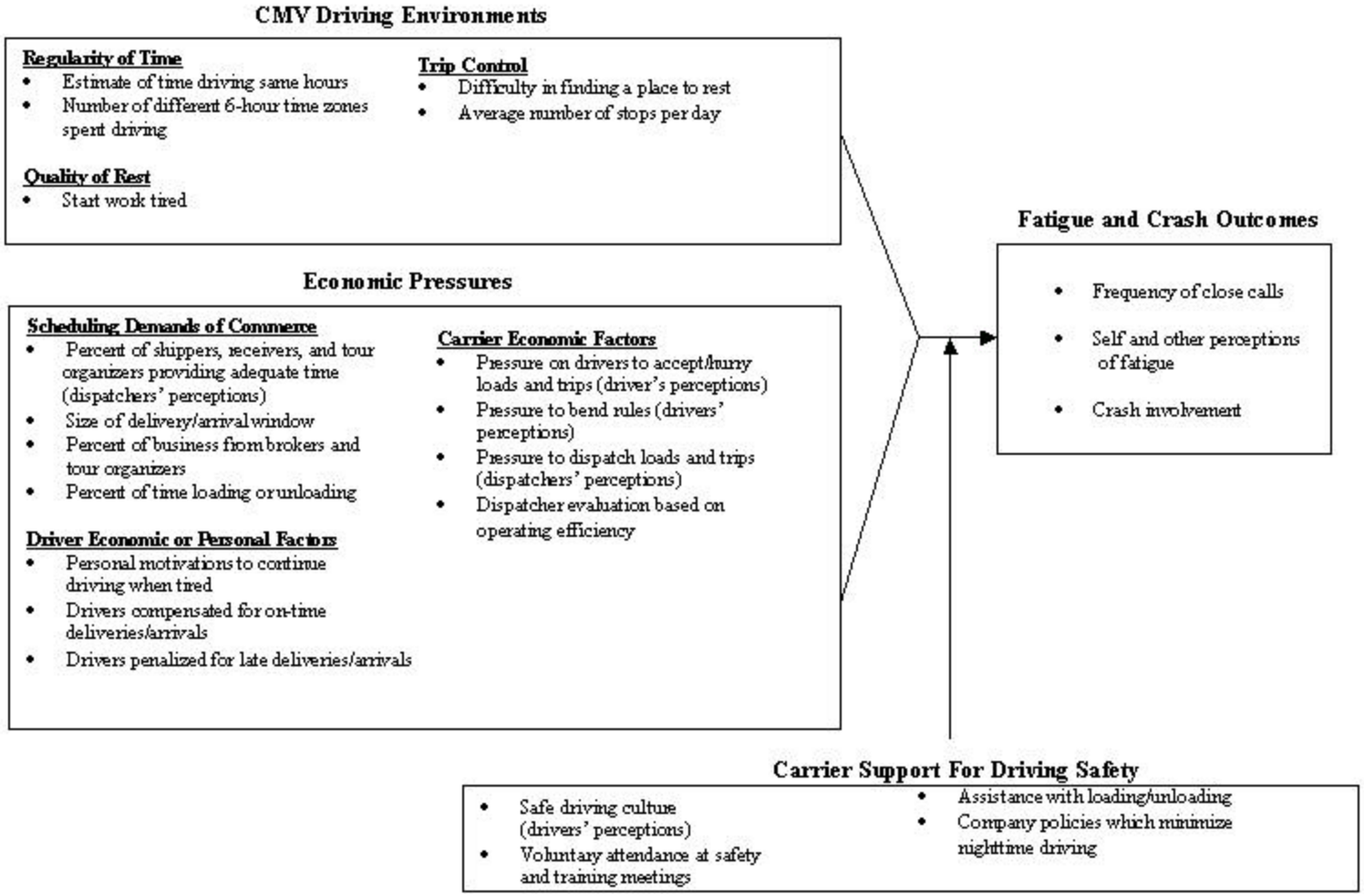
Model Predictor	Close Calls	Self and Others' Perceptions of Fatigue	Crash Involvement
Regularity of Time			
Driving the same hours	.14[a]	-.01	.05
Number of time zones	.06	.15*	-.04
Trip Control			
Regularity of route	.09	.02	-.04
Can choose own routes	.02	-.04	-.09
Long load time	.11	.04	-.04
Difficulty in finding a place to rest	.12[a]	.05	-.06
Schedule delays	-.05	-.03	-.08
Average stops per day	-.01	.13*	.04
Quality of Rest			
Extent of sleep at night	-.04	.00	.04
Uninterrupted hours of sleep	.06	-.08	.05
Frequency at home	.07	-.02	-.01
Start workweek tired	.11[a]	.39**	-.02
F	1.62[a]	5.32**	.931
Adjusted R^2	.03	.18	.00

*$p \leq .05$ **$p \leq .01$ ***$p \leq .001$ [a] $p \leq .10$

Note: Complete descriptions of each variable are available in Appendix F, "Definitions of Model Variables".

In order to gauge which indicators were most useful, each possible indicator was subjected to several assessments. Factor analysis was used to establish multiple-item measures of indicators and subsequent Cronbach alpha (α) measures of internal consistency reliability were calculated. The measures had to achieve an alpha of at least .7 to justify retention. Each indicator was also evaluated to assure that it yielded sufficient variability among the respondents to be of interest. Within a broad construct (e.g., scheduling demands of commerce), it was logical to presume that some of the various constituent indicators ought to be related to each other, although not to the extent they could be viewed as redundant. For example, perceptions regarding the extent to which shippers and receivers are perceived to provide adequate time for pick-ups and deliveries should be related to pick-up and delivery window size, since both of these factors have a bearing on the tightness of scheduling demands.

Figure 3.3
Revised Commercial Motor Vehicle (CMV) Driver Fatigue Model



Indicators demonstrating excessive multicollinearity (i.e., > .7) were judged to be redundant and, thus, eliminated.

Finally, since the overarching goal of this project is the identification of factors predictive of fatigue and crashes, an indicator's association with these outcomes (i.e., frequency of close calls, perceptions of fatigue, and crash involvement) was deemed useful in indicator selection. Stated differently, the most salient indicators were held to be those associated with fatigue and crash behavior. The ability of each indicator to demonstrate a statistically significant ($p \leq .10$) correlation with at least one of the three outcomes was required for indicator retention. Following this assessment, all of the retained indicators were simultaneously entered into a regression model seeking to explain each outcome (i.e., dependent variable). Each indicator that persists in exhibiting a statistically significant relationship (i.e., standardized beta weight) with at least one outcome becomes a final part of the CMV Driver Fatigue Model.

Scheduling Demands of Commerce

The first component of Economic Pressures is termed the scheduling demands of commerce. It reflects the external pressures that are brought to bear on CMV firms by the expectations and requirements of the shippers and receivers the carrier serves (i.e., its customers). These pressures are typically manifest in short pick-up and delivery time frames that shippers and receivers may allow, the amount of time a driver must wait for materials to be loaded or unloaded, the length of time allowed for delivery, and the extent to which a carrier is dependent on third parties (e.g., brokers) for on-going business. Four broad areas were explored: time allotted by shippers and receivers (two indicators), shipper/receiver concern with fatigue issues (one indicator), the percentage of business from brokers (one indicator), and the percent of time spent in non-driving work (two indicators). These indicators were drawn from dispatcher, safety director (or person charged with safety oversight), and driver surveys.

Time allotted by shippers and receivers was assessed via two potential indicators. These were (1) the percent of shippers and receivers (added together) that dispatchers describe as providing adequate delivery time, and (2) the dispatchers' estimate of their average delivery window. As seen in Table 3.5, these indicators exhibited considerable variation. Dispatcher estimates of customers providing adequate time ranged from 0 percent (no shippers or receivers provide adequate time) to 200 percent (all shippers and receivers provide adequate time). The factor analysis and Cronbach α findings were supportive (i.e., α=.73), and item intercorrelations were all below .20. The dispatchers' estimate of their average delivery window was formulated by dividing the responses to this question into two groups, dispatchers who estimated their average window as two hours or less (52 percent) and those who estimated their window to be greater than two hours (48 percent). With respect to correlations with the outcome measures,

dispatcher perceptions of adequate time was linked to close calls ($r = -.14$, $p \leq .05$) and crash involvement ($r = -.14$, $p \leq .05$). Stated differently, dispatcher perceptions of having adequate time manifest itself in terms of fewer close calls and crashes. The size of the delivery window was found to be related to perceptions of fatigue ($r = -.17$, $p \leq .01$), with larger windows associated with less fatigue.

Shipper/receiver concern with driver fatigue issues was evaluated using a 4-item inquiry posed to dispatchers. They were asked to what extent (using a 1-very little extent to 7-to a very large extent response framework) the following four statements were true: (1) Shippers/receivers are aware of hours of service regulation issues, (2) Shippers/receivers care about hours of service regulation issues, (3) Shippers/receivers are aware of driver fatigue issues, and (4) Shippers/receivers care about driver fatigue issues. Factor analysis indicated a single factor structure and the internal consistency reliability estimate was .89 (see Table 3.5). The measure also demonstrated good variation relative to its 4 to 28 range and its highest correlation with another scheduling indicator was only .12. Despite the logic behind this measure, it failed to demonstrate any statistically significant relations with the three outcome measures and was then eliminated from further consideration.

The percentage of business from brokers was measured through a single item provided by the safety director. As shown in Table 3.5, it ranged from 0 to 100 percent, with a mean of 13.39 percent and was not strongly related to other scheduling indicators. The relationship observed between the percent of business from brokers and fatigue and crash outcomes was not expected. Higher percentages of business from brokers was associated with fewer close calls ($r = -.12$, $p \leq .10$).

The percent of time spent in non-driving work was examined through drivers' estimates of the percent of their work time spent waiting or loading/unloading. These were both single item indicators. Drivers reported that the demands of their work cause them to spend an average of 11.01 percent of their work time waiting for a pick-up or delivery and 16.43 percent of their work time loading or unloading. Intercorrelations of these two indicators with other scheduling indicators were not excessive, never exceeding .17. The relationship between waiting time and outcomes was virtually zero (i.e., there were no significant findings), and thus this indicator was eliminated. However, the relationship between the percent of time spent loading and unloading was informative. It was strongly, positively related to crash involvement ($r = .26$, $p \leq .01$). Clearly this factor warrants further consideration.

In order to determine which of the indicators should be retained in this study, all were regressed on each of the three fatigue and crash outcome indicators (see Table 3.6). With the expectation that each indicator should exhibit a statistically significant relationship ($p \leq .10$) with at least one indicator, all four indicators appear worthy of retention. Providing adequate time for pickups and deliveries was

Table 3.5
Descriptive Statistics for Variables Specified in Scheduling Demands of Commerce and Fatigue and Crash Outcomes

Variable	Range	Mean	SD	1	2	3	4	5	6	7	8	9
Scheduling Demands of Commerce[a,b]												
1. Percent of shippers & receivers providing adequate time	0-200	88.84	45.93	(.73)								
2. Size of delivery window	1,2	1.48	.50	-.05	(-)							
3. Shipper/receiver care & awareness of driver fatigue issues	4-28	11.66	6.23	.12*	.01	(.89)						
4. Percent of business from brokers	0-100	13.39	22.29	-.12*	-.05	-.02	(-)					
5. Percent time spent waiting for pick-up or delivery	0-60	11.01	9.54	-.07	-.06	-.03	.13**	(-)				
6. Percent time spent loading or unloading	0-70	16.43	14.06	.01	.17***	.06	-.10	-.09	(-)			
Fatigue and Crash Outcomes												
7. Close calls	7-33	12.04	3.80	-.14**	.03	-.04	-.12*	-.03	.02	(.80)		
8. Perceptions of fatigue	6-27	13.93	3.75	-.04	-.17***	.10	-.10	.03	-.07	-.43***	(.78)	
9. Crash involvement	0-5.18	.30	1.16	-.14**	.07	-.01	-.05	-.05	.26***	.04	.03	(.85)

*$p \leq .10$ **$p \leq .05$ ***$p \leq .01$

Notes: (a) Ns ranged from 267 to 315 due to missing data
(b) Cronbach alphas for multi-item scales are on the diagonal
(c) Complete descriptions of each variable, including the scoring system used, are available in Appendix F, "Definitions of Model Variables."

significantly related to close calls (β = -.19, $p \leq .01$). The size of the delivery window was negatively associated with fatigue perceptions (β = -.18, $p \leq .05$). A rather inexplicable finding was that of a negative relationship between the percent of business from brokers and close calls (β = -.12, $p \leq .10$). Lastly, the percent of time spent loading or unloading was positively related to crash involvement (β = .31, $p \leq .001$). These four indicators will be used to operationalize scheduling demands of commerce.

Driver Economic or Personal Factors

The second component of Economic Pressures was intended to capture practices and circumstances that encourage positive and negative driving behaviors by drivers. It was termed, "driver economic and personal factors", to convey that these driving decisions were under the control of the driver. Four general categories are recognized: drivers' personal motivations to continue driving even when they are tired (one indicator), rewards or penalties for, respectively, on-time and late deliveries (two indicators), rewards for safe driving performance (one indicator), and the extent to which drivers take personal pride in on-time deliveries (one indicator). All indicators but one were acquired from driver surveys.

The possibility that drivers may be self-motivated to continue driving even when they are tired was measured by a two-item scale composed of driver responses to two questions: (1) to what extent do you think you drive when you are tired in order to make a good income? and (2) to what extent do you think you drive when you are tired to get somewhere for personal reasons (e.g., to get home, visit friends)? Response options ranged from 1 (to a very little extent) to 7 (to a very large extent). A factor analysis of the two items supported a single factor solution and the Cronbach α was .77. Table 3.7 shows that responses were highly variable and near the middle of the range, with a mean of 6.59 and standard deviation of 3.48. Personal motivation to continue driving even when tired was sufficiently independent of the other indicators within this construct, although it was interesting to note a positive relationship ($r = .27$, $p \leq .01$) between these motivations and penalties for late deliveries. There were two highly significant relationships between the fatigue and crash outcomes and motivation to continue driving. This indicator was related to close calls ($r = .20$, $p \leq .01$) and perceptions of fatigue ($r = .38$, $p \leq .01$).

Rewards and penalties for on-time and late deliveries were measured separately; that is one indicator assessed the extent to drivers were financially rewarded for on-time deliveries and one indicator focused on penalties for late deliveries. It was necessary to evaluate each practice separately since some companies have neither practice, some have both, and some have one practice but not the other. The

Table 3.6
Regression Analysis of Scheduling Demands of Commerce and Fatigue and Crash Involvement

Model Predictor	Close Calls	Self and Others' Perceptions of Fatigue	Crash Involvement
1. Percent of shippers & receivers providing adequate time	-.19**	-.10	-.09
2. Size of delivery Window	.04	-.18*	-.04
3. Percent of business from brokers	-.12 [a]	-.10	-.06
4. Percent time spent loading or unloading	-.07	-.08	.31***
F	2.62*	2.82*	5.71***
Adjusted R^2	.03	.04	.09

*$p \leq .05$ **$p \leq .01$ ***$p \leq .001$ [a] $p \leq .10$

Note: Complete descriptions of each variable are available in Appendix F, "Definitions of Model Variables."

reward practice was measured by asking safety directors whether or not drivers were compensated for on-time deliveries. The majority of companies (86.1 percent) did not reward drivers for on-time deliveries. The extent to which drivers might be penalized for late deliveries was determined by asking drivers whether or not their companies penalized them for late deliveries by (a) verbal criticism from their dispatchers, (b) pay reductions or fines, (c) engage in this practice, (c) loss of potential bonus money, (d) suspension from work, (e) employment termination, and (f) assigning less desirable loads in the future. The responses to these items were summed, with higher score indicating more penalties. The mean of 1.37 (see Table 3.7) suggests that relatively few companies have many penalties for late deliveries. Factor analytic examination supported a single factor structure and an internal consistency estimate of .76. Multicollinearity with other indicators within this construct was not a problem for either indicator. (It was also noteworthy that the rewards and penalties were independent of each other, as evidence by a correlation of only .06.)

The relationship between rewards and penalties for on-time and late deliveries and the outcome measures varied considerably. The extent to which companies had instituted rewards for on-time

deliveries was positively related to crash involvement ($r = .15$, $p \leq .05$) but unrelated to close calls or fatigue perceptions. In contrast, more penalties for late deliveries were positively associated with close calls ($r = .12$, $p \leq .10$) and fatigue ($r = .21$, $p \leq .01$). These findings suggest that both "carrot and stick" approaches to delivery have effects on fatigue and crash outcomes, but that these policies are far from interchangeable. It is unfortunate that a very customer-oriented tactic like rewarding drivers for on-time deliveries has such adverse (and perhaps unrecognized) consequences for crash involvement.

Table 3.7
Descriptive Statistics for Variables Specified in Driver Economic or Personal Factors and Fatigue and Crash Outcomes

Variable	Range	Mean	SD	1	2	3	4	5	6	7	8
Driver Economic or Personal Factors[a,b]											
1. Personal motivations to continue driving when tired	2-14	6.59	3.48	(.77)							
2. Drivers compensated for on-time deliveries	0,1	.14	.35	-.04	(-)						
3. Drivers penalized for late deliveries	0-6	1.37	1.66	.27***	.06	(.76)					
4. Drivers rewarded for safe driving	2-14	6.97	4.43	-.04	.18***	.06	(.73)				
5. Personal pride in on-time deliveries	1-7	6.44	1.02	.07	.12*	.18***	.01	(-)			
Fatigue and Crash Outcomes											
6. Close calls	7-33	12.04	3.80	.20***	-.04	.12*	.09	-.07	(.80)		
7. Perceptions of fatigue	6-27	13.93	3.75	.38***	-.02	.21***	.07	.00	-.43***	(.78)	
8. Crash involvement	0-15.18	.30	1.16	.07	.15**	-.07	-.02	-.05	.04	.03	(.85)

*$p \leq .10$ **$p \leq .05$ ***$p \leq .01$

Notes: (a) Ns ranged from 275 to 324 due to missing data
(b) Cronbach alphas for multi-item scales are on the diagonal
(c) Complete descriptions of each variable, including the scoring system used, are available in Appendix F, "Definitions of Model Variables."

The third component of driver personal and economic factors is the extent to which drivers are rewarded by their companies for safe driving (e.g., accident-free miles). Drivers were asked to evaluate the extent to which safe driving is rewarded by recognition programs (e.g., employee of the month) and by financial incentives (e.g., bonuses, gifts, higher mileage rates), using a response framework of 1 (to a very little extent) to 7 (to a very large extent). These responses were summed to form a single scale that generated a single factor structure and Cronbach α of .73. The mean of 6.97 and standard deviation of 4.43 suggests that the drivers experienced a wide variation in company rewards for safe driving. This indicator did not exhibit any overly strong relationships with any other indicators in the construct (i.e., all correlations were less than .19 in magnitude). However, company rewards for safe driving was also unrelated to any of the fatigue and crash outcomes, negating any further consideration of the factor.

A similar finding was observed with respect to the final indicator of this construct, drivers' personal pride in on-time deliveries. While this factor had been frequently mentioned in the interviews with drivers prior to survey data collection, it did not prove to be a useful predictor of fatigue and crash outcomes. Drivers were asked a single item, to evaluate the extent to which they took pride in making deliveries on time, using a 1 (to a very little extent) to 7 (to a very large extent) response framework. As shown in Table 3.7, drivers' responses were characterized by restriction in range. The mean of 6.44, on a 1 to 7 scale, suggests that virtually all of the drivers endorsed this statement strongly. The guidelines for multicollinearity within a construct were not violated. As already stated, there were no significant correlations between this indicator and the outcome measures. The restriction in range in the indicator may partially account for the absent of relationships. This item will not be retained in subsequent analyses.

Which of the indicators should be retained in the model was determined by regressing the three indicators exhibiting statistically significant correlations ($p \leq .10$) with at least one of the outcome measures (see Table 3.8). Using the guideline that each indicator should exhibit a statistically significant relationship ($p \leq .10$) with at least one indicator, all three indicators appear worthy of retention. Strong personal motivations to continue driving when tired was predictive of close calls ($\beta = .21$, $p \leq .01$), perceptions of fatigue ($\beta = .34$, $p \leq .001$) and crash involvement ($\beta = .11$, $p \leq .10$). Such a finding implies that the decision to drive tired is a shared one; that is, it is both a function of company policies and drivers' preferences. The practice of compensating driver for on-time deliveries was linked to crash involvement ($\beta = .15$, $p \leq .01$). This result suggests that such policies may provide incentives to drivers to drive faster or less carefully in order to deliver on-time, which in turn may lead to more crashes. The third indicator, the practice of penalizing driver for late deliveries, was marginally related to two outcomes, fatigue perceptions ($\beta = .11$, $p \leq .10$) and crash involvement ($\beta = -.12$, $p \leq .10$). The fatigue perception finding is

logical, with more penalties associated with more fatigue. However, the crash involvement finding is counterintuitive (i.e., more penalties are associated with fewer crashes). Nonetheless, all three of these indicators will be retained in further investigations of the model entailing driver economic and personal factors.

Carrier Economic Factors

The third component of Economic Pressures was identified as carrier economic factors. This component refers to the pressures perceived by various personnel within a carrier firm to be economically successful. It also entails the policies and practices adopted by carriers to promote economic outcomes, which may sometimes come at the expense of maximizing safety outcomes. Four general areas were investigated: the extent to which carriers are penalized by their customers for late deliveries (one indicator), the extent to which carriers emphasize financial performance over safety performance (four indicators), the extent to which there are rewards or penalties for dispatchers based on operating efficiency (one indicator), and the extent to which there are rewards or penalties for dispatchers for safe driving (one indicator). These indicators were derived from company perspective surveys completed by a senior manager (often the chief executive officer), dispatcher surveys, and driver surveys.

Information on the extent to which carriers are penalized for late deliveries was supplied from the company perspective survey. Respondents were simply asked to report the percentage of their company customers that impose a penalty for late deliveries. As shown in Table 3.9, responses ranged from 0 to 100 percent, with a mean of 11.5 percent. A little over half (54.3 percent) reported that no penalties were imposed. Although there was certainly evidence that many companies do not penalize firms for lateness, the variance was judged large enough to continue with the evaluation of this single-item factor. Moreover, this indicator was not strongly related to any other indicators in this category (i.e., the largest correlation was .20). With respect to fatigue and crash outcomes, however, penalties by customers for lateness appeared to have little impact. No significant correlations were observed and thus this indicator was not retained.

The extent to which carriers emphasize financial performance over safety performance was assessed via four indicators. The first was a 4-item measure of the extent to which drivers perceive pressure from their dispatchers to accept or hurry loads. It can be termed dispatcher pressure. The first two items asked, to what extent dispatchers asked them to continue driving when they were tired, or to

Table 3.8
Regression Analysis of Driver Economic or Personal Factors and Fatigue and Crash Involvement

Driver Economic or Personal Factors	Close Calls	Self and Others' Perceptions of Fatigue	Crash Involvement
1. Personal motivations to continue driving when tired	.21**	.34***	.11[a]
2. Drivers compensated for on-time deliveries	-.03	-.01	.15**
3. Drivers penalized for late deliveries	.06	.11[a]	-.12[a]
F	4.57**	14.12***	3.38*
Adjusted R^2	.04	.14	.03

*$p \leq .05$ **$p \leq .01$ ***$p \leq .001$ [a] $p \leq .10$

Note: Complete descriptions of each variable are available in Appendix F, "Definitions of Model Variables."

accept a load when they were tired. The third item asked drivers to what extent dispatchers pressured them to accept a load when they would be "out of hours" before delivery could be made. The fourth item was more global and asked drivers to what extent they thought that dispatchers in their company placed a higher priority on making deliveries on-time than on driver safety. All items used a 1 (to a very little extent) to 7 (to a very large extent) response framework. The factor analysis supported a single factor solution and the Cronbach α was .90. No excessive restriction in range was observed. This indicator was relatively independent of others although it correlated .47 with the next indicator, the extent to which drivers thought they had to "bend the rules" to get their jobs done. Dispatcher pressure was found to be related to two outcomes, close calls ($r = .20$, $p \leq .01$) and perceptions of fatigue ($r = .45$, $p \leq .01$). The magnitude of these findings suggests that pressure from dispatchers may be a potent predictor of these two outcomes.

A second indicator of the extent to which carriers emphasize financial performance over safety performance was the level of agreement a driver expressed with the statement: Drivers have to bend a driving safety rule or policy in order to "get the job done." Response options ranged from (1) strongly disagree to (7) strongly agree. The mean response to this item was 3.98, placing it near the middle of the 1 to 7 range, and with a considerable standard deviation of 2.11, this single item indicator exhibited wide variation. Bending a safety rule was generally unrelated to other carrier economic indicators, except dispatcher pressure (as noted above). With respect to outcomes, this indicator was related to close calls ($r = .11$, $p \leq .10$) and perceptions of fatigue ($r = .41$, $p \leq .01$).

The third indicator was a single-item estimate of the extent to which dispatchers felt that their company pressured them to accept or dispatch loads when all of their available drivers were out of hours.

Table 3.9
Descriptive Statistics for Variables Specified in Carrier Economic Factor and Fatigue and Crash Outcomes

Variable	Range	Mean	SD	1	2	3	4	5	6	7	8	9	10
Carrier Economic Factors[a,b]													
1. Percent of customers who penalize for lateness	0-100	11.50	22.87	(-)									
2. Pressure on drivers to accept/hurry (drivers' perceptions)	4-28	9.81	6.54	.01	(.90)								
3. Pressure to bend rules (drivers' perceptions)	1-7	3.98	2.11	-.02	.47***	(-)							
4. Pressure to dispatch loads (dispatchers' perceptions)	1-7	2.08	1.61	.16***	.26***	.17***	(-)						
5. Pressure to ask drivers to overlook rest (dispatchers' perceptions)	1-7	2.12	1.42	.20***	.26***	.16***	.53***	(-)					
6. Dispatchers evaluated on operating efficiency	0-2	.60	.80	.03	-.04	-.07	-.08	-.04	(.68)				
7. Dispatchers evaluated on driving safety	0,1	.29	.45	.07	-26***	-.13**	-.24***	-.21***	.49***	(-)			
Fatigue and Crash Outcomes													
8. Close calls	7-33	12.04	3.80	-.04	.20***	.11*	.16**	.07	.17***	.01	(.80)		
9. Perceptions of fatigue	6-27	13.93	3.75	-.06	.45***	.41***	.15**	.04	.16***	.01	-.43***	(.78)	
10. Crash involvement	0-15.18	.30	1.16	-.02	-.06	-.03	-.00	-.08	-.04	.03	.04	.03	(.85)

*$p \leq .10$ **$p \leq .05$ ***$p \leq .01$

Notes: (a) Ns ranged from 272 to 297 due to missing data
(b) Cronbach alphas for multi-item scales are on the diagonal
(c) Complete descriptions of each variable, including the scoring system used, are available in Appendix E, "Definitions of Model Variables."

Dispatchers recorded their views using a 1 (to a very little extent) to 7 (to a very large extent) response framework. The relatively low mean of 2.08 and small standard deviation of 1.61 suggested that pressure from the company to dispatch was not a widespread problem, but variable enough to merit further inquiry. This indicator was related to the next indicator (r =.53), pressure on dispatchers to overlook drivers' rest requirements, but was below the multicollinearity threshold for elimination (i.e., r >.7). Pressure from the company to dispatch loads was related to close calls (r =.16, $p \leq .05$) and perceptions of fatigue (r = .15, $p \leq .05$), implying that this form of pressure does have adverse consequences.

The last indicator of the extent to which carriers emphasize financial performance over safety performance was also based on dispatcher opinion. It consisted of a single item asking dispatchers to describe the extent to which the following statement was true, using a 1 (to a very little extent) to 7 (to a very large extent) framework: To what extent do you "Ask drivers to "overlook" rest requirements so that you can accept a load?" While the variance in the measure was judged to be adequate, the mean of 2.12 and standard deviation of 1.42 indicates that this was not a frequent problem for the sample as a whole. Other than the correlation noted above, asking drivers to overlook rest requirements was independent of other indicators in this set. However, the indicator itself did not demonstrate strong relations with any of the outcome measures. None was significant and thus this indicator was eliminated from further consideration.

The third general carrier economic factor was the extent to which there were rewards or penalties for dispatchers based on operating efficiency. Dispatchers were asked to indicate whether or not they were evaluated by their company on (1) the average number of miles driven per driver and (2) minimizing deadhead miles. Following supportive factor analytic results, the two items were added together to form a scale. Despite the limitation of achieving a Cronbach α of only .68, slightly less than the .7 retention standard, it was decided to continue the analysis for exploratory purposes. This decision was bolstered by evidence of good variation in the measure. Evaluation based on operating efficiency demonstrated some relation with the next indicator, rewards or penalties for dispatchers based on driving safety (r =.49). Again, however, this did not violate the multicollinearity standard. The correlations between evaluations based on operating efficiency and fatigue and crash outcomes were insightful. The indicator was related to both close calls (r =.17, $p \leq .01$ and perceptions of fatigue (r =.16, $p \leq .01$). These policies may thus have unintended, adverse consequences for close calls and fatigue.

The fourth and final general carrier economic factor was the extent to which there were rewards or penalties for dispatchers based on driving safety. Dispatchers were asked to indicate whether or not they were evaluated by their companies on accident-free miles by drivers or drivers' chargeable accidents. The majority of dispatchers (71.1 percent) were not evaluated on this basis, as indicated by the mean of .29. As noted above this indicator was related to evaluation based on operating efficiency; it was not strongly related to any other indicators in this set (i.e., all other correlations were less than .22). With respect to fatigue and crash outcomes, this indicator was found to be relatively ineffectual. It was not significantly related to any of the outcomes and was thus discontinued in any further analyses.

The last step is to determine which of the indicators should be retained in this study. The four indicators exhibiting statistically significant correlations ($p \leq .10$) with at least one outcome measure were regressed on each of the three fatigue and crash outcome indicators (see Table 3.10). Using the guideline that each indicator should exhibit a statistically significant relationship ($p \leq .10$) with at least one indicator, all four indicators appear worthy of retention. Drivers' perceptions of pressure from dispatchers to accept or hurry loads was significantly related to perceptions of fatigue ($\beta = .28$, $p \leq .001$). Drivers' perceptions that they have to bend safety rules to get the job done was positively associated with fatigue perceptions ($\beta = .28$, $p \leq .001$). Dispatchers perceptions that they are pressured by their companies to accept loads even when they have no drivers with remaining hours was marginally related to close calls ($\beta = .12$, $p \leq .10$). Lastly, dispatcher evaluation based on operating efficiency was positively related to close calls ($\beta = .20$, $p \leq .01$) and fatigue ($\beta = .18$, $p \leq .001$). These four indicators will be used to operationalize carrier economic factors.

Carrier Support for Driving Safety

As shown in Figure 3.1, carrier support for driving safety is positioned as a moderating variable, affecting the extent to which CMV driving environments and economic pressure impact fatigue and crash outcomes. Carriers can minimize or enhance the environment and/or economic determinants of fatigue and crashes by the extent to which they institute safety practices. For example, a company with a strong safety culture may employ dispatchers who are more aware of the difficulty drivers sometimes experience in finding a place to rest (i.e., a trip control indicator within the CMV driving environment factor). Such dispatchers may accordingly be more sensitive to drivers' needs for trip control. Though not depicted this way in the model, carrier support for driving safety may also have a direct impact on fatigue and crash outcomes.

Five areas of possible carrier support were investigated: safe driving culture, safety training and meetings (which included two indicators), company orientation toward driver tiredness, company assistance with loading and unloading, and company policies to minimize night time driving. As noted below, these indicators were derived from driver and safety director (i.e., person charged with safety oversight) surveys.

Table 3.10
Regression Analysis of Carrier Economic Factors and Fatigue and Crash Involvement

Carrier Economic Factors	Close Calls	Self and Others' Perceptions of Fatigue	Crash Involvement
1. Pressure on drivers to accept/hurry loads (drivers' perceptions)	.12	.28***	-.06
2. Pressure to bend rules (drivers' perceptions)	.08	.28***	-.01
3. Pressure to dispatch loads (dispatchers' perceptions)	.12 [a]	.05	.01
4. Dispatchers evaluated on operating efficiency	.20***	.18***	-.04
F	4.94***	19.24***	.27
Adjusted R^2	.07	.26	.01

*$p \leq .05$ **$p \leq .01$ ***$p \leq .001$ [a] $p \leq .10$

Note: Complete descriptions of each variable are available in Appendix F, "Definitions of Model Variables."

The first indicator was identified as drivers' perception of the extent to which a safe driving culture characterizes their company. It consisted of 11 statements to which drivers were asked to report the extent to which they disagreed or agreed (or the statement was accurate to a very little or to a very large extent), using a 7-point response framework. Example statements are "Our company makes driving safety a top priority", and "Drivers in your company have opportunities to make suggestions and voice complaints regarding safety and fatigue". The factor analysis supported a single factor solution and the Cronbach α was .94. The created measure exhibited dispersion relative to its range (see Table 3.11**).** The measure was clearly independent of other carrier support indicators, with all intercorrelations less than .12. Drivers' perceptions of a safe driving culture was significantly related to perceptions of fatigue ($r = -.32$, $p \leq .01$) but not to close calls or crash involvement. This finding suggests that safe driving cultures reduce perceptions of fatigue.

Two indicators were used to examine safety training and meetings: (1) the extent to which companies made attendance at safety training and safety meetings voluntary and (2) whether or not drivers are paid to attend safety training and meetings. The first indicator was derived from two inquiries made to safety directors regarding company policy with respect to on-going safety training and safety meetings. Response options were: (a) Drivers are required to attend some or all training (meetings), (b) drivers are encouraged to but not required to attend training (meetings), and (c) Driver attendance is purely voluntary. The responses to the two inquiries were summed to form a two to six point indicator. Interestingly, two-thirds (66.3 percent) made attendance at both types of events mandatory, with the remaining third allowing some flexibility. A single factor analytic solution was observed, as well as a Cronbach α of .90, and there was no evidence of restriction in range. This voluntary attendance indicator was independent of other Carrier Support indicators and was found to be significantly related to two outcomes measures, close calls ($r = -.11$, $p \leq .10$), and perceptions of fatigue ($r = -.14$, $p \leq .05$). This suggests that a voluntary attendance policy is associated with fewer close calls and less fatigue.

Table 3.11
Descriptive Statistics for Variables Specified in Support for Carrier Safety and Fatigue and Crash Outcomes

Variable	Range	Mean	SD	1	2	3	4	5	6	7	8	9
Carrier Support for Safety[a,b]												
1. Drivers' perceptions of company safe driving culture	15-77	55.18	15.68	(.94)								
2. Voluntary attendance at safety training and meetings	2-6	2.78	1.27	-.11*	(.90)							
3. Paid to attend safety training and meetings	0-2	1.10	.93	.04	-.43***	(.93)						
4. Safety directors' perceptions of driver autonomy with respect to tiredness	2-14	9.65	2.98	.07	-.17***	-.02	(.71)					
5. Company provides loading & unloading assistance	0,1	.43	.50	.05	.09	-.19***	-.00	(-)				
6. Company policies minimize night time driving	0,1	.24	.43	.04	-.02	-.02	.14**	.12*	(-)			
Fatigue and Crash Outcomes												
7. Close calls	7-33	12.04	3.80	-.09	-.11*	.08	-.04	-.10	.01	(.80)		
8. Perceptions of fatigue	6-27	13.93	3.75	-.32***	-.14**	.14**	-.14**	-.15**	-.23***	.43***	(.78)	
9. Crash involvement	0-15.18	.30	1.16	.00	-.09	.07	.08	-.02	-.01	.04	.03	(.85)

*$p \leq .10$ **$p \leq .05$ ***$p \leq .01$

Notes: (a) Ns ranged from 251 to 327 due to missing data
(b) Cronbach alphas for multi-item scales are on the diagonal
(c) Complete descriptions of each variable, including the scoring system used, are available in Appendix F, "Definitions of Model Variables".

The third indicator, whether or not drivers are paid to attend training and meetings, was based on safety director report of company policy with respect to each event. Following supportive factor analysis and reliability findings (α = .93), the two responses were added to create a single measure. About forty percent (41.7 percent) indicated that drivers in their companies were not paid for attending either type of event, a few (6.5 percent) were paid for attending one type of event, and slightly more than half (51.9 percent) were paid for attending both types of events. Being paid for attendance was reasonably independent of other carrier support indicators except, perhaps, voluntary attendance at safety training and meetings ($r = -.43$, $p \leq .01$). Although not judged to be excessive, this finding suggests that companies that require driver attendance at safety events are also more likely to pay their drivers for attending. Conversely, when attendance is voluntary, attendance is less likely to be paid. Being paid to attend safety training and meetings was positively related to one outcome measure, perceptions of fatigue ($r = .14$, $p \leq .05$). While this may seem counterintuitive at first glance, the positive relationship suggests that being paid to attend these events may increase driver participation, which in turn may serve to make drivers more aware of the fatigue they experience (i.e., a priming effect).

The fourth indicator was the safety director's perception of the extent to which top management and dispatchers within his or her company believe that drivers should be the final judges of whether they are too tired to drive. This indicator is termed, "driver autonomy with respect to tiredness". It was formed from two statements which safety directors were asked to indicate their level of agreement using a 1 (to a very little extent) to 7 (to a very large extent) response framework. These items were the extent to which top management "Believes drivers are the best judges of whether or not they are too tired to drive" and the extent to which company dispatchers "Believe that drivers are the best judges of whether or not they are too tired to drive". Factor analysis supported a single factor solution. The internal consistency reliability of driver autonomy with respect to tiredness was .71 and more than adequate dispersion of responses was noted. Safety directors' perceptions of driver autonomy was significantly related to drivers' perceptions of fatigue ($r = -.14$, $p \leq .05$), with higher levels of autonomy appearing to decrease perceptions of fatigue within a company. This indicator was unrelated to close calls and crash involvement.

The extent to which drivers believe their company minimizes loading and unloading by drivers was the fifth indicator. To operationalize this indicator, drivers were simply asked to indicate whether or not their companies engaged in this action, with "no" responses coded "0" and "yes" responses coded "1". Not quite half (42.6 percent) said that their companies did minimize loading activity, with the remaining 57.4 percent reporting that their company did not provide this form of assistance. With respect to

outcomes, minimizing loading and unloading was only significantly related ($r = -.15$, $p \leq .05$) to perceptions of fatigue and unrelated to close calls and crash involvement.

The sixth indicator of Carrier Support was whether or not drivers felt that their companies minimize nighttime driving (i.e., midnight to dawn). As in the loading indicator, drivers were simply asked to indicate whether or not their companies engaged in this action, with "no" responses coded "0" and "yes" responses coded "1". The majority of drivers (76.1 percent) reported that their companies did not minimize nighttime driving while 23.9 percent reported that their companies did take this action to help combat fatigue. While the variance in the measure was judged to be adequate, the tendency of carriers not to engage in this behavior should be noted. This indicator was significantly related to one outcome measure. It was negatively related to perceptions of fatigue ($r = -.23$, $p \leq .01$), suggesting that drivers at companies that attempt to minimize night driving have lower perceptions of fatigue.

In order to determine which of these six indicators should be retained in this study, all were regressed on each of the three fatigue and crash outcome indicators (see Table 3.12). With the expectation that each indicator should exhibit a statistically significant relationship ($p \leq .10$) with at least one outcome measure, four indicators appear worthy of retention. Drivers' perceptions of a safe driving culture was significantly related to close calls ($\beta = -.17$, $p \leq .01$) and fatigue perceptions ($\beta = -.28$, $p \leq .001$). Voluntary attendance was negatively and similarly related to close calls ($\beta = -.22$, $p \leq .01$) and fatigue perceptions ($\beta = -.14$, $p \leq .10$). Being paid to attend safety training and meetings and the safety directors' perceptions of driver autonomy with respect to tiredness were both unrelated to outcomes and therefore eliminated from further consideration. Company assistance with loading and unloading was negatively related to perceptions of fatigue ($\beta = -.12$, $p \leq .10$). Lastly, minimizing driving at night was found to be negatively related to fatigue perceptions ($\beta = -.22$, $p \leq .001$). Thus, four indicators will be used to operationalize Company Support for Safe Driving. (Note: Additional effective indicators of carrier support for driving safety are likely to exist, but were not detectable here, simply because the vast majority of companies in this sample already engage in these practices. In other words, there may be a restriction in the range of the number of companies following good safety practices. If virtually all of the carriers are engaged in these practices, variation in outcomes linked to these practices cannot be detected.)

Table 3.12
Regression Analysis of Support for Carrier Safety and Fatigue and Crash Involvement

Support for Safety Indicator	Close Calls	Self and Others' Perceptions of Fatigue	Crash Involvement
1. Drivers' perception of co. safe driving culture	-.17**	-.28***	-.03
2. Voluntary attendance at safety training and meetings	-.22**	-.14 [a]	-.08
3. Paid to attend safety training and meetings	-.04	.03	.03
4. Safety directors' perceptions of driver autonomy with respect to tiredness	.02	-.03	.02
5. Company provides loading & unloading assistance	-.11	-.12 [a]	-.07
6. Company policies minimize nighttime driving	.02	-.22***	.03
F	2.92**	7.22***	.56
Adjusted R^2	.05	.16	.01

*$p \leq .05$ **$p \leq .01$ ***$p \leq .001$ [a] $p \leq .10$

Note: Complete descriptions of each variable are available in Appendix F, "Definitions of Model Variables."

Testing the CMV Model: Assessing Operational Scheduling Requirements

Now that indicators for all components of the CMV Driver Fatigue Model have been articulated (see Figure 3.3), the extent to which operational scheduling requirements (i.e., driving environments and economic pressures) affect fatigue and crash outcomes can be assessed. This assessment was completed by regressing the sixteen indicators of operating requirements as independent variables on the three outcome measures of fatigue and crash involvement. Because this research represents initial inquiry into the determinants of fatigue and crashes, a conservative significance level of $p \leq .10$ was selected for evaluating both overall models and specific indicators. As shown in Table 3.13, the sixteen indicators specified in the model explained a statistically significant amount of variation in each outcome measure.

Model indicators accounted for 15 percent of the variation in close calls ($p \leq .001$). Four predictors were instrumental. Starting the workweek tired ($\beta = .15$, $p \leq .10$) and difficulty in finding a place to rest ($\beta = .19$, $p \leq .05$) were positively related to the frequency of close calls. The percent of shippers and receivers who provide adequate time for pick-ups and deliveries ($\beta = -.14$, $p \leq .10$) was negatively related to close calls. In addition, the percent of business from brokers ($\beta = -.16$, $p \leq .05$) was negatively related. This latter finding runs counter to what some interviewed carrier representatives predicted. They contended that broker-generated traffic was less predictable and harder to schedule, and

that brokered freight was often tendered without knowledge of the driver's rest needs. However, brokered freight also may reduce the downtime and deadhead (i.e., non-revenue) miles for drivers looking for loads. Our results seem to suggest that these countervailing positive influences of broker use on fatigue outweigh the negative influences for the sample firms.

Operational scheduling requirements explained nearly a third (32 percent, $p \leq .001$) of the variability in fatigue perceptions. Six indicators played an explanatory role. Starting the workweek tired was again a good predictor, with frequency of starting tired positively related to fatigue ($\beta = .22$, $p \leq .01$). Pressure on drivers to accept/hurry loads ($\beta = .15$, $p \leq .10$) and to bend rules ($\beta = .23$, $p \leq .01$) were both positively related to fatigue perceptions. Dispatcher evaluations based on operating efficiency ($\beta = .16$, $p \leq .05$) was also positively related to fatigue. The remaining two significant predictors were negatively related to fatigue: the size of the delivery window ($\beta = -.22$, $p \leq .01$) and the percentage of business from brokers ($\beta = -.12$, $p \leq .10$). All of these findings but the last seem quite logical and rational and were expected. Again, the use of brokers by the sample firms seems to produce favorable perceptions of fatigue by their drivers – suggesting that the "positive" influences of broker use described earlier outweigh the "negative." Even the model predicting crash involvement was statistically significant, although the amount of explained variation was relatively low at 6 percent. Outcomes like crash involvement, which are characterized by very high restriction-in-range, seldom produce statistically significant findings. In this examination, the lone individual predictor of crashes was the percent of time drivers spend in loading and unloading activities ($\beta = .28$, $p \leq .001$). Policy implications that can be drawn from such a robust finding are rather obvious and will be discussed in detail below.

Table 3.13
Regression Analysis of Operational Scheduling Requirements and Fatigue and Crash Involvement

Operational Scheduling Requirement Factor	Close Calls	Self and Others' Perceptions of Fatigue	Crash Involvement
CMV Driving Environments			
Driving the same hours	.08	.00	.12
Number of time zones	.05	.05	-.06
Start workweek tired	.15[a]	.22**	.04
Difficulty in finding a place to rest	.19*	-.04	-.06
Average number of stops per day	.00	-.03	.04
Economic Pressures			
Percent of shippers and receivers providing adequate time	-.14[a]	.00	-.05
Size of delivery window	.08	-.22**	-.02
Percent of business from brokers	-.16*	-.12[a]	-.05
Percent of time spent loading or unloading	-.02	-.08	.28***
Personal motivations to continue driving when tired	.08	.10	-.09
Drivers compensated for on-time deliveries	.01	-.01	.01
Drivers penalized for late deliveries	.11	.11	.02
Pressure on drivers to accept/hurry loads (drivers' perceptions)	.14	.15[a]	.01
Pressure to bend rules (drivers' perceptions)	-.06	.23**	-.08
Pressure to dispatch loads (dispatchers' perceptions)	.07	.03	-.02
Dispatcher evaluation based on operating efficiency	.08	.16*	.01
F	2.79***	5.75***	1.72*
Adjusted R^2	.15	.32	.06

*$p \leq .05$ **$p \leq .01$ *** $p \leq .001$ [a] $p \leq .10$

Note: Complete descriptions of each variable, including the scoring system used, are available in Appendix F, "Definitions of Model Variables."

The Role of Carrier Support for Driving Safety

The extent to which the effects of operational scheduling practices are strengthened or weakened by carrier safety practices can also now be examined. The nature of the relationship is visually presented in Figure 3.3. In essence, the model specifies four carrier practices that can "intervene" or moderate the effects of the CMV driving environment and economic pressures. These practices include (1) the presence of a safe driving culture, (2) a policy of voluntary attendance at safety meetings and training, (3) the extent to which the carrier provides drivers with assistance in loading and unloading activities, and (4) the extent to which company policies minimize driving at night. In order to determine if these safety practices played a role in fatigue and crash outcomes, we conducted three hierarchical regression analyses where the impact of the operational scheduling requirements was first considered (i.e., Step 1). Then, the ability of safety practices to enhance or offset these factors was considered in Step 2. Table 3.14 details the results.

Nineteen percent of the variance in close calls ($p \leq .001$) was accounted for by operating requirements. The addition of safety practices to the model increased the amount of explained variation to twenty percent. However, this increase was not statistically significant in magnitude. This small increase observed was primarily attributable to voluntary attendance at safety and training meetings ($\beta = -.15$, $p \leq .10$). Carriers who made attendance voluntary had drivers reporting fewer close calls due to tiredness. This finding suggests that carriers who create an environment where attendance is voluntary have more favorable results (i.e., fewer close calls). We cannot say with certainty that carriers with this practice have better or more conscientious drivers, but they certainly must perceive less need to make safety meetings and training mandatory. Looking ahead to the next outcome, this finding is replicated with respect to perceptions of fatigue. The reasoning behind why a voluntary policy produces more desirable outcomes clearly merits further inquiry.

Table 3.14
Hierarchical Regression Analysis of Operational Scheduling Requirements and Carrier Support For Driving Safety on Fatigue and Crash Involvement

Operational Scheduling Requirements and Carrier Support for Driving Safety	Close Calls		Self and Others' Perceptions of Fatigue		Crash Involvement	
	$Step_1$	$Step_2$	$Step_1$	$Step_2$	$Step_1$	$Step_2$
Step 1: Operational Scheduling Requirements						
Driving the same hours	.04	.02	-.00	.02	.15	.14
Number of time zones	.10	.12	.10	.09	-.06	-.07
Start workweek tired	.20*	.23*	.22*	.18*	.07	.07
Difficulty in finding a place to rest	.21*	.23**	-.06	-.03	-.02	.00
Average number of stops per day	.08	.06	-.00	-.00	.03	.02
Percent of shippers and receivers providing adequate time	-.14[a]	-.09	.02	.04	-.06	-.03
Size of delivery window	.08	.12	-.23**	-.26**	-.05	-.05
Percent of business from brokers	-.11	-.10	-.05	.00	-.05	-.03
Percent of time spent loading Or unloading	-.05	-.06	-.04	-.03	.30***	.31***
Personal motivations to continue Driving when tired	.14	.14	.15	.13	-.09	-.10
Drivers compensated for On-time deliveries	.05	.05	-.00	.08	-.00	.03
Drivers penalized for late deliveries	.13	.13	.10	.08	-.04	-.05
Pressure on drivers to accept/hurry loads (drivers' perceptions)	.11	.07	.13	.07	-.02	-.09
Pressure to bend rules (drivers' perceptions)	-.12	-.15	.17[a]	.15	-.04	-.08
Pressure to dispatch loads (dispatchers' perceptions)	.00	.02	-.05	-.05	-.05	-.04
Dispatcher evaluation based on Operating efficiency	.06	.05	.15[a]	.08	.05	.05
Step 2: Carrier Support For Driving Safety						
Safe driving culture (drivers' perceptions)		-.09		-.06		-.15
Voluntary attendance at safety and training meetings		-.15[a]		-.16*		-.08
Assistance with loading/unloading		-.08		-.20*		-.01
Company policies which minimize nighttime driving		-.11		-.18*		-.07
F	2.93***	2.66***	4.02***	4.39***	1.55[a]	1.37
Change in F	2.93***	1.43	4.02***	4.13**	1.55[a]	.72
Change in R^2	.29	.03	.36	.08	.17	.02
Adjusted R^2	.19	.20	.27	.34	.06	.05

*$p \leq .05$ **$p \leq .01$ *** $p \leq .001$ [a] $p \leq .10$

Notes: (1) Step 1 results are slightly different from Table 3.13 because of slight changes in sample size.
(2) Complete descriptions of each variable are available in Appendix F, "Definitions of Model Variables."

Safety practices have an even more impressive impact on fatigue perceptions. The amount of explained variation increased significantly ($p \leq .01$) from 27 percent when just the operational requirements are considered to 34 percent when safety is added to the model. The increase in explained variation was a function of three safety practices: voluntary attendance at safety and training meetings ($\beta = -.16$, $p \leq .05$), carrier assistance with loading and loading ($\beta = -.20$, $p \leq .05$), and company policies which minimize nighttime driving ($\beta = -.18$, $p \leq .05$).

The third outcome measure, crash involvement, did not exhibit any improvement in predictability with the addition of safety practices. The amount of explained variation actually declined from 6 percent to 5 percent with the inclusion of safety factors, since these models statistically "penalize" models when additional independent variables are added, so as not to capitalize on chance relationships that might inflate levels of explained variation. These findings suggest that changes in safety practices alone are unlikely to affect crash rates. Reducing the amount of time spent in loading and unloading appears to be the main intervention that could be used to reduce crash rates.

Summary

The proposed CMV Driver Fatigue Model is supported by the analysis conducted in Part 3. A number of driving environment characteristics and measures of economic pressures are good predictors of driver perceptions of fatigue as a problem and driver close calls due to fatigue. Furthermore, safety initiatives and interventions by the carrier companies have an impact on fatigue outcomes. The implications of these findings for carrier management and safety policies will be explored in more depth in Part 5. First, however, the testing of the CMV Driver Fatigue Model for the motor coach industry will be presented to determine the primary explanatory factors for driver fatigue in that industry.

Part 4. Testing the CMV Driver Fatigue Model in Motor Coach Companies

Part 3 of this report evaluated how motor carrier scheduling practices affect truck driver fatigue. Part 4 utilizes a similar research methodology to evaluate how motor carrier scheduling practices affect motor coach driver fatigue. Before describing the sampling, data collection, and data analysis, however, the differences between the trucking and motor coach surveys are briefly discussed and an amended CMV Driver Fatigue Model for the motor coach industry is presented.

Surveys and Model for Motor Coach Industry

The major differences between the two sets of surveys are related principally to differences in customers (i.e., tour organizers and passengers rather than shippers and brokers) and in potential schedule irregularities. The latter include group travel itineraries, passenger pickup and departure delays, and unscheduled requests for extended duties by drivers rather than issues related to loading and unloading of freight and pressures associated with delivery times.

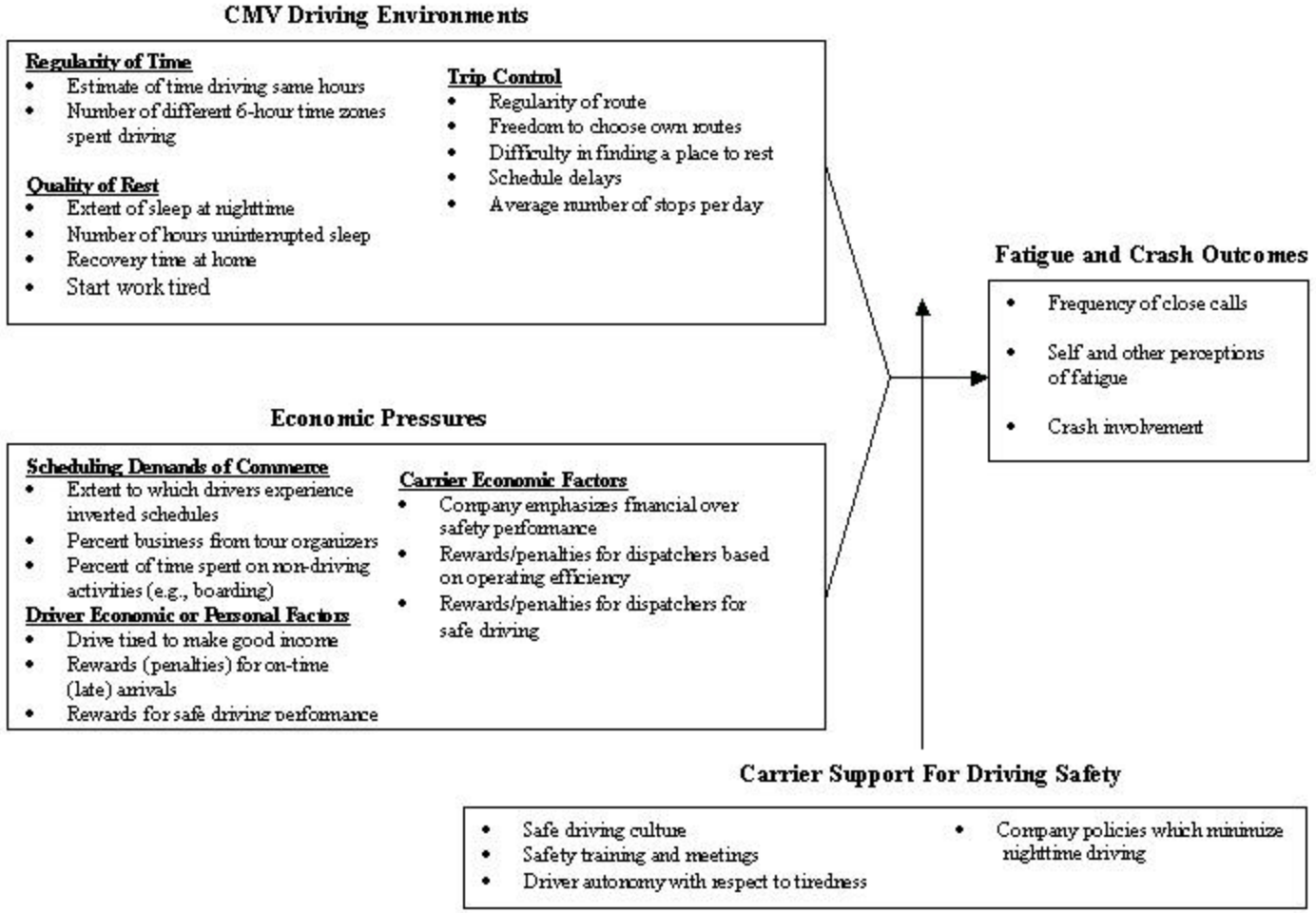
The commercial motor vehicle driver fatigue model for the motor coach industry that was assessed through the surveys is also amended to reflect the relevant differences between bus operations and truck operations. Figure 4.1 reflects these changes. Within the category of CMV Driving Environments, the trip control element is modified to reflect issues concerning schedules through an indicator termed “schedule delays”.

Under the general category of Economic Pressures, the element of scheduling demands of commerce incorporates elements concerning irregular driving schedules associated with trips and the impact of business associated with tour organizers. Under the element of Carrier Economic Factors, there is no need to consider penalties levied for late deliveries since this is only relevant to trucking operations. Finally, under the category Carrier Support for Driving Safety, the driver fatigue model for the motor coach industry does not include an item for assistance with loading or unloading since this is only relevant to the trucking operations. The category of Fatigue and Crash Outcomes is the same for the both industries and is unchanged in Figure 4.1.

Sample and Data Collection

This segment of the study sought to be representative of motor coach drivers working for all carriers with three distinct safety performance levels, as reflected in judgements made within the SafeStat, the FMCSA’s Motor Carrier Safety Status Measurement System (SafeStat, Version 6.1) data base. A description of SafeStat was provided in Part 3.

Figure 4.1
CMV Driver Fatigue Model Amended For Motor Coach Industry



Data Collection

A multi-step data collection effort was employed. The SafeStat database was first used to obtain a stratified population of carrier firms. Next, a sample of firms from each performance category was randomly selected. Given the fact that some carriers would not choose to participate, a strategy for selecting potential replacement carriers was also formulated. The next step was to contact the carriers identified to be in the sample by telephone and secure their agreement to participate. Each of these steps in data collection is described in more detail below.

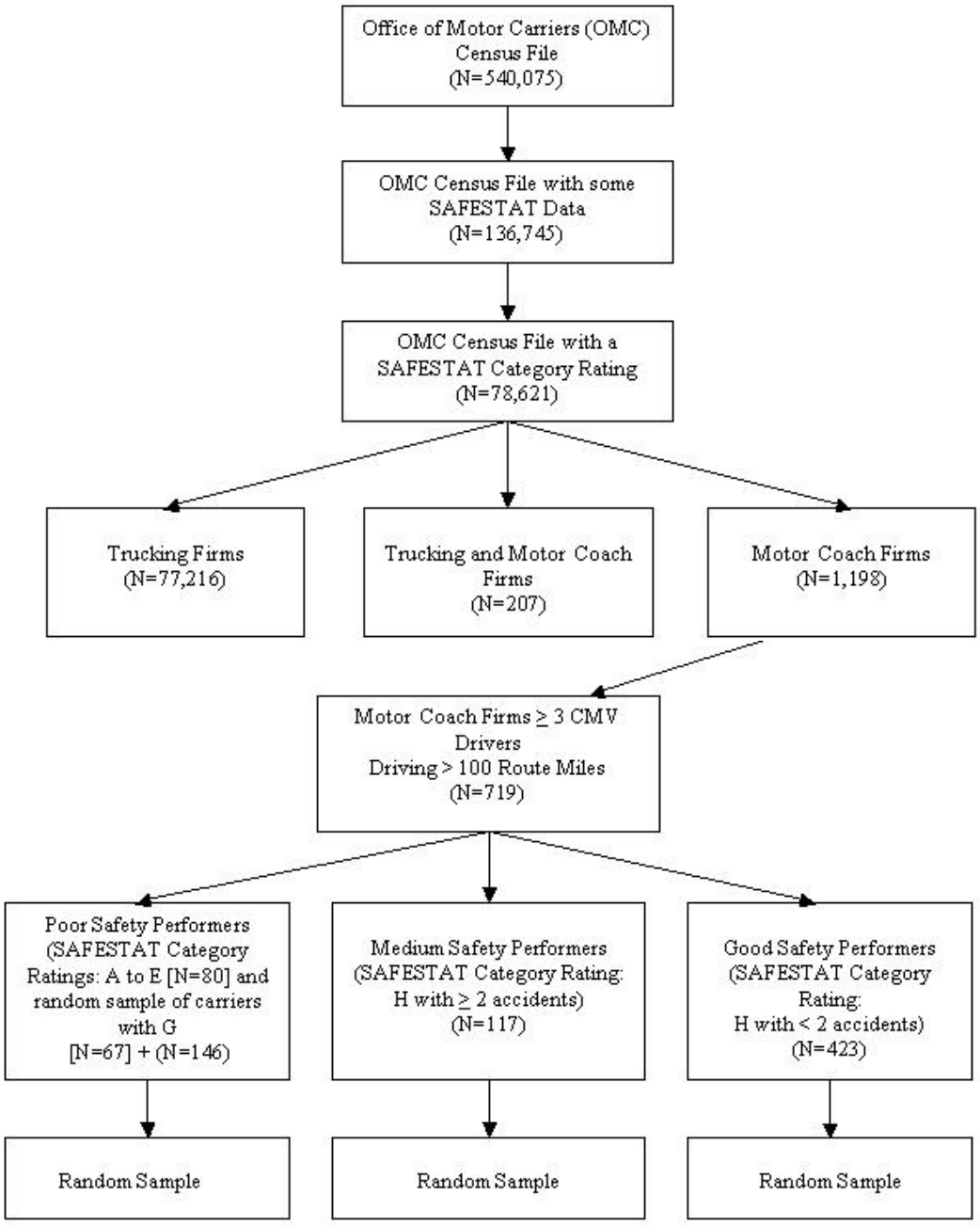
Identification of carriers. Candidate firms for inclusion in this study had to have accurate census data detailing their location, safety performance record, and a sufficient number of drivers (i.e., 2) to provide a reliable driver perspective. Carrier census data and safety performance data, specifically driver inspection and accident data, were available in FMCSA's Motor Carrier Safety Status Measurement System (SafeStat, Version 6.1). SafeStat has safety data for 136,745 firms. Census data could be matched with 78,621 CMV firms in the SafeStat database. Of these 78,621 firms, only 1198 were exclusively carriers of passengers. The 207 firms that carried both passengers and freight were excluded from the sample. Since the survey methodology required two motor coach driver respondents from each sample firm in order to get a reliable representation of the drivers' perspective, firms with three or fewer motor coach drivers were thus excluded from consideration. Accordingly, the universe consisted of 282 motor coach firms. More generally it could be defined as all interstate motor carriers in the United States registered in the FMCSA for which safety information is readily available and who employ at least three motor coach drivers.

This universe was stratified on the basis of safety performance prior to drawing the sample, in order to assure sufficient variation among the sample carriers on the dependent variables specified in the model (i.e., there needs to be some variance in safety performance and the frequency of driver fatigue occurrences). Consequently, universe carriers were grouped into three safety performance rating categories (i.e., first quartile, middle two quartiles, and fourth quartile). and sample carriers were selected randomly from within each category. An effort was made to sample an equal number of carriers from each safety performance rating category. However, the percentages of firms agreeing to participate more closely approximated a normal distribution, with nearly equal numbers of top and poor performers.

The poor safety performers (first quartile) were those carriers that had a SafeStat category rating of A through E. The average safety performers (middle two quartiles) were those carriers that had a SafeStat category rating of H and at least two crashes. The top safety performers were those carriers that

had a SafeStat category rating of H and fewer than two crashes. Figure 4.2 describes the universe of trucking firms from SafeStat and the stratification of these firms based on safety performance.

Figure 4.2
Sampling Flowchart of Motor Coach Firms



Data collection methodology. The data collection methodology involved telephone calls to the safety director at each of the selected carriers to solicit her or his firm's voluntary participation in the study. Carriers that chose not to participate were replaced with firms selected at random from the appropriate safety performance group with one exception. The poor performance group category had to be expanded to include carriers with a SafeStat category rating of G. Sampling continued until the data collection time deadline was reached.

At each motor coach company, the safety director was sent a packet of five (5) surveys -- one each for the executive, safety director, and dispatcher, and two for drivers. The safety director was instructed to complete the appropriate survey and to distribute the remainder to a top executive, a dispatcher and two drivers. The safety director was instructed to select "typical" dispatchers and drivers; that is, neither the best nor the worst. An envelope was provided for each survey. Each respondent was instructed to put her/his completed survey into the envelope, seal it, and return it to the safety director who would return the entire packet to the researchers.

Response rates. Tables 4.1 and 4.2 summarize the response rate from the motor coach companies in the aggregate and by the safety performance stratification (see OMB submission packet providing details of sampling and sampling stratification methods). The response rates are described at two stages of the data collection process: (1) the telephone calling stage where voluntary participation was sought (Table 4.1) and (2) for the data return stage where companies that had agreed to participate did or did not complete and return surveys (Table 4.2).

Table 4.1
Response Rates Associated with Telephone Calling Stage of Data Collection

	Performance Level of Motor Coach Company			
Companies Successfully Contacted	Top	Average	Poor	Total
Agreed	42 (97.7%)	65 (92.9%)	43 (89.6%)	150 (93.2%)
Refused	1 (2.3%)	5 (7.1%)	5 (10.4%)	11 (6.8%)
Contacted	43 (100%)	70 (100%)	48 (100%)	161 (100%)

As Table 4.1 shows, 150 (93.2 percent) of the 161 companies contacted agreed to participate in the project. The percentage of companies agreeing to participate by company performance level ranged from 89.6 percent (poor performers) to 97.7 percent (top performers).

Table 4.2 indicates that 66 (44.0 percent) of the 150 companies who agreed to participate in the study returned usable survey sets. This response rate is much higher than is typical for mailed surveys, especially in view of the methodology asking for surveys from four different occupational categories within each company. Response rates by company performance level ranged from 34.9 percent (poor performers) to 52.3 percent (average performers).

Table 4.2: Response Rates Associated with Company Return Stage of Data Collection				
	Performance Level of Motor Coach Company			
Returns Based on Telephone Agreements	Top	Average	Poor	Total
Did not return	25 (59.5%)	30 (46.2%)	28 (65.1%)	83 (55.3%)
Non-usable	0 (0.0%)	1 (1.5%)	0 (0.0%)	1 (0.7%)
Usable	17 (40.5%)	34 (52.3%)	15 (34.9%)	66 (44.0%)
Sent out	42 (100%)	65 (100%)	43 (100%)	150 (100%)

Sample

The composition of the sample can be described in several ways. One relates to the type of company that responded to the sample. Approximately 70 percent of the 66 companies were charter/tour operators. This is important since this type of operation would be more susceptible to the pressures from tour group organizers and from passenger pressures during trips. An average of 30 percent of respondent companies' business comes from tour organizers.

Half of all drivers employed by these companies were full-time drivers. The companies that responded employed an average of 60 drivers, with a range of 7 to 900 drivers being employed by any particular company. Approximately 80 percent of the drivers in these companies are non-union drivers. Eighty (80) percent of the companies pay their drivers principally by the hour; however, some also pay by the mile. Approximately 41 percent of all companies surveyed pay drivers by the mile. This indicates that some companies use a combination of these for bus driver pay.

The average fleet size for respondent firms is 26 buses, and the average vehicle age is 6 years. Most companies that responded to the survey operate regionally. The average bus trip for all respondents is 250 miles in length. Reported trips ranged in mileage from 50 to 1,200 miles. Drivers average 1,200 miles per week with a range of driving miles between 375 to 2,700. Drivers work an average of 48 hours per week with a reported range of 5 to 75 hours.

More than two-thirds (i.e., 68 percent) of all companies responding employed a Safety Director, however only one-third of these were full-time positions. The safety directors reported an average of two (2) reportable accidents and two (2) chargeable accidents during the past two years. The range of reportable accidents was 0 to 40 , while the range of chargeable accidents was 0 to 85.

A total of 122 drivers also offered valuable information through the surveys. One or two drivers represented each company and thus the following statistics differ some from those reported using a company perspective.

The average age of the drivers responding to the survey was 53 years, with a range of driver ages from 28 through 68. Most driver respondents (i.e., 85 percent) were regular full-time employees at their companies, and the overwhelming majority (i.e., 88 percent) was male. Nearly three-fourths (i.e., 71 percent) were not union members. Additionally, 71 percent worked for charter/tour operations with the remainder working for scheduled route operations.

Drivers reported driving an average 1,200 miles per week, with a range from 200 through 2,500 miles. The average number of miles reported per assignment was 300 with a range from 100 through 3,500. Drivers also reported working an average of 40 hours per week with a range from 6 to 75 weekly hours worked. The average number of stops reported per day was 4.

Drivers that responded to the survey indicated that the majority is paid by the hour. Three-fourths of drivers indicated that they were paid by the hour, while nearly half (i.e., 47 percent) indicated they were paid by the mile. This would indicate that some drivers are paid through a combination of hourly wage and miles driven, but this is not a high frequency situation.

About half (i.e., 54 percent) of the driver respondents reported that they were subjected to inverted duty/sleep cycles to some extent or to a very large extent. However, this response is tempered by the reported average number of inverted cycles per trip. According to the drivers, the average number of inverted duty/sleep cycles per trip was one with 61 percent reporting one or two inverted duty/sleep cycles per trip. An additional 10 percent of the drivers reported experiencing an average of 3 inverted duty/sleep cycles per trip. Conversely, 23 percent of the drivers reported that they experienced no inverted duty sleep cycles per trip.

Responding drivers reported an average of 20 years of experience as a commercial motor vehicle driver, with a range from 1 through 40 years. Furthermore, 85 percent of the drivers reported working for one company during the last 2 years; 99 percent reported working for 3 or fewer companies over the last 2 years.

With respect to safety performance, 81 percent of the drivers reported having no accidents during the past two years, and 99 percent of the drivers had two (2) or fewer accidents during the past two years. Finally, 84 percent of the drivers had no chargeable accidents during the past two years, and 100 percent of all drivers responding had two (2) or fewer chargeable accidents during the past two years.

Replication of CMV Driving Environments and Fatigue and Crash Outcomes

Building on the revisions to the CMV Driver Fatigue Model for the Motor Coach Industry, similar measures used to operationalize CMV Driving Environments and Fatigue Crash Outcomes were employed here (see Figure 4.1). The results of the replication of the dependent outcome variables are described first, followed by the results of the independent, driving environment variables.

Fatigue and Crash Outcomes

The three fatigue and crash outcomes were replicated: frequency of close calls, self and others' perceptions of bus driver fatigue, and crash involvement (normalized for exposure). As shown in Table 4.3, the first two indicators demonstrated adequate variability while crash involvement was again marked by restriction in range. The normalized crash involvement measure range is slightly inflated by the inclusion of a driver reporting 9.62 crashes per 100,000 miles. The next highest number of crashes was 3.85. The internal consistency of each indicator was more than adequate; that is, all αs were >.7.

CMV Driving Environments

The three dimensions of CMV driving environments were regularity of time, trip control, and quality of rest. Regularity of time, the extent to which drivers can achieve a set pattern of driving behavior during a 24-hour period, was measured via two indicators: (1) drivers' estimates of how often they drive the same hours and (2) the number of different 6-hour time zones spent driving. For the exact wording and measurement of each indicator, see Definitions of Model Variables - Motor Coach in Appendix F. These single-item measures exhibited adequate dispersion relative to their range and were relatively independent (i.e., r = .09, see Table 4.3).

Five single-item indicators measured trip control, the amount of discretion and flexibility drivers' experience while engaging in driving. They were: (1) regularity of route (i.e., the extent to which a driver drives the same routes frequently), (2) freedom to choose one's routes, (3) difficulty in finding a place to rest, (4) amount of work time consumed by scheduling delays, and (5) the average number of stops made daily. Again, adequate dispersion was observed and the intercorrelations among the five indicators ranged from r = $\pm$ .03 to r = -.26, suggesting relative independence among indicators.

Quality of rest was captured by four indicators: (1) the extent to which drivers get their sleep at night-time, (2) the amount of uninterrupted sleep a driver was able to get within a 24-hour period when working, (3) the frequency with which drivers get home, and (4) frequency of starting the workweek tired. These were all measured by single items and demonstrated adequate variation. The intercorrelations among these four indicators ranged from r = -.03 to r = .25, supporting independence.

Table 4.3
Descriptive Statistics for Variables Specified in Motor Coach Driving Environments and Fatigue Outcomes Indicators

Variable	Range	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Driving same hours	1,2	1.66	.48	(-)													
2. Number of time zones	1-4	2.66	.70	.09	(-)												
3. Regularity of route	1,2	1.50	.50	-.34	.17	(-)											
4. Choose own routes	1,2	1.56	.50	.36	.00	-.04	(-)										
5. Difficulty in finding a place to rest	1,2	1.24	.43	-.15	-.11	.10	-.05	(-)									
6. Schedule delays	0-65	26.63	15.14	-.16	.19	.21	.03	.11	(-)								
7. Avg. stops per day	1,2	1.52	.50	.18	-.07	-.10	-.03	.04	-.26	(-)							
8. Sleep at night	1,2	1.82	.39	.29	-.04	-.13	.19	-.36	-.05	-.11	(-)						
9. Uninterrupted sleep	1,2	1.76	.43	-.01	.01	.02	.01	-.02	-.15	-.00	.04	(-)					
10. Frequency at home	1,2	1.51	.50	.15	-.09	-.23	.15	-.05	-.09	.02	.25	-.03	(-)				
11. Start work week tired	1,2	1.48	.50	-.14	.01	.05	-.10	.25	.05	.03	-.24	-.05	-.03	(-)			
12. Close calls	4-13	7.29	2.25	-.15	.04	-.03	-.14	.17	.15	-.02	-.16	.06	-.13	.34	(.72)		
13. Fatigue	6-24	13.82	4.03	-.30	.04	.14	-.13	.28	.24	-.08	-.31	-.05	-.06	.56	.57	(.85)	
14. Crash involvement	0-9.62	.43	1.44	.05	.13	-.12	-.08	-.08	.01	-.13	.02	.11	.02	-.10	.09	.03	(.87)

Notes: (1) Ns ranged from 111 to 122 due to missing data
(2) Cronbach alphas for multi-item scales on diagonal
(3) Correlations ≥ ± .18 are statistically significant at $p \leq .05$ (2-tailed); correlations ≥ ± .23 are statistically significant at $p \leq .01$ (2-tailed)
(4) Complete descriptions of each variable, including the scoring system used, are available in Appendix G, "Definitions of Model Variables."

In order to determine whether these indicators should be retained in this study, all eleven indicators were regressed on each of the three fatigue and crash outcome indicators (see Table 4.4). With the expectation that each indicator should exhibit a statistically significant relationship ($p \leq .10$) with at least one indicator, three indicators appear worthy of retention. From regularity of time, driving the same hours ($\beta = -.18$, $p \leq .10$) was related to perceptions of fatigue. From quality of rest, uninterrupted hours of sleep was associated with close calls ($\beta = .19$, $p \leq .05$), and starting the workweek tired was associated with both close calls ($\beta = .37$, $p \leq .001$) and perception of fatigue ($\beta = .50$, $p \leq .001$). These three indicators will be used to operationalize CMV driving environments (see Figure 4.3).

Evolution of Indicators for Economic Pressures and Carrier Support for Driving Safety

A broad list of possible indicators for the Economic Pressures and Carriers Support for Driving Safety were devised, as shown in the proposed model. Note that Economic Pressures like CMV Driving Environments, is comprised of three components: scheduling demands of commerce, driver economic or personal factors, and carrier economic factors. Carrier Support for Driving Safety does not have internal, logically grouped components. Rather, a set of possible safety practices that might have a bearing on fatigue and crash outcomes was identified. Questions intended to measure each of these broad constructs were then developed and included on various surveys. The basis upon by which indicators of the broad constructs were selected and refined was the result of the outcome of the truck stop part of this study. They are described in Table 4.4.

In order to gauge which indicators were most useful, each possible indicator was subjected to several assessments. Factor analysis was used to establish multiple-item measures of indicators and subsequent Cronbach alpha (α) measures of internal consistency reliability were calculated. The measures had to achieve an alpha of at least 0.7 to justify retention (unless otherwise noted). Each indicator was also evaluated to assure that it yielded sufficient variability among the respondents to be of interest. Within a broad construct (e.g., scheduling demands of commerce), it was logical to presume that some of the various constituent indicators ought to be related to each other, although not to the extent they could be viewed as redundant. For example, inverted duty/sleep cycles experienced by drivers should be related to the percent of business received from tour organizers. Indicators demonstrating excessive multicollinearity (i.e., > 0.7) were judged as redundant and eliminated.

Finally, since the overarching goal of this project is the identification of factors predictive of fatigue and crashes, an indicator's association with these outcomes (i.e., frequency of close calls, perceptions of fatigue, and crash involvement) was deemed useful in indicator selection. Stated differently, the most salient indicators were held to be those associated with fatigue and crash behavior.

Table 4.4
Results of Regression Analysis of Motor Coach Industry Driving Environments and Fatigue and Crash Involvement

Model Predictor	Close Calls	Self and Others' Perceptions of Fatigue	Crash Involvement
Regularity of Time			
Driving the same hours	-.03	-.18[a]	.08
Number of time zones	.05	.02	.12
Trip Control			
Regularity of route	-.12	-.03	-.13
Can choose own routes	-.14	-.04	-.13
Difficulty in finding a place to rest	.08	.06	-.01
Schedule delays	.11	.14	.00
Average stops per day	-.03	-.02	-.15
Quality of Rest			
Extent of sleep at night	-.02	-.10	-.04
Uninterrupted hours of sleep	.19*	.08	.11
Frequency at home	-.06	.06	.03
Start workweek tired	.37**	.50**	-.07
F	2.32*	5.65**	.79
Adjusted R^2	.13	.34	.02

*$p \leq .05$ **$p \leq .001$ [a] $p \leq .10$

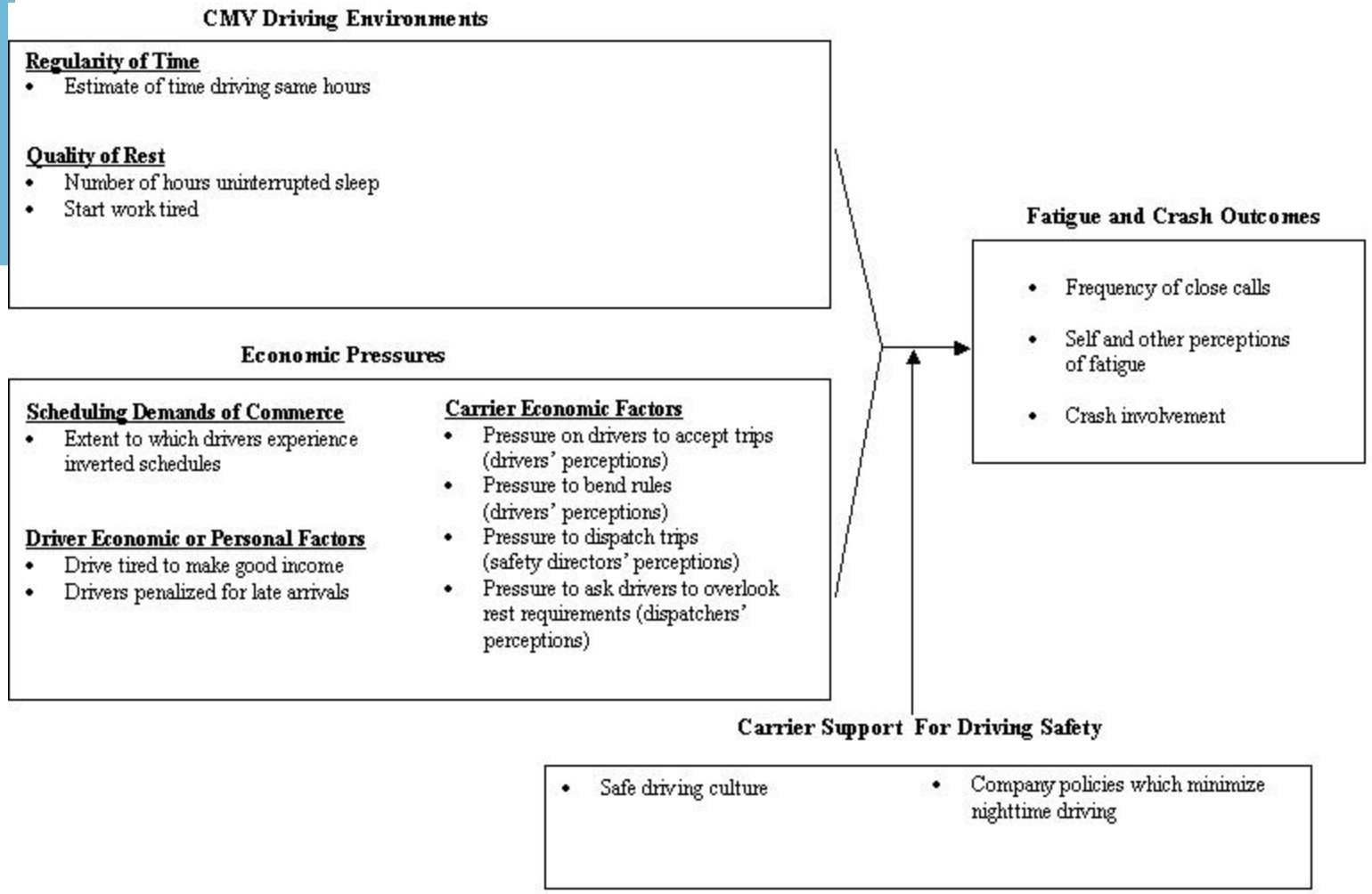
Note: Complete descriptions of each variable, including the scoring system used, are available in Appendix G, "Definitions of Model Variables."

The ability of each indicator to demonstrate a statistically significant ($p \leq .10$) correlation with at least one of the three outcomes was required for indicator retention. Following this assessment, all of the retained indicators are simultaneously entered into a regression model seeking to explain each outcome (i.e., dependent variable). Each indicator that persists in exhibiting a statistically significant relationship (i.e., standardized beta weight) with at least one outcome becomes a final part of the CMV Driver Fatigue Model.

Scheduling Demands of Commerce

The first component of Economic Pressures is termed the scheduling demands of commerce. It reflects the external pressures that are brought to bear on CMV firms by the expectations and requirements of the tour groups and passengers the carrier serves (i.e., its customers). These pressures are typically manifest in inverted duty/sleep cycles associated with tour schedules, the length of time spent on non-driving activities, and the extent to which a carrier is dependent on third parties (e.g.,

Figure 4.3
CMV Driver Fatigue Model Amended For Motor Coach Industry Revised



tour organizers) for on-going business. Three areas were explored: the extent to which drivers experience inverted schedules, the percentage of business from tour organizers, and the percent of time spent in non-driving work. These indicators were drawn from dispatcher, safety director (or person charged with safety oversight), and driver surveys.

The extent to which drivers experience inverted schedules was measured by a single item that asked the extent to which drivers experienced these schedules using a 1 (to a very little extent) to 7 (to a very large extent) response framework. Inverted duty/rest cycles were defined on the survey as occurring "when a driver drives/is on-duty during a certain time period of day, and is off-duty during the same period the next day, with variable lengths of on-duty and off-duty periods during this cycle". As illustrated in Table 4.5, drivers reported this was experienced to some extent, with a mean response of 4.34.

The percentage of business from tour organizers was derived from a single question posed to the safety directors. Their estimates ranged from 0 to 100 percent, with an average percent of 32.23 percent. Similarly, the percent of time spent in non-driving work, specifically boarding and unboarding, was measured by asking drivers to estimate the percent of their work time that was devoted to this activity. Responses ranged from 1 to 50 percent with an average percent estimate of 8.64 percent.

Descriptive statistics for these variables as defined from the surveys can be seen in Table 4.5. Because there were no multiple item indicators, Cronbach alphas are not relevant.

In order to determine which of the variables should be retained in the study, all were regressed on each of the 3 fatigue and crash outcome indicators. Table 4.6 shows the results of this analysis. With the expectation that each variable should exhibit a statistically significant relationship ($p \leq .10$) with at least one indicator, only the variable concerning inverted duty/rest cycles appears to be statistically worthy of retention. The frequency of inverted duty rest cycles experienced by drivers during an average trip was significantly related to close calls ($\beta = .29$, $p \leq .01$). This same variable was also statistically significant with perceptions of fatigue ($\beta = .28$, $p \leq .01$). This variable will be used to operationalize scheduling demands of commerce for the motor coach model.

Driver Economic or Personal Factors

The second component of Economic Pressures was intended to capture practices and circumstances that encourage positive and negative driving behaviors by drivers. It was termed, "driver economic and personal factors", to convey that these driving decisions were under the control of the driver. Four general categories are recognized: drivers' personal motivations to continue driving even when they are tired (one indicator), rewards or penalties for, respectively, on-time and late arrivals (two

Table 4.5
Descriptive Statistics for Variables Specified in Motor Coach Economic Pressures and Fatigue Outcome Indicators

	Variable	Range	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1.	Freq. inverted schedules	1-7	4.34	1.62	(-)																
2.	Percent tour organizers	0-100	32.23	28.26	.23	(-)															
3.	Percent time boarding	1-50	8.64	6.47	-.07	-.08	(-)														
4.	Drive for income	1-7	2.63	1.92	.29	.04	.18	(-)													
5.	Driver arrival compensation	0,1	.00	.27	.08	.35	.01	-.01	(-)												
6.	Driver arrival penalty	0-6	1.08	1.66	.12	.24	.02	.28	.27	(.82)											
7.	Driver safety compensation	2-14	6.92	4.35	.09	.04	-.07	-.02	.08	-.08	(.68)										
8.	Pride in being on time	1-7	5.92	1.39	.19	.26	-.11	.17	.11	.29	-.09	(-)									
9.	Pressure on drivers to accept trips	4-28	8.88	5.63	.25	-.15	.11	.46	.01	.37	-.07	.09	(.83)								
10.	Pressure to bend rules	1-7	3.13	2.19	.25	.08	.02	.56	.06	.20	-.12	.09	.50	(-)							
11.	Pressure to dispatch trips	1-7	2.56	1.52	-.05	-.17	.01	.06	.20	.12	.15	-.08	.27	.16	(-)						
12.	Ask drivers to overlook rest	1-7	1.59	1.37	.10	.20	.11	.13	.05	.07	-.14	-.09	.14	.27	.23	(-)					
13.	Dispatcher Fe. evaluation	0-2	.16	.48	.19	-.24	.07	-.11	-.07	-.01	.09	.03	-.05	.01	.22	.54	(.74)				
14.	Dispatcher safety evaluation	0,1	.30	.46	-.26	-.15	.15	-.04	.03	-.10	.06	-.13	.06	-.11	-.09	-.10	-.10	(-)			
15.	Close calls	4-13	7.29	2.25	.20	-.01	.15	.43	.05	.17	-.11	.01	.33	.33	.08	.10	.12	-.04	(.72)		
16.	Fatigue	6-24	13.82	4.03	.24	-.07	.05	.65	-.01	.27	-.06	.07	.56	.63	.22	.18	-.06	-.02	.57	(.85)	
17.	Crash involvement	0-9.62	.43	1.44	-.13	-.01	.14	-.01	-.10	-.03	-.05	.12	-.04	.01	.04	.30	.17	.02	.09	.03	(.87)

Notes: (1) Ns ranged from 91 to 122 due to missing data
(2) Cronbach alphas for multi-item scales on diagonal
(3) Correlations $\geq \pm .24$ are statistically significant at $p \leq .05$ (2-tailed); correlations $\geq \pm .26$ are statistically significant at $p \leq .01$ (2-tailed).
(4) Complete descriptions of each variable, including the scoring system used, are available in Appendix G, "Definitions of Model Variables".

Table 4.6
Regression Analysis of CMV Motor Coach Scheduling Demands of Commerce and Fatigue and Crash Involvement

Scheduling Demands of Commerce	Close Calls	Self and Others' Perceptions of Fatigue	Crash Involvement
1. Perceived frequency drivers experience inverted duty/rest cycles	.29**	.28**	-.16
2. Percent of business from tour organizers	-.08	-.12	.04
3. Percent time spent boarding and unboarding	.15	.03	.13
F	2.88*	2.38[a]	1.33
Adjusted R^2	.06	.04	.01

*$p \leq .05$ **$p \leq .01$ ***$p \leq .001$ [a] $p \leq .10$

Note: Complete descriptions of each variable, including the scoring system used, are available in Appendix G, "Definitions of Model Variables."

indicators), rewards for safe driving performance (one indicator), and the extent to which drivers take personal pride in on-time arrivals (one indicator). All but one indicator was acquired from driver surveys.

The possibility that drivers may be self-motivated to continue driving even when they are tired was measured through driver response to the question: to what extent do you think you drive when you are tired in order to make a good income? Response options ranged from 1 (to a very little extent) to 7 (to a very large extent). Table 4.5 shows that responses were moderately variable and near the bottom of the range, with a mean of 2.63 and standard deviation of 1.92.

Rewards and penalties for on-time and late arrivals were measured separately; one indicator assessed the extent that drivers were financially rewarded for on-time arrivals and one indicator focused on penalties for late arrivals. It was necessary to evaluate each practice separately since some companies have neither practice, some have both, and some have one practice but not the other. The reward practice was measured by asking safety directors whether or not drivers were compensated for on-time arrivals. Very few firms engaged in this practice, as evidenced by a mean of 0 and a standard deviation of .27. The extent to which drivers might be penalized for late arrivals was determined by asking drivers whether or not their companies penalized them for late arrivals by (a) verbal criticism from their dispatchers, (b) pay reductions or fines, (c) loss of potential bonus money, (d) suspension from work, (e) employment termination, and (f) assigning less desirable trips in the future. The responses to these items

were summed, with higher scores indicating more penalties. The Cronbach α was .82. The mean of 1.08 (see Table 4.5) suggests that very few companies have penalties for late arrivals.

The third component of driver personal and economic factors is the extent to which drivers are rewarded by their companies for safe driving (e.g., accident-free miles). Drivers were asked to evaluate the extent to which safe driving is rewarded by recognition programs (e.g., employee of the month) and by financial incentives (e.g., bonuses, gifts, higher mileage rates), using a response framework of 1 (to a very little extent) to 7 (to a very large extent). These responses were summed to form a single scale that generated a single factor structure and Cronbach α of .68. This is less than the minimum of .7 required for significance. However, the decision was made to continue the analyses on an exploratory basis. The mean of 6.92 and standard deviation of 4.35 suggests that the drivers experienced a wide variation in company rewards for safe driving.

The final indicator of this construct was drivers' personal pride in on-time arrivals. Drivers were asked a single item, to evaluate the extent to which they took pride in arriving on time, using a 1 (to a very little extent) to 7 (to a very large extent) response framework. As shown in Table 4.5, drivers' responses were characterized by restriction in range. The mean of 5.92 on a 1 to 7 scale, suggests that virtually all of the drivers endorsed this statement strongly. The guidelines for multicollinearity within a construct were not violated for any measures in Driver Economic or Personal Factors.

Which of the variables should be retained in the model was determined by regressing the three indicators exhibiting statistically significant correlations ($p \leq .10$) with at least one of the outcome measures (see Table 4.7). Using the guideline that each variable should exhibit a statistically significant relationship ($p \leq .10$) with at least one indicator, driving tired to make a good income appears worthy of retention. Strong personal motivations to continue driving when tired was predictive of close calls ($\beta = .50$, $p \leq .001$), and perceptions of fatigue ($\beta = .60$, $p \leq .001$). Penalties for late arrivals was significantly related to perceptions of fatigue ($\beta = .19$, $p \leq .05$). These variables will be retained in further investigations of the model entailing Driver Economic and Personal Factors.

Carrier Economic Factors

The third component of Economic Pressures was identified as carrier economic factors. This component refers to the pressures perceived by various personnel within a carrier firm to be economically successful. It also entails the policies and practices adopted by carriers to promote economic outcomes, which may sometimes come at the expense of maximizing safety outcomes. These general areas were

investigated: the extent to which carriers emphasize financial performance over safety performance (four indicators), the extent to which there are rewards or penalties for dispatchers based on operating efficiency (one indicator), and the extent to which there are rewards or penalties for dispatchers

Table 4.7
Regression Analysis of Motor Coach Industry Driver Economic or Personal Factors and Fatigue and Crash Involvement

Driver Economic or Personal Factors	Close Calls	Self and Others' Perceptions of Fatigue	Crash Involvement
1. Drive tired to make good income.	.50***	.60***	-.06
2. Drivers compensated for on-time arrivals	.03	-.08	-.12
3. Drivers penalized for late arrivals	.09	.19*	.03
4. Drivers rewarded for safe driving[a]	-.10	-.04	-.05
5. Personal pride in on-time arrivals	-.11	-.01	.16
F	6.00***	13.95***	.67
Adjusted R^2	.24	.45	.02

*$p \leq .05$ **$p \leq .01$ ***$p \leq .001$

[a]Cronbach $\alpha = .68$

Note: Complete descriptions of each variable, including the scoring system used, are available in Appendix G, "Definitions of Model Variables."

for safe driving (one indicator). These indicators were derived from company perspective surveys completed by a senior manager (often the chief executive officer), dispatcher surveys, and driver surveys.

The extent to which carriers emphasize financial performance over safety performance was assessed via four indicators. The first was a 4-item measure of the extent to which drivers perceive pressure from their dispatchers to accept trips. It can be termed dispatcher pressure. The first two items asked, to what extent dispatchers asked them to continue driving when they were tired, or to accept a trip when they were tired. The third item asked drivers to what extent dispatchers pressured them to accept a trip when they would be "out of hours". The fourth item was more global and asked drivers to what extent they thought that dispatchers in their company placed a higher priority on scheduling trips on-time than on driver safety. All items used a 1 (to a very little extent) to 7 (to a very large extent) response framework. The factor analysis supported a single factor solution and the Cronbach α was .83. The relatively low mean of 8.88, relative to the 4 to 28 range, suggests that dispatcher pressure is relatively low.

A second indicator of the extent to which carriers emphasize financial performance over safety performance was the level of agreement a driver expressed with the statement: Drivers have to bend a driving safety rule or policy in order to "get the job done." Response options ranged from 1 (strongly disagree) to 7 (strongly agree). The mean response to this item was 3.13 placing it near the middle of the 1 to 7 range, and with a considerable standard deviation of 2.19, this single item indicator exhibited wide variation. Bending a safety rule was generally unrelated to other carrier economic variables, except driving for income and dispatcher pressure.

The third indicator was a single-item estimate of the extent to which dispatchers felt that their company pressured them to accept or dispatch trips when all of their available drivers were out of hours. Dispatchers recorded their views using a 1 (to a very little extent) to 7 (to a very large extent) response framework. The relatively low mean of 2.56 and small standard deviation of 1.52 suggested that pressure from the company to dispatch was not a widespread problem.

The last indicator of the extent to which carriers emphasize financial performance over safety performance was also based on dispatcher opinion. It consisted of a single item asking dispatchers to describe the extent to which the following statement was true, using a 1 (to a very little extent) to 7 (to a very large extent) response framework: To what extent do you "ask drivers to "overlook" rest requirements so that you can accept a trip?" While the variance in the measure was judged to be adequate, the mean of 1.59 and standard deviation of 1.37 indicates that this was not a frequent problem for the sample as a whole. Other than a correlation with dispatcher evaluation on operating efficiency of .54 described next, asking drivers to overlook rest requirements was independent of other indicators in this set.

The third general carrier economic factor was the extent to which there were rewards or penalties for dispatchers based on operating efficiency. Dispatchers were asked to indicate whether or not they were evaluated by their company on (1) the average number of miles driven per driver and (2) minimizing deadhead miles. Following supportive factor analytic results, the two items were added together to form a scale. A Cronbach α of .74 exceeded the .7 retention standard.

The fourth and final general carrier economic factor was the extent to which there were rewards or penalties for dispatchers based on driving safety. Dispatchers were asked to indicate whether or not they were evaluated by their companies on accident-free miles by drivers or drivers' chargeable accidents. "No" responses were coded 1 where "yes" responses were coded 2. The majority of dispatchers were not evaluated on this basis as indicted by the mean of .30.

The last step is to determine which of the variables should be retained in this study. The variables were regressed on each of the three fatigue and crash outcome indicators (see Table 4.8). Using the guideline that each variable should exhibit a statistically significant relationship ($p \leq .10$) with at least one indicator, 4 of 6 variables appear worthy of retention. Drivers' perceptions of pressure from dispatchers to accept trips was significantly related to close calls ($\beta = .39$, $p \leq .01$), and perceptions of fatigue ($\beta = .33$, $p \leq .01$). Drivers' perceptions that they have to bend safety rules to get the job done was positively associated with fatigue perceptions ($\beta = .38$, $p \leq .001$). Safety Directors' perceptions regarding pressure by their companies to accept trips even when they have no drivers with remaining hours was significantly related to perceptions of fatigue ($\beta = .29$, $p \leq .01$). Pressure to ask drivers to overlook rest requirements was significantly related to crash involvement ($\beta = .30$, $p \leq .05$). These four variables will be used to operationalize carrier economic factors.

Carrier Support for Driving Safety

As shown in Figure 4.1, carrier support for driving safety is positioned as a moderating variable, affecting the extent to which CMV driving environments and economic pressure impact fatigue and crash outcomes. Carriers can minimize or enhance the environment and/or economic determinants of fatigue and crashes by the extent to which they institute safety practices. For example, a company with a strong safety culture may employ dispatchers who are more aware of the difficulty drivers sometimes experience. Such dispatchers may accordingly be more sensitive to drivers' needs. Though not depicted this way in the model, carrier support for driving safety may also have a direct impact on fatigue and crash outcomes.

Four areas of possible carrier support were investigated: safe driving culture, safety training and meetings (which included two indicators), company orientation toward driver tiredness, and company policies to minimize nighttime driving. As noted below, these indicators were derived from driver and safety director (i.e., person charged with safety oversight) surveys.

The first indicator was identified as drivers' perception of the extent to which a safe driving culture characterizes their company. It consisted of 11 statements to which drivers were asked to report the extent to which they disagreed or agreed (or the statement was accurate to a very little or to a very large extent), using a 7-point response framework. Example statements are "Our company makes driving safety a top priority", and "Drivers in your company have opportunities to make suggestions and voice complaints regarding safety and fatigue". The factor analysis supported a single factor solution and the

Cronbach α was .93. The single measure exhibited dispersion relative to its range (see Table 4.9). The measure was not strongly correlated with other carrier support indicators.

Two indicators were used to examine safety training and meetings: (1) the extent to which companies made attendance at safety training and safety meetings voluntary and (2) whether or not drivers are paid to attend safety training and meetings. The first indicator was derived from two inquiries made to safety directors regarding company policy with respect to on-going safety training and safety meetings. Response options were (a) Drivers are required to attend some or all training (meetings), (b) drivers are encouraged to but not required to attend training meetings, and (c) driver attendance is purely voluntary. The responses to the two inquiries were summed to form a two to six point indicator. A single factor analytic solution was observed, as well as a Cronbach α of .71, and there was no evidence of restriction in range. This voluntary attendance indicator was independent of other Carrier Support indicators except for the indicator identified as paid attendance (see next paragraph)..

Table 4.8
Regression Analysis of Motor Coach Industry Carrier Economic Factors and Fatigue and Crash Involvement

Carrier Economic Factors	Close Calls	Self and Others' Perceptions of Fatigue	Crash Involvement
1. Pressure on drivers to accept trips (drivers' perceptions)	.39**	.33**	.12
2. Pressure to bend rules (drivers' perceptions)	.22	.38***	.03
3. Pressure to dispatch trips (safety directors' perceptions)	-.01	.29**	-.19
4. Pressure to ask drivers to overlook rest requirements (dispatchers' perceptions)	-.14	.01	.30*
5. Dispatchers evaluated on operating efficiency (dispatchers' perceptions)	.08	-.09	-.11
6. Dispatchers evaluated on driving safety (dispatchers' perceptions)	.07	.10	.10
F	3.67**	9.47***	1.27
Adjusted R^2	.22	.47	.03

*$p \leq .05$ **$p \leq .01$ ***$p \leq .001$ [a] $p \leq .10$

Note: Complete descriptions of each variable, including the scoring system used, are available in Appendix G, "Definitions of Model Variables."

The third indicator, whether or not drivers are paid to attend training and meetings, was based on safety director report of company policy with respect to each event. Following supportive factor analysis and reliability findings ($\alpha = .77$), the two responses were added to create a single measure. Being paid for attendance was reasonably independent of other carrier support indicators except, perhaps, voluntary attendance at safety training and meetings ($r = .60$, $p \leq .01$). Although not judged to be excessive, this finding suggests that companies that require driver attendance at safety events are also more likely to pay their drivers for attending. Conversely, when attendance is voluntary, attendance is less likely to be paid.

The fourth indicator was the safety director's perception of the extent to which top management and dispatchers within his or her company believe that drivers should be the final judges of whether they are too tired to drive. This indicator is termed "driver autonomy with respect to tiredness". It was formed from two statements which safety directors were asked to indicated their level of agreement using a 1 (to a very little extent) to 7 (to a very large extent) response framework. These items were the extent to which top management "Believes drivers are the best judges of whether or not they are too tired to drive" and the extent to which company dispatchers "Believe that drivers are the best judges of whether or not

they are too tired to drive". Factor analysis supported a single factor solution. The internal consistency reliability of driver autonomy with respect to tiredness was .82 and more than adequate dispersion of responses was noted.

The fifth indicator of Carrier Support was whether or not drivers felt that their companies minimize nighttime driving (i.e., midnight to dawn). Drivers were simply asked to indicate whether or not their companies engaged in this action, with "no" responses coded "0" and "yes" responses coded "1". The majority of drivers reported that their companies did not minimize nighttime driving. While the variance in the measure was judged to be adequate, the tendency of carriers not to engage in this behavior should be noted.

In order to determine which of these five variables should be retained in this study, all were regressed on each of the three fatigue and crash outcome indicators (see Table 4.10). With the expectation that each indicator should exhibit a statistically significant relationship ($p \leq .10$) with at least one outcome measure. Two variables appear worthy of retention. Drivers' perceptions of a safe driving culture was significantly related to close calls ($\beta = -.39$, $p \leq .01$) and fatigue perceptions ($\beta = -.61$, $p \leq .001$). Company policies minimizing nighttime driving was significantly related to crash involvement ($\beta = .24$, $p \leq .05$). These variables will be used to operationalize Company Support for Safe Driving. (Note: Additional effective indicators of carrier support for driving safety are likely to exist, but were not detectable here, simply because the vast majority of companies in this sample already engage in these practices. In other words, there may be a restriction in the range of the number of companies following good safety practices. If virtually all of the carriers are engaged in these practices, variation in outcomes linked to these practices cannot be detected.)

Testing the CMV Model: Assessing Operational Scheduling Requirements

Now that indicators for all components of the CMV Driver Fatigue Model for the Motor Coach Industry have been articulated (see Figure 4.2), the extent to which operational scheduling requirements (i.e., driving environments and economic pressures) affect fatigue and crash outcomes can be assessed. This assessment was completed by regressing the ten indicators of operating requirements as independent variables on the three outcome measures of fatigue and crash involvement. Because this research represents initial inquiry into the determinants of fatigue and crashes, a liberal significance level of $p \leq .10$ was selected for evaluating both overall models and specific indicators. As shown in Table 4.11, the ten indicators specified in the model collectively explained a statistically significant amount of variation in each outcome measure.

Table 4.9
Descriptive Statistics for Variables Specified in Motor Coach Carrier Support for Driving Safety and Fatigue Outcome Indicators

Variable	Range	Mean	SD	1	2	3	4	5	6	7	8
1. Safe driving culture	19-77	56.38	16.09	(.93)							
2. Voluntary attendance	2-6	2.73	1.50	-.08	(.71)						
3. Paid attendance	0-2	1.03	.79	.08	-.60	(.79)					
4. Driver autonomy w/respect to tiredness	2-14	8.52	3.29	.15	.07	-.09	(.82)				
5. Co. policy minimizes nighttime driving	0,1	.30	.46	.33	-.10	.07	-.05	(-)			
6. Close calls	4-13	7.29	2.25	-.37	.20	-.20	.05	-.13	(.72)		
7. Fatigue	6-24	13.82	4.03	-.59	.17	-.06	.07	-.13	.57	(.85)	
8. Crash involvement	0-9.62	.43	1.44	-.02	-.11	.10	.06	.16	.09	.03	(.87)

Notes: (1) Ns ranged from 98 to 117 due to missing data
(2) Cronbach alphas for multi-item scales on diagonal
(3) Correlations ≥ ± .21 are statistically significant at $p \leq .05$ (2-tailed); correlations ≥ ± .26 are statistically significant at $p \leq .01$ (2-tailed)
(4) Complete descriptions of each variable, including the scoring system used, are available in Appendix G, "Definitions of Model Variables."

Table 4.10
Regression Analysis of Motor Coach Industry Support for Carrier Safety and Fatigue and Crash Involvement

Support for Safety Indicator	Close Calls	Self and Others' Perceptions of Fatigue	Crash Involvement
1. Drivers' perception of company safe driving culture	-.39***	-.61***	-.07
2. Voluntary attendance at safety training and meetings	.02	.07	-.08
3. Paid to attend safety training and meetings	-.16	.00	.05
4. Safety directors' perceptions of driver autonomy with respect to tiredness	.04	.12	.13
5. Company policies minimize nighttime driving	-.02	.06	.24*
F	3.57**	8.22***	1.24
Adjusted R^2	.15	.32	.02

*$p \leq .05$ **$p \leq .01$ ***$p \leq .001$ [a] $p \leq .10$

Note: Complete descriptions of each variable, including the scoring system used, are available in Appendix G, "Definitions of Model Variables."

Model indicators accounted for 26 percent of the variation in close calls ($p \leq .001$). One predictor was instrumental. Pressure on drivers to accept trips ($\beta = .28$, $p \leq .05$) was positively related to the frequency of close calls.

Operational scheduling requirements explained over half ($R^2 = 57$ percent, $p \leq .001$) of the variability in fatigue perceptions. Four indicators played an explanatory role. Starting the workweek tired was a good predictor, with frequency of starting tired positively related to perceptions of fatigue ($\beta = .22$, $p \leq .05$). Driving tired to make a good income ($\beta = .30$, $p \leq .01$), pressure on drivers to accept trips ($\beta = .29$, $p \leq .01$), and pressure to bend rules ($\beta = .20$, $p \leq .10$) were positively related to fatigue perceptions. All of these findings seem quite logical and rational.

The model predicting crash involvement was not statistically significant. The amount of explained variation was too small to be statistically significant (i.e., -9 percent), and there were no individual predictors of crash involvement that were statistically significant. The Role of Carrier Support for Driving Safety

The extent to which the effects of operational scheduling practices are strengthened or weakened by carrier safety practices can also now be examined. The nature of the relationship is visually presented in Figure 4.3. In essence, the model specifies two carrier practices that can "intervene" or moderate the effects of the CMV Driving Environment and Economic Pressures. These practices are (a) the presence of a safe driving culture and (b) the extent to which company policies minimize driving at night. In order to determine if these safety practices played a role in fatigue and crash outcomes, we conducted three hierarchical regression analyses where the impact of the operational scheduling requirements was first considered (i.e., Step 1). Then, the ability of safety practices to enhance or offset these factors was considered in step 2. Table 4.12 details the results.

Table 4.11
Regression Analysis of Motor Coach Industry Operational Scheduling Requirements and Fatigue and Crash Involvement

Operational Scheduling Requirement Factor	Close Calls	Self and Others' Perceptions of Fatigue	Crash Involvement
CMV Driving Environments			
Driving the same hours	-.11	-.13	.16
Number of hours of uninterrupted sleep	.05	-.04	-.03
Start workweek tired	.16	.22*	-.26
Economic Pressures			
Extent to which drivers experience inverted schedules	.18	.01	.05
Drive tired to make good income	.21	.30**	.15
Drivers penalized for late arrivals	-.01	.01	-.07
Pressure on drivers to accept trips (drivers' perceptions)	.28*	.29**	.11
Pressure to bend rules (drivers' perceptions)	.04	.20 [a]	.02
Pressure to dispatch trips (safety directors' perceptions)	.02	.01	.05
Pressure to ask drivers to overlook rest requirements (dispatchers' perceptions)	.00	.04	.16
F	3.30***	9.58***	.49
Adjusted R^2	.26	.57	.09

*$p \leq .05$ **$p \leq .01$ *** $p \leq .001$ [a] $p \leq .10$

Note: Complete descriptions of each variable, including the scoring system used, are available in Appendix G, "Definitions of Model Variables."

Twenty-three (23 percent) of the variance in close calls ($p \leq .001$) was accounted for by opeating requirements. The addition of safety practices to the model did not add to the prediction of close calls. With statistical adjustments made for the inclusion of additional independent variables (i.e., so as not to capitalize on chance relationships that might inflate levels of explained variation), the amount of explained variation actually decreased to 22 percent.

Similarly, safety practices appear not to have a significant impact on fatigue perceptions. The amount of unexplained variation associated with operational requirements was 56 percent, and increased to only 57 percent when safety was added to the model. This addition was not statistically significant.

The third outcome measure, crash involvement, did not exhibit any improvement in predictability with the addition of safety practices. The amount of explained variation linked to operational requirements was not significant and did not increase with the addition of safety. These findings suggest that changes in safety practices alone are unlikely to affect crash rates.

Summary

Results from an analysis of the motor coach industry provide substantial support for the proposed CMV Driver Fatigue Model. Similar to the results of the trucking companies study in Part 3, certain driving environment characteristics and measures of economic pressures proved to be good predictors of motor coach drivers' perceptions of fatigue as a problem and close calls due to fatigue. A key difference between the two industries, however, is the influence of carrier safety initiatives and activities. The implications of these findings and those from the truck stop study and trucking company study are addressed in Part 5.

Table 4.12
Hierarchical Regression Analysis of Motor Coach Industry Operational Scheduling Requirements and Carrier Support for Driving Safety on Fatigue and Crash Involvement

Operational Scheduling Requirements and Carrier Support for Driving Safety	Close Calls		Self and Others' Perceptions of Fatigue		Crash Involvement	
	$Step_1$	$Step_2$	$Step_1$	$Step_2$	$Step_1$	$Step_2$
Step 1: Operational Scheduling Requirements						
Driving the same hours	-.17	-.16	-.16[a]	-.15	.12	.12
Number of hours of uninterrupted sleep	.07	.08	-.04	-.03	-.05	-.08
Start workweek tired	.18	.17	.25*	.24*	-.24	-.25
Extent to which drivers experience inverted schedules	.14	.15	-.00	.01	.01	-.01
Drive tired to make good income	.18	.15	.28*	.24*	.17	.22
Drivers penalized for late arrivals	-.03	-.04	-.01	-.02	-.09	-.08
Pressure on drivers to accept trips (drivers' perceptions)	.28*	.24	.31**	.26*	.12	.17
Pressure to bend rules (drivers' perceptions)	-.02	-.03	.18[a]	.16	.02	.06
Pressure to dispatch trips (safety directors' perceptions)	-.08	-.03	-.00	.06	-.00	-.03
Pressure to ask drivers to overlook rest requirements (dispatchers' perceptions)	-.16	-.15	.04	.05	.18	.19
Step 2: Carrier Support For Driving Safety						
Safety driving culture (drivers' perceptions)				-.19		.18
Company policies which minimize nighttime driving		.03		.04		-.07
F	2.80**	2.36*	8.70***	7.56***	.45	.45
Change in F	2.80**	.47	8.70***	1.32	.45	.46
Change in R^2	.36	.01	.64	.02	.09	.02
Adjusted R^2	.23	.22	.56	.57	.10	.13

*$p \leq .05$ *$p \leq .01$ *** $p \leq .001$ [a] $p \leq .10$

Note: (1) Step 1 results are slightly different from Table 4-7 because of slight changes in sample size.
(2) Complete descriptions of each variable, including the scoring system used, are available in Appendix G, "Definitions of Model Variables."

Part 5. Summary and Implications

The Trucking Research Institute of the American Trucking Associations (ATA), the Private Fleet Management Institute of the National Private Truck Council (NPTC), Iowa State University, and Daecher & Associates collaborated on a research project to evaluate the role of carrier scheduling practices in truck and motor coach driver fatigue. Funding for and oversight of the study were provided by the Federal Motor Carrier Safety Administration (FMCSA). The objective of this project was threefold:

1. to develop a definition or typology of truck driving environments and determine the percentage of over-the-road drivers that fall within each type of environment,
2. to assess the operational scheduling requirements of truck and motor coach carriers that affect driver fatigue, and
3. to identify truck and motor coach carrier scheduling and related safety practices that influence driver fatigue and driver safety performance.

The Commercial Motor Vehicle Driver Fatigue Model

The foundation of the project is the Commercial Motor Vehicle (CMV) Driver Fatigue Model (Figure 1.4) that identifies the various scheduling-related factors that may influence driver fatigue, non-scheduling factors that may also have an effect on driver fatigue, and measures of driver fatigue. The three key fatigue-influencing factors included in the model are:

- CMV Driving Environments -- Regularity of Time, Trip Control, and Quality of Rest
- Economic Pressures -- Scheduling Demands of Commerce, Carrier Economic Factors, and Driver Economic or Personal Factors
- Carrier Support for Driving Safety

Additionally, the model includes two measures of fatigue and one measure of general safety performance:

1. Frequency of Close Calls Due to Fatigue
2. Driver Perceptions of Fatigue as a Problem
3. Crash Involvement

The model was developed after an extensive review of the literature, conducting focus group sessions with personnel from truck and motor coach firms, and company site visits. The literature review revealed that no one study had addressed the wide array of driver fatigue factors included in the CMV Driver Fatigue Model. Also, relatively few studies attempted to empirically determine the importance of the factors that influence CMV driver fatigue, and only a few studies focused on motor coach driver fatigue.

Research Design

The research design for the project included three separate but related studies and data collection efforts. Nine survey instruments were developed to collect the necessary data. The first study, the "truck stop study," addressed the first objective of the project -- the development of a driver environment typology for over-the-road truck drivers. A survey that focused on the driver environment was distributed to a random sample of 502 truck drivers at five geographically dispersed truck stops. The other two studies tested the CMV Driver Fatigue Model for the truck and motor coach industries, thus identifying the carrier scheduling and related practices that influence driver fatigue in each industry. Four survey instruments were developed to collect the necessary data from four different levels of the carrier organization for each industry (i.e., top management, safety director, dispatchers, and drivers).

The sampling approach for the trucking and motor coach companies involved segmenting carriers on the basis of their overall safety record. This was done to assure sufficient variation among the sample carriers on the dependent variables specified in the model (i.e., there needs to be some variance in safety performance and the frequency of driver fatigue occurrences). The FMCSA's SafeStat database was used to identify the population of carrier firms that had a safety category rating. This universe was stratified on the basis of safety performance prior to drawing the sample. Consequently, universe carriers were grouped into three safety performance rating categories (i.e., first quartile, middle two quartiles, and fourth quartile), and sample carriers were selected randomly from within each category. An effort was made to sample an equal number of carriers from each safety performance rating category. However, the percentages of firms agreeing to participate more closely approximated a normal distribution, with nearly equal numbers of top and poor performers.

For the truck firms, the poor safety performers (first quartile) were those carriers that had a SafeStat category rating of A or a rating of B and an Accident Safety Evaluation Area (SEA) score (i.e., motor carrier accident history data for the previous 30 months). The average safety performers (middle two quartiles) were those carriers that had a SafeStat category rating of H and at least two crashes. The top safety performers were those carriers that had a SafeStat category rating of H and fewer than two crashes. For the motor coach firms the poor safety performers (first quartile) were those carriers that had a SafeStat category rating of A through E. The average safety performers (middle two quartiles) were those carriers that had a SafeStat category rating of H and at least two crashes. The top safety performers were those carriers that had a SafeStat category rating of G or H and fewer than two crashes.

Company Data Collection and Samples

The data collection methodology involved telephone calls to the safety director at each of the selected carriers to solicit her or his firm's voluntary participation in the study. Carriers that chose not to participate were replaced with firms selected at random from the appropriate safety performance group. Sampling continued until the data collection time deadline was reached.

At each trucking company, the safety director was sent a packet of seven (7) surveys -- one each for the executive and safety director, two for dispatchers, and three for drivers. At each motor coach company, the safety director was sent a packet of five (5) surveys -- one each for the executive, safety director, and dispatcher, and two for drivers. The safety director was instructed to complete the appropriate survey and to distribute the remainder. The safety director was instructed to select "typical" dispatchers and drivers; that is, neither the best nor the worst. An envelope was provided for each survey. Each respondent was instructed to put her/his completed survey into the envelope, seal it, and return it to the safety director who would return the entire packet to the researchers.

A total of 116 truck companies completed the surveys, representing a 31 percent response rate for those firms that indicated they would participate. The breakdown by safety performance group was as follows: 32 top performers, 53 average performers, and 31 poor performers. A total of 279 drivers from these 116 companies provided usable responses.

A total of 66 motor coach companies completed the surveys, representing a 44 percent response rate for those firms that indicated they would participate. The breakdown by safety performance group was as follows: 17 top performers, 34 average performers, and 15 poor performers. A total of 122 drivers from these 66 companies provided usable responses.

Results and Implications

The analysis of the data provided by the truck and motor coach respondents reveals that the CMV Driver Fatigue Model explains a significant percentage of the variation in fatigue outcomes among the driver respondents. A number of carrier scheduling and safety practices proved to be good predictors of at least one measure of driver fatigue. Not surprisingly, the model performed less well in predicting crash involvement. Two likely explanations for this are: (1) this safety measure suffered from restriction in range for the sample of drivers in this study and (2) crash involvement is affected by several factors not addressed in this study.

The results emanating from this project have several implications for carrier management. A discussion of these implications is provided for each of the three studies.

Truck Stop Study

The two objectives of the truck stop component of this project were to (a) develop definitions or a typology of driving environments and (b) estimate how many interstate commercial vehicle drivers fall into each type of driving environment. Additionally, the data allowed for an investigation of how CMV Driving Environments alone were related to fatigue and crash outcomes. First, the results of the study are summarized, and then implications are discussed.

Individual Driving Environment Factors that Influence Fatigue and Crash Involvement

The truck driver survey instrument contained 25 items addressing the three hypothesized driving environment characteristics included in the CMV Driver Fatigue Model. However, only twelve individual items were found to be meaningfully related to fifteen fatigue and crash outcome measures: two items reflecting Regularity of Time, six measures of Trip Control, and four items indicating Quality of Rest. Figure 2.1 identifies these 12 indicators.

Regression analysis was employed to determine how well each of the three driving environment characteristics independently predicted fatigue and crashes and to determine the significance and relative strength of each of the twelve individual indicators. Regularity of Time was significantly related to four of the 15 fatigue and crash outcome measures, and Trip Control and Quality of Rest were significantly related to ten and eight, respectively. For Regularity of Time the single significant predictor of fatigue and crashes was how frequently the driver drives the same hours each day. Three indicators of Trip Control were good predictors of at least three measures of fatigue and crashes: loading/unloading time being longer than expected, difficulty in finding a place to rest, and the average number of stops per day. Finally, two indicators of Quality of Rest were good predictors of fatigue and crashes: starting the workweek tired and the frequency with which drivers get home.

Typology of Driving Environments

Because all three hypothesized driving environment characteristics were good predictors of fatigue, we utilized each in developing a 2x2x2 typology of driving environments. Given the number of individual indicators within each of the three sets of indicators, there are 48 (i.e., 2x6x4) possible combinations of indicators that could be used to define driving environments. For illustration purposes, we utilized the strongest single predictor of fatigue from each of the three driving environment characteristics (i.e., driving same hours each day, longer than expected loading/unloading time, and starting workweek tired) to create eight driver work environment "cells."

We employed a series of one-way analyses of variance to test the ability of our driving environment typology to predict fatigue and crashes. To simplify the analyses we utilized factor analysis to reduce the fifteen fatigue and crash outcome measures to three outcome measures: close calls due to

fatigue, drivers' perceptions of fatigue as a problem for themselves and other drivers, and crashes. We also tested several of the other possible combinations of driving environment indicators to determine if they would yield similar results to our illustration example.

In general, the driving environments as we defined them do a very good job of predicting the frequency of close calls due to fatigue and the drivers' perceptions of fatigue being a problem for themselves and other drivers. The environments are not as good at predicting crashes. As noted earlier, this is likely due, at least in part, to the low base rate of crashes.

Distribution of Drivers Across Environments

One problem with our typology of driver work environments is that it is possible only to identify the "best" cell with respect to fatigue and safety and the "worst" cell. The in-between cells are more difficult to assess because of the interactive effects of the fatigue indicators. That being said, simple observation seems to support our assumption that Regularity of Time is the most important predictor of fatigue, followed by Trip Control and Quality of Rest.

Each driving environment cell in each of the four examples we provided reflects the work environment of some sample drivers. That is, sample drivers experience the full range of driving environments. The percentage of drivers operating in the environment least likely to induce fatigue and crashes ranged from 12.6 to 22.7. The percentage of drivers operating in the environment most conducive to creating fatigue and crashes ranged from 11.5 to 16.5. Clearly, there are a large number of drivers who are at high risk of experiencing fatigue on the job.

Collective Influence of Driving Environment Factors on Fatigue and Crashes

We conducted regression analysis using all twelve driving environment indicators as independent variables and the three outcome measures of fatigue and crashes as dependent variables. The model provided statistically significant results for the two fatigue outcome measures and marginally significant results ($p \leq .10$) for the crash measure.

The driving environment characteristics explained only 5 percent of the variability in close calls due to fatigue. While this is a modest level of explanatory power, one must remember that the other components of the CMV Driver Fatigue were not included in this part of the study, and that there are several non-scheduling factors beyond the scope of this project that also affect driver fatigue. Starting the workweek tired and longer than expected loading/unloading times are positively related to close calls, as expected. Surprisingly, the number of time zones a driver drives in is negatively related to close calls. Further analysis of this indicator is warranted.

The driving environment characteristics explain 23 percent of the variability in driver perceptions of fatigue. Each of the three environment characteristics has at least one indicator that is statistically significant, and each is in the expected direction. Regularity of Time has one significant indicator (driving the same hours each day). Trip Control has two (longer than expected loading/unloading times and route regularity), as does Quality of Rest (starting the workweek tired and the number of hours of uninterrupted sleep).

Two percent of crash involvement is accounted for by the CMV model, primarily through average number of stops per day and starting the workweek tired. Perhaps most noteworthy is the finding that starting the workweek tired is a pervasive predictor of all three outcomes. These findings suggest that fewer close calls, less fatigue, and fewer crashes could be realized if drivers could alter their behavior to begin their work refreshed and alert.

Conclusions and Implications

Several conclusions and implications relative to the role of truck driving environments in reducing driver fatigue can be drawn from the truck stop study. Based on those factors that were statistically significant predictors of fatigue when investigating all 12 driving environment indicators, the following recommendations and findings emerge:

- Carriers should focus on providing adequate recovery time for drivers between driving stints.
- Drivers should utilize the provided recovery time to obtain adequate rest to begin the next driving period refreshed and alert.
- Shippers and carriers need to work together to improve the scheduling and performance of loading and unloading activities.
- To the extent possible, carriers should have their drivers drive the same hours on a regular basis. Also, having drivers run the same routes on a regular basis appears to diminish fatigue.
- Drivers who, on average, got more than the average number of hours of uninterrupted sleep during a 24-hour work period reported less fatigue.

Starting the workweek tired was the most significant single predictor of both measures of fatigue and a significant predictor of crash involvement. Drivers who do not obtain adequate rest during their recovery time are more prone to experiencing fatigue and having close calls due to fatigue. Obtaining adequate rest before beginning the new "workweek" is dependent upon (1) having adequate recovery time available, (2) the quality of rest during recovery time (e.g., where the recovery time takes place), and (3) effective use of recovery time to obtain rest. How much recovery time is needed has been addressed by other researchers and is beyond the scope of this project. Similarly, we did not explore through the surveys where recovery time takes place (other than how frequently drivers get home for their recovery

time) or how drivers utilize their recovery time. However, these concerns were raised a number of times during the focus group meetings and during the company site visits.

Interviewed carrier personnel offered a number of reasons why drivers might not obtain adequate rest during their recovery time, even if it occurs at home. Furthermore, they noted that frequently the home "schedule" runs counter to the work schedule. That is, a driver may drive fairly regular hours while working, but changes to a different schedule during the recovery time. Some carriers attempt to educate their drivers about the body's circadian rhythm and the need to maintain a regular sleeping schedule at all times. A few carriers attempt to extend this education effort to the drivers' families since many of the pressures to digress from the regular (i.e., work) sleeping schedule are family induced.

The only other significant predictor of both measures of fatigue was having loading or unloading times longer than expected. Again, this was an issue raised numerous times during focus group meetings and company site visits. These unanticipated delays create several potential problems for drivers that may lead to fatigue. Generally speaking, they may create considerable stress for the driver as subsequent loads or stops, including planned rest stops and rest locations, may be affected. It was also asserted that these delays may result in a driver continuing to drive when tired in order to make up for the lost revenue time. Though many carriers have begun providing hourly compensation to the drivers for time spent during loading and unloading, this practice did not emerge as a significant factor in reducing fatigue in this study.

Longer than expected loading and unloading time is also an important financial issue for trucking firms. The detention of equipment at shipper and receiver facilities adversely affects asset utilization. Trucking firms also contend this is a major contributor to their driver retention problems. Thus, this is a problem that has both safety and financial implications, and needs to be jointly addressed by carriers and their customers.

Finally, regularity of time, regularity of route, and uninterrupted hours of sleep were significant predictors of drivers' perceptions of fatigue. These results support the conventional wisdom about circadian rhythm and the favorable effects of putting drivers on regular time schedules. Running regular routes may help reduce fatigue because the drivers know where the good rest areas are, and the fewer uncertainties associated with knowing the route may reduce stress. The importance of obtaining an adequate amount of uninterrupted sleep supports other research on driver fatigue.

In conclusion, the results of the truck stop study indicate that the driving environment alone plays a key role in fatigue for the over-the-road driver. They also reveal that there is a large percentage of drivers who are at high risk of experiencing fatigue on the job. While certain driving environment indicators proved to be statistically significant predictors of fatigue, each of the 12 driving environment

indicators included in the final version of the CMV Driver Fatigue Model are worthy of attention from carriers.

Truck Company Study

The truck company study built upon the results of the truck stop study, using the same measures of Driving Environments and Fatigue and Crash Outcomes. Similar data refining measures were employed to determine the best indicators for Economic Pressures and Carrier Support for Driving Safety components of the model. These efforts thus allowed for a complete investigation of the CMV Driver Fatigue Model. The data analysis reveals that the full model explains a significant percentage of the variation for all three fatigue and crash outcome measures. First, the results of the study are summarized, and then implications are discussed. Figure 3.3 shows the individual indicators within each broad category of factors in the model.

Individual Driving Environment Factors that Influence Fatigue and Crash Involvement

The profile of driver respondents from the trucking companies was different from that of the truck stop respondents. Thus, some differences were to be expected and were found between the two samples in terms of the relative importance of individual driving environment indicators. However, the 12 indicators collectively do a good job of explaining the variation in the drivers' fatigue perceptions (and similar to that found in the truck stop study) and provide reasonably good results in explaining close calls due to fatigue. As was the case in the truck stop study, the driving environment by itself did not explain variation in the crash indicator.

Five driving environment indicators emerged as significant predictors of fatigue. Driving the same hours each day and the number of 6-hour time zones driven, regularity of time indicators, were associated with close calls due to fatigue and driver perceptions of fatigue, respectively. However, driving the same hours each day was positively related to close calls, not in the direction expected (i.e., negative). Difficulty in finding a place to rest and the average number of stops per day, both from the trip control category, were significantly related to close calls and fatigue perceptions, respectively. Lastly, starting the workweek tired, a quality of rest indicator, was positively and significantly associated with both close calls and fatigue perceptions.

Individual Indicators of Economic Pressures that Influence Fatigue and Crash Involvement

Scheduling Demands of Commerce reflect the external pressures that are exerted on trucking firms by their customers (i.e., shippers and receivers). Four individual indicators were found to have a significant influence on fatigue or crash outcomes. The percent of shippers and receivers that provide adequate delivery time and the percent of business from brokers are negatively associated with close calls

due to fatigue. The average size of shippers' and receivers' delivery window is negatively associated with drivers' perceptions of fatigue, and the percent of drivers' time spent loading and unloading was positively related to crash involvement.

Driver Economic and Personal Factors reflect the internal pressures faced by drivers that affect their driving behavior and may affect driver fatigue. Three indicators were found to have a statistically significant relationship to the fatigue and crash outcomes. Personal motivations to continue driving when tired (i.e., to make more income or to get somewhere for personal, non-economic reasons) was significantly and positively related to both fatigue measures and to crash involvement. The other two indicators involved rewards and penalties tied to delivery time performance. Being rewarded for on-time deliveries was positively related to crash involvement. Being penalized (mostly through pay reduction of some sort) for late deliveries was positively related to fatigue perceptions but negatively related to crash involvement. Driver Economic and Personal Factors was found to be unique in its ability to explain statistically significant amounts of variation in crashes, further suggesting that more attention be rendered to this class of determinants.

Carrier Economic Factors capture the pressures perceived by various personnel within a carrier firm to be economically successful. It assesses the extent to which carriers emphasize financial performance over safety performance. Four individual indicators were found to have statistically significant association with fatigue and crash outcomes. Dispatcher pressure on drivers to accept or hurry loads was positively related to driver fatigue perceptions. Drivers' perception that they have to bend a driving safety rule or policy to "get the job done" was also positively related to their perception of fatigue as a problem. Perceived company pressure on dispatchers to accept or dispatch loads when available drivers were out of hours was positively related to close calls due to fatigue. Finally, the extent to which dispatchers are evaluated (and rewarded or penalized) on the basis of operating efficiency measures was positively related to both perceptions of fatigue and close calls due to fatigue.

Collective Influence of Driving Environment Factors and Economic Pressures on Fatigue and Crashes

We conducted regression analysis using all sixteen driving environment and economic pressures fatigue indicators as independent variables and the three outcome measures of fatigue and crashes as dependent variables. The model provided statistically significant results for both fatigue outcome measures and for the crash measure.

These indicators explain 15 percent of the variability in close calls due to fatigue. Starting the workweek tired and difficulty in finding a place to rest are positively related to close calls, as expected.

The percentage of shippers and receivers providing adequate time is negatively related to close calls, also as expected. The percentage of business from brokers is negatively related, and this runs counter to what many interviewed trucking company personnel predicted.

The sixteen indicators explain 32 percent of the variability in driver perceptions of fatigue, and six indicators are statistically significant predictors. Starting the workweek tired, dispatcher pressure on drivers to bend safety rules, the pressure on drivers to accept or hurry loads, and the extent to which dispatchers are evaluated on operating efficiency are positively related to driver fatigue perceptions. The size of the delivery window and, again, the percent of business from brokers are negatively related.

Six percent of crash involvement is accounted for by the sixteen indicators, but only one indicator is statistically significant. The percent of time spent loading or unloading is positively related to crash involvement.

The Influence of Carrier Support for Driving Safety on Fatigue and Crash Involvement

Carrier Support for Driving Safety is positioned as a moderating variable in the CMV Driver Fatigue Model. That is, it is hypothesized that carriers can minimize of enhance the environment and/or economic determinants of fatigue and crashes by the extent to which they institute safety practices. The survey instruments included several items that addressed company safety attitudes, policies, and practices. These were reduced through factor analysis and other methods to five areas of possible carrier support. Four of these were found to be significant in predicting outcomes for the sample respondents.

Eleven items from the driver survey instrument comprise the scale that measures the drivers' perceptions of the company's safe driving culture. The drivers' perception that the company had a culture that fostered safe driving is negatively associated with both close calls and driver perceptions of fatigue. Similarly, voluntary attendance at safety training and safety meetings is negatively related to both fatigue outcomes. Company assistance with loading and unloading is negatively associated with driver perceptions of fatigue, as is company policies that minimize nighttime driving.

These four safety variables were added to the sixteen driving environment and economic pressures indicators and regressed against the fatigue and crash outcomes. The inclusion of Carrier Support for Driving Safety increases the explanatory power of the CMV Driver Fatigue Model to explain variation in both fatigue measures, but not in the crash involvement measure. Collectively, the safety indicators reduced the explanatory capacity associated with two significant predictors, the percentage of shippers and receivers that provide adequate delivery time and the drivers' perception that they have to bend safety rules to get the job done. Voluntary attendance at safety and training meetings, company

policies that minimize nighttime driving, and assistance with loading/unloading were most instrumental in explaining the incremental variation in perceptions of fatigue.

Conclusions and Implications

The truck company study provides additional support for many of the truck stop study findings, and provides some unique conclusions and implications. Key findings include:

- Starting the workweek tired was the single most significant factor in both studies, indicating the importance of adequate recovery time and effective use of that time to obtain rest.
- Difficulty in finding a place to rest surfaced as an important explanatory factor, emphasizing the need to address the nationwide rest area shortage problem that was mentioned by of the interviewed carrier personnel.
- Shippers'/receivers' scheduling practices and requirements play a very important, direct role in driver fatigue.
- The physical interface between carriers and shippers/receivers potentially exerts a significant influence on driver fatigue.
- Pressures exerted by the carrier company on drivers and dispatchers have a significant influence on the driver fatigue measures.
- The evaluation and reward (penalty) methods used by carrier firms may create driver fatigue problems.
- Doing business with brokers, at least for the respondents in this study, does not have a negative impact on driver fatigue. Just the opposite was found.
- In this study, assistance with loading/unloading and efforts to minimize nighttime driving are carrier practices that mitigated driver perceptions that fatigue is a problem. The percent of drivers' time spent loading and unloading is particularly important given its association with crash involvement.
- The corporate safety culture affects driver fatigue, and the drivers' perception of safety culture is dependent upon their view of top management's commitment to safety and willingness to receive and discuss drivers' input.

The major driving environment findings were discussed in the truck stop study section. Therefore, the remainder of this section will focus on the other results.

The role of shippers and receivers in driver fatigue is strongly supported by the results of our analysis. Their role manifests itself in two ways: (1) through scheduling practices and requirements and (2) through the physical interface with the carrier (i.e., loading and unloading). The influence of the former is reflected in the significance of the two indicators, adequate delivery time and size of the delivery window. The influence of the latter is reflected in a number measures including, percent of time spent loading/unloading, loading/unloading time taking longer than expected, and the average number of stops per day. This last measure is more important in the trucking company study perhaps because these driver

respondents, on average, have more stops per day than do the respondents in the truck stop study. Stated differently, the truck stop study was represented by a higher percentage of over-the-road drivers. The truck stop study found loading/unloading time taking longer than expected to be a significant predictor of fatigue. These two sets of findings mutually support one another. That is, both reflect the adverse consequences of unexpected loading/unloading time on the drivers. For the truck company drivers, the average number of stops may reflect the cumulative impact of delays. While no single stop may create an unreasonable delay, the more stops incurred increases the likelihood that one will "fall behind schedule" due to multiple short delays. An alternative explanation may be that stops are physically tiring, particularly if the driver is performing the loading/unloading.

The standards used by carrier firms to evaluate and reward/penalize the performance of dispatchers and drivers exert an influence on driver fatigue. Performance criteria that are focused on operating efficiency measures and pay or penalties tied to delivery service performance may lead to violations of good safety behavior and practices. Dispatchers may feel pressure to accept or hurry loads they should not accept, or to schedule drivers that are not well rested. Drivers may feel pressure to bend safety rules or to continue driving when tired in order to earn extra compensation or to avoid penalties.

The percentage of business coming from freight brokers was initially included in the CMV Driver Fatigue Model because of assertions made in focus group sessions and during company site visits. Some carrier representatives contended that broker-generated traffic was less predictable and harder to schedule, and that brokered freight was often tendered without knowledge of the driver's rest needs. However, there are countervailing considerations. Brokered freight may reduce the downtime and deadhead (i.e., non-revenue) miles for drivers looking for loads. It was also suggested by one carrier representative that brokered loads are less time-sensitive, thus putting less pressure on the driver and company. Our results suggest that the potential positive influences of brokers relative to fatigue outweigh the negative influences for the sample firms.

Finally, some discussion of the findings concerning carrier support for safety is warranted. First, it is important to note that many safety practices and policies were included in the surveys. Most of these did not show up as having a significant impact on fatigue or crashes. It should not be interpreted that these safety elements are not important. Rather, they may not emerge as significant factors because most firms are doing them (i.e., there's a restriction in range). Indeed, two practices that were found to have a statistically significant and favorable influence on fatigue are not implemented by most firms. Company assistance with loading/unloading is provided for 43 percent of the driver respondents and company efforts to minimize nighttime driving are reported by only 24 percent of the driver respondents. With respect to

the "common" safety practices, a better approach to determining their impact on fatigue would be to assess how effectively carrier companies are applying them rather than just whether they exist. Case studies may prove to be a better approach for such a determination.

Company safety culture is a good example of an important component of safety that was not statistically significant in the testing of the complete CMV Driver Fatigue Model. It was, however, one of the indicators that survived the initial screening of indicators. The eleven-item scale that measures this indicator reveals the importance of open communication between management and drivers on safety issues and the drivers' perception that safety is a top priority of the company.

In conclusion, the results of the truck company study provide empirical support for the CMV Driver Fatigue Model. The study provides useful insights for truck management on the underlying factors related to carrier scheduling practices that influence driver fatigue. These practices should be the focus of efforts to improve driver fatigue, including educational efforts aimed at all employees and customers involved in the scheduling of drivers.

Motor Coach Study

The motor coach study used the feedback collected from motor coach companies, including CEOs, safety directors, dispatchers, and drivers. The surveys were prepared to reflect relevant elements contained in the CMV Driver Fatigue Model for the Motor Coach Industry (Figure 4-1).

The data collected through the survey process were refined to determine the best indicators for the Driving Environments, Economic Pressures, Carrier Support for Driving Safety, and Fatigue and Crash Outcomes components of the model.

The data analysis revealed that the full model explained a significant percentage of the variation for two of the three fatigue and crash outcome measures. First the results of the study are summarized and then implications are discussed.

Individual Driving Environment Factors That Influence Fatigue and Crash Involvement

The ten indicators collectively did a good job of explaining the variation in the drivers' fatigue perceptions and in explaining close calls due to fatigue. However, the driving environment by itself did not explain variation in the crash involvement indicator.

Three driving environment indicators emerged as significant predictors of fatigue. Driving the same hours each day was related to drivers' perceptions of fatigue. The measure uninterrupted hours of sleep was associated with close calls. Starting the workweek tired was associated with both close calls and drivers' perception of fatigue.

Individual Indicators of Economic Pressures That Influence Fatigue and Crash Involvement

Scheduling demands of commerce reflect the external pressures that are brought to bear on motor coach firms by the expectations and requirements of tour groups and passengers. Only one individual indicator related to inverted duty/rest cycles was found to have a significant influence on fatigue or crash outcomes. The frequency of inverted duty/rest cycles experienced by drivers during an average trip was significantly related to close calls and drivers perceptions of fatigue.

Driver economic and personal factors reflect practices and circumstances that encourage both positive and negative driving behaviors by drivers. Two indicators were found to be significantly related to the fatigue and crash outcomes. Driving tired to make a good income was predictive of close calls and drivers' perceptions of fatigue. Penalties or negative repercussions associated with late arrivals were significantly related to drivers' perceptions of fatigue.

Carrier economic factors relate to the pressures perceived by various personnel within a motor coach company to be economically successful. It assesses the extent to which carriers emphasize financial performance over safety performance. Four individual indicators were found to be significantly associated with fatigue and crash outcomes. Drivers' perceptions of pressure from dispatchers to accept trips were significantly related to close calls and drivers' perceptions of fatigue. The perception that drivers have to bend safety rules to get the job done was significantly related to perceptions of fatigue. Safety directors' perceptions regarding pressure by their companies to accept trips even when they have no drivers with sufficient hours was significantly related to drivers' perceptions of fatigue. Pressure to ask drivers to overlook rest requirements was significantly related to crash involvement.

Collective Influence of Driving Environment Factors and Economic Pressures on Fatigue and Crashes

Regression analysis was conducted using all ten significant driving environment and economic pressure indicators as independent variables and the three outcome measures of fatigue and crashes as dependent variables. The model provided statistically significant results for fatigue outcome measures but not for crash involvement.

These ten indicators explained 23 percent of the variability in close calls due to fatigue. Pressure on drivers to accept trips was positively related to close calls.

The ten indicators explained 56 percent of the variability in driver perceptions of fatigue. Five indicators were statistically significant predictors. Driving the same hours was negatively related to driver perception of fatigue. Starting the workweek tired, driving tired to make a good income, pressure on

drivers to accept trips, and pressure to bend rules were all positively associated with driver perception of fatigue.

The regression analysis indicated no collective impact of the driving environment and economic pressures on crash involvement. Moreover, no single indicator demonstrated any significant relationship to crash involvement in this analysis.

The Influence of Carrier Support for Driving Safety on Fatigue and Crash Involvement

Carrier support for driver safety is positioned as a moderating variable in the CMV Driver Fatigue Model. That is, it is hypothesized that carriers can minimize or enhance the environment and/or economic determinates of fatigue and crashes by the extent to which they institute safety practices. The survey instruments included several items that addressed company safety attitudes, policies, and practices. These were reduced through factor analysis and other methods to five areas of possible carrier support. Two of these were found to be significant in predicting outcomes for respondents.

Eleven items from the driver survey instrument comprised the scale that measures the drivers' perceptions of the company's safe driving culture. The drivers' perceptions that the company had a culture that fostered safe driving is negatively associated with both close calls and driver perceptions of fatigue. Company policies that minimize nighttime driving were significantly related to crash involvement.

These two safety variables were added to the ten driving environment and economic pressures indicators and regressed against the fatigue and crash outcomes. The inclusion of carrier support for driving safety slightly increased the explanatory power of the CMV Driver Fatigue Model to explain variation in the drivers' perceptions of fatigue but this increase was not statistically significant. These safety indicators did not increase the explanatory capacity of the model in explaining variation in close calls and crash involvement.

The inclusion of carrier support for driver safety in the regression analysis reduced the number of significant indicators to three. Starting the workweek tired, driving tired to make a good income, and pressure on drivers to accept trips were significantly related to drivers perceptions of fatigue.

Conclusions and Implications

Key findings from the survey of motor coach companies and their personnel are:

- Regularity of time worked was found to be a significant factor in reducing drivers' perceptions of fatigue. This result is consistent with knowledge being gained through research on sleeping behavior and circadian rhythms.
- Starting the workweek tired was a significant factor, indicating the importance of adequate recovery time and effective use of that time to obtain rest. The number of hours of uninterrupted sleep was also a significant factor related to quality of rest.

- Driving tired to make a good income is a significant factor, indicating the acceptance of such practices by drivers and the relative difficulty in changing the situations and circumstances that create this viewpoint. Most importantly, there is a perception that it is necessary in order to earn desired income.
- Driver perception of pressure by dispatchers or others to accept trips is a significant factor in contributing to driver fatigue. In part, this pressure is related to earning a desired income. It is also related to the pressures of meeting customer demands.
- Driver perception of pressure from dispatchers and others to bend rules is also a significant factor regarding driver fatigue. It is primarily related to the pressures of meeting customer demands.
- The drivers' perceptions of their company's safe driving culture and the company's policies or attempts to minimize nighttime driving were important factors affecting driver fatigue, according to drivers.
- While the above elements of carrier support for driving safety were viewed as important by drivers, carrier support did not significantly contribute to mitigating the fatigue or crash outcomes when viewed in combination with driving environment and economic pressure factors.

The results of the study depict situations that are mostly controlled by the individual driver yet significantly influenced by his or her company. Obtaining adequate rest and recovery time to begin the workweek refreshed requires personal responsibility and time management by drivers during their extended off-duty periods. The apparent pressure felt by drivers to drive tired to make a good income and to accept trips or bend rules indicate a belief by drivers that if they do not respond to passenger or company demands their incomes will suffer. It also reflects a reluctance on the part of drivers to say "no", possibly because of their personal and family pressures for earning income. The driver shortage, which has been experienced through the 1990's in conjunction with high demand for motor coach services, may also contribute to these outcomes.

In spite of these pressures, drivers apparently like what they do. Respondents were clearly stable in their employment situations (i.e., the average driver had 20 years of CMV experience). Thus, drivers apparently find many more positive aspects to their jobs, and accept the negative pressures as part of it.

Customer pressures have a part to play in those situations that are significant towards driver fatigue. Drivers and other members of companies feel the pressure to respond to customer requests. These demands, and the pressures felt by the companies and drivers to meet them, create the atmosphere within which drivers' perceptions related to driving tired and accepting trips or bending rules is formed.

While company safety culture and company policies which minimize nighttime driving were not statistically significant in the testing of the final Motor coach Driver Fatigue Model, they were important in

the initial screening of indicators. Carrier support for driving safety is important in developing necessary communications between customers, management, and drivers on safety and operational issues. The quality of this support will be reflected through the effectiveness in managing customer demands and driver assignments. Carrier support systems are the conduit through which customer and driver perceptions of service and safety are formed. Carrier support is also an important channel for assisting drivers in their personal time and life style management.

In conclusion, the results of the motor coach company study provide empirical support for the CMV Driver Fatigue Model. This study provides useful insights for individual and company management on the underlying factors related to carrier scheduling practices that influence driver fatigue. These practices should be the focus of efforts to minimize driver fatigue, including effective education for individual employees which should include open discussion of carrier practices and their impacts on individual drivers, personal time and fatigue management, and customer services practices as they relate to driver fatigue. Educational efforts should also be aimed at customers to help them better understand both the capabilities and limitations of services provided by motor coach companies, regulatory requirements, and potential fatigue impacts of customer demands during trips. Lastly, the carrier's ability to hire and retain sufficient drivers to reduce the individual pressures associated with healthy demand is critical. Having a sufficient number of drivers to operate a carrier's vehicle fleet for expected and planned demand is fundamentally important in reducing the scheduling pressures associated with driver fatigue.

Appendix A: Bibliography of Sources Reviewed in Support of the Motor Carrier Scheduling Practices and Their Influence on Driver Fatigue Project

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Appendix D: Surveys Used in the Project

Commercial Motor Vehicle (CMV) Operations: Trucking Company Perspective

The following questions are related to your opinions about driver fatigue and other safety issues. Please indicate the extent to which you believe the statement is true by circling the number which best corresponds to your opinion using a scale of 1-7, with 1=To a Very Little Extent and 7=To a Very Large Extent.

	To what extent do you think or believe…	To a Very Little Extent			To Some Extent			To a Very Large Extent
1.	Current hours-of-service regulations, when followed, do not effectively prevent driver fatigue?	1	2	3	4	5	6	7
2.	Drivers are the best judges of whether or not they are too tired to drive?	1	2	3	4	5	6	7
3.	Driving at night (i.e., between midnight and dawn) is as safe for CMV drivers as driving during the daytime?	1	2	3	4	5	6	7
4.	Companies throughout the CMV industry are committed to driving safety?	1	2	3	4	5	6	7
5.	Shippers' and receivers' requirements influence driver fatigue (e.g., cause excessive waiting time, provide insufficient driving time to make on-time deliveries)?	1	2	3	4	5	6	7
6.	Shippers and receivers are **aware** about hours of service regulations and driver fatigue issues?	1	2	3	4	5	6	7
7.	Shippers and receivers **care** about hours of service regulations and driver fatigue issues?	1	2	3	4	5	6	7
8.	Top management of **your** company is aware of driver fatigue issues?	1	2	3	4	5	6	7
9.	Competitive pressures lead **your** employees to bend safety rules in order to "get the job done"?	1	2	3	4	5	6	7
10.	Drivers in **your** company have opportunities to make suggestions and voice complaints regarding safety and fatigue?	1	2	3	4	5	6	7
11.	**Your** company acts on suggestions and complaints made by drivers concerning safety and fatigue?	1	2	3	4	5	6	7
12.	Top management at **your** company is committed to driving safety?	1	2	3	4	5	6	7

13. Many factors are thought to cause fatigue among CMV drivers. Please rate the importance of the following possible seven factors according to which factors you think are important in causing driving fatigue. Use a scale of 1 to 7 with "1" = Not At All Important and "7" = Very Important to rate each factor. (Circle one number for each factor.)

	Possible Fatigue Causing Factor	Not At All Important			Of Some Importance			Very Important
a.	**Irregularity of CMV driving time** (e.g., different times of driving each day, seasonality or variability of work).	1	2	3	4	5	6	7
b.	**Lack of trip control** (e.g., different routes, cannot control or predict schedule due to factors like waiting or loading/unloading).	1	2	3	4	5	6	7
c.	**Poor quality of rest while working** (e.g., not sleeping at home, nighttime driving, interrupted sleep, difficulty in finding a place to rest or sleep).	1	2	3	4	5	6	7
d.	**Scheduling demands of CMV driving work** (e.g., time allotted by shippers and receivers, waiting time).	1	2	3	4	5	6	7
e.	**Driver economics** (e.g., need to earn more money, rewards for on-time pick-ups and deliveries, penalties for late pick-ups and deliveries, no rewards for safe driving) or personal factors (e.g., desire to get home, personal pride in on-time pickups and deliveries).	1	2	3	4	5	6	7
f.	**Business pressures on company passed onto drivers** (e.g., pressure on drivers from dispatchers to accept loads or be on-time, company penalized for late deliveries, company emphasizes business over safety).	1	2	3	4	5	6	7
g.	**Inadequate company support for fatigue safety issues** (e.g., lack of equipment that might reduce fatigue, no relay or driver teams, little or poor driver fatigue training, low understanding of driver fatigue or commitment to reduce driver fatigue among managers).	1	2	3	4	5	6	7

14. What percentage of your company's customers impose a monetary penalty for late deliveries? _____ %

15. How often does your company have to pay these penalties?

a. _____ Never
b. _____ Rarely
c. _____ Sometimes
d. _____ Frequently
e._____ Don't know

Listed below are statements about driving fatigue and safety. Please indicate the extent to which you agree or disagree with each statement by circling the number which best corresponds to your opinion, using a scale of 1 to 7, with 1 = Strongly Disagree and 7 = Strongly Agree. (Circle one number for each statement)

	I. Statement about driving fatigue and safety	Strongly Disagree			Neutral			Strongly Agree
16.	Our company makes driving safety a top priority.	1	2	3	4	5	6	7
17.	Driving safety is an important concern at this company.	1	2	3	4	5	6	7
18.	I am satisfied with the amount of emphasis this company places on driving safety.	1	2	3	4	5	6	7
19.	Drivers and management openly discuss issues related to driver fatigue.	1	2	3	4	5	6	7
20.	This company is interested in driver input on driving safety matters.	1	2	3	4	5	6	7
21.	Drivers provide useful insights into driver fatigue issues.	1	2	3	4	5	6	7
22.	Driver input has played an important role in setting company policies pertaining to driver fatigue.	1	2	3	4	5	6	7
23.	We need more training related to driver fatigue issues.	1	2	3	4	5	6	7
24.	Drivers have to bend a driving safety rule or policy in order to "get the job done."	1	2	3	4	5	6	7

25. Your company is best described as what type of carrier? (check all that apply)
    a. _____ Truckload
    b. _____ Less-than-truckload
    c. _____ Specialized commodity
    d. _____ For-hire carrier
    e. _____ Private carrier

26. What is your position or title? _____

27. What is the position or title of the person you directly report to, if anyone? _____

FEEL FREE TO MAKE ANY ADDITIONAL COMMENTS ON THE BACK OF THIS PAGE.

Commercial Motor Vehicle (CMV) Operations:
Truck Safety Director Survey

Section 1: Nature of Work

1. Persons charged with driving safety, which includes an understanding of driver fatigue issues, have widely varying job responsibilities. How much importance do you attach to each of these activities? Circle one number or NA (not applicable–not part of my job) for each statement.

Please rate on a scale of 1 to 5 the importance of these activities.	**Not Important**	**A Little Important**	**Somewhat Important**	**Important**	**Very Important**	**Not Applicable**
Recruiting/screening new drivers	1	2	3	4	5	NA
Providing training on managing driver fatigue to **new** recruits	1	2	3	4	5	NA
Providing training on managing driver fatigue to **experienced** drivers	1	2	3	4	5	NA
Providing training on managing driver fatigue to **dispatchers**	1	2	3	4	5	NA
Communicating with shippers and receivers about scheduling as it relates to driver fatigue	1	2	3	4	5	NA
Monitoring drivers' hours	1	2	3	4	5	NA
Managing (reducing) driver turnover	1	2	3	4	5	NA
Utilizing safety teams to address driver issues.	1	2	3	4	5	NA

2. What policies or programs does your company have for drivers to promote safe driving (e.g., accident free miles). (Check as many as apply)

_____ None
_____ Recognition programs (e.g., employee of the month, certificates)
_____ Publication of good driver names in newsletter or bulletin boards
_____ Differential mileage rate for safe driving
_____ Cash bonuses for drivers with safe driving records
_____ Extra holidays or vacation for drivers with safe driving records
_____ Merchandise or discounts on merchandise
_____ Free license renewal
_____ Savings bonds; gift certificates, etc.
_____ Other (Please specify _____)

Section 2: Perspectives on Top Management and Shippers/Receivers

The following questions are related to your personal opinions about top management at your company and shippers. Please indicate the extent to which you feel the statement is true by circling the number which best corresponds to your opinion, using a scale of 1 to 7, with 1 = To a Very Little Extent and 7 = To a Very Large Extent. (Circle one number for each statement)

	To what extent does top management . . .	**To a Very Little Extent**			**To Some Extent**			**To a Very Large Extent**
3.	Demonstrate awareness of driving fatigue issues?	1	2	3	4	5	6	7
4.	Regard hours-of-service regulations as a general guideline rather than a set of regulations that should be strictly enforced?	1	2	3	4	5	6	7
5.	Believe that drivers are the best judges of whether or not they are too tired to drive?	1	2	3	4	5	6	7
6.	Pressure employees not "to turn away business" even when drivers are "out of hours."	1	2	3	4	5	6	7
7.	Believe driving at night (i.e., between midnight and dawn) is as safe for CMV drivers as driving during the daytime?	1	2	3	4	5	6	7
8.	Participate in the safety management program (e.g., meetings, recognitions)	1	2	3	4	5	6	7
	To what extent do shippers/receivers . . .	**To a Very Little Extent**			**To Some Extent**			**To a Very Large Extent**
9.	Demonstrate awareness of hours of service regulations and driver fatigue issues?	1	2	3	4	5	6	7
10.	Care about hours-of-service regulations and driver fatigue issues?	1	2	3	4	5	6	7
11.	Contribute to driver fatigue (e.g., cause excessive waiting time, do not allow sufficient time to make on-time deliveries)?	1	2	3	4	5	6	7

Section 3: Perspectives on Dispatchers

The following questions are related to your personal opinions about the dispatchers at your company. Please indicate the extent to which you think the statement is true by circling the number which best corresponds to your opinion, using a scale of 1 to 7, with 1 = To a Very Little Extent and 7 = To a Very Large Extent. (Circle one number for each statement.)

	To what extent do dispatchers . . .	**To a Very Little Extent**			**To Some Extent**			**To a Very Large Extent**
12.	Place a higher priority on making deliveries on-time than on driver safety?	1	2	3	4	5	6	7
13.	Regard hours-of-service regulations as a general guideline rather than a set of regulations that should be strictly enforced?	1	2	3	4	5	6	7
14.	Believe that drivers are the best judges of whether or not they are too tired to drive?	1	2	3	4	5	6	7
15.	Feel pressure not "to turn away business" even when they know all of their available drivers are "out of hours"?	1	2	3	4	5	6	7
16.	"Punish" drivers who stop driving when they are tired and then are late with a delivery (e.g., future load assignments)?	1	2	3	4	5	6	7
17.	Receive training about driver fatigue issues?	1	2	3	4	5	6	7

Section 4: Perspectives on Drivers

18. What percentages of your drivers fall into each classification?
    a. _____ % Company drivers
    b. _____ % Owner-operators
    c. _____ % Temporary/casual drivers
    d. _____ % Leased drivers
    100 % Total

19. How many drivers, in total, does your company employ? _____ Drivers

20. How many of your drivers drive in teams on a regular basis? _____ Drivers

21. How many of your drivers participate in **relay** runs on a regular basis? _____ Drivers

22. What percentages of your drivers are (a) unionized and (b) turnover each year?

    a. _____ % Union
    _____ % Non-unionized
    100% Total

    b. _____ % Voluntary turnover (quits)
    _____ % Involuntary turnover (discharges)
    100% Total

23. How are drivers in your company paid for driving? (check as many as apply)
    a. _____ By the mile
    b. _____ By the hour
    c. _____ Straight salary
    d. _____ As a percentage of the load
    e. _____ Base rate plus product sales commission
    f. _____ Other (Please specify _____)

24. What is the current average driver compensation per mile (or in per mile equivalent)? _____ Cents per mile

25. For which of the following are drivers compensated? (check as many as apply)
    a. _____ Loading and unloading
    b. _____ Waiting time at shipper or receiver facilities
    c. _____ Safe driving
    d. _____ On-time deliveries
    e. _____ Operating efficiently
    f. _____ Hotel expenses/per diem
    g. _____ Driving "overtime" (higher hourly rate for excess hours)
    h. _____ Other (please specify) _____

26. Are drivers penalized financially by the company for poor work performance? (check as many as apply)
    a. _____ No
    b. _____ Yes, for preventable accidents
    c. _____ Yes, for traffic violations
    d. _____ Yes, for customer (shipper or receiver) complaints about driver behavior
    e. _____ Yes, for late deliveries attributed to driver performance
    f. _____ Yes, for damage to freight
    g. _____ Yes, for excessive absenteeism or tardiness

The following questions are related to your personal opinions about drivers and fatigue issues at your company. Please indicate the extent to which you think each statement is true by circling the number which best corresponds to your opinion, using a scale of 1 to 7, with 1 = To a Very Little Extent and 7 = To a Very Large Extent. (Circle one number for each statement)

	To what extent do drivers . . .	**To a Very Little Extent**			**To Some Extent**			**To a Very Large Extent**
27.	Receive training about driver fatigue issues?	1	2	3	4	5	6	7
28.	Regard hours-of-service regulations as a general guideline rather than a set of regulations that should be strictly enforced?	1	2	3	4	5	6	7
29.	Believe they can stop driving when they are tired without being "punished" by their dispatcher (e.g., future load assignments)?	1	2	3	4	5	6	7
30.	Pressure dispatchers to "overlook" rest requirements?	1	2	3	4	5	6	7
31.	Believe that driving at night (i.e., between midnight and dawn) is as safe as driving during the daytime?	1	2	3	4	5	6	7
32.	Believe they have opportunities to make suggestions and voice complaints regarding safety and fatigue?	1	2	3	4	5	6	7
33.	Believe that the company acts on suggestions and complaints made by drivers concerning safety and fatigue?	1	2	3	4	5	6	7
34.	Think top management at your company is committed to driver safety?	1	2	3	4	5	6	7

Questions 35-40 are related to driving safety training and meetings. For this survey, **training** refers to formal educational programs on driving safety and **meetings** refer to open discussions on driving safety topics such as new government regulations, new company policies, and accident investigations.

35. How frequently does your company provide on-going or "refresher" **training** related to driving safety?
    a. _____ Never
    b. _____ Once in a while, no pattern of frequency
    c. _____ Once a month
    d. _____ Once every 2-3 months
    e. _____ Once every six months
    f. _____ Once a year
    g. _____ Other (please specify) _____

36. With regard to driver attendance at on-going safety **training**, which of the following apply (check one)?
    a. _____ Drivers are required to attend some or all training
    b. _____ Drivers are encouraged but not required to attend training
    c. _____ Driver attendance is purely voluntary

37. Are drivers paid to attend safety **training**? _____ Yes _____ No

38. How frequently does your company hold **meetings** related to driving safety (as opposed to safety training)?
    a. _____ Never
    b. _____ Once in a while, no pattern of frequency
    c. _____ Once a month
    d. _____ Once every 2-3 months
    e. _____ Once every six months
    f. _____ Once a year
    g. _____ Other (please specify) _____

39. With regard to driver attendance at **meetings** related to driving safety, which of the following apply (check one)?
    a. _____ Drivers are required to attend some or all meetings
    b. _____ Drivers are encouraged but not required to attend meetings
    c. _____ Driver attendance is purely voluntary
    d. _____ Drivers are represented at the meeting
    e. _____ Other (please specify) _____

40. Are drivers paid to attend safety **meetings**? _____ Yes _____ No

41. Many factors are thought to cause fatigue among CMV drivers. Please rate the importance of the following possible seven factors according to which factors you think are important in causing driving fatigue. Use a scale of 1 to 7 with "1" = Not At All Important and "7" = Very Important to rate each factor. (Circle one number for each factor.)

	Possible Fatigue Causing Factor	Not At All Important			Of Some Importance			Very Important
a.	**Irregularity of CMV driving time** (e.g., different times of driving each day, seasonality or variability of work).	1	2	3	4	5	6	7
b.	**Lack of trip control** (e.g., different routes, cannot control or predict schedule due to factors like waiting or loading/unloading).	1	2	3	4	5	6	7
c.	**Poor quality of rest while working** (e.g., not sleeping at home, nighttime driving, interrupted sleep, difficulty in finding a place to rest or sleep).	1	2	3	4	5	6	7
d.	**Scheduling demands of CMV driving work** (e.g., time allotted by shippers and receivers, waiting time).	1	2	3	4	5	6	7

	Possible Fatigue Causing Factor	Not At All Important			Of Some Importance			Very Important
e.	**Driver economics** (e.g., need to earn more money, rewards for on-time pick-ups and deliveries, penalties for late pick-ups and deliveries, no rewards for safe driving) or personal factors (e.g., desire to get home, personal pride in on-time pickups and deliveries).	1	2	3	4	5	6	7
f.	**Business pressures on company passed onto drivers** (e.g., pressure on drivers from dispatchers to accept loads or be on-time, company penalized for late deliveries, company emphasizes business over safety).	1	2	3	4	5	6	7
g.	**Inadequate company support for fatigue safety issues** (e.g., lack of equipment that might reduce fatigue, no relay or driver teams, little or poor driver fatigue training, low understanding of driver fatigue or commitment to reduce driver fatigue among managers).	1	2	3	4	5	6	7

Section 5: Nature of Operations and Safety Climate

42. Your company is best characterized as what type of carrier? (Check all that apply.)
    a. _____ Truckload
    b. _____ Less-than-truckload
    c. _____ Specialized commodity
    d. _____ For-hire carrier
    e. _____ Private carrier

43. What is the average haul, in miles, for your drivers? _____ Miles

44. On average, how many miles do your drivers drive per week? _____ Miles

45. For the majority of your runs, how widely does your company operate?
    a. _____ Locally
    b. _____ Intra-state
    c. _____ Regionally
    d. _____ Nationally

46. What is the average size (number of trucks and trailers) and average age of your fleet today?
    a. _____ Number of trucks _____ Average age of trucks
    b. _____ Number of trailers _____ Average age of trailers

47. What types of equipment/devices are available on your trucks? Check as many as apply and indicate the percent of trucks with the equipment:

	Apply		
a.	_____	(_____% of trucks)	Sleeper beds
b.	_____	(_____% of trucks)	Lumbar support seats
c.	_____	(_____% of trucks)	Speed control devices
d.	_____	(_____% of trucks)	Other (please specify) _____

48. What percent of your receivers refuse to accept late loads or penalize drivers by moving vehicles to "back of the line"? _____%

49. What percent of your business comes from brokers? _____%

50. How many dispatchers does your company have? _____ Dispatchers

51. How is dispatching organized?
    a. _____ Each dispatcher is responsible for the same drivers
    b. _____ Each dispatcher has a changing set of drivers
    c. _____ Some of our dispatchers have the same drivers, others have a changing set of drivers
    d. _____ Other (please specify) _____

52. On average, how many drivers are assigned to each dispatcher? _____ Drivers

53. Describe the working relationship you feel your dispatchers have with your drivers. What percent of your driver/dispatcher relationships fall into each of the following categories?
    a. _____ % Very poor
    b. _____ % Difficult
    c. _____ % Fair
    d. _____ % Good
    e. _____ % Excellent
    100 % Total

54. How many reportable driving accidents was your company involved in over the last two years?
    _____ Reportable accidents

55. How many chargeable driving accidents was your company involved in over the last two years?
    _____ Chargeable accidents

Listed below are statements that represent opinions people have about driving fatigue and safety. Please indicate the extent to which you agree or disagree with each statement by circling the number which best corresponds to your opinion, using a scale of 1 to 7, with 1 = Strongly Disagree and 7 = Strongly Agree. (Circle one number for each statement)

	Statement about driving fatigue and safety	**Strongly Disagree**			**Neutral**			**Strongly Agree**
56.	Our company makes driving safety a top priority.	1	2	3	4	5	6	7
57.	Driving safety is an important concern at this company.	1	2	3	4	5	6	7
58.	I am satisfied with the amount of emphasis this company places on driving safety.	1	2	3	4	5	6	7
59.	Drivers and management openly discuss issues related to driver fatigue.	1	2	3	4	5	6	7
60.	This company is interested in driver input on driving safety matters.	1	2	3	4	5	6	7
61.	Drivers provide useful insights into driver fatigue issues.	1	2	3	4	5	6	7
62.	Driver input has played an important role in setting company policies pertaining to driver fatigue.	1	2	3	4	5	6	7
63.	We need more training related to driver fatigue issues.	1	2	3	4	5	6	7
64.	Drivers have to bend a driving safety rule or policy in order to "get the job done."	1	2	3	4	5	6	7

65. To what extent do you think that driving at night (i.e., between midnight and dawn) is as safe for CMV drivers as driving during the daytime? (Circle one number.)

1	2	3	4	5	6	7
To a Very Little Extent			To Some Extent			To a Very Large Extent

66. Does your company allow drivers to take rest breaks when they are tired? (check one)
    a. _____ No
    b. _____ Yes, but it is not a written policy
    c. _____ Yes, and it is a written policy

67. Are dispatchers required to have prior commercial driving experience? _____ Yes _____ No

68. Does your company encourage dispatchers to take individual differences of drivers into account when making driving assignments (e.g., some drivers are more or less susceptible to fatigue, some drivers experience more drowsiness when driving at night)?
    _____ Yes _____ No

69. What is your position or title? _____

70. What is the position or title of the person you directly report to? _____

71. Which description best describes your position?
    a. _____ Full-time safety director
    b. _____ Responsible for safety but have additional duties

72. With respect to safety, are you responsible for driving operations or for safety in non-driving operations (e.g., dock operations, warehouse operations) as well?
    a. _____ Responsible for driving operations only
    b. _____ Responsible for safety in both driving and non-driving operations

FEEL FREE TO MAKE ANY ADDITIONAL COMMENTS ON THE BACK OF THIS PAGE.

Commercial Motor Vehicle (CMV) Operations:
Truck Dispatcher Survey

Section 1: Nature of Work

1. How many commercial motor vehicle (CMV) drivers do you dispatch? _____ Drivers

2. What percentage of your drivers are primarily long haul, over-the-road drivers? _____%

3. What percentage of your drivers are short-haul or within city drivers? _____%

4. What percentage of your time is spent in each of these possible job activities?
   a. _____ % Talking to drivers about pick-ups, deliveries, routes, time off, etc.
   b. _____ % Talking with shippers (i.e., booking loads)
   c. _____ % *Talking with sales people, load coordinators, or others in your company who influence scheduling drivers*
   d. _____ % Talking with receivers about delivery times, delays, etc.
   e. _____ % Other (Please specify _____)
   100 % Total

5. What kinds of technology are available to help you? (Check as many as apply)
   a. _____ Global positioning systems
   b. _____ Computers on-board trucks
   c. _____ Cell phones for drivers
   d. _____ Pagers assigned to drivers
   e. _____ Computer-aided dispatch software
   f. _____ Electronic logbooks
   g. _____ Paper and board
   h. _____ Driver call-in requirement
   i. _____ Other (please specify _____)

6. In dealing with decisions that potentially affect hours-of-service regulations, what do you rely on? (Check as many as apply)
   a. _____ Oral reports from drivers on hours driven
   b. _____ Oral reports from drivers regarding degree of tiredness
   c. _____ Computer generated summaries of hours driven
   d. _____ Electronic logbooks
   e. _____ Other (please specify) _____

7. In general, what do you assume to be the average truck speed when calculating the time needed to make an on-time delivery?
   _____ Miles per hour for short hauls _____ Miles per hour for long hauls

8. What sorts of criteria are used to judge <u>your</u> job performance? For which can you receive rewards/penalties (e.g., bonus)? (Check as many as apply.)

	Evaluated On	Rewards/ Penalties For	
a.			Average number of miles driven per driver
b.			Meeting company policy on getting drivers home
c.			Minimizing deadhead miles
d.			Driver hours-of-service violations
e.			Percent of on-time deliveries
f.			Driver turnover
g.			Accident free miles by drivers or drivers' chargeable accidents
h.			Driver speeding violations
i.			Other (please specify)

9a. In dealing with shippers, what percentage of shippers fall into each of the following categories with respect to the amount of lead time they typically give your company for pick-up and delivery?

a. _____ % Shippers who allow more than adequate time for pick-up and delivery

b. _____ % Shippers who allow adequate time for pick-up and delivery
c. _____ % Shippers who do not allow adequate time for pick-up and delivery
100 % Total

9b. In dealing with receivers, what percentage of receivers fall into each of the following categories with respect to the amount of time they typically give your company as a window for delivery?

a. _____ % Receivers who allow more than adequate delivery time
b. _____ % Receivers who allow adequate delivery time
c. _____ % Receivers who do not allow adequate delivery time
100 % Total

10. What is your average delivery window? _____ Hours _____ Minutes

11. How much time should an average delivery window be? _____ Hours _____ Minutes

The following questions are related to your personal opinions. Please indicate the extent to which you think the statement is true, by circling the number which best corresponds to your opinion, using a scale of 1 to 7, with 1 = To a Very Little Extent and 7 = To a Very Large Extent. (Circle one number for each statement.)

	To what extent do you think . . .	**To a Very Little Extent**			**To Some Extent**			**To a Very Large Extent**
12.	You have been trained about driver fatigue issues?	1	2	3	4	5	6	7
13.	Your company regards hours-of-service regulations as a general guideline rather than a set of regulations that should be strictly enforced?	1	2	3	4	5	6	7
14.	Drivers are the best judges of whether or not they are too tired to drive?	1	2	3	4	5	6	7
15.	You are pressured by your company to accept or dispatch loads when you know all of your available drivers are "out of hours"?	1	2	3	4	5	6	7
16.	Shippers/receivers are **aware** of hours of service regulation issues?	1	2	3	4	5	6	7
17.	Shippers/receivers **care** about hours of service regulation issues?	1	2	3	4	5	6	7
18.	Shippers/receivers are **aware** of driver fatigue issues?	1	2	3	4	5	6	7
19.	Shippers/receivers **care** about driver fatigue issues?	1	2	3	4	5	6	7
20.	Shippers require such tight delivery schedules that drivers often have to drive when they are tired to make an on-time pick-up or delivery?	1	2	3	4	5	6	7
21.	Receivers require such tight delivery schedules that drivers often have to drive when they are tired to make an on-time delivery?	1	2	3	4	5	6	7
22.	Driving at night (i.e., between midnight and dawn) is as safe for CMV drivers as driving during the daytime?	1	2	3	4	5	6	7

23. Many factors are thought to cause fatigue among CMV drivers. Please rate the importance of the following possible seven factors according to which factors you think are important in causing driving fatigue. Use a scale of 1 to 7 with "1" = Not At All Important and "7" = Very Important to rate each factor. (Circle one number for each factor.)

	Possible Fatigue Causing Factor	Not At All Important			Of Some Importance			Very Important
a.	**Irregularity of CMV driving time** (e.g., different times of driving each day, seasonality or variability of work).	1	2	3	4	5	6	7
b.	**Lack of trip control** (e.g., different routes, cannot control or predict schedule due to factors like waiting or loading/unloading).	1	2	3	4	5	6	7
c.	**Poor quality of rest while working** (e.g., not sleeping at home, nighttime driving, interrupted sleep, difficulty in finding a place to rest or sleep).	1	2	3	4	5	6	7
d.	**Scheduling demands of CMV driving work** (e.g., time allotted by shippers and receivers, waiting time).	1	2	3	4	5	6	7
e.	**Driver economics** (e.g., need to earn more money, rewards for on-time pick-ups and deliveries, penalties for late pick-ups and deliveries, no rewards for safe driving) or personal factors (e.g., desire to get home, personal pride in on-time pickups and deliveries).	1	2	3	4	5	6	7
f.	**Business pressures on company passed onto drivers** (e.g., pressure on drivers from dispatchers to accept loads or be on-time, company penalized for late deliveries, company emphasizes business over safety).	1	2	3	4	5	6	7
g.	**Inadequate company support for fatigue safety issues** (e.g., lack of equipment that might reduce fatigue, no relay or driver teams, little or poor driver fatigue training, low understanding of driver fatigue or commitment to reduce driver fatigue among managers).	1	2	3	4	5	6	7

Section 2: Relationships with Drivers

The following questions are related to your personal opinions about the drivers at your company. Please indicate the extent to which you think the statement is true, by circling the number which best corresponds to your opinion, using a scale of 1 to 7, with 1 = To a Very Little Extent and 7 = To a Very Large Extent. (Circle a number for each statement.)

	To what extent do you . . .	**To a Very Little Extent**			**To Some Extent**			**To a Very Large Extent**
24.	Think drivers are trained about driver fatigue issues?	1	2	3	4	5	6	7
25.	Feel pressured by drivers to "overlook" rest requirements?	1	2	3	4	5	6	7
26.	Ask drivers to "overlook" rest requirements so that you can accept a load?	1	2	3	4	5	6	7
27.	Ask drivers to "overlook" rest requirements in order to get a load delivered on-time?	1	2	3	4	5	6	7
28.	Ask drivers to drive faster in order to get a load delivered on-time?	1	2	3	4	5	6	7
29.	Think that drivers in your company have opportunities to make suggestions and voice complaints regarding safety and fatigue?	1	2	3	4	5	6	7
30.	Think that your company acts on suggestions and complaints made by drivers concerning safety and fatigue?	1	2	3	4	5	6	7
31.	Think top management at your company is committed to driving safety?	1	2	3	4	5	6	7
32.	Think that **top management** believes driving at night (i.e., between midnight and dawn) is as safe for CMV drivers as driving during the daytime?	1	2	3	4	5	6	7

33. Describe the working relationship you have with drivers. What percent of your interactions fall into each of the following categories?
    a. _____ % Very poor
    b. _____ % Difficult
    c. _____ % Fair
    d. _____ % Good
    e. _____ % Excellent
    100 % Total

Section 3: Safety Climate and Background Information

Below are statements about driving fatigue and safety. Please indicate the extent to which you agree or disagree with each statement by circling the number which best corresponds to your opinion, using a scale of 1 to 7, with 1 = Strongly Disagree and 7 = Strongly Agree. (Circle one number for each statement)

	Statement about driving fatigue and safety	**Strongly Disagree**			**Neutral**			**Strongly Agree**
34.	Our company makes driving safety a top priority.	1	2	3	4	5	6	7
35.	Driving safety is an important concern at this company.	1	2	3	4	5	6	7
36.	I am satisfied with the amount of emphasis this company places on driving safety.	1	2	3	4	5	6	7
37.	Drivers and management openly discuss issues related to driver fatigue.	1	2	3	4	5	6	7
38.	This company is interested in driver input on driving safety matters.	1	2	3	4	5	6	7
39.	Drivers provide useful insights into driver fatigue issues.	1	2	3	4	5	6	7
40.	Driver input has played an important role in setting company policies pertaining to driver fatigue.	1	2	3	4	5	6	7
41.	We need more training related to driver fatigue issues.	1	2	3	4	5	6	7
42.	Drivers have to bend a driving safety rule or policy in order to "get the job done."	1	2	3	4	5	6	7

43. How frequently do you consider individual differences in drivers' susceptibility to fatigue (e.g., some drivers are more or less susceptible to fatigue, some drivers experience more drowsiness when driving at night) when making driving assignments?
    a. Never
    b. Rarely
    c. Sometimes
    d. Frequently
    e. Always

44. How many years of experience do you have working as a dispatcher?
    _____ Years

45. How many years of experience, if any, do you have working as a CMV driver?
    _____ Years

46. How many CMV companies have you worked for or contracted with over the last two years?
    _____ Companies

47. What is the nature of your dispatching job?
    a. _____ I am responsible for dispatching the same drivers
    b. _____ I am responsible for dispatching a changing set of drivers (e.g., I dispatch for a set of customers or a region)
    c. _____ I am responsible for a group of the same drivers but also others
    d. _____ Other (Please specify _____)

48. In what state is your dispatching facility located? _____ (name of state)

49. Age today:
    _____ Years

50. Sex:
    _____ Male
    _____ Female

FEEL FREE TO MAKE ANY ADDITIONAL COMMENTS ON THE BACK OF THIS PAGE.

Commercial Motor Vehicle (CMV) Operations:
Truck Driver Survey

Section 1: Driving Patterns

In this section of the survey we would like to learn about your driving patterns and when you get your rest. Please answer the following questions by filling in the blank or by circling the response that best corresponds to your opinion.

1. Using a scale of 1 to 5, with 1 = Never and 5 = Always, please indicate the frequency of the following (Circle one number for each statement):

How often do you . . .	**Never**	**Rarely**	**Sometimes**	**Frequently**	**Always**
Start and stop driving nearly the same time each day	1	2	3	4	5
Drive on interstates or major highways	1	2	3	4	5
Drive in urban areas and secondary roads	1	2	3	4	5
Have difficulty finding a safe place to stop for rest or sleep	1	2	3	4	5
Sleep at home	1	2	3	4	5
Get your sleep at nighttime	1	2	3	4	5

2. Which <u>one</u> of the following best describes the type of route(s) you drive? (circle one letter)
   a. I drive the same route nearly every time I drive
   b. I drive several different routes but I drive them fairly often
   c. I drive a mix of regular and irregular (different) routes
   d. I drive a wide variety of different routes

3. What percent of work time is spent on the following?
   a. Driving _____%
   b. Loading/Unloading _____%
   c. Waiting to make pick-up or delivery _____%
   d. Traffic delays _____%
   e. Other (e.g., paperwork, resting, eating) _____%
   100% Total

4. During an average week, please estimate what percent of your <u>driving time</u> falls into each of these time periods. (Please be sure your percents sum to 100%.)

	Driving Time	
6:00 am to noon	_____	%
Noon to 6:00 pm	_____	%
6:00 pm to midnight	_____	%
Midnight to 6:00 am	_____	%
Total	100	%

5a. On average, how many hours of continuous, uninterrupted sleep do you get during a 24-hour period when you are:
Working? _____ Hours Not working? _____ Hours

5b. My ideal amount of sleep during a 24-hour period is: _____ Hours

5c. On average, how many naps do you take in a 24-hour period when you are working? _____ Naps

5d. What is the average length of each nap? _____ Minutes

6. In a typical workweek, **when** do you sleep for an extended period without waking up? Please indicate what percent of your uninterrupted sleep falls into each of four possible time periods.
   a. 6:00 am to noon _____ % of total uninterrupted sleep
   b. Noon to 6:00 pm _____ % of total uninterrupted sleep
   c. 6:00 pm to midnight _____ % of total uninterrupted sleep
   d. Midnight to 6:00 am _____ % of total uninterrupted sleep
   100 % Total

7. Does your company allow you to take rest breaks when you are tired? (check one)
   a. _____ No
   b. _____ Yes, but it is not a written policy
   c. _____ Yes, and it is a written policy

8. Over the last two years, what were the fewest, the most, and the average number of miles you drove per week?
   a. Fewest miles driven in a week _____ Miles
   b. Most miles driven in a week _____ Miles
   c. Average number of miles driven in a week _____ Miles

9a. How many stops for pick-ups and deliveries do you make on an average day? (Estimate the number.)
   _____ Pick-ups and deliveries

9.b. When do you make these pick-ups and deliveries? Please indicate what percentage typically occurs in each time zone. (Please be sure your percents sum to 100%.)
   a. 6 AM to Noon _____ %
   b. Noon to 6 PM _____ %
   c. 6 PM to Midnight _____ %
   d. Midnight to 6 AM _____ %
   Total 100 %

10. How far away do **most** of your driving assignments take you? (Estimate the number of miles.)
   _____ Miles

Section 2: Opinions About Truck Driving

The following questions are related to your personal opinions. Please indicate the extent to which you think the statement is true, by circling the number which best corresponds to your opinion, using a scale of 1 to 7, with 1 = To a Very Little Extent and 7 = To a Very Large Extent. (Circle one number for each statement).

	To what extent do you think . . .	**To a Very Little Extent**			**To Some Extent**			**To a Very Large Extent**
11.	You have been trained about driver fatigue issues?	1	2	3	4	5	6	7
12.	Dispatchers are trained about driver fatigue issues?	1	2	3	4	5	6	7
13.	Your company regards hours-of-service regulations as a general guideline rather than a set of regulations that should be strictly enforced?	1	2	3	4	5	6	7
14.	Drivers are the best judges of whether or not they are too tired to drive?	1	2	3	4	5	6	7
15.	You are pressured by your dispatcher to continue driving when you know you are tired?	1	2	3	4	5	6	7
16.	You are pressured by your dispatcher to accept a load when you know you are tired?	1	2	3	4	5	6	7

	To what extent do you think . . .	To a Very Little Extent			To Some Extent			To a Very Large Extent
17.	You are pressured by your dispatcher to accept a load when you know you will be "out of hours" before you can make delivery?	1	2	3	4	5	6	7
18.	Dispatchers in this company place a higher priority on making deliveries on- time than driver safety?	1	2	3	4	5	6	7
19.	You can go to the person in charge of safety (or the operations manager) if you are pressured by your dispatcher to drive when you are tired?	1	2	3	4	5	6	7
20.	Driving at night (i.e., between midnight and dawn) is as safe as driving during the daytime?	1	2	3	4	5	6	7
21.	You drive when you are tired in order to make a good income?	1	2	3	4	5	6	7
22.	You drive when you are tired in order to get somewhere for personal reasons (e.g., to get home, visit friends)?	1	2	3	4	5	6	7
23.	Your company rewards safe driving (e.g., accident-free miles) through recognition programs like "employee of the month" or publishing names of safe drivers in an employee newsletter?	1	2	3	4	5	6	7
24.	Your company rewards safe driving (e.g., accident free miles) through financial incentives like bonuses, gifts, or higher mileage rates?	1	2	3	4	5	6	7
25.	Recognition programs improve driver safety performance?	1	2	3	4	5	6	7
26.	Financial incentives improve driver safety performance?	1	2	3	4	5	6	7
27.	Drivers in your company have opportunities to make suggestions and voice complaints regarding safety and fatigue?	1	2	3	4	5	6	7
28.	Your company acts on suggestions and complaints made by drivers concerning safety and fatigue?	1	2	3	4	5	6	7
29.	Top management at your company is committed to driving safety?	1	2	3	4	5	6	7
30.	You take personal pride in making deliveries on-time?	1	2	3	4	5	6	7
31.	There are financial rewards for on-time deliveries?	1	2	3	4	5	6	7
32.	You are given the flexibility to choose which route to drive?	1	2	3	4	5	6	7
33.	You are allowed to decide where you will make your rest stops?	1	2	3	4	5	6	7
34.	You can predict where you will be making your rest stops at the beginning of a trip?	1	2	3	4	5	6	7

35. Many factors are thought to cause fatigue among CMV drivers. Please rate the importance of the following possible seven factors according to which factors you think are important in causing driving fatigue. Use a scale of 1 to 7 with "1" = Not At All Important and "7" = Very Important to rate each factor. (Circle one number for each factor.)

	Possible Fatigue Causing Factor	Not At All Important			Of Some Importance			Very Important
a.	**Irregularity of CMV driving time** (e.g., different times of driving each day, seasonality or variability of work).	1	2	3	4	5	6	7
b.	**Lack of trip control** (e.g., different routes, cannot control or predict schedule due to factors like waiting or loading/unloading).	1	2	3	4	5	6	7
c.	**Poor quality of rest while working** (e.g., not sleeping at home, nighttime driving, interrupted sleep, difficulty in finding a place to rest or sleep).	1	2	3	4	5	6	7
d.	**Scheduling demands of CMV driving work** (e.g., time allotted by shippers and receivers, waiting time).	1	2	3	4	5	6	7
e.	**Driver economics** (e.g., need to earn more money, rewards for on-time pick-ups and deliveries, penalties for late pick-ups and deliveries, no rewards for safe driving) or personal factors (e.g., desire to get home, personal pride in on-time pickups and deliveries).	1	2	3	4	5	6	7
f.	**Business pressures on company passed onto drivers** (e.g., pressure on drivers from dispatchers to accept loads or be on-time, company penalized for late deliveries, company emphasizes business over safety).	1	2	3	4	5	6	7
g.	**Inadequate company support for fatigue safety issues** (e.g., lack of equipment that might reduce fatigue, no relay or driver teams, little or poor driver fatigue training, low understanding of driver fatigue or commitment to reduce driver fatigue among managers).	1	2	3	4	5	6	7

Section 3: Opinions About Shippers/Receivers

36. How many different facilities do you deal with in making deliveries on an average day? _____ Different facilities

37. Does your company penalize drivers for late deliveries? (Check all that apply.)
    a. _____ No, my company does not penalize drivers for late deliveries
    b. _____ Yes, drivers receive verbal criticism from their dispatchers
    c. _____ Yes, driver pay is reduced or drivers are fined
    d. _____ Yes, drivers lose potential bonus money
    e. _____ Yes, drivers can be suspended
    f. _____ Yes, drivers can be fired
    g. _____ Yes, drivers receive less desirable loads in the future
    h. _____ Yes, other (How? Please specify _____)

38. For what percentage of your loads do you have to help with loading and unloading?
    a. Pick-ups _____%
    b. Deliveries _____%

39. Will your company pay for loading and unloading? _____ Yes _____ No

40. For what percentage of your loads do you have to wait longer than you planned to load or unload?
    _____ % of loads

Section 4: Driving Experiences and Safety Climate

Questions 41-46 are related to driving safety training and meetings. For this survey, **training** refers to formal educational programs on driving safety while **meetings** refer to open discussions on driving safety topics such as new government regulations, new company policies, and accident investigations.

41. How frequently does your company provide on-going or "refresher" **training** related to **driving** safety? (Circle your answer)
    a. Never
    b. Once in a while, no pattern of frequency
    c. Once a month
    d. Once every 2-3 months
    e. Once every 6 months
    f. Once a year
    g. Other (please specify) _____

42. How frequently do you attend these ongoing or "refresher**"** **training** programs related to driving safety? (Circle your answer.)
    a. Never
    b. Once in a while, no pattern of frequency
    c. Once a month
    d. Once every 2-3 months
    e. Once every 6 months
    f. Once a year
    g. Other (please specify) _____

43. How frequently does your company hold safety **meetings** related to driving safety (as opposed to safety training)? (Circle your answer.)
    a. Never
    b. Once in a while, no pattern of frequency
    c. Once a month
    d. Once every 2-3 months
    e. Once every 6 months
    f. Once a year
    g. Other (please specify) _____

44. How frequently do you attend these **meetings** related to driving safety? (Circle your answer.)
    a. Never
    b. Once in a while, no pattern of frequency
    c. Once a month
    d. Once every 2-3 months
    e. Once every 6 months
    f. Once a year
    g. Other (please specify) _____

45. Does your company penalize drivers for unsafe driving? (Circle **all** that apply.)
    a. No, my company does not penalize drivers for unsafe driving
    b. Yes, drivers receive verbal criticism from the company
    c. Yes, driver pay is reduced or drivers are fined by the company
    d. Yes, drivers lose potential bonus money
    e. Yes, drivers can be suspended
    f. Yes, drivers can be fired
    g. Yes, drivers receive less desirable loads in the future
    h. Yes, other (please specify) _____

46. How does your company pay you for driving? (Circle your answer)
    a. By the mile
    b. By the hour
    c. Straight salary
    d. As a percentage of the load
    e. Base rate plus product sales commission
    f. Other (please specify) _____

47. What is your average compensation per mile (or in per mile equivalent)? _____ Cents Per Mile

48. Are there opportunities for you to earn additional money? (Check all that apply)
    a. _____ No
    b. _____ Yes, for loading and unloading
    c. _____ Yes, for waiting time
    d. _____ Yes, for safe driving
    e. _____ Yes, for on-time deliveries
    f. _____ Yes, for operating efficiently, such as fuel mileage or idle time.
    g. _____ Yes, for multiple pick-ups or deliveries
    h. _____ Yes, other (please specify) _____

49. Most drivers have an "ideal" balance between work and off-duty time. Which <u>one</u> best describes you?
    a. I would prefer to work more in order to increase my income.
    b. I would prefer to work more for reasons other than money.
    c. I have the right balance between work and off-duty time.
    d. I would prefer more off-duty time if my income could remain the same.
    e. I would prefer more off-duty time even if my income would decrease.

50. Most professional drivers have some "close calls" or "near misses" (i.e., near accidents) while working **because they were less than fully alert**. Please tell us about your experiences with close calls by indicating how often you have had a close call at each of the following locations over the last two years **<u>because you were less than fully alert</u>**. Answer the following questions by circling the number which best corresponds to your opinion, using a scale of 1 to 5, with 1 = Never and 5 = Very Frequently. (Circle one number for each statement.)

	How often have you had a "close call" . . .	**Never**	**Rarely**	**Occasionally**	**Often**	**Very Frequently**
a.	At a terminal	1	2	3	4	5
b.	At a weigh station	1	2	3	4	5
c.	At a truck stop	1	2	3	4	5
d.	At a shipper or receiver facility	1	2	3	4	5
e.	While driving in an urban area or on a secondary road	1	2	3	4	5
f.	While driving on an interstate or major highway	1	2	3	4	5
g.	Other, please specify:	1	2	3	4	5

Please answer the following questions using the same response format.

	How often do you . . .	**Never**	**Rarely**	**Occasionally**	**Often**	**Very Frequently**
51.	Experience a "close call" or "near miss" because you are less than fully alert?	1	2	3	4	5
52.	Nod off while driving?	1	2	3	4	5
53.	Think fatigue is a problem for you when you are driving?	1	2	3	4	5
54.	Find yourself continuing to drive when you are less than fully alert?	1	2	3	4	5
55.	Reject a load because you think you are too tired to drive the load in the time allotted?	1	2	3	4	5
56.	Think fatigue is a problem for other CMV drivers **in your company**?	1	2	3	4	5
57.	Think fatigue is a problem for CMV drivers in general, throughout the industry?	1	2	3	4	5

Listed below are statements that represent opinions people have about driving fatigue and safety. Please indicate the extent to which you agree or disagree with each statement by circling the number which best corresponds to your opinion, using a scale of 1 to 7, with 1 = Strongly Disagree and 7 = Strongly Agree. (Circle one number for each statement.)

	I. Statement about driving fatigue and safety	Strongly Disagree			Neutral			Strongly Agree
58.	Our company makes driving safety a top priority.	1	2	3	4	5	6	7
59.	Driving safety is an important concern at this company.	1	2	3	4	5	6	7
60.	I am satisfied with the amount of emphasis this company places on driving safety.	1	2	3	4	5	6	7
61.	Drivers and management openly discuss issues related to driver fatigue.	1	2	3	4	5	6	7
62.	This company is interested in driver input on driving safety matters.	1	2	3	4	5	6	7
63.	Drivers provide useful insights into driver fatigue issues.	1	2	3	4	5	6	7
64.	Driver input has played an important role in setting company policies pertaining to driver fatigue.	1	2	3	4	5	6	7
65.	We need more training related to driver fatigue issues.	1	2	3	4	5	6	7
66.	Drivers have to bend a driving safety rule or policy in order to "get the job done."	1	2	3	4	5	6	7

67. Many actions have been proposed to help drivers combat fatigue while they are driving. Please check those actions that your company takes.

	Action	Company Takes
a.	Provides education and training about fatigue	
b.	Gives driver control over schedule	
c.	Allows driver adequate time off between trips	
d.	Provides enough sleep time on trip	
e.	Uses shared driving arrangements (e.g., relays, driver teams)	
f.	Minimizes night driving (midnight to dawn)	
g.	Minimizes loading/unloading by driver	
h.	Other (please specify)	

68. How often do you typically get home for your "off-duty" (recovery) days?
    a. Home every day
    b. At least once a week
    c. At least once every two weeks
    d. Away from home more than two weeks

69. Following your off-duty (recovery) days, how often do you begin a new "workweek" feeling tired or fatigued?
    a. Never
    b. Rarely
    c. Sometimes
    d. Frequently
    e. Always

70. How often have you engaged in team driving during the last two years?
    a. Never
    b. Rarely
    c. Sometimes
    d. Frequently
    e. Always

Section 5: Background Information

71. How many years of experience do you have as a CMV driver? _____ Years

72. How many motor carrier (freight or passenger) companies have you worked for or contracted with over the last two years? _____ Companies

73. How many breaks do you usually take during a 10-hour run just to rest? _____ Breaks

74. How long is an average rest break during a 10-hour run? _____ Minutes

75. How many reportable accidents were you involved in, while working, over the last two years?
    _____ Reportable accidents

76. How many chargeable accidents were you involved in, while working, over the last two years?
    _____ Chargeable accidents

77. How many dispatchers do you work with on a regular basis at your company? _____ Dispatchers

78. Describe the relationship you feel you have with your dispatcher(s) by marking the most appropriate description:
    _____ Excellent _____ Difficult
    _____ Good _____ Very poor
    _____ Fair

79. What type of equipment do you typically drive? (Check as many as apply.)
    _____ Tractor-trailer
    _____ Double-combination (tandem trailers)
    _____ Longer combination (Rocky Mountain doubles or triples)
    _____ Truck with a sleeper berth
    _____ Straight truck
    _____ Other (Please specify _____)

80. Age Today: _____ Years

81. Sex: _____ Male _____ Female

82. Are you currently a member of a union? _____ Yes _____ No

83. For what type of carrier do you presently work?
    _____ For-hire carrier
    _____ Private fleet

84. How would you classify yourself? (Check the most appropriate category.)
    a. _____ Company driver
    b. _____ Owner-operator
    c. _____ Temporary or casual driver
    d. _____ Leased driver

85. To your knowledge, do you have any medical sleep disorders? _____ Yes _____ No

FEEL FREE TO MAKE ANY ADDITIONAL COMMENTS ON THE BACK OF THIS PAGE.

Commercial Motor Vehicle (CMV) Operations: Company Perspective – Bus

The following questions are related to your opinions about driver fatigue and other safety issues. Please indicate the extent to which you believe the statement is true by circling the number which best corresponds to your opinion using a scale of 1-7, with 1=To a Very Little Extent and 7=To a Very Large Extent.

	To what extent do you think or believe…	To a Very Little Extent			To Some Extent			To a Very Large Extent
1.	Current hours-of-service regulations, when followed, do not effectively prevent driver fatigue?	1	2	3	4	5	6	7
2.	Drivers are the best judges of whether or not they are too tired to drive?	1	2	3	4	5	6	7
3.	Driving at night (i.e., between midnight and dawn) is as safe for CMV drivers as driving during the daytime?	1	2	3	4	5	6	7
4.	Companies throughout the CMV industry are committed to driving safety?	1	2	3	4	5	6	7
5.	Regular route schedules, tour group itineraries and demands influence driver fatigue (e.g., cause excessive waiting time, provide insufficient driving time to make on-time deliveries)?	1	2	3	4	5	6	7
6.	Tour group organizers are **aware** about hours of service regulations and driver fatigue issues?	1	2	3	4	5	6	7
7.	Tour group organizers **care** about hours of service regulations and driver fatigue issues?	1	2	3	4	5	6	7
8.	Top management of **your** company is aware of driver fatigue issues?	1	2	3	4	5	6	7
9.	Competitive pressures lead **your** employees to bend safety rules in order to "get the job done"?	1	2	3	4	5	6	7
10.	Drivers in **your** company have opportunities to make suggestions and voice complaints regarding safety and fatigue?	1	2	3	4	5	6	7
11.	**Your** company acts on suggestions and complaints made by drivers concerning safety and fatigue?	1	2	3	4	5	6	7
12.	Top management at **your** company is committed to driving safety?	1	2	3	4	5	6	7

13. Many factors are thought to cause fatigue among CMV drivers. Please rate the importance of the following possible seven factors according to which factors you think are important in causing driving fatigue. Use a scale of 1 to 7 with "1" = Not At All Important and "7" = Very Important to rate each factor. (Circle one number for each factor.)

	Possible Fatigue Causing Factor	Not At All Important			Of Some Importance			Very Important
a.	**Irregularity of CMV driving time** (e.g., different times of driving each day (inverted duty/sleep cycle), or variability of work).	1	2	3	4	5	6	7
b.	**Lack of trip control** (e.g., different routes, cannot control or predict schedule due to factors like waiting or boarding/unboarding).	1	2	3	4	5	6	7
c.	**Poor quality of rest while working** (e.g., not sleeping at home, nighttime driving, interrupted sleep, difficulty in finding a place to rest or sleep).	1	2	3	4	5	6	7
d.	**Scheduling demands of CMV driving work** (e.g., time allotted by tour organizers/customers, waiting time).	1	2	3	4	5	6	7
e.	**Driver economics** (e.g., need to earn more money, rewards for on-time arrivals and departures, penalties for late arrivals and departures, no rewards for safe driving) or personal factors (e.g., desire to get home, personal pride in on-time arrivals and departures).	1	2	3	4	5	6	7
f.	**Business pressures on company passed onto drivers** (e.g., pressure on drivers from dispatchers to accept trips or be on-time, company emphasizes business over safety).	1	2	3	4	5	6	7
g.	**Inadequate company support for fatigue safety issues** (e.g., lack of equipment that might reduce fatigue, no relay or driver teams, little or poor driver fatigue training, low understanding of driver fatigue or commitment to reduce driver fatigue among managers).	1	2	3	4	5	6	7

Listed below are statements about driving fatigue and safety. Please indicate the extent to which you agree or disagree with each statement by circling the number which best corresponds to your opinion, using a scale of 1 to 7, with 1 = Strongly Disagree and 7 = Strongly Agree. (Circle one number for each statement)

	Statement about driving fatigue and safety	**Strongly Disagree**			**Neutral**			**Strongly Agree**
14.	Our company makes driving safety a top priority.	1	2	3	4	5	6	7
15.	Driving safety is an important concern at this company.	1	2	3	4	5	6	7
16.	I am satisfied with the amount of emphasis this company places on driving safety.	1	2	3	4	5	6	7
17.	Drivers and management openly discuss issues related to driver fatigue.	1	2	3	4	5	6	7
18.	This company is interested in driver input on driving safety matters.	1	2	3	4	5	6	7
19.	Drivers provide useful insights into driver fatigue issues.	1	2	3	4	5	6	7
20.	Driver input has played an important role in setting company policies pertaining to driver fatigue.	1	2	3	4	5	6	7
21.	We need more training related to driver fatigue issues.	1	2	3	4	5	6	7
22.	Drivers have to bend a driving safety rule or policy in order to "get the job done."	1	2	3	4	5	6	7

23. Your company is best described as what type of carrier?
    _____ Scheduled route
    _____ Charter/Tour

24. What is your position or title? _____

25. What is the position or title of the person you directly report to, if anyone? _____

FEEL FREE TO MAKE ANY ADDITIONAL COMMENTS ON THE BACK OF THIS PAGE.

Commercial Motor Vehicle (CMV) Operations:
Safety Director Survey – Bus

Section 1: Nature of Work

1. Persons charged with driving safety, which includes an understanding of driver fatigue issues, have widely varying job responsibilities. How much importance do you attach to each of these activities? Circle one number or NA (not applicable–not part of my job) for each statement.

	Please rate on a scale of 1 to 5 the importance of these activities.	Not Important	A Little Important	Somewhat Important	Important	Very Important	Not Applicable
a.	Recruiting/screening new drivers	1	2	3	4	5	NA
b.	Providing training on managing driver fatigue to **new** recruits	1	2	3	4	5	NA
c.	Providing training on managing driver fatigue to **experienced** drivers	1	2	3	4	5	NA
d.	Providing training on managing driver fatigue to **dispatchers**	1	2	3	4	5	NA
e.	Communicating with tour group organizers about scheduling as it relates to driver fatigue	1	2	3	4	5	NA
f.	Monitoring drivers' hours	1	2	3	4	5	NA
g.	**Managing (reducing) driver turnover**	1	2	3	4	5	NA
h.	Utilizing safety teams to address driver issues.	1	2	3	4	5	NA

2. What policies or programs does your company have for drivers to promote safe driving (e.g., accident free miles). (Check as many as apply)

_____ None
_____ Recognition programs (e.g., employee o f the month, certificates)
_____ Publication of good driver names in newsletter or bulletin boards
_____ Differential mileage rate for safe driving
_____ Cash bonuses for drivers with safe driving records
_____ Extra holidays or vacation for drivers with safe driving records
_____ Merchandise or discounts on merchandise
_____ Free license renewal
_____ Savings bonds; gift certificates, etc.
_____ Other (Please specify _____)

Section 2: Perspectives on Top Management and Customers/Passengers

The following questions are related to your personal opinions about top management at your company and customers. Please indicate the extent to which you feel the statement is true by circling the number which best corresponds to your opinion, using a scale of 1 to 7, with 1 = To a Very Little Extent and 7 = To a Very Large Extent. (Circle one number for each statement.)

	To what extent does top management . . .	**To a Very Little Extent**			**To Some Extent**			**To a Very Large Extent**
3.	Demonstrate awareness of driving fatigue issues?	1	2	3	4	5	6	7
4.	Regard hours-of-service regulations as a general guideline rather than a set of regulations that should be strictly enforced?	1	2	3	4	5	6	7
5.	Believe that drivers are the best judges of whether or not they are too tired to drive?	1	2	3	4	5	6	7
6.	Pressure employees not "to turn away business" even when drivers are "out of hours."	1	2	3	4	5	6	7
7.	Believe driving at night (i.e., between midnight and dawn) is as safe for CMV drivers as driving during the daytime?	1	2	3	4	5	6	7
8.	Participate in the safety management program (e.g., meetings, recognitions)	1	2	3	4	5	6	7
	To what extent do customers . . .	**To a Very Little Extent**			**To Some Extent**			**To a Very Large Extent**
9.	Demonstrate awareness of hours of service regulations and driver fatigue issues?	1	2	3	4	5	6	7
10.	Care about hours-of-service regulations and driver fatigue issues?	1	2	3	4	5	6	7
11.	Contribute to driver fatigue (e.g., cause excessive waiting time, demand excessive driving time)?	1	2	3	4	5	6	7

Section 3: Perspectives on Dispatchers

The following questions are related to your personal opinions about the dispatchers at your company. Please indicate the extent to which you think the statement is true by circling the number which best corresponds to your opinion, using a scale of 1 to 7, with 1 = To a Very Little Extent and 7 = To a Very Large Extent. (Circle one number for each statement.)

	To what extent do dispatchers . . .	**To a Very Little Extent**			**To Some Extent**			**To a Very Large Extent**
12.	Place a higher priority on keeping schedules than on driver safety?	1	2	3	4	5	6	7
13.	Regard hours-of-service regulations as a general guideline rather than a set of regulations that should be strictly enforced?	1	2	3	4	5	6	7
14.	Believe that drivers are the best judges of whether or not they are too tired to drive?	1	2	3	4	5	6	7
15.	Feel pressure not "to turn away business" even when they know all of their available drivers are "out of hours"?	1	2	3	4	5	6	7
16.	"Punish" drivers who stop driving more often when they are tired and then are behind schedule (e.g., less desirable trip assignments)?	1	2	3	4	5	6	7
17.	Receive training about driver fatigue issues?	1	2	3	4	5	6	7

Section 4: Perspectives on Drivers

18. What percentages of your drivers fall into each classification?
    a. _____ % Regular, full-time
    b. _____ % Extra-board
    c. _____ % Part-time
    100 % Total

19. How many drivers, in total, does your company employ? _____ Drivers

20. How many of your drivers drive in teams on a regular basis? _____ Drivers

21. How many of your drivers participate in **relay** runs? _____ Drivers

22. What percentages of your drivers are (a) unionized and (b) turnover each year?
    a. _____ % Union
    _____ % Non-union
    100 % Total
    b. _____ % Voluntary turnover (quits)
    _____ % Involuntary turnover (discharges)
    100 % Total

23. How are drivers in your company paid? (Check as many as apply)
    a. _____ By the mile
    b. _____ By the hour
    c. _____ Straight salary
    d. _____ As a percentage of trip revenue
    e. _____ Base rate plus product sales commission
    f. _____ Other (Please specify _____)

24. What is the current average driver compensation per mile (or in per mile equivalent)? _____ Cents per mile

25. Can drivers earn additional compensation for any of the following: (Check as many as apply)
    a. _____ Overtime
    b. _____ Safe driving
    c. _____ On-time arrivals
    d. _____ Operating efficiently
    e. _____ Other (please specify: _____)

26. Are drivers penalized financially by the company for poor work performance? (Check as many as apply)
    a. _____ No
    b. _____ Yes, for preventable accidents
    c. _____ Yes, for traffic violations
    d. _____ Yes, for customer complaints about driver behavior
    e. _____ Yes, for late arrivals attributed to driver performance
    f. _____ Yes, for damage to luggage
    g. _____ Yes, for excessive absenteeism or tardiness
    h. _____ Yes, for other reasons (please specify:_____)

The following questions are related to your personal opinions about drivers and fatigue issues at your company. Please indicate the extent to which you think each statement is true by circling the number which best corresponds to your opinion, using a scale of 1 to 7, with 1 = To a Very Little Extent and 7 = To a Very Large Extent. (Circle one number for each statement)

	To what extent do drivers . . .	**To a Very Little Extent**			**To Some Extent**			**To a Very Large Extent**
27.	Receive training about driver fatigue issues?	1	2	3	4	5	6	7
28.	Regard hours-of-service regulations as a general guideline rather than a set of regulations that should be strictly enforced?	1	2	3	4	5	6	7
29.	Believe they can stop driving more often when they are tired without being "punished" by their dispatcher (e.g., future trip assignments)?	1	2	3	4	5	6	7
30.	Pressure dispatchers to "overlook" rest requirements?	1	2	3	4	5	6	7
31.	Believe that driving at night (i.e., between midnight and dawn) is as safe as driving during the daytime?	1	2	3	4	5	6	7
32.	Believe they have opportunities to make suggestions and voice complaints regarding safety and fatigue?	1	2	3	4	5	6	7
33.	Believe that the company acts on suggestions and complaints made by drivers concerning safety and fatigue?	1	2	3	4	5	6	7
34.	Think top management at your company is committed to driver safety?	1	2	3	4	5	6	7

Questions 35-40 are related to driving safety training and meetings. For this survey, **training** refers to formal educational programs on driving safety and **meetings** refer to open discussions on driving safety topics such as new government regulations, new company policies, and accident investigations.

35. How frequently does your company provide on-going or "refresher" **training** related to driving safety?
    a. _____ Never
    b. _____ Once in a while, no pattern of frequency
    c. _____ Once a month
    d. _____ Once every 2-3 months
    e. _____ Once every six months
    f. _____ Once a year
    g. _____ Other (please specify) _____

36. With regard to driver attendance at on-going safety **training**, which of the following apply (check one)?
    a. _____ Drivers are required to attend some or all training
    b. _____ Drivers are encouraged but not required to attend training
    c. _____ Driver attendance is purely voluntary

37. Are drivers paid to attend safety **training**? _____ Yes _____ No

38. How frequently does your company hold **meetings** related to driving safety (as opposed to safety training)?
    a. _____ Never
    b. _____ Once in a while, no pattern of frequency
    c. _____ Once a month
    d. _____ Once every 2-3 months
    e. _____ Once every six months
    f. _____ Once a year
    g. _____ Other (please specify) _____

39. With regard to driver attendance at **meetings** related to driving safety, which of the following apply (check one)?
    a. _____ Drivers are required to attend some or all meetings
    b. _____ Drivers are encouraged but not required to attend meetings
    c. _____ Driver attendance is purely voluntary
    d. _____ Drivers are represented at the meeting
    e. _____ Other (please specify) _____

40. Are drivers paid to attend safety **meetings**? _____ Yes _____ No

41. Many factors are thought to cause fatigue among CMV drivers. Please rate the importance of the following possible seven factors according to which factors you think are important in causing driving fatigue. Use a scale of 1 to 7 with "1" = Not At All Important and "7" = Very Important to rate each factor. (Circle one number for each factor.)

	Possible Fatigue Causing Factor	Not At All Important			Of Some Importance			Very Important
a.	**Irregularity of CMV driving time** (e.g., different times of driving each day (inverted duty/sleep cycles), variability of work).	1	2	3	4	5	6	7
b.	**Lack of trip control** (e.g., different routes, cannot control or predict schedule due to factors like waiting or boarding/unboarding).	1	2	3	4	5	6	7
c.	**Poor quality of rest while working** (e.g., not sleeping at home, nighttime driving, interrupted sleep, difficulty in finding a place to rest or sleep).	1	2	3	4	5	6	7
d.	**Scheduling demands of CMV driving work** (e.g., time allotted by tour organizers/customers, waiting time).	1	2	3	4	5	6	7
e.	**Driver economics** (e.g., need to earn more money, rewards for on-time arrivals and departures, penalties for late arrivals and departures, no rewards for safe driving) or personal factors (e.g., desire to get home, personal pride in on-time arrivals and departures).	1	2	3	4	5	6	7
f.	**Business pressures on company passed onto drivers** (e.g., pressure on drivers from dispatchers to accept trips or be on-time, company emphasizes business over safety).	1	2	3	4	5	6	7
g.	**Inadequate company support for fatigue safety issues** (e.g., lack of equipment that might reduce fatigue, no relay or driver teams, little or poor driver fatigue training, low understanding of driver fatigue or commitment to reduce driver fatigue among managers).	1	2	3	4	5	6	7

Section 5: Nature of Operations and Safety Climate

42. Your company is best characterized as what type of carrier? (Check all that apply.)
    a. _____ Scheduled Route
    b. _____ Charter/Tour

43. What is the average trip, in miles, for your drivers? _____ Miles

44. On average, how many miles or hours do your drivers drive per week? _____ Miles _____ Hours

45. For the majority of your runs, how widely does your company operate?
    a. _____ Locally
    b. _____ Intrastate
    c. _____ Regionally
    d. _____ Nationally

46. What is the average size (number of units) and average age of your fleet today?
    _____ Number of 45 ft motorcoaches
    _____ Number of 40 ft motorcoaches
    _____ Number of vans/buses less than 40 ft
    _____ Average age of fleet

47. What types of equipment/devices are available on your vehicles? Check as many as apply and indicate the percent of vehicles with the equipment:

	Apply		
a.	_____	(_____% of vehicles)	Sleeper beds
b.	_____	(_____% of vehicles)	Lumbar support seats
c.	_____	(_____% of vehicles)	Speed control devices
d.	_____	(_____% of vehicles)	Other (please specify) _____

48. What percent of your business comes from tour organizers? _____%

49. How many dispatchers does your company have? _____ Dispatchers

50. How is dispatching organized?
    a. _____ Each dispatcher is responsible for the same drivers
    b. _____ Each dispatcher has a changing set of drivers
    c. _____ Some of our dispatchers have the same drivers, others have a changing set of drivers

51. On average, how many drivers are assigned to each dispatcher? _____ Drivers

52. Describe the relationship you feel your dispatchers have with your drivers. What percent of your driver/dispatcher relationships fall into each of the following categories?
    a. _____ % Very poor
    b. _____ % Difficult
    c. _____ % Fair
    d. _____ % Good
    e. _____ % Excellent
    101 % Total

53. How many reportable driving accidents was your company involved in over the last two years?
    _____ Reportable accidents

54. How many chargeable driving accidents was your company involved in over the last two years?
    _____ Chargeable accidents

Listed below are statements that represent opinions people have about driving fatigue and safety. Please indicate the extent to which you agree or disagree with each statement by circling the number which best corresponds to your opinion, using a scale of 1 to 7, with 1 = Strongly Disagree and 7 = Strongly Agree. (Circle one number for each statement)

	Statement about driving fatigue and safety	**Strongly Disagree**			**Neutral**			**Strongly Agree**
55.	Our company makes driving safety a top priority.	1	2	3	4	5	6	7
56.	Driving safety is an important concern at this company.	1	2	3	4	5	6	7
57.	I am satisfied with the amount of emphasis this company places on driving safety.	1	2	3	4	5	6	7
58.	Drivers and management openly discuss issues related to driver fatigue.	1	2	3	4	5	6	7
59.	This company is interested in driver input on driving safety matters.	1	2	3	4	5	6	7
60.	Drivers provide useful insights into driver fatigue issues.	1	2	3	4	5	6	7
61.	Driver input has played an important role in setting company policies pertaining to driver fatigue.	1	2	3	4	5	6	7
62.	We need more training related to driver fatigue issues.	1	2	3	4	5	6	7
63.	Drivers have to bend a driving safety rule or policy in order to "get the job done."	1	2	3	4	5	6	7

64. To what extent do you think that driving at night (i.e., between midnight and dawn) is as safe for CMV drivers as driving during the daytime? (Circle one number.)

1 2 3 4 5 6 7
To a Very Little Extent To Some Extent To a Very Large Extent

65. To what extent do you think inverted duty/rest cycles* are experienced by drivers during trips?

1 2 3 4 5 6 7
To a Very Little Extent To Some Extent To a Very Large Extent

66. On an average, how many inverted duty/rest cycles* are experienced by a driver during a trip? _____

67. To what extent do you use relief drivers for extended trips & itineraries?

1 2 3 4 5 6 7
To a Very Little Extent To Some Extent To a Very Large Extent

68. Does your company allow drivers to take unscheduled rest breaks when they are tired? (check one)
   a. _____ No
   b. _____ Yes, but it is not a written policy
   c. _____ Yes, and it is a written policy

69. Are dispatchers required to have prior commercial driving experience? _____ Yes _____ No

70. Does your company encourage dispatchers to take individual differences of drivers into account when making driving assignments (e.g., some drivers are more or less susceptible to fatigue, some drivers experience more drowsiness when driving at night)? _____ Yes _____ No

71. What is your position or title? _____

72. What is the position or title of the person you directly report to? _____

73. Which description best describes your position?
    a. _____ Full-time safety director
    b. _____ Responsible for safety but have additional duties

74. With respect to safety, are you responsible for driving operations or for safety in non-driving operations (e.g., maintenance shop, passenger terminal) as well?
    a. _____ Responsible for driving operations only
    b. _____ Responsible for safety in both driving and non-driving operations

FEEL FREE TO MAKE ANY ADDITIONAL COMMENTS ON THE BACK OF THIS PAGE.

*An inverted duty/rest cycle occurs when a driver drives/is on-duty during a certain time period of a day, and is off-duty during the same time period the next day, with variable lengths of on-duty and off-duty periods during this cycle.

Commercial Motor Vehicle (CMV) Operations:
Driver Survey – Bus

Section 1: Driving Patterns

In this section of the survey we would like to learn about your driving patterns and when you get your rest. Please answer the following questions by filling in the blank or by circling the response that best corresponds to your opinion.

1. Using a scale of 1 to 5, with 1 = Never and 5 = Always, please indicate the frequency of the following (Circle one number for each statement):

	How often do you . . .	Never	Rarely	Sometimes	Frequently	Always
a.	Start and stop driving nearly the same time each day	1	2	3	4	5
b.	Drive on interstates or major highways	1	2	3	4	5
c.	Drive in urban areas and secondary roads	1	2	3	4	5
d.	Have difficulty finding a safe place to stop for rest or sleep	1	2	3	4	5
e.	Sleep at home	1	2	3	4	5
f.	Get your sleep at nighttime	1	2	3	4	5
g.	Drive during nighttime on one day and during daytime the next day	1	2	3	4	5

2. Which one of the following best describes the type of route(s) you drive? (circle one letter)
   a. I drive the same route nearly every time I drive
   b. I drive several different routes but I drive them fairly often
   c. I drive a mix of regular and irregular (different) routes
   d. I drive a wide variety of different routes

3. What percent of work time is spent on the following?
   a. Driving _____%
   b. Boarding/Unboarding _____%
   c. Waiting _____%
   d. Traffic delays _____%
   e. Other (e.g., paperwork, resting, eating) _____%
   100% Total

4. During an average week, please estimate what percent of your driving time falls into each of these time periods. (Please be sure your percentages total 100%.)

	Driving Time	
a. 6:00 am to noon	_____	%
b. Noon to 6:00 pm	_____	%
c. 6:00 pm to midnight	_____	%
d. Midnight to 6:00 am	_____	%
Total	100 %	

5a. On average, how many hours of continuous, uninterrupted sleep do you get during a 24-hour period when you are: Working? _____ Hours Not working? _____ Hours

5b. My ideal amount of sleep during a 24-hour period is: _____ Hours

5c. On average, how many naps do you take in a 24-hour period when you are working? _____ Naps

5d. Average length of each nap: _____ Minutes

6. During a typical work week, **when** do you sleep for an extended period (more than two hours) without waking up? Please indicate what percent of your uninterrupted sleep fell into each of four possible time periods.
   a. 6:00 AM to noon _____ % of total uninterrupted sleep
   b. Noon to 6:00 PM _____ % of total uninterrupted sleep
   c. 6:00 PM to midnight _____ % of total uninterrupted sleep
   d. Midnight to 6:00 AM _____ % of total uninterrupted sleep
   100 % Total

7. Does your company allow you to take unscheduled rest breaks when you are tired?
   a. No
   b. Yes, but it is not a written policy
   c. Yes, and it is a written policy

8. Over the last two years, what were the fewest, the most, and the average number of miles or hours you drove per week?
   a. Fewest miles driven in a week _____ Miles _____ Hours
   b. Most miles driven in a week _____ Miles _____ Hours
   c. Average number of miles driven in a week _____ Miles _____ Hours

9a. How many stops for arrivals and departures do you make on an average day? (Estimate the number.)
   _____ Arrivals and departures

9b. When do you make these arrivals and departures? Please indicate what percentage typically occurs in each time zone. (Please be sure your percentages total 100%.)
   a. 6 AM to Noon _____ %
   b. Noon to 6 PM _____ %
   c. 6 PM to midnight _____ %
   d. Midnight to 6 AM _____ %
   Total 100 %

10. How far away do **most** of your driving assignments take you? (Estimate the number of miles.)
   _____ Miles

Section 2: Opinions About Driving

The following questions are related to your personal opinions. Please indicate the extent to which you think the statement is true, by circling the number which best corresponds to your opinion, using a scale of 1 to 7, with 1 = To a Very Little Extent and 7 = To a Very Large Extent. (Circle one number for each statement).

	To what extent do you think . . .	**To a Very Little Extent**			**To Some Extent**			**To a Very Large Extent**
11.	You have been trained about driver fatigue issues?	1	2	3	4	5	6	7
12.	Dispatchers are trained about driver fatigue issues?	1	2	3	4	5	6	7
13.	Your company regards hours-of-service regulations as a general guideline rather than a set of regulations that should be strictly enforced?	1	2	3	4	5	6	7
14.	Drivers are the best judges of whether or not they are too tired to drive?	1	2	3	4	5	6	7
15.	You are pressured by your dispatcher to continue driving when you know you are tired?	1	2	3	4	5	6	7

16.	You are pressured by your dispatcher to accept a trip when you know you are tired?	1	2	3	4	5	6	7
17.	You are pressured by your dispatcher to accept a trip when you know you will be "out of hours" before you can reach your destination?	1	2	3	4	5	6	7
18.	Dispatchers in this company place a higher priority on arriving on- time than driver safety?	1	2	3	4	5	6	7
19.	You can go to the person in charge of safety (or the operations manager) if you are pressured by your dispatcher to drive when you are tired?	1	2	3	4	5	6	7
20.	Driving at night (i.e., between midnight and dawn) is as safe as driving during the daytime?	1	2	3	4	5	6	7
21.	You drive when you are tired in order to make a good income?	1	2	3	4	5	6	7
22.	You drive when you are tired in order to get somewhere for personal reasons (e.g., to get home, visit friends)?	1	2	3	4	5	6	7
23.	Your company rewards safe driving (e.g., accident-free miles) through recognition programs like "employee of the month" or publishing names of safe drivers in an employee newsletter?	1	2	3	4	5	6	7
24.	Your company rewards safe driving (e.g., accident free miles) through financial incentives like bonuses, gifts, or higher mileage rates?	1	2	3	4	5	6	7
25.	Recognition programs improve driver safety performance?	1	2	3	4	5	6	7
26.	Financial incentives improve driver safety performance?	1	2	3	4	5	6	7
27.	Drivers in your company have opportunities to make suggestions and voice complaints regarding safety and fatigue?	1	2	3	4	5	6	7
28.	Your company acts on suggestions and complaints made by drivers concerning safety and fatigue?	1	2	3	4	5	6	7
29.	Top management at your company is committed to driving safety?	1	2	3	4	5	6	7
30.	You take personal pride in making arrivals on-time?	1	2	3	4	5	6	7
31.	There are financial rewards for on-time arrivals?	1	2	3	4	5	6	7
32.	You are given the flexibility to choose which trip/route to drive?	1	2	3	4	5	6	7
33.	You are allowed to decide where you will make your meal/rest stops?	1	2	3	4	5	6	7
34.	You can predict where you will be making your meal/rest stops at the beginning of a trip?	1	2	3	4	5	6	7

35. Many factors are thought to cause fatigue among CMV drivers. Please rate the following list of seven possible factors according to which factors you think are most important in causing driving fatigue. Use a scale of 1 to 7, with "1" = not at all important, and "7" very important to rate each factor. (Circle one number for each factor.)

a.	Possible fatigue causing factor…	Not at all important			Of some importance			Very important
b.	**Irregularity of CMV driving time** (e.g., different times of driving each day (inverted duty/sleep cycle), variability of work).	1	2	3	4	5	6	7
c.	**Lack of trip control** (e.g., different routes, cannot control or predict schedule due to factors like waiting or boarding/unboarding).	1	2	3	4	5	6	7
d.	**Poor quality of rest while working** (e.g., not sleeping at home, nighttime driving, interrupted sleep, difficulty in finding a place to rest or sleep).	1	2	3	4	5	6	7
e.	**Scheduling demands of CMV driving work** (e.g., time allotted by tour organizers and customers, waiting time).	1	2	3	4	5	6	7
f.	**Driver economics** (e.g., need to earn more money, rewards for on-time arrivals and departures, penalties for late arrivals and departures, no rewards for safe driving) or personal factors (e.g., desire to get home, personal pride in on-time arrivals and departures).	1	2	3	4	5	6	7
g.	**Business pressures on company passed onto drivers** (e.g., pressure on drivers from dispatchers to accept trips or arrive on-time, company emphasizes business over safety).	1	2	3	4	5	6	7
g.	**Inadequate company support for fatigue safety issues** (e.g., lack of equipment that might reduce fatigue, no relay or driver teams, little or poor driver fatigue training, low understanding of driver fatigue or commitment to reduce driver fatigue among managers).	1	2	3	4	5	6	7

Section 3: Opinions About Route Activities

36. How many different terminals/destinations do you stop at on an average day?
_____ Different locations

37. Does your company penalize drivers for late arrivals? (Check all that apply.)
a. _____ No, my company does not penalize drivers for late arrivals
b. _____ Yes, drivers receive verbal criticism from their dispatchers
c. _____ Yes, driver pay is reduced or drivers are fined
d. _____ Yes, drivers lose potential bonus money
e. _____ Yes, drivers can be suspended
f. _____ Yes, drivers can be fired
g. _____ Yes, drivers receive less desirable trips in the future
h. _____ Yes, other (How? Please specify _____)

Section 4: Driving Experiences and Safety Climate

Questions 38-41 are related to driving safety training and meetings. For this survey, **training** refers to formal educational programs on driving safety while **meetings** refer to open discussions on driving safety topics such as new government regulations, new company policies, and accident investigations.

38. How frequently does your company provide on-going or "refresher" **training** related to **driving** safety? (Circle your answer)
    a. Never
    b. Once in a while, no pattern of frequency
    c. Once a month
    d. Once every 2-3 months
    e. Once every 6 months
    f. Once a year
    g. Other (please specify) _____

39. How frequently do you attend these on-going or "refresher" **training** programs related to driving safety? (Circle your answer.)
    a. Never
    b. Once in a while, no pattern of frequency
    c. Once a month
    d. Once every 2-3 months
    e. Once every 6 months
    f. Once a year
    g. Other (please specify) _____

40. How frequently does your company hold safety **meetings** related to driving safety (as opposed to safety training)? (Circle your answer.)
    a. Never
    b. Once in a while, no pattern of frequency
    c. Once a month
    d. Once every 2-3 months
    e. Once every 6 months
    f. Once a year
    g. Other (please specify) _____

41. How frequently do you attend these **meetings** related to driving safety? (Circle your answer.)
    a. Never
    b. Once in a while, no pattern of frequency
    c. Once a month
    d. Once every 2-3 months
    e. Once every 6 months
    f. Once a year
    g. Other (please specify) _____

42. Does your company penalize drivers for unsafe driving? (Circle **all** that apply.)
    a. No, my company does not penalize drivers for unsafe driving
    b. Yes, drivers receive verbal criticism from the company
    c. Yes, driver pay is reduced or drivers are fined by the company
    d. Yes, drivers lose potential bonus money
    e. Yes, drivers can be suspended
    f. Yes, drivers can be fired
    g. Yes, drivers receive less desirable trips in the future
    h. Yes, other (please specify) _____

43. How does your company pay you for driving? (Circle all that apply)
    a. By the mile
    b. By the hour
    c. Straight salary
    d. As a percentage of the trip revenue
    e. Base rate plus sales commission
    f. Other (please specify) _____

44. Are there opportunities for you to earn additional money? (Check all that apply)
    a. _____ No
    b. _____ Yes, for safe driving
    c. _____ Yes, for on-time arrivals
    d. _____ Yes, for operating efficiently
    e. _____ Yes, other (please specify) _____

45. Most drivers have an "ideal" balance between work and off-duty time. Which one best describes you?
    a. I would prefer to work more in order to increase my income.
    b. I would prefer to work more for reasons other than money.
    c. I have the right balance between work and off-duty time.
    d. I would prefer more off-duty time if my income could remain the same.
    e. I would prefer more off-duty time even if my income would decrease.

46. Most professional drivers have some "close calls" or "near misses" (i.e., near accidents) while working because **they were less than fully alert**. Please tell us about your experiences with close calls by indicating how often you have had a close call at each of the following locations over the last two years **because you were less than fully alert**. Answer the following questions by circling the number which best corresponds to your opinion, using a scale of 1 to 5, with 1 = Never and 5 = Very Frequently. (Circle one number for each statement.)

	How often have you had a "close call" . . .	**Never**	**Rarely**	**Occasionally**	**Often**	**Very Frequently**
a.	At a terminal	1	2	3	4	5
b.	At a weigh station	1	2	3	4	5
c.	At a destination	1	2	3	4	5
d.	While driving in an urban area or on a secondary road	1	2	3	4	5
e.	While driving on an interstate or major highway	1	2	3	4	5
f.	Other, please specify:	1	2	3	4	5

Please answer the following questions using the same response format.

	How often do you . . .	**Never**	**Rarely**	**Occasionally**	**Often**	**Very Frequently**
47.	Experience a "close call" or "near miss" because you are less than fully alert?	1	2	3	4	5
48.	Nod off while driving?	1	2	3	4	5
49.	Think fatigue is a problem for you when you are driving?	1	2	3	4	5
50.	Find yourself continuing to drive when you are less than fully alert?	1	2	3	4	5
51.	Reject a trip because you think you are too tired to drive the trip in the time allotted?	1	2	3	4	5
52.	Think fatigue is a problem for other CMV drivers **in your company**?	1	2	3	4	5
53.	Think fatigue is a problem for CMV drivers in general, throughout the industry?	1	2	3	4	5

Listed below are statements that represent opinions people have about driving fatigue and safety. Please indicate the extent to which you agree or disagree with each statement by circling the number which best corresponds to your opinion, using a scale of 1 to 7, with 1 = Strongly Disagree and 7 = Strongly Agree. (Circle one number for each statement)

	II. **Statement about driving fatigue and safety**	**Strongly Disagree** 1	2	3	**Neutral** 4	5	6	**Strongly Agree** 7
54.	Our company makes driving safety a top priority.	1	2	3	4	5	6	7
55.	Driving safety is an important concern at this company.	1	2	3	4	5	6	7
56.	I am satisfied with the amount of emphasis this company places on driving safety.	1	2	3	4	5	6	7
57.	Drivers and management openly discuss issues related to driver fatigue.	1	2	3	4	5	6	7
58.	This company is interested in driver input on driving safety matters.	1	2	3	4	5	6	7
59.	Drivers provide useful insights into driver fatigue issues.	1	2	3	4	5	6	7
60.	Driver input has played an important role in setting company policies pertaining to driver fatigue.	1	2	3	4	5	6	7
61.	We need more training related to driver fatigue issues.	1	2	3	4	5	6	7
62.	Drivers have to bend a driving safety rule or policy in order to "get the job done."	1	2	3	4	5	6	7

63. Many actions have been proposed to help drivers combat fatigue while they are driving. Please check those actions that your company takes.

	Action	Company Takes
a.	Provides education and training about fatigue	
b.	Gives driver control over schedule	
c.	Allows driver adequate time off between trips	
d.	Provides enough sleep time on trip	
e.	Uses shared driving arrangements (e.g., relays, driver teams)	
f.	Minimizes night driving (midnight to dawn)	
g.	Other (please specify)	

64. How often do you typically get home for your "off-duty" (recovery) days?
    a. Home every day
    b. Twice a week
    c. Once a week
    d. Once every two weeks

65. Following your off-duty (recovery) days, how often do you begin a new "workweek" feeling tired or fatigued?
    a. Never
    b. Rarely
    c. Sometimes
    d. Frequently
    e. Always

66. How frequently do you engage in team driving/relief driving in the last two years?
    a. Never
    b. Rarely
    c. Sometimes
    d. Frequently
    e. Always

Section 5: Background Information

67. How many years of experience do you have as a CMV driver? _____ Years

68. To what extent do you experience inverted duty/rest cycles* during trips?

1	2	3	4	5	6	7
To a Very Little Extent			To Some Extent			To a Very Large Extent

69. On average, how many inverted duty/rest cycles* do you experience during a trip? _____

70. How many motor carrier (freight or passenger) companies have you worked for over the last two years?
    _____ Companies

71. How many breaks do you usually take during a 10-hour run just to rest? _____ Breaks

72. How long is an average rest break during a 10-hour run? _____ Minutes

73. How many reportable accidents were you involved in, while working, over the last two years?
    _____ Reportable accidents

74. How many accidents were you involved in, while working, over the last two years which were considered preventable by your company?
    _____ Preventable accidents

75. How many dispatchers do you work with on a regular basis at your company?
    _____ Dispatchers

76. Describe the relationship you feel you have with your dispatcher(s) by marking the most appropriate description:
    _____ Excellent
    _____ Good
    _____ Fair
    _____ Difficult
    _____ Very poor

77. What type of equipment do you typically drive? (Check as many as apply.)
    _____ 45 ft motorcoach
    _____ van/bus less than 40 ft
    _____ 40 ft motorcoach
    _____ Other (Please specify _____)

78. Age Today: _____ Years

79. Sex: _____ Male _____ Female

80. Are you currently a member of a union? _____ Yes _____ No

81. For what type of carrier do you presently work?
_____ Scheduled Route
_____ Charter/Tour

82. How would you classify yourself? (Check the most appropriate category.)
a. _____ Regular, full-time c. _____ Part-time
b. _____ Extra-board

83. To your knowledge, do you have any medical sleep disorders? _____ Yes _____ No

FEEL FREE TO MAKE ANY ADDITIONAL COMMENTS ON THE BACK OF THIS PAGE.

- An inverted duty/rest cycle occurs when a driver drives/is on-duty during a certain time period of a day, and is off-duty during the same time period the next day, with variable lengths of on-duty and off-duty periods during this cycle.

Commercial Motor Vehicle (CMV) Operations:
Dispatcher Survey – Bus

Section 1: Nature of Work

1. How many commercial motor vehicle (CMV) drivers do you dispatch? _____ Drivers

2. What percentage of your drivers are primarily intercity/extended trip drivers? _____%

3. What percentage of your drivers are local route/day trip drivers? _____%

4. What percentage of your time is spent in each of these possible job activities?
   a. _____ % Talking to drivers about pick-ups, arrivals, routes, time off, etc.
   b. _____ % Talking with customers about trip planning
   c. _____ % Talking with sales people, trip coordinators, or others in your company who influence scheduling drivers
   d. _____ % Talking with customers about arrival times, delays, etc.
   e. _____ % Other (Please specify _____)
   100 % Total

5. What kinds of technology are available to help you? (Check as many as apply)
   a. _____ Global positioning systems
   b. _____ Computers on-board
   c. _____ Cell phones for drivers
   d. _____ Computer-aided dispatch software
   e. _____ Electronic logbooks
   f. _____ Pagers assigned to drivers

6. In dealing with decisions that potentially affect hours-of-service regulations, what do you rely on? (Check as many as apply)
   a. _____ Oral reports from drivers on hours driven
   b. _____ Oral reports from drivers regarding degree of tiredness
   c. _____ Computer generated summaries of hours driven
   d. _____ Electronic logbooks
   e. _____ Others (please specify)

7. In general, what do you assume to be the average vehicle speed when calculating the time needed to make an on-time arrival?
   _____ Miles per hour for local/day trip _____ Miles per hour for intercity/extended trip

8. What sorts of crite ria are used to judge <u>your</u> job performance? For which can you receive rewards/penalties (e.g., bonus)? (Check as many as apply.)

	Evaluated On	Rewards/ Penalties For	
a.			Average number of miles driven per driver
b.			Meeting company policy on getting drivers home
c.			Minimizing deadhead miles
d.			Driver hours-of-service violations
e.			Percent of on-time arrivals
f.			Driver turnover
g.			Accident free miles by drivers or drivers' chargeable accidents
h.			Driver speeding violations
i.			Other (please specify)

The following questions are related to your personal opinions. Please indicate the extent to which you think the statement is true, by circling the number which best corresponds to your opinion, using a scale of 1 to 7, with 1 = To a Very Little Extent and 7 = To a Very Large Extent. (Circle one number for each statement)

	To what extent do you think . . .	**To a Very Little**			**To Some Extent**			**To a Very Large**
9.	You have been trained about driver fatigue issues?	1	2	3	4	5	6	7
10.	Your company regards hours-of-service regulations as a general guideline rather than a set of regulations that should be strictly enforced?	1	2	3	4	5	6	7
11.	Drivers are the best judges of whether or not they are too tired to drive?	1	2	3	4	5	6	7
12.	You are pressured by your company to accept or dispatch trips when you know all of your available drivers are "out of hours"?	1	2	3	4	5	6	7
13.	Tour organizers/customers are **aware** of hours of service regulation issues?	1	2	3	4	5	6	7
14.	Tour organizers/customers **care** about hours of service regulation issues?	1	2	3	4	5	6	7
15.	Tour organizers/customers are **aware** of driver fatigue issues?	1	2	3	4	5	6	7
16.	Tour organizers/customers **care** about driver fatigue issues?	1	2	3	4	5	6	7
17.	Tour organizers require such tight trip schedules that drivers often have to drive when they are tired to make an on-time arrival?	1	2	3	4	5	6	7
18.	Driving at night (i.e., between midnight and dawn) is as safe for CMV drivers as driving during the daytime?	1	2	3	4	5	6	7

19. Many factors are thought to cause fatigue among CMV drivers. Please rate the importance of the following possible seven factors according to which factors you think are important in causing driving fatigue. Use a scale of 1 to 7 with "1" = Not At All Important and "7" = Very Important to rate each factor. (Circle one number for each factor.)

	Possible Fatigue Causing Factor	Not At All Important			Of Some Importance			Very Important
a.	**Irregularity of CMV driving time** (e.g., different times of driving each day (inverted duty/sleep cycles), variability of work).	1	2	3	4	5	6	7
b.	**Lack of trip control** (e.g., different routes, cannot control or predict schedule due to factors like waiting or boarding/unboarding).	1	2	3	4	5	6	7
c.	**Poor quality of rest while working** (e.g., not sleeping at home, nighttime driving, interrupted sleep, difficulty in finding a place to rest or sleep).	1	2	3	4	5	6	7
d.	**Scheduling demands of CMV driving work** (e.g., time allotted by tour organizers/customers, waiting time).	1	2	3	4	5	6	7
e.	**Driver economics** (e.g., need to earn more money, rewards for on-time arrivals and departures, penalties for late arrivals and departures, no rewards for safe driving) or personal factors (e.g., desire to get home, personal pride in on-time arrivals and departures).	1	2	3	4	5	6	7
f.	**Business pressures on company passed onto drivers** (e.g., pressure on drivers from dispatchers to accept trips or be on-time, company emphasizes business over safety).	1	2	3	4	5	6	7
g.	**Inadequate company support for fatigue safety issues** (e.g., lack of equipment that might reduce fatigue, no relay or driver teams, little or poor driver fatigue training, low understanding of driver fatigue or commitment to reduce driver fatigue among managers).	1	2	3	4	5	6	7

Section 2: Relationships with Drivers

The following questions are related to your personal opinions about the drivers at your company. Please indicate the extent to which you think the statement is true, by circling the number which best corresponds to your opinion, using a scale of 1 to 7, with 1 = To a Very Little Extent and 7 = To a Very Large Extent. (Circle a number for each statement.)

	To what extent do you . . .	**To a Very Little Extent**			**To Some Extent**			**To a Very Large Extent**
20.	Think drivers are trained about driver fatigue issues?	1	2	3	4	5	6	7
21.	Feel pressured by drivers to "overlook" rest requirements?	1	2	3	4	5	6	7
22.	Ask drivers to "overlook" rest requirements so that you can accept a trip?	1	2	3	4	5	6	7
23.	Ask drivers to "overlook" rest requirements in order to arrive on-time?	1	2	3	4	5	6	7
24.	Ask drivers to drive faster in order to arrive on-time?	1	2	3	4	5	6	7
25.	Think that drivers in your company have opportunities to make suggestions and voice complaints regarding safety and fatigue?	1	2	3	4	5	6	7
26.	Think that your company acts on suggestions and complaints made by drivers concerning safety and fatigue?	1	2	3	4	5	6	7
27.	Think top management at your company is committed to driving safety?	1	2	3	4	5	6	7
28.	Think that **top management** believes driving at night (i.e., between midnight and dawn) is as safe for CMV drivers as driving during the daytime?	1	2	3	4	5	6	7

29. Describe the working relationship you have with drivers. What percent of your interactions fall into each of the following categories?
    a. _____ % Very poor
    b. _____ % Difficult
    c. _____ % Fair
    d. _____ % Good
    e. _____ % Excellent
    100 % Total

Section 3: Safety Climate and Background Information

Below are statements about driving fatigue and safety. Please indicate the extent to which you agree or disagree with each statement by circling the number which best corresponds to your opinion, using a scale of 1 to 7, with 1 = Strongly Disagree and 7 = Strongly Agree. (Circle one number for each statement)

	Statement about driving fatigue and safety	**Strongly Disagree**			**Neutral**			**Strongly Agree**
30.	Our company makes driving safety a top priority.	1	2	3	4	5	6	7
31.	Driving safety is an important concern at this company.	1	2	3	4	5	6	7
32.	I am satisfied with the amount of emphasis this company places on driving safety.	1	2	3	4	5	6	7
33.	Drivers and management openly discuss issues related to driver fatigue.	1	2	3	4	5	6	7
34.	This company is interested in driver input on driving safety matters.	1	2	3	4	5	6	7
35.	Drivers provide useful insights into driver fatigue issues.	1	2	3	4	5	6	7
36.	Driver input has played an important role in setting company policies pertaining to driver fatigue.	1	2	3	4	5	6	7
37.	We need more training related to driver fatigue issues.	1	2	3	4	5	6	7
38.	Drivers have to bend a driving safety rule or policy in order to "get the job done."	1	2	3	4	5	6	7

39. How frequently do you consider individual differences in drivers' susceptibility to fatigue (e.g., some drivers are more or less susceptible to fatigue, some drivers experience more drowsiness when driving at night) when making driving assignments?
    a. _____ Never
    b. _____ Rarely
    c. _____ Sometimes
    d. _____ Frequently
    e. _____ Always

40. To what extent are inverted duty/rest cycles* experienced by drivers during trips?

1	2	3	4	5	6	7
To a Very Little Extent			To Some Extent			To a Very Large Extent

41. On an average, how many inverted duty/rest cycles* are experienced by a driver during a trip? _____

42. To what extent do you use relief drivers for extended trips and itineraries?

1	2	3	4	5	6	7
To a Very Little Extent			To Some Extent			To a Very Large Extent

43. How many years of experience do you have working as a dispatcher?
    _____ Years

44. How many years of experience if any do you have working as a CMV driver?
_____ Years

45. How many CMV companies have you worked for over the last two years?
_____ Companies

46. What is the nature of your dispatching job?
a. _____ I am responsible for dispatching the same drivers
b. _____ I am responsible for dispatching a changing set of drivers (e.g., I dispatch for a set of customers or a region)
c. _____ I am responsible for a group of the same drivers but also others
d. _____ Other (Please specify _____)

47. In what state is your dispatching facility located? _____ (name of state)

48. Age today:
_____ Years

49. Sex:
_____ Male
_____ Female

FEEL FREE TO MAKE ANY ADDITIONAL COMMENTS ON THE BACK OF THIS PAGE.

- An inverted duty/rest cycle occurs when a driver drives/is on-duty during a certain time period of a day, and is off-duty during the same time period the next day, with variable lengths of on-duty and off-duty periods during this cycle.

Commercial Motor Vehicle (CMV) Driver Survey (Truck Stop)

Section 1: Driving Patterns

In this section of the survey we would like to learn about your driving patterns and when you get your rest. Please answer the following questions by filling in the blank or by circling the response that best corresponds to your opinion.

1. Using a scale of 1 to 5, with 1 = Never and 5 = Always, please indicate the frequency of the following (Circle one number for each statement):

How often do you . . .	**Never**	**Rarely**	**Sometimes**	**Frequently**	**Always**
Start and stop driving nearly the same time each day	1	2	3	4	5
Drive on interstates or major highways	1	2	3	4	5
Drive in urban areas and secondary roads	1	2	3	4	5
Have difficulty finding a safe place to stop for rest or sleep	1	2	3	4	5
Sleep at home	1	2	3	4	5
Get your sleep at nighttime	1	2	3	4	5

2. Which one of the following best describes the type of route(s) you drive? (circle one letter)
   a. I drive the same route nearly every time I drive
   b. I drive several different routes but I drive them fairly often
   c. I drive a mix of regular and irregular (different) routes
   d. I drive a wide variety of different routes

3. What percent of work time is spent on the following?
   a. Driving _____%
   b. Loading/Unloading _____%
   c. Waiting to make pick-up or delivery _____%
   d. Traffic delays _____%
   e. Other (e.g., paperwork, resting, eating) _____%
   100% Total

4. During an average week, please estimate what percent of your driving time and your pick-ups and deliveries fall into each of these time periods.

	Driving Time	Pick-Ups and Deliveries
6:00 am to noon	_____ %	_____ %
Noon to 6:00 pm	_____ %	_____ %
6:00 pm to midnight	_____ %	_____ %
Midnight to 6:00 am	_____ %	_____ %
Total	100 %	100 %

5a. On average, how many hours of continuous, uninterrupted sleep do you get during a 24-hour period when you are:
Working? _____ Hours Not working? _____ Hours

5b. My ideal amount of sleep during a 24-hour period is: _____ Hours

5c. On average, how many naps do you take in a 24-hour period when you are working? _____ Naps

5d. What is the average length of each nap? _____ Minutes

6. In a typical workweek, **when** do you sleep for an extended period without waking up? Please indicate what percent of your uninterrupted sleep falls into each of four possible time periods.
   a. 6:00 am to noon _____ % of total uninterrupted sleep
   b. Noon to 6:00 pm _____ % of total uninterrupted sleep
   c. 6:00 pm to midnight _____ % of total uninterrupted sleep
   d. Midnight to 6:00 am _____ % of total uninterrupted sleep
   100 % Total

7. Does your company allow you to take rest breaks when you are tired? (check one)
   a. _____ No
   b. _____ Yes, but it is not a written policy
   c. _____ Yes, and it is a written policy

8. Over the last two years, what were the fewest, the most, and the average number of miles you drove per week?
   a. Fewest miles driven in a week _____ Miles
   b. Most miles driven in a week _____ Miles
   c. Average number of miles driven in a week _____ Miles

9. How many stops for pick-ups and deliveries do you make on an average day? (Estimate the number.)
   _____ Pick-ups and deliveries

10. How far away do **most** of your driving assignments take you? (Estimate the number of miles.)
    _____ Miles

11. How many different facilities do you deal with in making deliveries on an average day?
    _____ Different facilities

12. For what percentage of your loads do you have to help with loading and unloading?
    a. Pick-ups _____% b. Deliveries _____%

13. For what percentage of your loads do you have to wait longer than you planned to load or unload?
    _____% of loads

14. How often do you typically get home for your "off-duty" (recovery) days?
    a. Home every day
    b. At least once a week
    c. At least once every two weeks
    d. Away from home more than two weeks

15. Following your off-duty (recovery) days, how often do you begin a new "workweek" feeling tired or fatigued?
    a. Never
    b. Rarely
    c. Sometimes
    d. Frequently
    e. Always

16. How frequently do you engage in team driving?
    a. Never
    b. Rarely
    c. Sometimes
    d. Frequently
    e. Always

Questions 17-19 are related to your personal opinions. Please indicate the extent to which you think the statement is true, by circling the number which best corresponds to your opinion, using a scale of 1 to 7, with 1 = To a Very Little Extent and 7 = To a Very Large Extent. (Circle one number for each statement).

	To what extent do you think . . .	**To a Very Little Extent**			**To Some Extent**			**To a Very Large Extent**
17.	You are given the flexibility to choose which route to drive?	1	2	3	4	5	6	7
18.	You are allowed to decide where you will make your rest stops?	1	2	3	4	5	6	7
19.	You can predict where you will be making your rest stops at the beginning of a trip?	1	2	3	4	5	6	7

Section 2: Driving Experiences

20. Many actions have been proposed to help drivers combat fatigue while they are driving. Please place a check mark in the box next to those actions that your company practices.

	Action	
a.	Provides education and training about fatigue	
b.	Gives driver control over schedule	
c.	Allows driver adequate time off between trips	
d.	Provides enough sleep time on trip	
e.	Uses shared driving arrangements (e.g., relays, driver teams)	
f.	Minimizes night driving (midnight to dawn)	
g.	Minimizes loading/unloading by driver	
h.	Other (please specify)	

21. Most professional drivers have some "close calls" or "near misses" (i.e., near accidents) while working **because they were less than fully alert**. Please tell us about your experiences with close calls by indicating how often you have had a close call at each of the following locations over the last two years **BECAUSE YOU WERE LESS THAN FULLY ALERT**. Answer the following questions by circling the number which best corresponds to your opinion, using a scale of 1 to 5, with 1 = Never and 5 = Very Frequently. (Circle one number for each statement.)

	How often have you had a "close call" . . .	**Never**	**Rarely**	**Occasionally**	**Often**	**Very Frequently**
a.	At a terminal	1	2	3	4	5
b.	At a weigh station	1	2	3	4	5
c.	At a truck stop	1	2	3	4	5
d.	At a shipper or receiver facility	1	2	3	4	5
e.	While driving in an urban area or on a secondary road	1	2	3	4	5
f.	While driving on an interstate or major highway	1	2	3	4	5
g.	Other, please specify (e.g., toll booths, rest areas, merging on or off the highway):	1	2	3	4	5

22. Please answer the following questions using the same response format.

	How often do you . . .	Never	Rarely	Occasionally	Often	Very Frequently
a.	Experience a "close call" or "near miss" because you are less than fully alert?	1	2	3	4	5
b.	Nod off while driving?	1	2	3	4	5
c.	Think fatigue is a problem for you when you are driving?	1	2	3	4	5
d.	Find yourself continuing to drive when you are less than fully alert?	1	2	3	4	5
e.	Reject a load because you think you are too tired to drive the load in the time allotted?	1	2	3	4	5
f.	Think fatigue is a problem for other CMV drivers **in your company**?	1	2	3	4	5
g.	Think fatigue is a problem for CMV drivers in general, throughout the industry?	1	2	3	4	5

Section 3: Background Information

23. How many years of experience do you have as a CMV driver? _____ Years

24. How many motor carrier (freight or passenger) companies have you worked for or contracted with over the last two years? _____ Companies

25. How many breaks do you usually take during a 10-hour run just to rest? _____ Breaks

26. How long is an average rest break during a 10-hour run? _____ Minutes

27. How many reportable accidents were you involved in, while working, over the last two years?
_____ Reportable accidents

28. How many chargeable accidents were you involved in, while working, over the last two years?
_____ Chargeable accidents

29. What type of equipment do you typically drive? (**Check as many as apply**)
_____ Tractor-trailer
_____ Double-combination (tandem trailers)
_____ Longer combination (Rocky Mountain doubles/triples)
_____ Truck with a sleeper berth
_____ Straight truck
_____ Other (Please specify _____)

30. Age Today: _____ Years

31. Sex: _____ Male _____ Female

32. For what type of carrier do you presently work? _____ For-hire carrier _____ Private fleet (carry your company's own products)

33. What type of runs do you most often make? (Check one) _____ Mainly interstate _____ Mainly intrastate

34. How would you classify yourself? (Check the most appropriate category.)
a. _____ Company driver
b. _____ Owner-operator
c. _____ Temporary or casual driver
d. _____ Leased driver

35. To your knowledge, do you have any medical sleep disorders? _____ Yes _____ No

FEEL FREE TO MAKE ANY ADDITIONAL COMMENTS ON THE BACK OF THIS SHEET.

Appendix E: Definitions of Model Variables for Truck Stop Drivers

These entries describe the operationalizations of the constructs presented in the CMV Driver Fatigue Model and Tables 2.1 to 2.16. detailing the empirical findings.

Fatigue and Crash Outcomes

- Close calls: Frequency of close calls
  Drivers were asked to report the frequency of close calls or near misses due to fatigue (a) at terminals, (b) at weigh stations, (c) at truck stops, (d) at a shipper or receiver facility, (e) in urban areas or on secondary roads, and (f) while driving on interstate or major highways. Response options for each location ranged from (1) never to (5) very frequently. Responses were summed to yield a theoretical range of 6 to 30 and an observed range of 7 to 33.
- Self and others perceptions of fatigue
  Drivers were asked to report the frequency with which they believe each of the following six fatigue-related items occurred:

Experience a "close call" or "near miss" because you are less than fully alert?
Nod off while driving?
Think fatigue is a problem for you when you are driving?
Find yourself continuing to drive when you are less than fully alert?
Think fatigue is a problem for other CMV drivers **in your company**?
Think fatigue is a problem for CMV drivers in general, throughout the industry?

  Response options ranged from (1) never to (5) very frequently. Responses were summed to yield a theoretical range of 6 to 30 and an observed range of 6 to 27.

- Crash Involvement
  Drivers were asked to report the number of reportable and preventable accidents they had while working over the last two years. These responses were summed and normalized to adjust for the amount of driving exposure experienced by the driver. The number of accidents per 100,000 miles of driving was used. The observed range was 0 to 15.18 accidents per 100,000 miles driven.

CMV Driving Environments

Regularity of Time

- Driving same hours: Estimate of time driving same hours
  Drivers were asked how often they start and stop driving nearly the same time each day. Response options ranged from (1) never or rarely to (2) sometimes, frequently or always, yielding theoretical and observed ranges between 1 and 2.
- Number of time zones: Number of different 6-hour time zones spent driving
  Drivers were asked to estimate those time zones that they spent more than 10 percent of their time driving in using the following cut points: (a) 6:00 am to noon, (b) Noon to 6:00 pm, (c) 6:00 pm to midnight, and (d) Midnight to 6:00 am. Theoretical and observed responses ranged from 1 to 4.

Trip Control

- Regularity of route
  Drivers were asked which of four statements best described their routes. Drivers who characterized their routes as the same route nearly every time, several different routes driven often, or a mix of regular and irregular routes were coded as "1" while drivers indicating that they drove a wide variety of different routes were coded "2". Theoretical and observed responses ranged from 1 to 2.
- Choose own routes: Freedom to choose own routes

Drivers were asked the extent to which they were given flexibility to choose routes using a (1) to a very little extent to (7) to a very large extent response option framework. Drivers answering 1 to 3 were coded as "1", low flexibility, while drivers answering 4 to 7 were coded as "2", high flexibility. Theoretical and observed responses ranged from 1 to 2.

- Long load time: Number of loads taking longer than expected to load or unload
  Drivers were asked to estimate the percentage of their loads they had to wait longer than they had planned for loading or unloading to be completed. Driver responses of less than 30 percent were coded as "1" (short load time) while those estimating 30 percent or more were coded as "2" (long load time). Theoretical and observed responses ranged from 1 to 2.
- Difficulty in finding a place to rest
  Drivers were asked how often they had difficulty finding a safe place to stop for rest or sleep. Response options ranged from (1) never, rarely, or sometimes to (2) frequently or always, yielding theoretical and observed ranges between 1 and 2.
- Schedule delays: Percent of time spent waiting for pickups, deliveries, or in traffic delays
  Drivers were asked to estimate the percent of their work time spent (a) waiting and (b) in traffic delays. These two responses were summed generating a theoretical range of 0 to 200 percent. The observed range however was only 0 to 90 percent.
- Avg, stops per day: Average number of stops per day
  Drivers were asked how many stops for pickups and deliveries do you make in an average day. Drivers reporting 1 or less stops per day were coded as "1" while drivers reporting more than 1 stop were coded as "2". Theoretical and observed responses ranged from 1 to 2.

Quality of Rest

- Sleep at night: Extent of sleep at nighttime
  Drivers were asked how often they were able to get their sleep at nighttime. Response options ranged from (1) never, rarely, or sometimes to (2) frequently or always, yielding theoretical and observed ranges between 1 and 2.
- Uninterrupted sleep: Number of hours uninterrupted sleep
  Drivers were asked how many hours of continuous, uninterrupted sleep they got during a 24-hour period when they were working. Drivers getting 5 or less hours of sleep were coded as "1" while driver getting more than 5 hours of sleep were coded as "2". Theoretical and observed responses ranged from 1 to 2.
- Frequency at home: Recovery time at home
  Drivers were asked how frequently they typically got home for "off-duty" (recovery) days. Drivers who did not get home at least once a week were coded "1" while drivers who did get home every day or at least once a week were coded '2". Theoretical and observed responses ranged from 1 to 2.
- Start workweek tired: Start work tired
  Drivers were asked how often they began a new "workweek" feeling tired or fatigued. Response options ranged from (1) never or rarely to (2) sometimes, frequently or always, yielding theoretical and observed ranges between 1 and 2.

Appendix F: Definitions of Model Variables for Trucking Industry

These entries describe the operationalizations of the constructs presented in the CMV Driver Fatigue Model and Tables 3.1 to 3.12, detailing the empirical findings.

Fatigue and Crash Outcomes

- Close calls: Frequency of close calls
  Drivers were asked to report the frequency of close calls or near misses due to fatigue (a) at terminals, (b) at weigh stations, (c) at truck stops, (d) at a shipper or receiver facility, (e) in urban areas or on secondary roads, and (f) while driving on interstate or major highways. Response options for each location ranged from (1) never to (5) very frequently. Responses were summed to yield a theoretical range of 6 to 30 and an observed range of 7 to 33.
- Self and others perceptions of fatigue
  Drivers were asked to report the frequency with which they believe each of the following six fatigue-related items occurred:

Experience a "close call" or "near miss" because you are less than fully alert?
Nod off while driving?
Think fatigue is a problem for you when you are driving?
Find yourself continuing to drive when you are less than fully alert?
Think fatigue is a problem for other CMV drivers **in your company**?
Think fatigue is a problem for CMV drivers in general, throughout the industry?

  Response options ranged from (1) never to (5) very frequently. Responses were summed to yield a theoretical range of 6 to 30 and an observed range of 6 to 27.

- Crash Involvement
  Drivers were asked to report the number of reportable and preventable accidents they had while working over the last two years. These responses were summed and normalized to adjust for the amount of driving exposure experienced by the driver. The number of accidents per 100,000 miles of driving was used. The observed range was 0 to 15.18 accidents per 100,000 miles driven.

CMV Driving Environments

Regularity of Time

- Driving same hours: Estimate of time driving same hours
  Drivers were asked how often they start and stop driving nearly the same time each day. Response options ranged from (1) never or rarely to (2) sometimes, frequently or always, yielding theoretical and observed ranges between 1 and 2.
- Number of time zones: Number of different 6-hour time zones spent driving
  Drivers were asked to estimate those time zones that they spent more than 10 percent of their time driving in using the following cut points: (a) 6:00 am to noon, (b) Noon to 6:00 pm, (c) 6:00 pm to midnight, and (d) Midnight to 6:00 am. Theoretical and observed responses ranged from 1 to 4.

Trip Control

- Regularity of route
  Drivers were asked which of four statements best described their routes. Drivers who characterized their routes as the same route nearly every time, several different routes driven often, or a mix of regular and irregular routes were coded as "1" while drivers indicating that they drove a wide variety of different routes were coded "2". Theoretical and observed responses ranged from 1 to 2.

- Choose own routes: Freedom to choose own routes
  Drivers were asked the extent to which they were given flexibility to choose routes using a (1) to a very little extent to (7) to a very large extent response option framework. Drivers answering 1 to 3 were coded as "1", low flexibility, while drivers answering 4 to 7 were coded as "2", high flexibility. Theoretical and observed responses ranged from 1 to 2.
- Long load time: Number of loads taking longer than expected to load or unload
  Drivers were asked to estimate the percentage of their loads they had to wait longer than they had planned for loading or unloading to be completed. Driver responses of less than 30% were coded as "1" (short load time) while those estimating 30% or more were coded as "2" (long load time). Theoretical and observed responses ranged from 1 to 2.
- Difficulty in finding a place to rest
  Drivers were asked how often they had difficulty finding a safe place to stop for rest or sleep. Response options ranged from (1) never, rarely, or sometimes to (2) frequently or always, yielding theoretical and observed ranges between 1 and 2.
- Schedule delays: Percent of time spent waiting for pickups, deliveries, or in traffic delays
  Drivers were asked to estimate the percent of their work time spent (a) waiting and (b) in traffic delays. These two responses were summed generating a theoretical range of 0 to 200 percent. The observed range however was only 0 to 90 percent.
- Avg. stops per day: Average number of stops per day
  Drivers were asked how many stops for pickups and deliveries do you make in an average day. Drivers reporting 1 or less stops per day were coded as "1" while drivers reporting more than 1 stop were coded as "2". Theoretical and observed responses ranged from 1 to 2.

Quality of Rest

- Sleep at night: Extent of sleep at nighttime
  Drivers were asked how often they were able to get their sleep at nighttime. Response options ranged from (1) never, rarely, or sometimes to (2) frequently or always, yielding theoretical and observed ranges between 1 and 2.
- Uninterrupted sleep: Number of hours uninterrupted sleep
  Drivers were asked how many hours of continuous, uninterrupted sleep they got during a 24-hour period when they were working. Drivers getting 5 or less hours of sleep were coded as "1" while driver getting more than 5 hours of sleep were coded as "2". Theoretical and observed responses ranged from 1 to 2.
- Frequency at home: Recovery time at home
  Drivers were asked how frequently they typically got home for "off-duty" (recovery) days. Drivers who did not get home at least once a week were coded "1" while drivers who did get home every day or at least once a week were coded '2". Theoretical and observed responses ranged from 1 to 2.
- Start workweek tired: Start work tired
  Drivers were asked how often they began a new "workweek" feeling tired or fatigued. Response options ranged from (1) never or rarely to (2) sometimes, frequently or always, yielding theoretical and observed ranges between 1 and 2.

Economic Pressures

Scheduling Demands of Commerce

- Time allotted by shippers and receivers: Percent of shippers and receivers providing adequate time.
  Dispatchers were asked to estimate the percent of (a) shippers and (b) receivers who provide adequate time for pick-up or delivery. The two estimates were summed, yielding a theoretical and observed range of 0 to 200%.

- Time allotted by shippers and receivers: Size of delivery window
  Dispatchers were asked to estimate their average delivery window. Estimates of zero to two hours were coded as "1" and estimates greater than two hours were coded as "2". The theoretical and observed ranges were 1 to 2.
- Shipper/receiver conern with fatigue issues: Shipper/receiver care and awareness of driver fatigue issues
  Dispatchers were given four statements regarding shipper and receiver orientation regarding hours of service and fatigue issues and asked to report their level of agreement using a (1) to a very little extent or strongly disagree to (7) to a very large extent or strongly agree response option framework. These statements are listed below:

Shippers/receivers are **aware** of hours of service regulation issues?
Shippers/receivers **care** about hours of service regulation issues?
Shippers/receivers are **aware** of driver fatigue issues?
Shippers/receivers **care** about driver fatigue issues?

  Responses were summed to yield a theoretical range of 7 to 28 and an observed range of 4 to 28.

- Percent of business from brokers
  Safety directors were asked what percent of their company's business came from brokers. Theoretical and observed responses ranged from 0 to 100 percent.
- Percent time spent in non-driving activities: Percent of time spent on waiting for pickup and delivery
  Drivers were asked to estimate the percent of their work time spent on waiting for pickup and delivery. The theoretical range of this response was 0 to 100 percent while the observed range was 0 to 60 percent.
- Percent time spent in non-driving activities: Percent of time spent on loading or unloading
  Drivers were asked to estimate the percent of their work time spent on loading or unloading. The theoretical range of this response was 0 to 100 percent while the observed range was 0 to 70 percent.

Driver Economic or Personal Factors

- Personal motivations to continue driving when tired
  Drivers were asked the extent to which they (a) drive when they are tired in order to make a good income and (b) drive when they are tired in order to get somewhere for personal reasons, using a (1) to a very little extent to (7) to a very large extent response option framework. The responses were summed and generated a theoretical and observed responses ranged from 2 to 14.
- Drivers compensated for on-time deliveries: Rewards for on-time deliveries
  Safety directors were asked if drivers could earn additional compensation for on-time deliveries, with "no" responses coded as "0" and "yes" responses coded as "1". Theoretical and observed responses ranged from 0 to 1.
- Drivers penalized for late deliveries: Rewards (penalties) for on-time (late) deliveries
  Drivers were asked whether any of six possible penalties (e.g., verbal criticism, loss of bonus money) for late arrivals were used by their companies, with "no" responses to each item coded as "0" and "yes" responses coded as "1". Theoretical and observed responses ranged from 0 to 6.
- Drivers rewarded for safe driving: Rewards for safe driving performance
  Drivers were asked the extent to which their company rewarded safe driving by (a) recognition programs and (b) financial incentives using a (1) to a very little extent to (7) to a very large extent response option for each possible reward. The responses to the two items were summed, generating theoretical and observed scores of 2 to 14.

- Personal pride in on-time deliveries
  Drivers were asked the extent to which they took personal pride in making arrivals on-time, using a (1) to a very little extent to (7) to a very large extent response option framework. Theoretical and observed responses ranged from 1 to 7.

Carrier Economic Factors

- Percent of customers who penalize for lateness: Penalties levied on carrier for late deliveries
  CEOs were asked to estimate the percentage of company customers that impose a monetary penalty for late deliveries. A theoretical and observed range of responses between 0 and 100 percent was observed.
- Pressure on drivers to accept/hurry loads: Company emphasizes financial over safety performance
  Drivers were ask to indicate their level of agreement with the following four statements using a (1) to a very little extent to (7) to a very large extent response option for each:

a.	You are pressured by your dispatcher to continue driving when you know you are tired?
b.	You are pressured by your dispatcher to accept a trip when you know you are tired?
c.	You are pressured by your dispatcher to accept a trip when you know you will be "out of hours" before you can reach your destination?
d.	Dispatchers in this company place a higher priority on arriving on- time than driver safety?

  Response options were summed and yielded a theoretical and observed range of 4 to 28.

- Pressure to bend rules: Company emphasizes financial over safety performance
  Drivers were asked the extent to which they have to bend a driving safety rule or policy in order to "get the job done", using a (1) to a very little extent to (7) to a very large extent response option framework. Theoretical and observed responses ranged from 1 to 7.
- Pressure to dispatch loads: Company emphasizes financial over safety performance
  Safety directors were asked the extent to which dispatchers place a higher priority on keeping schedules than on driver safety, using a (1) to a very little extent to (7) to a very large extent response option framework. Theoretical and observed responses ranged from 1 to 7.
- Pressure to ask drivers to overlook rest: Company emphasizes financial over safety performance
  Dispatchers were asked the extent to which they ask drivers to "overlook" rest requirements so that they could accept a trip, using a (1) to a very little extent to (7) to a very large extent response option framework.. Theoretical and observed responses ranged from 1 to 7.
- Dispatchers evaluated on operating efficiency: Rewards/penalties for dispatchers based on operating efficiency
  Dispatchers were asked whether they were evaluated on (a) the average number of miles driven per driver and (b) minimizing deadhead miles, with "no" responses to each item coded as "0" and "yes" responses coded as "1". Responses were summed, and theoretical and observed responses ranged from 0 to 2.
- Dispatcher safety evaluation: Rewards/penalties for dispatchers for safe driving
  Dispatchers were asked whether they were rewarded or penalized for accident free miles by drivers or drivers' chargeable accidents, with a "no" response coded as "0" and a "yes" response coded as "1". Theoretical and observed responses ranged from 0 to 1.

Carrier Support for Driving Safety

- Drivers' perceptions of company safe driving culture: Safe driving culture
  Drivers were given eleven statements regarding company safety culture for which they were asked to report their level of agreement using a (1) to a very little extent or strongly disagree to (7) to a very large extent or strongly agree response option framework. These statements are listed below:

Our company makes driving safety a top priority.
Driving safety is an important concern at this company.
I am satisfied with the amount of emphasis this company places on driving safety.
Drivers and management openly discuss issues related to driver fatigue.
This company is interested in driver input on driving safety matters.
Drivers provide useful insights into driver fatigue issues.
Driver input has played an important role in setting company policies pertaining to driver fatigue.
You can go to the person in charge of safety (or the operations manager) if you are pressured by your dispatcher to drive when you are tired?
Drivers in your company have opportunities to make suggestions and voice complaints regarding safety and fatigue?
Your company acts on suggestions and complaints made by drivers concerning safety and fatigue?
Top management at your company is committed to driving safety?

  Responses were summed to yield a theoretical range of 11 to 77 and an observed range of 15 to 77.

- Voluntary attendance at safety training and meetings: Safety training and meetings
  Safety directors were asked to describe their company policy with respect to attendance at (a) on-going safety training and (b) safety meetings. Response options were (1) drivers are required to attend, (2) drivers are encouraged to attend, and (3) driver attendance is voluntary. The response to these two items were summed, and yielded a theoretical and observed range of 2 to 6.
- Paid to attend safety training and meetings: Safety training and meetings
  Safety directors were asked to describe their company policy with respect to paying drivers to attend (a) on-going safety training and (b) safety meetings. Response options were (0) no and (1) yes. The response to these two items were summed, and yielded a theoretical and observed range of 0 to 2.
- Safety directors' perceptions of driver autonomy with respect to tiredness: Driver autonomy with respect to tiredness
  Safety directors were asked to evaluate the extent to which they believe that their (a) top management and (b) dispatchers believe that drivers are the best judges of whether or not they are too tired to drive. A (1) to a very little extent to (7) to a very large extent response option framework was used and the two items were summed. The theoretical and observed responses ranged from 2 to 14.
- Company provides loading and unloading assistance: Assistance with loading and unloading
  Drivers were asked to indicate whether or not their company acted to minimize loading and unloading by drivers. Response options were (0) "no" and (1) "yes". The response to this item yielded a theoretical and observed range of 0 to 1.
- Company policies minimize night time driving: Company policies which minimize nighttime driving
  Drivers were asked to indicate whether or not their company acted to minimize night driving. Response options were (0) "no" and (1) "yes". The response to this item yielded a theoretical and observed range of 0 to 1.

Appendix G: Definitions of Model Variables for Motor Coach Industry

These entries describe the operationalizations of the constructs presented in the CMV Driver Fatigue Model amended for the Motor Coach Industry and Tables 4.1 to 4.8, detailing the empirical findings.

Fatigue and Crash Outcomes

- Close calls: Frequency of close calls
  Drivers were asked to report the frequency of close calls or near misses due to fatigue (a) at terminals, (b) at destinations, (c) in urban areas or on secondary roads, and (d) while driving on interstate or major highways. Response options for each location ranged from (1) never to (5) very frequently. Responses were summed to yield a theoretical range of 4 to 20 and an observed range of 4 to 13.
- Self and others perceptions of fatigue
  Drivers were asked to report the frequency with which they believed each of the following six fatigue-related items occurred:

Experience a "close call" or "near miss" because you are less than fully alert?
Nod off while driving?
Think fatigue is a problem for you when you are driving?
Find yourself continuing to drive when you are less than fully alert?
Think fatigue is a problem for other CMV drivers **in your company**?
Think fatigue is a problem for CMV drivers in general, throughout the industry?

  Response options ranged from (1) never to (5) very frequently. Responses were summed to yield a theoretical range of 6 to 30 and an observed range of 6 to 24.

- Crash Involvement
  Drivers were asked to report the number of reportable and preventable accidents they had while working over the last two years. These responses were summed and normalized to adjust for the amount of driving exposure experienced by the driver. The number of accidents per 100,000 miles of driving was used. The observed range was 0 to 9.62 accidents per 100,000 miles driven.

CMV Driving Environments

Regularity of Time

- Driving same hours: Estimate of time driving same hours
  Drivers were asked how often they start and stop driving nearly the same time each day. Response options ranged from (1) never or rarely to (2) sometimes, frequently or always, yielding theoretical and observed ranges between 1 and 2.
- Number of time zones: Number of different 6-hour time zones spent driving
  Drivers were asked to estimate those time zones that they spent more than 10 percent of their time driving in using the following cut points: (a) 6:00 am to noon, (b) Noon to 6:00 pm, (c) 6:00 pm to midnight, and (d) Midnight to 6:00 am. Theoretical and observed responses ranged from 1 to 4.

Trip Control

- Regularity of route
  Drivers were asked which of four statements best described their routes. Drivers who characterized their routes as the same route nearly every time, several different routes driven often, or a mix of regular or irregular routes were coded as "1" while drivers indicating that they drove a wide variety of different routes were coded "2". Theoretical and observed responses ranged from 1 to 2.

- Choose own routes: Freedom to choose own routes
  Drivers were asked the extent to which they were given flexibility to choose routes using a (1) to a very little extent to (7) to a very large extent response option framework. Drivers answering 1 to 4 were coded as "1", low flexibility, while drivers answering 5 to 7 were coded as "2", high flexibility. Theoretical and observed responses ranged from 1 to 2.
- Difficulty in finding a place to rest
  Drivers were asked how often they had difficulty finding a safe place to stop for rest or sleep. Response options ranged from (1) never or rarely to (2) sometimes, frequently or always, yielding theoretical and observed ranges between 1 and 2.
- Schedule delays
  Drivers were asked to estimate the percent of their work time spent (a) waiting and (b) in traffic delays. These two responses were summed generating a theoretical range of 0 to 200 percent. The observed range however was only 0 to 65 percent.
- Avg, stops per day: Average number of stops per day
  Drivers were asked how many stops for arrivals and departures do you make in an average day. Drivers reporting 1 to 4 stops per day were coded as "1" while drivers reporting more than 4 stops were coded as "2". Theoretical and observed responses ranged from 1 to 2.

Quality of Rest

- Sleep at night: Extent of sleep at nighttime
  Drivers were asked how often they were able to get their sleep at nighttime. Response options ranged from (1) never, rarely, or sometimes to (2) frequently or always, yielding theoretical and observed ranges between 1 and 2.
- Uninterrupted sleep: Number of hours uninterrupted sleep
  Drivers were asked how many hours of continuous, uninterrupted sleep they got during a 24-hour period when they were working. Drivers getting 5 or less hours of sleep were coded as "1" while driver getting more than 5 hours of sleep were coded as "2". Theoretical and observed responses ranged from 1 to 2.
- Frequency at home: Recovery time at home
  Drivers were asked how frequently they typically got home for "off-duty" (recovery) days. Drivers who did not get home every day were coded "1" while drivers who did get home every day were coded '2". Theoretical and observed responses ranged from 1 to 2.
- Start workweek tired: Start work tired
  Drivers were asked how often they began a new "workweek" feeling tired or fatigued. Response options ranged from (1) never or rarely to (2) sometimes, frequently or always, yielding theoretical and observed ranges between 1 and 2.

Economic Pressures

Scheduling Demands of Commerce

- Freq. Inverted schedules: Extent to which drivers experience inverted schedules
  Safety directors were asked the extent to which drivers experienced inverted duty/rest cycles, using a (1) to a very little extent to (7) to a very large extent response option framework. Theoretical and observed responses ranged from 1 to 7.
- Percent tour organizers: Percent business from tour organizers
  Safety directors were asked what percent of their company's business came from tour organizers. Theoretical and observed responses ranged from 0 to 100 percent.

- Percent time boarding: Percent of time spent on non-driving activities (e.g., boarding)
  Drivers were asked to estimate the percent of their work time spent on boarding and unboarding activity. The theoretical range of this response was 0 to 100 percent while the observed range was 1 to 50 percent.

Driver Economic or Personal Factors

- Drive for income: Drive tired to make good income
  Drivers were asked the extent to which they drive when they are tired in order to make a good income, using a (1) to a very little extent to (7) to a very large extent response option framework. Theoretical and observed responses ranged from 1 to 7.
- Driver arrival compensation: Rewards for on-time arrivals
  Safety directors were asked if drivers could earn additional compensation for on-time arrivals, with "no" responses coded as "0" and "yes" responses coded as "1". Theoretical and observed responses ranged from 0 to 1.
- Driver arrival penalty: Rewards (penalties) for on-time (late) arrivals
  Drivers were asked whether any of six possible penalties (e.g., verbal criticism, loss of bonus money) for late arrivals were used by their companies, with "no" responses to each item coded as "0" and "yes" responses coded as "1". Theoretical and observed responses ranged from 0 to 6.
- Driver safety compensation: Rewards for safe driving performance
  Drivers were asked the extent to which their company rewarded safe driving by (a) recognition programs and (b) financial incentives using a (1) to a very little extent to (7) to a very large extent response option for each possible reward. The responses to the two items were summed, generating theoretical and observed scores of 2 to 14.
- Pride in being on time: Personal pride in on-time arrivals
  Drivers were asked the extent to which they took personal pride in making arrivals on-time, using a (1) to a very little extent to (7) to a very large extent response option framework. Theoretical and observed responses ranged from 1 to 7.

Carrier Economic Factors

- Pressure on drivers to accept trips: Company emphasizes financial over safety performance
  Drivers were ask to indicate their level of agreement with the following four statements using a (1) to a very little extent to (7) to a very large extent response option for each:

a.	You are pressured by your dispatcher to continue driving when you know you are tired?
b.	You are pressured by your dispatcher to accept a trip when you know you are tired?
c.	You are pressured by your dispatcher to accept a trip when you know you will be "out of hours" before you can reach your destination?
d.	Dispatchers in this company place a higher priority on arriving on- time than driver safety?

Response options were summed and yielded a theoretical and observed range of 4 to 28.

- Pressure to bend rules: Company emphasizes financial over safety performance
  Drivers were asked the extent to which they have to bend a driving safety rule or policy in order to "get the job done", using a (1) to a very little extent to (7) to a very large extent response option framework. Theoretical and observed responses ranged from 1 to 7.
- Pressure to dispatch trips: Company emphasizes financial over safety performance
  Safety directors were asked the extent to which dispatchers place a higher priority on keeping schedules than on driver safety, using a (1) to a very little extent to (7) to a very large extent response option framework. Theoretical and observed responses ranged from 1 to 7.

- Ask drivers to overlook rest: Company emphasizes financial over safety performance
  Dispatchers were asked the extent to which they ask drivers to "overlook" rest requirements so that they could accept a trip, using a (1) to a very little extent to (7) to a very large extent response option framework.. Theoretical and observed responses ranged from 1 to 7.
- Dispatcher efficiency (eff.) evaluation: Rewards/penalties for dispatchers based on operating efficiency
  Dispatchers were asked whether they were evaluated on (a) the average number of miles driven per driver and (b) minimizing deadhead miles, with "no" responses to each item coded as "0" and "yes" responses coded as "1". Responses were summed, and theoretical and observed responses ranged from 0 to 2.
- Dispatcher safety evaluation: Rewards/penalties for dispatchers for safe driving
  Dispatchers were asked whether they were rewarded or penalized for accident free miles by drivers or drivers' chargeable accidents, with a "no" response coded as "0" and a "yes" response coded as "1". Theoretical and observed responses ranged from 0 to 1.

Carrier Support for Driving Safety

- Safe driving culture
  Drivers were given eleven statements regarding company safety culture for which they were asked to report their level of agreement using a (1) to a very little extent or strongly disagree to (7) to a very large extent or strongly agree response option framework. These statements are listed below:

Our company makes driving safety a top priority.
Driving safety is an important concern at this company.
I am satisfied with the amount of emphasis this company places on driving safety.
Drivers and management openly discuss issues related to driver fatigue.
This company is interested in driver input on driving safety matters.
Drivers provide useful insights into driver fatigue issues.
Driver input has played an important role in setting company policies pertaining to driver fatigue.
You can go to the person in charge of safety (or the operations manager) if you are pressured by your dispatcher to drive when you are tired?
Drivers in your company have opportunities to make suggestions and voice complaints regarding safety and fatigue?
Your company acts on suggestions and complaints made by drivers concerning safety and fatigue?
Top management at your company is committed to driving safety?

  Responses were summed to yield a theoretical range of 11 to 77 and an observed range of 19 to 77.

- Voluntary attendance: Safety training and meetings
  Safety directors were asked to describe their company policy with respect to attendance at (a) on-going safety training and (b) safety meetings. Response options were (1) drivers are required to attend, (2) drivers are encouraged to attend, and (3) driver attendance is voluntary. The response to these two items were summed, and yielded a theoretical and observed range of 2 to 6.
- Paid attendance: Safety training and meetings
  Safety directors were asked to describe their company policy with respect to paying drivers to attend (a) on-going safety training and (b) safety meetings. Response options were (0) no and (1) yes. The response to these two items were summed, and yielded a theoretical and observed range of 0 to 2.

- Driver autonomy re tiredness: Driver autonomy with respect to tiredness
  Safety directors were asked to evaluate the extent to which they believe that their (a) top management and (b) dispatchers believe that drivers are the best judges of whether or not they are too tired to drive. A (1) to a very little extent to (7) to a very large extent response option framework was used and the two items were summed. The theoretical and observed responses ranged from 2 to 14.
- Co. policy minimizes nighttime driving: Company policies which minimize nighttime driving
  Drivers were asked to indicate whether or not their company acted to minimize driving at night. Response options were (0) "no" and (1) "yes". The response to this item yielded a theoretical and observed range of 0 to 1.

For more information on the Federal Motor Carrier Safety Administration and the Office of Research and Technology, check our website at www.fmcsa.dot.gov.

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