INSURANCE INSTITUTE
FOR HIGHWAY SAFETY

August 4, 2000

The Honorable Clyde J. Hart, Jr.
Acting Deputy Administrator
Federal Motor Carrier Safety Administration
U.S. Department of Transportation
400 Seventh Street, S.W.
Washington, D.C. 20590

49 CFR Part 395
Hours of Service of Commercial Drivers
Docket No. FMCSA 97-2350

Dear Mr. Hart:

The Insurance Institute for Highway Safety strongly supports major provisions of the Federal Motor Carrier Safety Administration's (FMCSA) notice of proposed rulemaking concerning the hours of service of commercial drivers, but we oppose some aspects of the proposal. The Institute applauds the proposed requirement for tamper-resistant automated time record systems and the proposed minimum daily rest time of 12 hours. Implementing these two requirements would be a major safety advance for truck drivers and those who share the road with them. Notwithstanding our strong opposition to extending permissible driving time from 10 hours to 12 hours, which may increase large truck crash involvement rates, we expect that the net safety effects of the rule, as proposed, would be positive.

The Insurance Institute for Highway Safety (IIHS) is a nonprofit research and communications organization, sponsored by auto insurers, that identifies ways to reduce deaths, injuries, and property damage from motor vehicle crashes. We have published scientific research concerning the problem of fatigued commercial drivers in peer-reviewed journals (Braver et al., 1992; Hertz, 1991; Jones and Stein, 1987, 1989) and have submitted numerous reviews of the scientific evidence relating to fatigue and hours of service to the U.S. Department of Transportation (IIHS, 1992, 1995, 1997, 1998a, 1998b, 1998c, 1999a). Our positions and concerns are explained in more detail below.

Fatigue-Impaired Driving Contributes to Many Large Truck Crashes
Numerous scientific studies have observed an increased crash risk among drivers operating large trucks for more than 8-10 hours (Campbell, 1988; Frith, 1994; Harris, 1978; Jones and Stein, 1987, 1989; Kaneko and Jovanis, 1992; Lin et al., 1993, 1994; Mackie and Miller, 1978;

1005 N. GLEBE RD. ARLINGTON, VA 22201-4751 PHONE 703/247-1500 FAX 703/247-1678
email iihs@highwaysafety.org website http://www.highwaysafety.org

National Transportation Safety Board, 1995; Saccomanno et al., 1995, 1996; Summala and Mikkola, 1994), even after controlling for the effects of time of day (Frith, 1994; Jones and Stein, 1987, 1989; Lin et al., 1993, 1994; Saccomanno et al., 1995, 1996). Increased crash risks associated with long hours of driving have been reported as twofold or higher (Frith, 1994; Jones and Stein, 1987, 1989; Lin et al., 1993, 1994; Saccomanno et al., 1995, 1996).

FMCSA estimates that fatigue contributes to 15 percent of fatal and nonfatal injury crashes involving large trucks (65 FR 25546). The agency's estimate is reasonable, based on the increased crash risks cited above and the proportion of driving hours in excess of 8-10 hours (see Lilienfeld and Stolley, 1994, for the formula to estimate the proportion of an outcome attributable to a risk factor). In three surveys of driving hours, percentages of drivers reporting they routinely drove trucks for more than 10 hours at a stretch or for more than 70 hours during a week ranged from 20 to 25 percent (Braver et al., 1992; Campbell and Belzer, 2000; McCartt et al., 2000).

FMCSA states that "the number of fatigue-related PDO [property damage only] crashes is probably small" (65 FR 25547). No research is cited to support this statement. On the contrary, many studies that show a relationship between long driving hours and increased crash risk were based on police-reported large truck crashes, which primarily consist of property-damage-only crashes (Frith, 1994; Jones and Stein, 1987, 1989; Lin et al., 1993, 1994; Saccomanno et al., 1995, 1996). FMCSA has underestimated the benefits of preventing fatigue-related property-damage-only crashes.

Tamper-Resistant Automated Recording of Driving Hours Must Be Required

The Institute commends FMCSA for proposing to mandate tamper-resistant electronic recording devices on vehicles of commercial drivers who spend at least one night away from home during their trips. Any efforts to improve the hours-of-service rules would be meaningless in the absence of a requirement for tamper-resistant recorders.

A great deal of data points to the need for electronic recorders. The studies cited above show significantly increased crash risk among drivers who have driven more than 8-10 hours, and there is ample evidence that the current driving hour limits are widely flouted (Beilock, 1995; Beilock and Capelle, 1987; Belman et al., 1998; Braver et al., 1992; Hertz, 1991; McCartt et al., 1997; McKane, 1994; Ouellet, 1994). Attached is a study that reports crash reductions among commercial vehicles equipped with onboard recorders, including a bus fleet equipped with an electronic recorder designed to record driving hours (Wouter and Bos, 2000).

Logbooks, the principal means of enforcing current hours-of-service rules, are easy to falsify. According to a survey of truck drivers, fewer than 20 percent thought logbooks reflected the hours most drivers work (Braver et al., 1992). Unlike logbooks, electronic recorders are reliable indicators of when trucks are in motion. Drivers and motor carriers have strong economic incentives to operate trucks longer than is safe (Campbell and Belzer, 2000; Ouellet, 1994); electronic recorders can supply the necessary counterbalance to these incentives.

Much of the opposition to the overall proposal actually is opposition to the prospect of having to adhere to the driving hour limits. A driver criticizing the proposed rule said, "It's not going to work because 80 percent of truckers don't run their log books legal now. If they did, nothing would get delivered" (Kelley, 2000). Changing a system that relies upon routine violations of work hour limits and excessive work hours is justifiable.

Electronic recorders are economically feasible, with the simpler models costing less than $1,000 per truck (IIHS, 1995; Reynolds, 2000). At least one electronic device costs less than $300 as original equipment and $500-600 if it is retrofitted to existing vehicles (Reynolds, 2000). The cost-effectiveness of electronic devices also is demonstrated by motor carriers' widespread adoption of onboard computers, wireless communication systems, and global positioning systems since the 1980s. Furthermore, most truck engines already contain electronic control modules that could be inexpensively modified to function as electronic logs (Vise, 1999).

A requirement for electronic recorders on commercial vehicles is long overdue. The Institute has repeatedly petitioned the U.S. Department of Transportation to require onboard recorders in large trucks to increase adherence to hours-of-service rules (IIHS, 1986, 1987, 1989, 1995). Other organizations have joined us in petitioning the Department of Transportation for electronic onboard recording devices: Advocates for Highway and Auto Safety, Parents Against Tired Truckers, Families Against Speeding Trucks, National Association of Governors' Highway Safety Representatives, and Public Citizen. Starting in 1990, the National Transportation Safety Board also recommended automated tamper-resistant onboard recording devices to monitor driving hours of commercial truck drivers. Another organization calling for mandatory onboard monitoring is the National Sleep Foundation (2000), which recognizes the relationship between excessive driving hours and sleep loss. In addition, some trucking industry representatives have come forward to support the use of electronic monitoring devices in lieu of paper logs, including the California Trucking Association (Barnes, 2000), Arkansas Trucking Association (2000), Werner Enterprises (Abry,

1998), T.F. Boyle Transportation (Whitten, 2000), and the president of Kenan Transport Company (Barnes, 1999).

Throughout the world -- including the 15 countries belonging to the European Union, Chile, Israel, Japan, South Korea, Turkey, and Venezuela -- onboard recorders are required for large commercial vehicles (Lehmann, 1999). The United States should stop lagging behind other countries in enforcement technology. FMCSA must strengthen the ability of state and federal authorities to enforce hours-of-service rules by requiring tamper-resistant automated recording devices on commercial vehicles.

Commercial Drivers Need at Least 12 Hours of Off-Duty Time Each Day
Scientific literature consistently indicates that sleep deprivation adversely affects task performance, including driving performance (National Sleep Foundation, 2000; Federal Highway Administration, 1998). Truck drivers frequently drive at night, and sleep deficits are especially prevalent among night workers in all occupations (Gold et al., 1992; Rosa, 1991; Rosa and Bonnet, 1993). The longer the work shifts, the greater the sleep losses each day and over the course of the work week (Rosa et al., 1989). Reductions in total sleep time are severe among workers on 12-hour night shifts (Rosa, 1991; Rosa and Bonnet, 1993).

Another reason for needing at least 12 hours off duty is that research has shown measurable performance impairments among workers who had only 12 hours of off-duty time per day compared with those having 16 hours off per day (Baker et al., 1994; Rosa, 1991; Rosa and Bonnet, 1993; Rosa and Colligan, 1988; Rosa et al., 1989). Impaired performance was observed among workers on 12-hour day and 12-hour night shifts (Rosa, 1991; Rosa and Bonnet, 1993; Rosa et al., 1989). Long work hours contribute to performance decrements even after controlling for the amount of sleep obtained (Rosa et al., 1989).

FMCSA's proposed 12 hours of off-duty time, including 10 consecutive hours of rest, is a sensible and reasonable compromise between the need for alert well-rested drivers and the productivity needs of the trucking industry. Employees at fixed work sites usually have a minimum of 15 hours off between the end of one work period and the beginning of the next. There is virtually universal consensus that the current 8-hour off-duty period for drivers is inadequate because it does not allow sufficient time for drivers to meet their personal needs and get enough sleep (American Trucking Associations, 1999; Federal Highway Administration, 1998; National Sleep Foundation, 2000).

The controversy seems to be how much additional rest time drivers need, with some advocating as little as 10 hours of off-duty time (American Trucking Associations, 1999; Detter, 2000). Both the National Sleep Foundation (2000) and the expert panel convened by the Federal Highway Administration (1998) recommended 12 hours of off-duty time. Optimally, drivers should sleep 8 hours. Having only 2 hours to attend to all other personal requirements is insufficient (Jaster, 2000). Truck drivers have the same needs as other human beings, and if they have no more than 10 hours of off-duty time per day, sleep inevitably will be shortchanged.

Driving More than 10 Hours Daily Increases Crash Risk

FMCSA has proposed to permit up to 12 hours of driving per day. Currently, truck drivers are allowed up to 10 hours of driving at a stretch. Driving a large truck safely for 10 hours is taxing, even under the best conditions. Driving 12 hours would place truck drivers and other road users at undue risk. About 85 percent of 1998 deaths in large truck crashes were among people sharing the road with large trucks (IIHS, 1999b). Driving should be recognized for what it is: a sedentary and often monotonous task requiring constant vigilance; momentary lapses of attention can have devastating consequences.

Current rules differentiate between driving and nondriving duties by limiting driving hours to 10 and specifying that no driving can occur after 15 total work hours. The proposal, however, sets an overall 12-hour work limit without making any distinction between driving and nondriving time. The rationale for eliminating the distinction between driving and nondriving duties is that "all on-duty time should be treated the same, as the effect on driver safety is similar" (65 FR 25561). It is true that all duties result in fatigue and that an overall work hour limit is appropriate, but it is not true that all duties have the same effect on driver safety. Deaths and serious injuries among truck occupants and other road users can occur only when the truck is in motion.

FMCSA has placed insufficient weight on studies of driving hours that observed increased large truck crash risk after 8-10 hours of driving, including studies that controlled for the effects of time of day (Frith, 1994; Jones and Stein, 1987, 1989; Lin et al., 1993, 1994; Saccomanno et al., 1995, 1996). Techniques used to control for the effects of time of day were matching cases and controls by time of the crash (Frith, 1994; Jones and Stein, 1987, 1989), multivariate analyses (Lin et al., 1993, 1994), and stratification of the study population by daytime and nighttime (Saccomanno et al., 1995, 1996). One strength of these studies relative to other analyses is that they used an objective definition of potential fatigue (driving more than 8-10 hours) rather than relying on subjective assessments made by investigating officers of whether a crash was related to fatigue.

Another strength is that these studies had comparison groups, enabling control of confounding effects from travel patterns and other variables.

FMCSA states there is uncertainty concerning the high odds ratio (OR=6.2) observed by Lin et al. (1994) for the 10th hour of driving. However, this does not negate the findings for previous driving hours. Controlling for time of day, the authors observed significant increases in the odds of crashing starting at the 5th hour of driving (OR=1.6) and continuing through the 9th hour (OR=2.5). These findings strongly suggest that driving more than 10 hours is unsafe.

Other studies have observed a relationship between long driving hours and falling asleep at the wheel of a large truck (Braver et al., 1992; IIHS, 1992; McCartt et al., 2000). Drivers reporting work hours longer than 60-70 per week or other hours-of-service violations were 1.8 times as likely to report falling asleep while driving during the month prior to their interview as drivers reporting fewer work hours (IIHS, 1992). McCartt et al. (2000) reported a significant correlation between driving more than 10 hours and having dozed while driving.

In addition, the research on crash risk and driving performance is consistent with findings in other work settings. Hanecke et al. (1998) observed an exponential increase in injuries beyond the 9th work hour for the German working population. Microsleeps in airline pilots "multiplied after 8 hours of flight time during the day-time operations" (Samel et al., 1997). Task performance is decreased among those working 12-hour shifts compared with 8-hour shifts (Baker et al., 1994), including studies that controlled for hour of day (Rosa, 1991; Rosa and Bonnet, 1993; Rosa and Colligan, 1988; Rosa et al., 1989). FMCSA cited three of the preceding studies (Rosa, 1991; Rosa and Bonnet, 1993; Rosa et al., 1989) as evidence that risk increases *after* the 12th hour of duty time (65 FR 25556); however, these studies indicated substantial decrements in skills *before* persons had worked a full 12 hours.

With regard to involvement in fatigue-related crashes, FMCSA reports relative risks of 1.6 for driving 8 hours, 1.9 for driving 9 hours, 3.4 for driving 10 hours, and even higher relative risks for driving more than 10 hours (Campbell and Belzer, 2000). Given the agency's analysis, together with other research, FMCSA's proposal to allow drivers to operate trucks for 12 hours is perplexing.

Perhaps FMCSA assumes that the proposed 12-hour off-duty period will make it safe for drivers to operate vehicles for more than 10 hours, but there is no sound evidence that this is the case. Existing driving simulator studies purporting to show this are limited by the small number of driver participants (Rogers, 1999) and serious

questions about generalizing simulator results to real-world conditions and driver behavior (National Highway Traffic Safety Administration, 1997). Twelve-hour work shifts result in impaired performance, independently of the amount of sleep obtained (Rosa et al., 1989). Increasing the off-duty period should make it safer for drivers to operate vehicles during 10-hour driving shifts. Fatigue-related impairment can occur long before the current 10-hour limit is reached.

The best method of keeping overall duty time close to the 12-hour limit proposed by FMCSA is to maintain the 10-hour driving limit, enforced by electronic recording devices. Apart from the risk of driving more than 10 hours, another problem with allowing drivers to operate trucks for 12 hours is that, judging from current practices, many drivers will not comply with the proposed 12-hour duty-time limit. Because drivers usually are not paid for nondriving duties, they avoid recording these duty hours so as to maximize the hours available for paid work (Campbell and Belzer, 2000; Owner-Operator Independent Drivers Association, 1997). Nondriving duties are considerable, averaging 15-40 hours each week (Braver et al., 1992; Campbell and Belzer, 2000; Martin Labbe Associates, 1998, 1999; McCartt et al., 1997). Under the proposed rule, it is likely that many drivers will drive 12 hours and spend additional hours on nondriving tasks such as unloading cargo. Electronic recording devices do an excellent job of automatically recording driving hours but rely on drivers' manual inputs of time spent on nondriving tasks, which can be falsified if the truck does not move during those tasks.

An alternative approach is to limit weekly cumulative driving hours to some quantity less than the proposed weekly maximum of 60 work hours. A limit of 50 driving hours for each 60 cumulative work hours would not guarantee adherence to the overall work hour limits, but it would decrease one of the most common types of time record falsification. Assuming that at least 10 hours of work time per week would be spent on nondriving tasks is conservative, based on the survey research cited above that reports nondriving tasks average 15-40 hours per week. An analogous policy has been adopted by safety inspectors: drivers operating trucks for distances greater than 550-600 miles during one driving shift, over roads where the maximum speed limit is 65 mph, are suspected of being in violation of either the speed limits or the 10-hour driving limit (Office of Safety Policy, 2000).

Will There Be More Trucks on the Road if the Proposal Is Implemented?
Trucking executives have testified there will be more trucks on the road and thus more crashes if the proposal is implemented (American Trucking Associations, 2000). This assertion is overly simplistic because increased exposure to truck traffic will not necessarily occur if the amount of freight remains the same. The proposed increase in

off-duty hours may affect a particular load in several possible ways: a driver may take longer to deliver it, may hand off the same load to another driver prior to taking required rest, or may team up with another driver. The same load of freight requiring a fixed number of driving hours to get from one place to another may or may not be divided among several drivers, but that load would not result in more exposure from multiple trucks traveling on the road at the same time. Depending on how motor carriers organize multiple pickups and deliveries, individual trips currently carried out by one truck driver may have the same, fewer, or more total hours of driving if additional drivers are utilized. The growing transportation logistics industry is developing networks of shippers and carriers to make more efficient use of drivers and trucks, which may reduce truck traffic (J.B. Hunt, 2000).

Another safety question raised by trucking industry executives is whether the proposed requirement for 2 nights off following 60 hours of work would lead to more trucks traveling during daylight hours (Birkhead, 2000). The proposal would allow drivers to start work at 7 a.m. if they have had at least 32 hours off spanning a period that would include 11 p.m. to 7 a.m. on 2 successive nights. Whether the proposed requirement for 2 nights off would result in more daytime truck traffic is questionable because current rules already require drivers to take several days off, including 3 nights, if they have reached maximum driving hour limits (60-70 hours over 7-8 days) within 5 days. Truck driver surveys indicate that many long-haul drivers currently reach maximum work hour limits before 5 days have elapsed and must take at least 3 days (and nights) off before they legally can drive again (Belman et al., 1998; IIHS, 1992).

FMCSA Should Clarify Some Aspects of the Hours-of-Service Proposal

Although the requirements of the proposal appear to be clear, questions have arisen at the public hearings concerning the proposed revision to the hours-of-service rules for commercial drivers (see Appendix for a list of questions). FMCSA must publish responses to these questions in the Federal Register and on its website to ensure that all interested parties understand the intended proposal. After this clarification is published, the Institute might have further comments on the proposal.

Summary

FMCSA has proposed a rule that should save lives and decrease injuries and property damage arising from large truck crashes. One provision of the proposal that may result in adverse safety consequences is the expansion of permissible driving shifts to 12 hours. The costs of the proposed rule are reasonable, given the proportion of crashes in which fatigue is a contributing factor and the estimated public health

benefits. Electronic recorders to monitor driving hours, which cost as little as $300-600, are essential to monitor compliance with hours-of-service limits; otherwise, the pattern of widespread violations of these limits will continue. Another provision critical to reducing fatigue-impaired driving among commercial drivers is the proposed increase in the daily mandatory rest period to 12 hours. If these two provisions are adopted, for the first time since the hours-of-service rules were promulgated more than 60 years ago, all drivers will be able to get a reasonable amount of rest on work days and will have to adhere to the driving hour limits.

Sincerely,

Elisa R. Braver

Elisa R. Braver, Ph.D.
Senior Epidemiologist

cc: The Honorable Rodney Slater
Docket Clerk, Docket No. FHWA-97-2350

Appendix

Attachment

Appendix
Questions About Hours-of-Service Proposal (65 FR 25540; May 2, 2000)

The Institute reads the proposed rule as unambiguously requiring that all the following requirements be met and that a motor carrier would not be in compliance with the proposed rule if Types 1-4 drivers were permitted to work longer than 60 hours over 7 days. Yet in public hearings the possibility was raised that compliance with the mandatory time-off requirements (32-56 hours that include 2 consecutive nights off) would relieve motor carriers of having to adhere to the maximum limit of 60 work hours over 7 days. FMCSA must respond to questions about the proposal that have arisen at the public hearings.

Requirements

- A maximum of 60 work hours over 7 days
- A daily maximum of 12 work hours within 14 consecutive hours
- A 7-day workweek that is fixed and recurs regularly
- An extended off-duty period of at least 32-56 consecutive hours that spans a minimum of two 11 p.m. to 7 a.m. periods before the beginning of a new workweek (hereafter referred to as a "weekend" although it may occur on weekdays)

Questions

1. Is the limitation of 60 work hours over 7 days absolute for drivers (Types 1-4) except for Type 1 drivers averaging work hours over 2 successive weeks? Or may a driver who has had the requisite "weekend" begin working again before the 7-day workweek has concluded?

   For example, suppose a driver with an assigned workweek of Monday-Sunday works 12 hours a day for 5 days starting on Monday and is released from work by 11 p.m. on Friday. Can that driver go back to work on Sunday at 7 a.m., or does that driver have to wait until Monday before starting work again?

2. May a driver take the extended off-duty period ("weekend") in the middle of the 7-day workweek, rather than at the end of it, and then start working again on the first day of the next workweek?

   For example, may a driver with a regular Monday-Sunday workweek work 12 hours on Monday and 12 hours on Tuesday, go off duty at 11 p.m. Tuesday night until 7 a.m. Friday morning, work 12 hours each day on Friday, Saturday, and Sunday, and then start working again on the following Monday, the first day of the next workweek? Such a driver would have worked no more than 60 hours over 7 days and would have had a "weekend" in the middle of that workweek.

References

Abry, G. 1998. Satellite logs get trial run in FHWA plan. *Transport Topics* (April 13, 1998):1,28.

American Trucking Associations (Walter B. McCormick, Jr.). 2000. DOT's hours of service proposal is a 'recipe for disaster.' Alexandria, VA. Available at http://www.truckline.com/insideata/comments/070600_wbm_fmcsatest.html. Accessed July 7, 2000.

American Trucking Associations. 1999. Recommendations for future hours of service rules. Submitted to U.S. Department of Transportation and Office of Management and Budget. Alexandria, VA.

Arkansas Trucking Association. 2000. Arkansas Trucking Association adopts hours-of-service policy. Little Rock, AR. Available at http://www.arkansastrucking.com/news.html. Accessed June 2, 2000.

Baker, K.; Olson, J.; and Morisseau, D. 1994. Work practices, fatigue, and nuclear power plant safety performance. *Human Factors* 36:244-57.

Barnes, D. 1999. Shaffer embraces 'black boxes.' *Transport Topics* (November 8, 1999):1,27.

Barnes, D. 2000. California group backs recorders. *Transport Topics* (July 17, 2000):52.

Beilock, R. 1995. Schedule-induced hours-of-service and speed limit violations among tractor-trailer drivers. *Accident Analysis and Prevention* 27:33-42.

Beilock, R. and Capelle, R.B. 1987. Economic pressure, long distance trucking, and safety. *Journal of the Transportation Research Forum* 28:177-85.

Belman, D.L.; Monaco, K.A.; and Brooks, T.J. 1998. And Lord, let it be palletized: a portrait of truck drivers' work and life. Ann Arbor, MI: University of Michigan Trucking Industry Program.

Birkhead, P. 2000. Testimony regarding the Department of Transportation's proposed driver hours-of-service regulation before the House Transportation and Infrastructure Ground Transportation Subcommittee. Alexandria, VA: Snack Food Association.

Braver, E.R.; Preusser, C.W.; Preusser, D.F.; Baum, H.M.; Beilock, R.; and Ulmer, R. 1992. Long hours and fatigue: a survey of tractor-trailer drivers. *Journal of Public Health Policy* 13:341-66.

Campbell, K.L. 1988. Evidence of fatigue and the circadian rhythm. *Proceedings of Federal Highway Administration Symposium on Truck and Bus Driver Fatigue,* 20-38. Washington, DC: U.S. Department of Transportation.

Campbell, K.L. and Belzer, M.H. 2000. Hours of service regulatory evaluation analytical support. task 1: baseline risk estimates and carrier experience. Prepared for the Federal Motor Carrier Safety Administration (UMTRI-2000-11). Ann Arbor, MI: University of Michigan.

Detter, G.L. 2000. Testimony before the House Transportation and Infrastructure Committee, Ground Transportation Subcommittee. Available at http://www.truckline.com/legislative/testimony/062600_detter.html. Accessed July 7, 2000.

Federal Highway Administration. 1998. Potential Hours-of-Service Regulations for Commercial Drivers: Report of the Expert Panel on Review of the Federal Highway Administration Candidate Options for Hours of Service Regulations. Washington, DC: U.S. Department of Transportation.

Frith, W.J. 1994. A case-control study of heavy vehicle drivers' working time and safety. *Proceedings of the 17th Australian Road Research Board Conference* 17:17-30. Queensland, Australia: Australian Road Research Board.

Gold, D.R.; Rogacz, S.; Bock, N.; Tosteson, T.D.; Baum, T.M.; Speizer, F.E.; and Czeisler, C.A. 1992. Rotating shift work, sleep, and accidents related to sleepiness in hospital nurses. *American Journal of Public Health* 82:1011-14.

Hanecke, K.; Tiedemann, S.; Nachreiner, F.; and Grzech-Sukalo, H. 1998. Accident risk as a function of hour at work and time of day as determined from accident data and exposure models for the German working population. *Scandinavian Journal of Work, Environment, and Health* 24(suppl. 3):43-48.

Harris, W. 1978. Fatigue, circadian rhythm, and truck accidents. *Vigilance: Theory, Operational Performance, and Physiological Correlates* (ed. Mackie, R.), 133-46. New York, NY: Plenum Press.

Hertz, R.P. 1991. Hours of service violations among tractor-trailer drivers. *Accident Analysis and Prevention* 23:29-36.

Insurance Institute for Highway Safety. 1986. Petition to require automatic on-board recording devices for motor carriers. Submitted to the Bureau of Motor Carrier Safety (October 1, 1986). Washington, DC: U.S. Department of Transportation.

Insurance Institute for Highway Safety. 1987. Petition for reconsideration to require automatic on-board recording devices for motor carriers. Submitted to the Federal Highway Administration (February 25, 1987). Washington, DC: U.S. Department of Transportation.

Insurance Institute for Highway Safety. 1989. Petition to require automatic on-board recording devices for motor carriers transporting hazardous materials. Submitted to the Federal Highway Administration (December 20, 1989). Washington, DC: U.S. Department of Transportation.

Insurance Institute for Highway Safety. 1992. Comments submitted to the Federal Highway Administration. Docket No. MC-92-30 (November 4, 1992). Washington, DC: U.S. Department of Transportation.

Insurance Institute for Highway Safety. 1995. Petition to require electronic onboard recording devices for motor carriers. Submitted to the Federal Highway Administration (August 3, 1995). Washington, DC: U.S. Department of Transportation.

Insurance Institute for Highway Safety. 1997. Comments submitted to the Federal Highway Administration. Docket No. FHWA-97-2350 (June 30, 1997). Washington, DC: U.S. Department of Transportation.

Insurance Institute for Highway Safety. 1998a. Comments submitted to the Federal Highway Administration. Docket No. FHWA-97-2350 (January 27, 1998). Washington, DC: U.S. Department of Transportation.

Insurance Institute for Highway Safety. 1998b. Comments submitted to the Federal Highway Administration. Docket No. FHWA-97-3706 (June 19, 1998). Washington, DC: U.S. Department of Transportation.

Insurance Institute for Highway Safety. 1998c. Comments submitted to the Federal Highway Administration. Docket No. FHWA-97-2350 (August 27, 1998). Washington, DC: U.S. Department of Transportation.

Insurance Institute for Highway Safety. 1999a. Comments submitted to the Federal Highway Administration. Docket No. FHWA-97-2350 (July 30, 1999). Washington, D.C.: U.S. Department of Transportation.

Insurance Institute for Highway Safety. 1999b. Fatality facts: large trucks. Available at http://www.highwaysafety.org/safety_facts/fatality_facts/trucks.htm. Accessed July 20, 2000.

Jaster, W. 2000. Eight is not enough (letter to the editor). *RoadStar* 2:12.

J.B. Hunt, Inc. 2000. Six of the Nation's Largest Transportation Companies Merge Logistics Businesses in New Internet Venture, Transplace.com, to Maximize Marketing, Utilization, and Purchasing Efficiencies. Available at http://www.jbhunt.com/Newsroom/Transplace/transplace.html. Accessed August 3, 2000.

Jones, I.S. and Stein, H.S. 1987. Effect of driver hours of service on tractor-trailer crash involvement. Arlington, VA: Insurance Institute for Highway Safety.

Jones, I.S. and Stein, H.S. 1989. Defective equipment and tractor-trailer crash involvement. *Accident Analysis and Prevention* 21:469-81.

Kaneko, T. and Jovanis, P.P. 1992. Multiday driving patterns and motor carrier accident risk: a disaggregate analysis. *Accident Analysis and Prevention* 24:437-56.

Kelley, S. 2000. Industry bristles over hours reduction, on-board recorders. *Overdrive* 40:36-40.

Lehmann, G. 1999. Highway recording systems: a report on European and U.S. experiences. International Symposium on Transportation Recorders. Crystal City, VA: National Transportation Safety Board and International Transportation Safety Association.

Lin, T.D.; Jovanis, P.P.; and Yang, C.Z. 1993. Modeling the safety of truck driver service hours using time-dependent logistic regression. *Transportation Research Record* 1407:1-10. Washington, DC: Transportation Research Board.

Lin, T.D.; Jovanis, P.P.; and Yang, C.Z. 1994. Time of day models of motor carrier accident risk. *Transportation Research Record* 1467:1-8. Washington, DC: Transportation Research Board.

Lilienfeld, D.E. and Stolley, P.D. 1994. *Foundations of Epidemiology*, 3rd ed. New York, NY: Oxford University Press.

Mackie, R.R. and Miller, J.C. 1978. Effects of hours of service, regularity of schedules, and cargo loading on truck and bus driver fatigue (DOT HS-803-799). Washington, DC: National Highway Traffic Safety Administration.

Martin Labbe Associates. 1998. *National Refrigerated Driver Survey*. Ormond Beach, FL.

Martin Labbe Associates. 1999. *1999 Dry Van Drivers Survey*. Ormond Beach, FL.

McCartt, A.T.; Hammer, M.C.; and Fuller, S.Z. 1997. Work and sleep/rest factors associated with driving while drowsy experiences among long-distance truck drivers. *Proceedings of the 41st Annual Conference of the Association for the Advancement of Automotive Medicine*, 95-108. Des Plaines, IL: Association for the Advancement of Automotive Medicine.

McCartt, A.T.; Rohrbaugh, J.W.; Hammer, M.C.; and Fuller, S.Z. 2000. Factors associated with falling asleep at the wheel among long-distance truck drivers. *Accident Analysis and Prevention* 32:493-504.

McKane, D. 1994. Three-state effort enforces hours of service regulations. *The Guardian* 1:4-5.

National Highway Traffic Safety Administration. 1997. An investigation of the safety implications of wireless communications in vehicles (DOT HS-808-635). Washington, DC: U.S. Department of Transportation.

National Sleep Foundation. 2000. Position statement regarding hours-of-service rules for commercial drivers and fatigue interventions/ countermeasures. Washington, DC.

National Transportation Safety Board. 1990. Fatigue, alcohol, other drugs, and medical factors in fatal-to-the-driver heavy truck crashes (vol. I). NTSB/SS-90-01. Washington, DC: National Transportation Safety Board.

National Transportation Safety Board. 1995. Factors that affect fatigue in heavy truck accidents (vol. I). NTSB/SS-95-01. Washington, DC: National Transportation Safety Board.

Office of Safety Policy. 2000. Interpretation and guidance for compliance officers (unpublished information). Alexandria, VA: American Trucking Associations.

Ouellet, L.J. 1994. The work lives of truckers. *Pedal to the Metal*. Philadelphia, PA: Temple University Press.

Owner-Operator Independent Drivers Association. 1997. Comments in response to advance notice of proposed rulemaking concerning hours of service regulations. Submitted to Federal Highway Administration. Washington, DC.

Reynolds, T. 2000. Hours of service of drivers. Testimony before the Federal Motor Carrier Safety Administration. Winchester, VA: VDO North America.

Rogers, W.C. 1999. Effects of operating practices on commercial driver alertness. Presented at Traffic Safety of Two Continents, Malmo, Sweden. Alexandria, VA: ATA Foundation.

Rosa, R.R. 1991. Performance, alertness, and sleep after 3-5 years of 12 h shifts: a follow-up study. *Work and Stress* 5:107-16.

Rosa, R.R. and Bonnet, M.H. 1993. Performance and alertness on 8 and 12 h rotating shifts at a natural gas utility. *Ergonomics* 36:1177-93.

Rosa, R.R. and Colligan, M.J. 1988. Long workdays versus restdays: assessing fatigue and alertness with a portable performance battery. *Human Factors* 30:305-17.

Rosa, R.R.; Colligan, M.J.; and Lewis, P. 1989. Extended workdays: effects of 8-hour and 12-hour rotating shift schedules on performance, subjective alertness, sleep patterns, and psycho-social variables. *Work and Stress* 3:21-32.

Saccomanno, F.F.; Yu, M.; and Shortreed, J.H. 1995. Effect of driver fatigue on truck accident rates. *Urban Transport and the Environment for the 21st Century* (ed. Sucharov, L.J.), 439-46. Southampton, United Kingdom: Computational Mechanics Publications.

Saccomanno, F.F.; Shortreed, J.H.; and Yu, M. 1996. Effect of driver fatigue on commercial vehicle accidents. *Truck Safety: Perceptions and Reality*, 157-74. Waterloo, Canada: The Institute for Risk Research.

Samel, A.; Wegmann, H.M.; and Vejvoda, M. 1997. Aircrew fatigue in long-haul operations. *Accident Analysis and Prevention* 29:439-52.

Summala, H. and Mikkola, T. 1994. Fatal accidents among car and truck drivers: effects of fatigue, age, and alcohol consumption. *Human Factors* 36:315-26.

Vise, A. 1999. Big brother under your hood. *Trucking Co.* (December, 1999):7.

Whitten, D.L. 2000. Black boxes and the small carrier. *Transport Topics* (June 26, 2000):1,13-14.

Wouters, P.I.J. and Bos, J.M.J. 2000. Traffic accident reduction by monitoring driver behaviour with in-car data recorders. *Accident Analysis and Prevention* 32:643-50.