Trainees watch an instructor demonstrate how to back up a truck.
Heavy vehicle drivers must continuously process and react to a variety of information, and even momentary lapses in concentration can cause an accident. The behavior of other drivers, the vehicle, roadway design, and the traffic environment all can distract the driver, as can other factors such as carrier management attitudes and policies or economic and scheduling pressures. Human error is cited as the cause of over 60 percent of motor carrier accidents.

Although the Federal Government has focused on some aspects of vehicle and highway design, it has given inadequate attention to the interacting and subtle human factors that affect motor carrier safety. This chapter describes driver performance and explores the relationships between human factors and truck safety, describing industry safety programs and identifying Federal policy options.

**THE DRIVER**

The typical human information processing sequence includes receiving information, recognizing and evaluating it, reaching a decision, and taking action—all within a very short time period. (See figure 6-1.) An alert driver can process information in less than 2 seconds when confronted with an unexpected hazard in the roadway. However, fatigue or other impairment affects both the speed of the driver's mental processes and the accuracy of his judgment. The continual changes in the roadway, environment and the special skills required in stopping and maneuvering heavy trucks suggest that a competent heavy truck driver should be well trained, experienced, and alert.

**Driver Screening**

Driving a heavy vehicle demands greater skills than operating a passenger car, both in normal driving situations and in responding to potential hazards. Heavy trucks are less easily maneuvered than automobiles, requiring greater distances for passing, stopping, turning, and accelerating, and forcing drivers to anticipate and avoid potential traffic conflicts. Thus, a safety-conscious carrier manager will take seriously the task of identifying and hiring drivers with appropriate skills, attitudes, and training.

U.S. Department of Transportation (DOT) requirements for carrier hiring procedures are broad enough to permit wide variations in company practices. All driver applicants must complete a written application and must take a road test and a written test. However, DOT gives no clear guidelines for what constitutes “passing” either test. In fact, DOT does not require that the knowledge test be passed, only that the applicant be told the correct answer for the items missed. (For further details on requirements, see chapter 3.) In practice, even these regulations are ignored by some carriers or interpreted with considerable latitude. Commercial Driver’s License Program tests will determine whether a prospective driver has the minimal level of skills to operate a heavy truck. However, the carrier management’s evaluation of a driver’s background and skills will remain the dominant hiring standard.

Many carriers devote careful attention to driver hiring, requiring reference checks, referrals, drug screening, and interviews, over and above the back-
ground checks and pre-employment physical examinations that DOT requires. Thorough prehiring evaluation can pay major dividends for management. One company uses a carefully developed test to help determine which applicants have the coordination, physical capability, and mental attitude to handle a tractor-trailer combination. The company has found a very strong correlation between the driving skill level exhibited during the evaluation and driver performance after hirings. Moreover, when a driver eventually does have an accident, the cause is frequently a driving behavior characteristic that the test had identified as needing improvement. Such a diagnostic tool can provide a carrier with invaluable information to use in both initial driver training and retraining.

Automotive safety research shows that those who indicate on a screening test that they are risk-takers are likely to be relatively aggressive in their driving behavior, less mindful of cautions about safety, and more likely to drive longer hours without rest. On the other hand, risk averse drivers, though not necessarily more skilled, are likely to give other highway users a way out in dangerous road situations and to show prudence in their driving decisions. However, not all carriers understand the benefits of careful screening—a DOT study of carriers rated unsatisfactory in the Pacific Northwest found that 35 percent of the firms had unsatisfactory driver qualification procedures.

Although driving a truck requires different skills than driving a car, one study that examined the relationship between a truck driver's driving records in his personal vehicle and in his truck found a strong similarity between the records. OTA analysis of the National Accident Sampling System data also shows that heavy truck drivers involved in accidents have received citations for previous safety violations, particularly for speeding (see figure 6-2). However, the prior record in the truck is a better predictor than either the record in the private vehicle or the total record including both private and commercial driving.

Management interest in more stringent screening procedures may be thwarted by demographic and economic pressures. The Department of Labor reports that the truck driving work force is expected to increase 17.2 percent by 1995, placing truck driving among the 37 fastest growing occupations out of 500 studied. At the same time, industry analysts forecast that finding qualified truck drivers will become more difficult over the next decade, with a 30-percent reduction in the available driver pool expected by 1992. This reduction will be due to retirements, drug screening, tighter Federal driver requirements and licensing standards, a shrinking national labor force, and the perception that truck driving is a high-stress job requiring excessive time

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**Figure 6-2. Incident History of Heavy Truck Drivers Involved in Accidents**

![Graph showing incident history of heavy truck drivers involved in accidents.](image)

KEY: DWI = Driving while intoxicated.

SOURCE: Office of Technology Assessment, 1988; based on National Accident Sampling System data.

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*Shirley B. Geisinger et al., The Relationship Between a Truck Driver's Performance in a Personal Vehicle and in a Large Truck (Chapel Hill, NC: University of North Carolina, Highway Safety Research Center, June 1986).

away from home.\textsuperscript{11} Truck driver wages rose just over 20 percent between 1979 and 1987, as compared to a rise of almost 50 percent for all occupations.\textsuperscript{13}

To meet its needs, industry may have to resort to nontraditional labor sources, such as women and minorities, and increase wages. Recent proposals to allow 18- to 20-year-olds to operate commercial vehicles and heavy trucks as on-the-job trainees are a result of the shrinking driver pool. These proposals raise safety concerns, since accident statistics point directly at young drivers as a high-risk group.

Thus, although the importance of the selection process in screening out unqualified drivers is well recognized by many carriers, the need for personnel may cause the numbers of problem drivers behind the wheel to grow. Steps may be required to bolster application of uniform and stringent driver selection practices throughout the industry.

Alcohol and Drug Use Among Drivers

Although currently being revised, Federal Motor Carrier Safety Regulations now prohibit possessing, being under the influence of, or using an intoxicating beverage or drug while on duty, or consuming an intoxicating beverage within 4 hours of going on duty. Furthermore, a person is not qualified to drive if he or she has a current clinical diagnosis of alcoholism or drug dependency. These rules were based on the knowledge that driving performance is directly affected by intoxication or the influence of drugs. While the reaction to the ingestion of drugs and alcohol varies depending on the individual,\textsuperscript{13} studies show that, for the majority, human performance is degraded by blood-alcohol concentration (BAC) levels of 0.05 or even lower. Epidemiological studies also indicate that the risk of being involved, as well as at-fault, in a motor vehicle accident begins increasing at low BAC levels.\textsuperscript{13} This is in contrast to a legal standard for intoxication in highway driving currently set at 0.10 BAC in most States.\textsuperscript{15}

Many of these research findings are based on automobile driving performance, and heavy vehicle drivers operate more complicated equipment on roadways often designed for smaller vehicles. Previous studies suggest that although more skilled persons are better able to compensate for the effects of alcohol than those less skilled, even skilled drivers show a decreased ability to handle complex tasks at low BAC levels.\textsuperscript{16} Data analysis clearly correlates drinking with truck accident severity (see figure 4-6 in chapter 4). Recognizing the dangers of alcohol consumption and driving, one large petroleum refining company that sells fuel to truck stop operators has written provisions into its service contracts forbidding the sale of alcohol at those stops.\textsuperscript{17} Alcohol use is a problem that cuts across driver classifications as shown in tables 6-1 and 6-2.

\textsuperscript{14}Transportation Research Board, op. cit., footnote 3, p. 40.

### Table 6-1.—Drinking-Related Accidents by Driver Classification

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<tr>
<th>Number of drivers</th>
<th>Drinking involved</th>
<th>Drinking not involved</th>
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<td>90,234</td>
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<tr>
<td>Full time</td>
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<td>Part time</td>
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<td>Leased</td>
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<td>11,832</td>
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<td>Other</td>
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<td>2,319</td>
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</tbody>
</table>


### Table 6-2.—Drinking-Related Accidents by Carrier Classification

<table>
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<th>Number of drivers</th>
<th>Drinking involved</th>
<th>Drinking not involved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noncommercial</td>
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<td>90,234</td>
</tr>
<tr>
<td>For-hire/common</td>
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<td>179,682</td>
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<td>ICC Exempt</td>
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<tr>
<td>Other</td>
<td>151</td>
<td>20,163</td>
</tr>
</tbody>
</table>

Evaluations of other drug-related impairment levels are far more primitive. Reliable evidence about the effects of drugs on drivers is sketchy, and most States do not test for drugs other than alcohol. Further research on the subject is needed for marijuana and other controlled substances before adequate impairment guidelines can be established. The National Transportation Safety Board (NTSB) hopes to establish some guidelines for impairment levels as part of its current drug and alcohol study; the study is currently scheduled for completion in 1989.18

**Drug Testing**

Many carriers require pre-employment drug and alcohol testing. When one company started a drug-alcohol testing program 2 years ago, 15 percent of the applicants tested positive in the first year.19 A year later, only 8 percent of applicants tested positive; this company had sent a signal to prospective drivers that they need not apply if they have a drug or alcohol problem. Such individuals may seek employment from other carriers with different screening policies; indeed, one company in the Midwest reported that 47 percent of the applicants it screened had positive drug screens. Another carrier that conducted drug screening of current employees and job applicants found that 17 percent of the tests were positive.20

Where management fails to take assertive action, the drug problem among employees can become entrenched. For example, one motor carrier safety director found evidence of marijuana use while making spot checks of his company’s tractors. A subsequent investigation led to the discharge of 50 percent of the drivers at the terminal involved. In another instance, a laborator that performs drug screening for several major carriers found that even for repeat examinations, 13 to 18 percent of the tests were positive. In some cases, this occurred despite the fact that employees were given 30 to 60 days advance notice of the tests.21 OTA staff found that

17Pat Leach, project director, National Transportation Safety Board, personal communication, Mar. 18, 1988.
18Ken Thompson, Yellow Freight System, Inc., in Office of Technology Assessment, op. cit., footnote 5, p. 147.
20Ibid., p. 28.

... drugs are readily available at truck stops, some of which are well-known among drivers for drug activity, and CB radios are used openly for advertising or soliciting drugs.22

Appropriate formal procedures for periodic drug and alcohol testing of employees have been the subject of much debate. Many motor carriers conduct testing on a calendar basis for all employees; others test a sample of employees.23 The International Brotherhood of Teamsters’ master freight agreement guidelines for physical examinations and for testing urine for marijuana and other classes of drugs generally follow standards set by the U.S. Department of Health and Human Services. Members can be tested during their regular DOT physical examinations and when probable suspicion or cause can be established.24 Although the Teamsters represent many drivers working for large trucking concerns, the majority of drivers are not subject to this agreement. When an independent driver contracts with a larger carrier, however, he must abide by that company’s policy. It has been estimated that carriers large enough to mount their own alcohol and drug abuse programs are responsible for less than one-third of the heavy trucks using the highways.25

In a survey of 1,762 truck drivers conducted recently in Florida, 33 percent of the drivers reported being previously tested for alcohol, and 38 percent reported being previously tested for drugs by the company they were presently driving for or to which they were leased. Owner-operators reported the lowest frequency of testing, 29 percent for alcohol and 31 percent tested for drugs, respectively. Drivers employed by for-hire carriers reported the largest percentage of prior testing. Attesting to concern about substance abuse among drivers, 73 percent of those surveyed stated that they support mandatory random alcohol and drug testing by employers.26

The reliability of the testing methods is of special concern for drug tests. The most accurate tests,
which are also the most expensive ($30-$125), can produce 2 to 3 false positives per 100 tests. Because of the likelihood of false readings, laboratory experts urge a followup test. While many cost-conscious employers are not willing to pay for additional tests, others share information with the applicant and will re-evaluate the applicant if he or she takes a second test at personal expense.

Some companies are sensitive to the counseling needs of drug and alcohol abusers. One carrier's employees are given a drug test as part of their annual physical examination; they are notified of their scheduled appointment 30 days in advance. The company feels a responsibility to assist the driver in obtaining treatment if the employee informs management prior to the physical of a drug or alcohol problem.

More stringent methods for detection of alcohol use by truck drivers while on the road have also been discussed as enforcement measures. A recent study conducted by the Transportation Research Board (TRB) concluded that the technical ability to detect and measure BAC levels of less than 0.05 is available with current screening and testing devices. However, the legal authority of public enforcement officers to enforce a law based on a low BAC standard with breath-screening devices has not been definitively established. If the ability to do so survives legal scrutiny, the TRB report indicates cost-effective enforcement could be carried out by screening drivers at truck weigh stations and as part of vehicle safety inspections. Blood tests could be mandatory after injury-producing accidents. TRB estimates that vigorous enforcement of this kind would save between 80 to 140 lives annually at a minimum BAC level of 0.10, 110 to 190 lives at a 0.04 BAC threshold, and 130 to 250 lives at a limit of 0.00 BAC. The total public and private costs for enforcement at each level is estimated at $30 million, $40 million, and $50 million, respectively.

Driver attitude is a major influence on truck safety and that attitude is affected by company management philosophy and the work environment. A carrier that actively promotes safety and rewards good practices establishes safety as a major driver responsibility. This approach often requires extra effort to develop staff leadership and provide safety incentives; however, under such management, drivers are more likely to view themselves as professionals, accountable for the safe operation of their vehicles. Incentive programs may include cash bonuses, award programs, group recognition, and distribution of patches, pins, wallet cards, rings, and even stock for different levels of achievement.

One firm has adopted a formal corporate approach to safety that focuses on: 1) driver selection, 2) driver training, 3) driver conditioning, and 4) driver management. Communication is an important safety ingredient at another firm. For instance, group discussions between management and drivers encourage driver feedback and provide management with constructive information about operations. Good rapport between labor and manage-
ment brings better agreement about organizational goals and how to achieve them.

One management consulting company has developed a program to establish a positive corporate attitude toward safety through management strategies, technical training, and operations. The program addresses vehicle inspection, driver selection, drug screening, driver health, hazardous materials handling, city and over-the-road driving, hours of service, accident reporting, worker’s safety, and security. Another company that produces industry-related instructional material is developing a series of video-training programs on trucking. Safety programs will cover driver fatigue, road vision, driving a bobtail with an empty trailer, and professionalism. Technical training programs will include brake systems, motors, truck specifications, and gauges and switches. Numerous other trucking associations and commercial firms also publish training materials. No widely accepted standards exist for evaluating any of these programs.

Companies that have mounted carefully structured and intensive safety efforts have found major cost benefits in the quality of customer service, productivity improvements, and accident avoidance leading to lower insurance costs. United Parcel Service (UPS), one of the most successful carriers in the country, is such a company, and its accident rate is one-tenth the national average. Box 6-A describes UPS operations and safety management techniques.

Creating an environment that does not compromise safety requires management to balance regulatory requirements, such as hours-of-service rules, and customer service needs—just-in-time deliveries, for example. Intense competition for freight and market share provides a powerful incentive to increase productivity, utilize capacity, and push drivers to the limit of their ability to stay alert at the wheel. Some companies inform customers directly that trade-offs exist between costs and quality of service, and that safe, reliable service is worth slightly higher rates. However, drivers complain that shippers, brokers, and dispatchers often push hard for unrealistic delivery schedules that violate regulations. While an oversupply of carriers in the mid-1980s enabled shippers to shop around for carriers willing to take a load on any terms, this is less true today. Nonetheless, drivers resent being held responsible for violations of weight laws or hours-of-service regulations. The American Trucking Associations, Inc. (ATA) advocate placing responsibility directly on shippers for demanding that truckers drive longer or faster than is legal to deliver goods. Others claim that the need to use brokers places additional constraints on both shippers and carriers. The State of Rhode Island has acknowledged that drivers are often subject to strong pressure from carrier management and imposes fines and citations for motor carrier owners whenever their drivers are cited.

One expert finds that drivers feel less pressured to take loads exceeding weight limits in States where this change in policy has occurred.

The Federal Highway Administration (FHWA) has two small, new programs that address similar issues. The Commercial Accident Prevention and Evaluation Program was started in 1987 to identify carriers with high at-fault accident rates and develop countermeasures to reduce risks. The Educational and Technical Assistance Program is a nationwide safety information program aimed at carriers, drivers, and industry associations. Mass mailings of literature identify highway locations with high accident rates and detail accident avoidance techniques.

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4 Dannemiller, op. cit. footnote 5, p. 46, and ibid.
5 Donohue, op. cit., footnote 23, p. 50.
This page was originally printed on a gray background. The scanned version of the page is almost entirely black and is unusable. It has been intentionally omitted. If a replacement page image of higher quality becomes available, it will be posted within the copy of this report found on one of the OTA websites.
OTA accident data analysis shows that level of driver training is the second most frequently cited factor for motor carrier accidents. Although reliable statistics do not exist, industry experts estimate that the majority of drivers have not had adequate formal training. Research indicates that experienced drivers often acquire bad driving habits that could be corrected through remedial or inservice training. A number of carriers have recognized the importance of thorough training and have developed their own programs, described later in this section.

At present, no Federal requirement exists for drivers of heavy trucks to receive formal training, nor does a single State impose a training requirement for all drivers of heavy trucks. Federal regulations for the Commercial Driver's License establish qualifications on the basis of whether a person can safely operate the vehicle and secure the load to be carried, skills that can be acquired through either training or experience. Many motor carriers do not impose specific training requirements, but require applicants to have a minimum of 2 years of on-the-road experience. This poses difficulties for graduates of accredited training programs, since the only way to meet this demand is to drive for a firm that has no such requirement.

Formal truck driver education is available through proprietary truck driver training schools, nonprofit public education institutions, and in-house motor carrier training programs. The number of proprietary training programs is estimated at around 200, with fewer than 10 being in-house programs. Tuition ranges from $350 to $5,000. Course length, qualifications of the instructors, student/teacher ratios, and, most importantly, time spent on the road driving vary widely among programs. A survey of truckers in Florida indicated that 23 percent of the 1,800 respondents reported receiving formal driver training school instruction prior to becoming a professional driver; the average time as a truck driver was 15 years.

DOT issued proposed minimum standards for training tractor-trailer drivers in 1984, in an effort to establish guidelines for truck driver training. The standards call for a minimum 320-hour course lasting 8 weeks, if taken on a full-time basis. Course content included basic truck operation, safe operating practices, advanced operating practices, vehicle maintenance, and nonvehicle activities. The standards also covered instructor qualifications, school facilities, graduation requirements, and student placement. No final action was ever taken on the proposed standards, although the Office of Motor Carriers (formerly the Bureau of Motor Carrier Safety) published a ready-made curriculum, Model Curriculum for Training Tractor-Trailer Drivers, in

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1. National Transportation Safety Board, op. cit., footnote 10, p. 11.
1984. Included in the 2,500-page document are instructions for the school administrator, instructor, and student. These standards cannot be used for evaluating existing schools until their validity has been tested with actual schools and students, and DOT has not taken steps to do this.

The Professional Truck Driver Institute of America (PTDIA) was formed by industry in 1986 to certify acceptable training schools. PTDIA has adopted a curriculum based on the Federal model and started certifying driver training programs in mid-1988. PTDIA is funded entirely by industry and has both carrier and public enforcement representatives on its Board of Directors. The organization emphasizes the critical importance of the number of hours of hands-on, behind-the-wheel driving time a student receives. While PTDIA’s activities have been supported by many in the industry, the Commission of Accredited Truck Driving Schools maintains that driving schools should be free to structure their curricula to meet their educational objectives.

Training Programs

Although relatively few in number, carriers’ in-house training activities can be very effective (see box 6-A on UPS, for an example). In 1980, a large commodities motor carrier implemented a training program to instruct all new drivers in the safe handling of the vehicle and cargo and has reported a 14-percent decrease in line-haul accident frequency despite a 38-percent increase in line-haul mileage. In another case, a trucking firm’s commitment to training led to the provision of a curriculum, equipment, instructors, and course evaluations as aids to outside training schools. This firm’s screening test for prospective drivers has been carefully crafted to identify driving patterns and habits that have the potential to cause accidents.

The insurance industry has also developed training programs to promote safe driving behavior. One insurance company offers a 5-day seminar, open to driver trainers, safety personnel, maintenance supervisors, and to the management of fleet policyholders. It includes both classroom and behind-the-wheel experience. The examination of several fleets’ safety records before and after personnel received training showed consistent reductions in accident frequency and loss rate per vehicle.

An alternative approach is developing a truck driver apprenticeship program so that new drivers will receive qualified supervision and develop safe driving habits. In the Netherlands, for instance, prospective new drivers undergo a 2-year apprenticeship. There is currently no organized apprenticeship program for heavy truck drivers in the United States, although the issue has been raised in the past and is again being discussed.

Recurrent training of employees is important not only to keep experienced drivers up-to-date, but to identify bad habits that may have developed over time. For example, research in Europe has shown how little perception even experienced drivers have of their actual speed when they are in a monotonous or repetitive driving situation. On U.S. highways, difficulties with speed perception are acute when a driver leaves the Interstate system and moves onto two-lane roads, where speed limits, access, median control, and signs are quite different.

Keeping drivers physically fit, through physical conditioning, weight control, and aerobic capacity can reduce fatigue and stress. One carrier is installing a physical conditioning program nationwide for its line-haul drivers to assist them in developing physical and mental stamina to cope with long-haul driving.

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16 Strah, op. cit., footnote 46.
17 “Dannemiller, op. cit., footnote 5, pp. 43-44.
SHARING THE ROAD WITH THE DRIVING PUBLIC

Heavy vehicle operators often claim that most automobile drivers are unaware of the limitations and space requirements of heavy trucks. The longer, wider trucks now permitted are difficult to see around and require longer distances to pass than current highway designs allow. Heavy truck drivers operating in congested areas try to leave enough distance between their own and other vehicles for a complete stop. However, automobile drivers often cut sharply in front of trucks, making it difficult to avoid an accident—for which the truck driver may be cited.

Education programs for automobile drivers could help make them aware of safety issues related to sharing the road with trucks. States such as Tennessee are considering reorganizing their driver licensing programs to include material and questions on truck safety. An information videotape for automobile drivers on sharing the road with trucks is another possibility; it could be shown to people waiting to obtain driver licenses.

Education programs to inform small carriers about better road safety have also been developed. Available through the National Safety Council and ATA, these materials describe how a carrier as small as a 10-person trucking company can implement an effective safety program.

HOURS OF SERVICE

The hours-of-service rules in effect today are essentially the same as those promulgated in 1937 and 1938 by the Interstate Commerce Commission (ICC). The regulations prohibit carriers from requiring or permitting any driver to drive more than 10 hours at a time after being on duty more than 15 hours. Drivers must have 8 consecutive hours off-duty before driving again. In addition, drivers are prohibited from driving after 60 hours of on-duty time in any 7-day period, or 70 on-duty hours in any period of 8 consecutive days. Drivers are required to keep records of their driving in a logbook that must be available for inspection by enforcement officers at all times.

Complex and difficult to enforce, the hours-of-service rule is subject to problems ranging from falsification and abuse of logbooks by drivers to loose interpretations of “on duty” and “off duty” by management. The 15-hour on-duty period can be accounted for during the course of a driver’s overall duty day in any number of ways. For example, the driver’s employers may “relieve” him of duty—responsibility for the vehicle—for meals and rest breaks. Tiring and strenuous activities, such as loading and unloading performed by the driver, are not considered part of driving time, although they are considered duty time and usually contribute to fatigue. Furthermore, 8 hours of off-duty time often does not afford drivers adequate time to travel to and from their jobs, eat, bathe, and attend to life’s other requirements, as well as to get adequate undisturbed sleep. Finally, the illegal practice of requiring a driver to wait at a terminal in an “off-duty” status for a work assignment contributes to fatigue prior to the start of a driving tour. These factors help explain why many drivers keep double logbooks (one for enforcement officers and one for themselves) or make false entries.

Many drivers are compensated on the basis of how many miles they drive during a pay period. A long-haul driver faces a choice between violating hours-of-service rules and maintaining his income if bad weather, highway conditions, or shipper-related delays prevent him from driving an acceptable number of miles. Drivers risk accidents and deny themselves adequate sleep by accepting loads that require many consecutive hours of driving to reach a final

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56Trucking is not subject to the Fair Labor Standards Act. Carriers do not have to pay time-and-a-half for a greater than 40-hour workweek. This creates an incentive for a carrier to hire the fewest drivers possible and to have them work the longest hours possible in order to maximize profits.


58Ibid., p. 9.
Federal regulations require drivers to record their hours of service.

destination on time. Nonetheless, drivers sometimes boast of their long-distance driving accomplishments and stoically shrug-off unrealistic shipper deadlines.  

ICC, and subsequently DOT, have recognized that the hours-of-service rules are subject to abuse. In 1972, the Bureau of Motor Carrier Safety (BMCS) in DOT initiated a comprehensive study of the relationship between dangerous levels of fatigue among truck drivers and the current hours-of-service regulations. The report compiled and analyzed scientific and medical data reflecting driver performance and physiological responses collected during 195 truck and bus runs. A total of 1,550 hours of continuous data was obtained and analyzed on 62,000 miles of highway truck travel in all parts of the country, and in all weather and traffic conditions. The study concluded:

\[
\text{\ldots driver performance deteriorates, driver alertness \ldots, diminishes, rest breaks become less effective, and accident probability increases, all within the current 10-hour daily limitation on driving time. It [the regulation] is further at odds with a good deal of anecdotal evidence from the drivers to the effect that they do suffer from considerable fatigue but are}
\]

\text{\ldots}

\text{On duty activities such as loading and unloading, in addition to driving, contribute to driver fatigue.}
unwilling to admit it because of the feared economic consequences. 

This study focused on scheduled relay operations of large common carriers whose drivers were able to plan their rest, and no formal regulatory action was taken. BMCS acknowledged that further research was needed to provide data for revising hours-of-service rules, especially on drivers whose assignments were irregular in frequency, duration, and starting times, and who often could not predict when they would be driving.

The second phase of BMCS's fatigue study, issued in 1978, found that relay drivers operating irregular schedules suffered greater fatigue, physiological stress, and performance degradation than drivers working similar hours on a regular schedule. Fatigue effects were evident after about 8 hours of relay truck driving on a regular schedule and considerably earlier when the schedule was irregular. Cargo loading increased the severity of fatigue associated with irregular working schedules. The reported findings were considered conservative, since the drivers in the study were allowed 8 hours of sleep each day.

A separate, concurrent study of accident data found that the length of driving time by itself was not related to frequency or severity of truck accidents. However, the combination of driving and nondriving time could be related to driver fatigue and play a role in accident occurrence. Following the results of these studies, BMCS subsequently issued a Notice of Proposed Rulemaking and conducted public hearings in several cities around the country. By the end of 1978, BMCS had accumulated what it considered to be sufficient information to justify amending the hours-of-service regulations.

In 1981, however, the agency terminated the rulemaking action and closed the docket, citing the absence of a direct relationship between the hours-of-service rules and accidents. Also, in 1981 BMCS commissioned an economic study of the cost of modifying the hours-of-service rules to conform with Office of Management and Budget and DOT policy requirements. The projected costs of each of the government's three major options were considered to be significantly greater than the projected benefits.

Medically-related sleep disorders and occupationally-induced sleep disturbances seriously impair driving ability. Scientific literature makes clear that human performance is best at moderate levels of arousal. At low levels, the brain loses the capacity to make quick and informed decisions; at high levels, actions may be frequent, but ill-directed. Fatigue and sleepiness are associated with low levels of arousal. Normal fatigue can be exacerbated by three categories of stress factors: 1) physical environment such as temperature and vibration; 2) physiological factors such as poor or inadequate sleep, drugs and alcohol, or irregular eating habits; and 3) psychological factors such as anger, fear, and frustration. A distinction is sometimes made for drivers between single-trip fatigue, where an opportunity for recovery may exist; cumulative fatigue, in which recovery time between trips is not adequate; and chronic fatigue, which usually requires medical assistance. The behavioral symptoms of all three types

FATIGUE AND SLEEP NEEDS

Medically-related sleep disorders and occupationally-induced sleep disturbances seriously impair driving ability. Scientific literature makes clear that human performance is best at moderate levels of arousal. At low levels, the brain loses the capacity to make quick and informed decisions; at high levels, actions may be frequent, but ill-directed. Fatigue and sleepiness are associated with low levels of arousal. Normal fatigue can be exacerbated by three categories of stress factors: 1) physical environment such as temperature and vibration; 2) physiological factors such as poor or inadequate sleep, drugs and alcohol, or irregular eating habits; and 3) psychological factors such as anger, fear, and frustration. A distinction is sometimes made for drivers between single-trip fatigue, where an opportunity for recovery may exist; cumulative fatigue, in which recovery time between trips is not adequate; and chronic fatigue, which usually requires medical assistance. The behavioral symptoms of all three types
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<td>60 hours in 7-day period</td>
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<td>8 hours</td>
</tr>
<tr>
<td></td>
<td>10 hours at home terminal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>24 consecutive hours after driving during 6 days</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meal period</td>
<td>None required</td>
<td>30 minutes after 7 or more hours on duty (logged as on duty)</td>
<td>30 minutes after 7 or more hours on duty (logged as on duty)</td>
<td>None required</td>
</tr>
<tr>
<td>Driving relief period</td>
<td>None required</td>
<td>30 minutes after 4 hours (logged as on duty), may include meal period</td>
<td>30 minutes after 4 hours (logged as on duty), may include meal period</td>
<td>None required</td>
</tr>
<tr>
<td>Intermittent off duty</td>
<td>Not prohibited</td>
<td>Prohibited</td>
<td>Not prohibited</td>
<td>Not prohibited</td>
</tr>
<tr>
<td>Duty tour limit</td>
<td>No specific limit</td>
<td>15 consecutive hours</td>
<td>12 consecutive hours</td>
<td>No specific limit</td>
</tr>
<tr>
<td>Sleeper berth</td>
<td>2 periods totaling 8 hours, neither less than 2 hours</td>
<td>2 periods totaling 8 hours, neither less than 2 hours</td>
<td>Any 8 consecutive hours of duty may include sleeper berth time and off duty combined if consecutive</td>
<td>2 periods totaling 8 hours, neither less than 2 hours</td>
</tr>
<tr>
<td>Time-of-day restrictions</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>Driving between midnight and 6 a.m. prohibited</td>
</tr>
</tbody>
</table>

of fatigue are similar, however. "Sound, adequate sleep is the best way to relieve fatigue, which is an independent variable affecting behavior and performance.

Off-duty time, as specified in the regulations, often does not translate into sleep or rest time, as it was intended to do, partly because of the way the body functions biologically. Sleep researchers have shown that the body typically functions according to a circadian, or 24-hour, cycle that includes regular, defined periods of rest. Thus, when a driver starts his off-duty time, he may not be biologically ready to rest. As an example, a driver who begins a driving day at 6:00 a.m. must stop to rest at 4:00 p.m., according to the regulations. However, unless this is his accustomed time for sleep, his circadian cycle is not ready for him to begin prolonged rest. The driver is likely to take a nap eventually, but can begin driving again at midnight, just when the body’s normal circadian cycle prepares him for sleep. As a result, his alertness level and ability to operate a vehicle will be severely impaired.

The type of rest can affect driver performance as well. One recent study of truck drivers found that sleep disruption associated with sleeper berth use causes fatigue and deterioration of truck driver performance. In fact, the accumulation of 8 hours rest split between two sleeper berth shifts increased the risk of death by a factor of three for truck drivers involved in accidents, according to the research results. Moreover, research in Europe shows that accident involvement rates for truck drivers increase dramatically as work shift duration exceeds 8 hours (see figure 6-3).

Research also shows that no amount of mental or physical conditioning can prepare people to operate at normal levels if deprived of sleep. Reaction times double or triple, and the brain lapses into sleep for fractions of seconds at a time, especially, during monotonous circumstances, such as driving. Such factors may explain the disproportionate share of

![Figure 6.3.—Truck Accident Risk Compared With Duration of Truck Work Shift](image)

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5Robin P. Hertz, "Sleeper Berth Use as a Risk Factor for Tractor-Trailer Driver Fatality," paper presented to the American Association for Automotive Medicine, New Orleans, LA, September 1987, pp. 9-10.
6David Dinges, University of Pennsylvania, in Office of Technology Assessment, op. cit., footnote 5, pp. 73, 75, 127.
7 Ibid., p. 18.
8 Ibid., p. 18.
accidents that occur 1 or 2 hours into a driving shift, and the high level of fatal accidents in the early morning hours between 5:00 and 7:00 a.m. According to sleep researchers, these are times when a person is particularly vulnerable to an accident-causing situation due to lowered alertness. Experts have found that an additional period of decreased alertness also occurs in the mid-afternoon. Drugs and alcohol also affect a sleepy person much more strongly.

Overweight, middle-aged males, a description fitting many truck drivers, are primary targets for a sleep disorder known as sleep apnea. A person suffering from sleep apnea rarely knows he or she suffers from the disorder, which is characterized by abnormal breathing at night and results in excessive daytime sleeping. While some companies can sched-

TECHNOLOGIES TO ADDRESS HUMAN PERFORMANCE ISSUES

Carriers utilize numerous technologies to address management concerns about driver performance. For example, driving at high speed and the frequency and severity of accidents are strongly correlated (see chapter 4). Many carriers have chosen to install road-speed governors to limit the speed at which their tractors operate. These devices prevent the engine from generating more than the specified revolutions per minute, thus controlling the top speed of the vehicle. If maintained in good working order, governors can keep speed close to the legal limit and improve fuel economy as well.

Some States, such as Virginia, have outlawed the use of radar detectors in efforts to curtail speeding. Since the sole function of a radar detector is to recognize when radar is measuring the vehicle’s speed, the prevalence of these devices in trucks indicates the potential for abusing speed limits. One recent study found that radar detectors encourage speeding, with the vehicles traveling fastest being most likely to be equipped with the devices. Moreover, of all vehicles on the road, tractor-trailers are the most likely to be equipped with radar detectors. In another survey, 69 percent of owner-operators responding acknowledged that their vehicles were equipped with radar detectors. Further study of driver behavior in radar detector-equipped vehicles is underway at the Texas Transportation Institute, although results are not yet available. A separate survey of truckers in Florida found that 79 percent use radar detectors.

The use of detectable radar by enforcement officers countered by the use of radar detectors and radar jamming devices by drivers reflect the conflicts between a highly competitive market and enforcing safety standards. While some segments of the car-

\[ \text{Hertz, op. cit., footnote 71, p. 76.} \]
\[ \text{“Technology Review,” “Mathematics of Sleep,” February-March 1987, p. 13.} \]
\[ \text{David Dinges, University of Pennsylvania, testimony before the Senate Committee on Appropriations, Subcommittee on Transportation, May 14, 1987.} \]
\[ \text{David Dinges, University of Pennsylvania, personal communication, May 19, 1985.} \]
\[ \text{“Owner-Operators Independent Drivers Association of America, “Survey,” unpublished manuscript, Mar. 23, 1988.} \]
\[ \text{Dave Seiler, National Highway Traffic Safety Administration, personal communication, Apr. 11, 1988.} \]
\[ \text{Regular Common Carrier Conference, op. cit., footnote 26, p. 2} \]
carrier industry oppose legal sanctions against the devices, a joint petition to DOT was filed in spring 1988 by the American Automobile Association, ATA, the Insurance Institute for Highway Safety, and the National Safety Council, asking that they be prohibited.

**On-Board Recording Devices**

Safety advocates have proposed using on-board recording devices to monitor compliance with hours-of-service rules. Units are currently available that can track distance traveled, driving time, breaks, daily rest periods, and speed limit compliance in addition to equipment-related information. These devices are discussed at length in chapter 5.

![Photo credit: Rockwell International Corp](image)

Computers that store driving records and hours-of-service information can be an efficient alternative to paperwork.

**CONCLUSIONS AND POLICY OPTIONS**

Improving human performance in an industry that must meet demanding time schedules to prosper is a difficult task. However, since human error is the largest single cause of motor carrier accidents, OTA concludes that an aggressive Federal program to address human factors issues is a top priority.

Legislation passed in 1986 requiring a Commercial Driver's License (CDL) is a major step in establishing uniform truck driver licensing standards and practices. OTA concludes that for public safety, no exemptions to the requirement for a CDL are warranted. Exemptions of any kind would weaken the effectiveness of the legislation. Congress will wish to monitor closely DOT's decisions as the CDL program is implemented. For example, abundant evidence exists that truck driver performance is impaired by BAC levels below 0.10 percent and that alcohol use increases both the likelihood and severity of accidents. Congress may wish to ensure that DOT sets acceptable BAC levels for truck drivers at 0.04 percent (or lower), corresponding to the levels for airline crews and railroad engineers.

Further, OTA concludes that drug abuse by truck drivers is a significant safety factor that deserves substantial study to prepare for regulation. The results of the current NTSB study will provide valuable information on levels of drug use and their contribution to driver impairment. However, more study will be necessary to determine the appropriate regulatory standards. A requirement for drug and alcohol screening for driver applicants, as part of periodic DOT-required physical examina-
tions, and for probable suspicion or cause, deserves consideration. Furthermore, a DOT pilot demonstration program with one or more States for random drug testing could provide valuable information on the role of such testing in accident reduction and the acceptability of such a program on a national basis. Congress may wish to encourage DOT to act on these options. Since a record of previous violations is characteristic of many truck drivers involved in serious accidents, Congress may wish to monitor DOT’s decisions about violations committed during part-time employment or off-duty driving.

The contribution that careful, appropriate training can make to accident reduction has been amply documented by industry. OTA concludes that training is an area neglected by DOT and that national guidelines for driver training are needed. (See chapter 4 for policy options that address this issue.)

Considerable public and private effort will be required to make any new safety standards effective. Carrier management commitment to safety and to implementing new standards play pivotal roles. A cooperative government-private sector research and education program is one way to address management issues such as driver hiring, screening, training programs, and scheduling revisions to help accommodate circadian rhythm.

The hours-of-service regulations, do not adequately account for the effects of operating on the Interstate highway system, new vehicle technologies, and advances in understanding of fatigue and sleep needs. OTA finds compelling reasons for DOT to reexamine the hours-of-service rules and, if warranted, to develop revised standards based on current research results and today’s around-the-clock operating environment. A carefully phased program to address the issue is essential. Cooperative government-industry studies including independent drivers, private carriers, and large and small for-hire carriers to explore feasible scheduling, training, and education programs are important initial steps. Congress may wish to encourage more DOT research on this issue, to provide funds for the research, and to meet specified deadlines for revised standards.

OTA concludes that Federal programs are needed to help management and drivers understand when drivers are most vulnerable to accidents and how alterations to scheduling and other procedures could reduce driver vulnerability. Moreover, a research program to develop simple, effective, and inexpensive techniques to screen drivers who may have a sleep disorder could help identify the high-risk driver.

OTA finds that the use of radar detectors by motor carrier and automobile drivers alike promotes speeding and thus increases the likelihood of an accident. Because high speeds are closely tied to accident severity, Congress may wish to consider taking decisive steps at the Federal level to prohibit these devices.

Finally, education programs directed at motor carrier and automobile drivers could enhance awareness of safety issues related to sharing the roads. These programs should focus on the handling and stability characteristics of trucks, the need to maintain adequate distance between vehicles, the longer distances required for a heavy truck to stop, and the severe damage that can result from a collision between cars and trucks. Congress may wish to require the National Highway Traffic Safety Administration and FHWA to play mutually supportive roles in developing a model program for States to ensure that these messages reach a broad population by being incorporated into the driver license and renewal process.