

fic enforcement increases the hourly cost, depending on the type of use. For patrol of a highway, including the activity generated, the costs rise to \$59.36/h. The use of the airplane for speed enforcement is more expensive--\$247.54/h (for a two-hour session). Its use is practical only because it is more covert than radar. The airplane is superior for manhunts and related activity. It appears also to be cost effective for line patrol. Without substantial improvement in productivity of the ground support, its use for speed enforcement may not be cost effective.

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## Truck Safety, Regulation, Inspection, and Enforcement in Virginia

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An investigation of state and federal regulations, inspection programs, and enforcement activities regarding truck safety was carried out to ascertain whether there were problems with the state's regulations and activity in these areas and to suggest remedial measures for any problems identified. The research, carried out with guidance from a project advisory group, included a review of relevant literature; a questionnaire survey of state enforcement programs; observations of on-road safety inspections; a review and comparison of state and federal laws and regulations that govern the trucking industry, including those that deal with hazardous materials; and an analysis of available data concerning truck accidents, registrations, miles of travel, vehicle type, load carried, and percentage of overloaded trucks. It was concluded that some revisions to the regulatory provisions that govern the trucking industry and the transportation of hazardous materials in Virginia were warranted and appropriate. Recommendations for the revision of some of the state's regulations and enforcement program activities were offered.

A great deal of attention has been focused on the safety aspects of the movement of goods by heavy trucks. Both state and federal governments have shown concern about statistics that indicate a significant increase in the involvement of heavy trucks in traffic crashes and fatalities. The response at the federal level included the introduction of the Truck Safety Act of 1978 and the Trucking Competition and Safety Act of 1979. These represent an effort to reduce crashes, injuries, and property damage; to provide drivers of commercial vehicles with safe and healthy working conditions; and to increase compliance with current regulations. Legislation has also been introduced to set national truck weight and length limits.

A 1977 General Accounting Office report to Congress stated that 20 percent of all traffic deaths resulted from truck and bus crashes and recommended an increase in funds for safety activities (1). A 1979 study by the same agency determined that "excessive truck weight is a major cause of highway damage," but the study did not deal directly with the relation between truck weight and crashes (2).

A study by the National Highway Traffic Safety Administration (NHTSA) found that, between 1975 and 1978, fatal crashes that involved heavy trucks increased by 40 percent; 10 percent of all fatalities on the nation's highways were related to accidents that involved heavy trucks; and fatal injuries to the occupants of passenger cars that collided with heavy trucks increased by nearly 30 percent (3).

The popular press, newspapers, and magazines have given considerable attention to crashes that involve heavy trucks, especially when multiple fatalities have occurred or when hazardous materials have been involved. A number of exposé articles have detailed a calculated disregard for weight and safety regulations by certain truckers.

In light of the above, officials of the Commonwealth of Virginia requested a study of the state's safety, regulation, inspection, and enforcement programs that deal with heavy trucks.

## METHODOLOGY

The initial task in this study was a review of the literature on safety issues concerning heavy truck transportation. The sources of literature included federal and state agencies, the trucking and insurance industries, private and university research groups, and congressional and legislative hearings. In an attempt to determine whether truck crashes constitute a significant hazard to the users of Virginia highways, national and state data on truck accidents were analyzed. A survey was made of state programs for the enforcement of regulations on truck weights, safety, and the transport of hazardous materials, and Virginia and federal regulations on the movement of goods by the trucking industry were examined and compared. Because of the special dangers that attend the transport of hazardous materials, a significant portion of the study dealt with regulations on the transportation of these materials.

Because of the complex nature of most of the issues concerning heavy truck safety, the study was carried out with guidance from a project advisory group whose members represented the trucking industry and a variety of state and federal agencies charged with regulating the industry.

## LITERATURE REVIEW

In 1976, more than 4000 people were killed in motor vehicle crashes that involved heavy trucks in the United States. This number represented a 15.7 percent increase over the number killed in 1975 and accounted for 8.9 percent of all traffic fatalities (4). Crashes that involved trucks resulted in twice the number of fatalities per crash as crashes that involved only passenger cars. Although the proportion of heavy trucks in the vehicle population is small, their exposure is disproportionately great, and their increasing involvement in fatal traffic crashes is a major safety concern (5).

### General Crash Experience

The most-frequent accident that involves a tractor trailer is a collision between such a unit and a passenger car; this is followed by single-vehicle crashes and collisions with other commercial vehicles (6). Because of the relatively large size and weight of heavy trucks, collisions between them and passenger cars are especially dangerous for automobile occupants (4). Only 20 percent of the people killed in all heavy truck crashes are truck occupants and 80 percent are occupants of passenger cars, pedestrians, and bystanders (4). Such statistics suggest the need for a special sensitivity to issues of truck safety.

### Causes of Accidents

Human error has been identified as one of the primary causes of accidents involving heavy trucks. A study by the University of Southern California, in conjunction with the California Highway Patrol, of accidents that involved commercial vehicles found that 45.7 percent of the truck drivers involved were at fault. Among the chief causes were driving at an unsafe speed and making unsafe lane changes (7). An important contributory factor to human error is driver fatigue. Not only driving time, but irregular scheduling, the use of sleeper operations, and variations in regular daily sleep patterns have been connected with driver fatigue (8).

Mechanical failures and vehicle defects also play a significant role in crashes of heavy trucks; they

were identified as the determining factor in 10.8 percent of the accidents in the California study. Brake failures and inadequate braking ability accounted for the greatest proportion of mechanical problems. Tire and wheel failures were also important vehicle defects (7,9,10).

## ACCIDENT ANALYSIS

An analysis of nationwide Bureau of Motor Carrier Safety (BMCS) data and Virginia data on truck crashes revealed several characteristics of these accidents that could be used to generate countermeasures. Major findings were as follows:

1. New drivers are more likely to be involved in truck crashes than experienced drivers, and the crash rates for new drivers increase more rapidly than those for experienced drivers;

2. Most truck collisions in Virginia involved passenger vehicles; crashes that involved two trucks ranked second; and

3. The largest percentage of noncollision, single-vehicle accidents involved either running off the road or overturning on the roadway.

Although the data indicated considerably more passenger-vehicle-related crashes than truck crashes, due to the greater numbers of passenger cars, truck crashes tended to be more severe. Trucks were less likely than cars to be involved in nonfatal accidents; however, they are more likely to be involved in fatal crashes. Overall, the average truck has more accidents per year than the average car but has fewer accidents per mile of travel.

Crash-trend data showed that Virginia's truck crash rates increased significantly between 1975 and 1977. These increases far exceeded the rates of passenger cars during the same time span. It was also determined that Virginia's truck crash rates were increasing much more rapidly than were the national truck crash rates and the passenger car crash rates in the state. Finally, fatalities are increasing at a rate greater than that for injuries or total crashes in the nation. Thus, although the limitations of the data prevent a strong conclusion that Virginia currently has a serious truck accident problem, the problem clearly exists and is worsening at an increasing rate.

## SURVEY OF ENFORCEMENT PROGRAMS

In Virginia, three state agencies have responsibility for enforcing state laws related to truck weight and safety and the transportation of hazardous materials. The State Corporation Commission (SCC), State Police, and the Department of Highways and Transportation all have roles. In addition, BMCS of the Federal Highway Administration (FHWA) has the responsibility for enforcing federal regulations on truck safety and the transportation of hazardous materials.

The Department of State Police and the Department of Highways and Transportation share the responsibility for enforcing Virginia laws on truck weights. The latter operates the equipment used to weigh trucks but does not have authority to issue citations or summonses for violations of weight limits. Consequently, a state police officer works with the weigh station personnel to write tickets and issue citations.

The state police may conduct weighing activities independent of the Virginia Department of Highways and Transportation. An officer may stop a truck he or she suspects is overweight and direct the driver to travel as far as 10 miles to a permanent weigh station. The police are authorized to weigh such

trucks at any permanent station, even if it is not officially open at the time. If the distance to the nearest permanent weigh station is greater than 10 miles, the officer may weigh the truck on portable scales.

The SCC and state police have responsibility for safety inspections of motor vehicles in Virginia. The SCC investigators do not work directly with the state police, although they do have contact with the police when working at the weigh stations. They have authority to enforce the laws, rules, and regulations that govern the operations of motor vehicles and authority to issue a summons or arrest any person found in violation. They may stop and examine the lading and documents of any motor vehicle, trailer, or semi-trailer that operates on any highway in the state.

The SCC investigators conduct safety inspections at the permanent weigh stations after first checking vehicles for SCC authority. Investigators will usually stand at the scales and give the trucks cursory visual inspections. When an investigator sees a truck he or she thinks is likely to have safety problems, he or she can order the driver to pull the vehicle into the inspection area for a thorough inspection.

The SCC and state police are also responsible for the enforcement of the hazardous materials regulations. They have authority to stop and examine the lading of any motor vehicle thought to be transporting dangerous articles to determine whether it is in compliance with the rules and regulations that govern the transportation of dangerous articles. These investigations are also carried out as part of the safety checks conducted at the permanent weigh stations.

To evaluate Virginia's truck safety enforcement programs as compared with those of other areas, a questionnaire was sent to highway officials of the other 49 states and the District of Columbia. The questionnaire contained questions about programs for enforcing regulations on truck weight and safety and the transport of hazardous materials. Responses, which were received from 44 states and the District, gave a fairly complete picture of enforcement activities.

#### Weighing Operations

All of the respondents had some sort of truck weighing program, and most used both permanent and portable scales. Frequently, portable scales were used in conjunction with permanent scales in an effort to detect trucks that attempted to bypass the permanent scales.

Most states used the same basic equipment; however, the number of scales used and hours of operation varied greatly. One-third of the states operated at least one permanent scale seven days a week, 24 h/day, and more than two-thirds of the states had permanent scales open at least five days a week. Many states also used irregular scheduling, particularly for mobile weighing teams.

Both state police and highway or transportation departments played a significant role in the operation of weighing programs. More than half of the states named the state police and roughly 40 percent named the highway or transportation department as the agency responsible for the program. State regulatory commissions and motor vehicle agencies also had responsibility for weighing programs.

#### Effectiveness of Weighing Programs

An attempt was made to determine the relative effectiveness of the truck weighing programs. The number of trucks weighed varied tremendously. At

one end of the spectrum, Virginia weighed more than 7 million trucks; at the other end, the District of Columbia weighed only 2240. However, because the volume of truck traffic varies considerably from state to state, the number of trucks weighed does not indicate a program's effectiveness.

Violation rates were also examined and tended to increase as the number of trucks weighed decreased. This would be expected because a program that has a reputation of not identifying violators of weight limits cannot be expected to deter truckers from running over the weight limit. When the probability of detection is low, the number of trucks that have loads in excess of the allowable limits tends to increase.

The measures that produced the most-consistent results involved comparison of the number of vehicles weighed to the number of commercial and private trucks registered in the state, the amount of diesel fuel consumed, and the number of truck miles of travel as estimated by FHWA. If the effectiveness of a truck weighing program increases as the percentage of trucks weighed increases, which should be true as more trucks that carry weights over the limit should be detected, these ratios should indicate the relative effectiveness of truck weight-enforcement programs. Therefore, program effectiveness increases as these ratios increase.

Table 1 shows the results of these calculations, with the states ranked from best to worst. Note that most of the states that have permanent scales that operate seven days a week, 24 h a day were among the states with the most-effective weigh programs. Also, the five states that had no permanent weigh stations were among the states cited by the U.S. Department of Transportation for inadequate weight enforcement and were the lowest-ranked states according to these calculations.

All of these rankings have certain problems. One is that the numbers used in the computations are proxy values and, therefore, are not completely accurate representations of the amount of truck traffic in a state. In addition, not all of the states that have permanent scales weigh every truck that passes the scales. Consequently, the number of trucks weighed for those states is lower than if all trucks were weighed, even though those allowed to pass the weigh stations are probably under the weight limits.

#### On-Road Safety-Inspection Programs

Thirty-six states conducted an on-road safety-inspection program. Unfortunately, many states lacked data on the number of trucks inspected so no attempt was made to determine the effectiveness of these programs.

Almost one-half of the states that performed safety inspections indicated that they did so in conjunction with weighing operations. This provided the opportunity to make a cursory visual inspection for obvious safety problems prior to performing a complete safety inspection. In the inspections themselves, most states focused on easily accessible equipment, such as brakes, tires, and lights.

More than 80 percent of the states cited the state police as having some responsibility for safety inspections and 50 percent said it was the sole responsible agency. Regulatory commissions were involved in roughly 30 percent of the states, and highway departments had some responsibility in about 20 percent.

The reported violation rate for safety inspections was far greater than the violation rate for truck weighings. For the 19 states that had data on safety inspections, the average violation rate was

Table 1. Ranking of state weight programs by effectiveness.

State	Scale Classification <sup>a</sup>	Weighing/ Registrations	Weighing/ Fuel Consumption	Weighing/ Vehicle Miles
Alabama	N,C	44	42	42
Arizona	P,C	25	28	26
Arkansas	P	3	4	2
California		20	20	19
Colorado	P	15	9	10
Connecticut	C	29	32	33
District of Columbia	M	33	41	39
Florida	P	11	11	16
Georgia	M	21	23	23
Hawaii	N,C	32	29	31
Idaho		31	31	28
Illinois		9	13	13
Indiana		23	26	22
Kansas	P	27	25	25
Kentucky		26	24	27
Louisiana	P	6	7	6
Maine	N,C	37	33	36
Maryland	M	28	27	30
Massachusetts	C	43	44	44
Michigan		18	18	20
Missouri	P	12	14	12
Montana	P	19	17	14
Nebraska		14	12	11
Nevada	N,C	41	40	37
New Hampshire	M	39	36	40
New Jersey	C	36	39	38
New Mexico	P	2	2	1
New York	N,C	40	38	41
North Carolina		7	10	9
North Dakota	P	10	6	5
Ohio		13	15	17
Oklahoma	C	38	34	35
Oregon	P	16	16	15
Pennsylvania	C	42	43	43
South Carolina	M	22	22	24
South Dakota	C	30	30	29
Tennessee	P	4	8	7
Utah	P	5	3	3
Vermont	M	34	35	34
Virginia	P	1	1	4
Washington	P	8	5	8
West Virginia	M	24	21	21
Wisconsin		17	19	18
Wyoming	P,M	35	37	32

<sup>a</sup>P = At least one permanent scale is operated 24 h/day, 7 days/week; N = no permanent scales; C = cited by U.S. Department of Transportation in February 1978 for inadequate weight enforcement; and M = classified as marginal in weight enforcement by U.S. Department of Transportation in February 1978.

20.5 percent. Rates ranged from a low of 0.03 percent to a high of 92.5 percent.

#### Hazardous Materials

Only 24 states actively enforced their regulations on the transportation of hazardous materials, and one state reported that it had no such regulations. Thus, fewer states had hazardous materials programs than had either weighing or on-road safety-inspection programs.

Most states conducted random inspections on the road as opposed to systematic roadway inspections or terminal inspections. Also, fewer states inspected private carriers than they did for-hire carriers because some state agencies had no authority to inspect private carriers.

In two-thirds of the states, the state police had some enforcement responsibility, and state regulatory commissions and highway or transportation departments each had some enforcement responsibility in one-third of the states. The enforcement responsibility tended to be more fragmented than that for the other programs because it was often shared among agencies that deal with health, environmental protection, and emergency services.

In summary, the data obtained on the questionnaire disclosed that all of the states that responded (45) had some sort of weighing program, 36

states had an on-the-road safety-inspection program, and 24 states had a hazardous-materials inspection program.

#### REGULATIONS OF THE TRUCKING INDUSTRY

In Virginia, the SCC is vested with the authority to supervise, regulate, and control all public service companies that do business in Virginia. This control includes the authority to regulate the transportation of passengers or property for compensation by motor carriers, unless the carrier is specifically exempt. Motor carriers are required by Virginia Code Sections 56-278 and 56-288 to secure approval from the SCC to operate in the state. The SCC also has authority over rates, routes, and schedules. In addition, it has appointed investigators to enforce its regulations under Title 56 of the Code and the general highway laws that apply to motor carriers under Title 46.1 of the Code.

Another general power of the SCC involves the investigation and reporting of accidents. Under Virginia Code Section 56-332, it has the authority to require motor carriers that do business in the state to report information concerning all crashes that result in injury to persons or in property damage of any kind. However, it does not require this reporting so as to avoid a duplication of recordkeeping by the Division of Motor Vehicles (DMV).

Weight and size limitations and equipment requirements are specified in the Virginia Code and apply to all vehicles that travel on Virginia highways, regardless of where they are licensed. Hauling or moving permits must be secured from the Department of Highways and Transportation for the operation of any vehicle or vehicle combination in excess of the statutory size and weight limits.

The transportation of hazardous materials is regulated pursuant to the Rules and Regulations Governing the Operation of Motor Vehicles Transporting Explosives and Other Dangerous Articles, promulgated by the SCC in 1958, which are being revised by the Department of Health under new legislative authority. Exemptions are permitted for materials transported in accordance with or exempt from federal regulations. The central purpose of the regulations is to prescribe the conditions under which dangerous articles must be loaded, transported, and unloaded. These conditions are designed to ensure that hazardous materials are handled and transported in a manner that is safe for the public and the motor carrier. Motor carriers of hazardous materials must also abide by all other laws and rules that govern transportation in Virginia.

#### Overview of Federal Regulations

In 1967 BMCS was established as a part of FHWA. Its primary function is to reduce commercial vehicle accidents, fatalities, injuries, and property losses. To encourage the safe operation of commercial vehicles, the Bureau also initiates research and development projects within FHWA. The jurisdiction of BMCS stems primarily from four pieces of legislation.

Congress originally passed the Interstate Commerce Act, which established the Interstate Commerce Commission (ICC), in 1887 and subsequently amended it several times, most recently in 1978. In 1935 Congress passed an amendment known as the Motor Carrier Act. Its purpose was to establish a uniform national system of motor carrier regulation. This Act authorized ICC to regulate the qualifications and hours of service of employees and to ensure the safety of operations and equipment of common, contract, and private carriers of property engaged in interstate commerce. The Act also gives ICC the authority to promulgate regulations, hold hearings, and conduct research. In addition, it defines that agency's very broad inspection and investigatory authority.

In 1966 the Department of Transportation Act established the U.S. Department of Transportation (DOT) and transferred the functions cited above from ICC to DOT. Subsequently, authority was delegated to BMCS to carry out the functions authorized by the Act.

The Noise Control Act of 1972, 42 U.S. Code Section 4917, empowers the Secretary of Transportation, in cooperation with the Administrator of the U.S. Environmental Protection Agency (EPA) to promulgate regulations that govern noise emissions from commercial vehicles operated by interstate carriers. In addition, the Act established inspection and enforcement powers within DOT.

The Hazardous Materials Transportation Act of 1976, 49 U.S. Code Section 1809, consolidated the general responsibility to supervise the issuance and enforcement of regulations on the transportation of hazardous materials within the Materials Transportation Bureau of DOT. BMCS, however, retained primary responsibility for originating regulations and carrying out the inspection, enforcement, and training functions related to motor carriers.

#### Comparison of Virginia and Federal Regulations

The Federal Motor Carrier Safety Regulations (FMCSR), 49 Code of Federal Regulations Sections 386-398, sets the boundaries for the inspection and enforcement activities of BMCS and provides a comprehensive set of definitions, standards, and procedures for all aspects of motor carrier safety. Drivers and trucks subject to the FMCSR include those that haul (a) cargo from overseas, (b) property from state to state, (c) cargo across a border, and (d) loads of interstate cargo within one state.

Although a number of states have adopted the FMCSR in whole or in part, Virginia has not. Neither has the state developed a section of the Virginia Code that deals specifically with motor carrier safety in a topical fashion. Although numerous aspects of the Virginia Code parallel the FMCSR, the lack of a topical approach makes it more difficult to assess the state's standards for motor carrier safety. It may also make it more difficult for state officials to educate carriers and enforcement personnel concerning safety standards. Consequently, some consolidation or reorganization of sections that affect motor carrier safety should be helpful.

The following sections discuss differences between state and federal regulations that affect the road operations of the trucking industry. Some of the differences prompted recommendations that the Virginia regulations be altered to conform with the FMCSR. Other differences are also noted where the significance cannot be ascertained without better data on truck accidents. At present we cannot determine which set of regulations better promote safety in transportation.

#### Qualifications of Drivers

The FMCSR requires that drivers be 21 years old, able to read and speak enough English to understand highway signs and communicate with officials, and able to operate a vehicle safely. In addition to the application process and the review of the driver's operating record, the driver qualification procedures include a road test, a written examination, and a physical examination.

The Virginia provisions differ in several respects. Virginia's minimum age for a chauffeur's license is only 18. The Code, although it requires a road test for drivers of vehicles of more than 40 000 lb, does not set forth requirements for this test. Also, the test may be waived if the applicant certifies that he or she has driven at least 500 miles in the type of vehicle he or she intends to drive. Apparently, the waiver is meant for drivers who have been licensed by other states, participated in motor carrier training programs, or driven with a learner's permit under the supervision of a licensed driver. However, the Code contains no provisions on how drivers can accumulate the 500 miles.

With regard to Virginia's lower minimum age requirements, there are no state crash statistics to indicate whether Virginia truck drivers under 21 years of age have a higher accident rate than older drivers. However, there are U.S. data to indicate that driver inexperience may be a causative factor in accidents [see Table 2 (6)]. In 1975 the BMCS considered lowering the FMCSR minimum age to 18, but decided against such action because available data indicated that persons under 21 lack the maturity, judgment, and skill to drive heavy trucks. In addition, researchers at the University of North Carolina have found higher accident involvements for young truck drivers. Finally, in 1978, the National Transportation Safety Board recommended that Vir-

Table 2. Involvements by driver experience.

Years of Driving Experience	1977	1976	1975	Change 1975-1977 (%)
0-1	14 182	10 603	9 357	+51.6
2-4	6 198	6 488	6 397	-3.1
5-9	4 830	4 024	3 969	+21.7
10-14	2 190	1 952	1 819	+20.4
15-19	1 131	1 141	1 219	-7.2
20+	2 032	1 795	1 958	+3.8
Total	30 563	26 003	24 719	+23.6

ginia eliminate the 500-mile waiver and expressed concern about the 18-year-old minimum age.

#### Driving of Motor Vehicles

The federal rules and Virginia laws that govern the operation of trucks are identical, or nearly identical, on many points. However, some differences exist and a significant one relates to use of seat belts. FMCSR requires use of seat belts but the Virginia Code requires only that seat belts be installed and explicitly states that the failure to use seat belts is not negligence.

The inspection provisions of FMCSR emphasize the pretrip inspection of safety devices by the driver. Although the Virginia Code requires a vehicle inspection every six months and prohibits operation with defective equipment, it does not require pretrip inspections. Although the Code implies a policy of pretrip inspection, state officials have no grounds on which to enforce a day-to-day accident-prevention program. Federal regulations, in contrast, require recordkeeping on pretrip procedures.

#### Parts and Accessories

Section 393 of FMCSR describes the scope of safety checks conducted by BMCS inspectors and establishes standards that equipment must meet. Again, the Virginia Code, under Title 46.1, parallels many of the regulations of FMCSR. One difference between federal and state rules concerns the stopping distance standards for brakes. FMCSR contains somewhat more stringent requirements. The federal regulations concerning tires are also more stringent. Federal tread-depth requirements are stricter and FMCSR also contains extensive provisions governing tire loads and pressures. Virginia has no standards for tire loads and pressures.

A final positive note is that both the SCC and state police truck-safety-enforcement teams are familiar with FMCSR and use them and BMCS inspection techniques as the basis for their truck-safety-enforcement programs. In view of the small size of BMCS enforcement staff, however, it is frustrating that state inspectors cannot cite obvious violations of federal law.

#### Reporting Accidents

Both federal and state requirements exist for reporting accidents; however, there are significant differences in the report forms used. The state police use a general field note form for all accidents, regardless of the type of vehicles involved. This form provides a great deal of information, but there are inadequacies in the data relevant to truck safety. As a result, the truck accident data for the state are insufficient for making generalizations in a number of significant areas of information.

#### Hours of Service

Under Section 395 of FMCSR, BMCS limits most truck

drivers to a maximum of 10 h of driving time after accumulation of a minimum of 8 h off-duty. Additional regulations of driving time apply, based on the number of consecutive hours on duty and the number of consecutive days of operation. BMCS ensures compliance with these regulations by checking a daily log of hours that drivers must keep. If a driver is detected in violation, he or she may be placed out-of-service.

The only Virginia law governing hours of service applies to all drivers and states that it is unlawful to drive more than 13 h in a 24-h period. Apparently, this rule is invoked only for determining driver negligence after a crash, and the state has no requirements for keeping a log or other methods for enforcing the law.

#### In-Field Safety Checks

Both federal and state officials conduct on-the-road safety checks. BMCS inspectors have the authority to place vehicles out-of-service for violations of FMCSR until repairs are performed. In Virginia, however, SCC inspectors responsible for enforcement of state laws do not have the authority to declare unsafe vehicles out-of-service, although they can cite drivers and carriers for violations that can result in fines.

#### HAZARDOUS MATERIALS

Definitions of the term hazardous material generally tend toward extremes of either vagueness or specificity. Ideally, a compact definition of hazardous materials could be fashioned that would indicate whether a substance in question is hazardous or not. In practice, however, general criteria to fit all dangerous substances is difficult to develop. The annual introduction of chemicals alone accounts for nearly 500 new substances of varying characteristics and potential for harm. The definition must anticipate these substances and also apply to those already known. Because of the concern for identification and regulation of all applicable hazardous materials, the definition becomes either exceedingly specific, and resembles a listing of materials and their traits, or increasingly generalized in order to account for all possibilities.

The broad federal definition in the Hazardous Materials Transportation Act focuses not on the means by which harm occurs but rather on the fact that it does occur. Hazardous materials are defined as a substance or material in a quantity and form that may pose an unreasonable risk to health and safety or property when transported in commerce. This definition does not attempt to provide a functional guideline for determining whether a substance is harmful. Whether the risk is unreasonable is determined by the Secretary of Transportation through the hazardous materials regulations authorized by the Act. The regulations contain a list of 1200 substances judged to be capable of posing an unreasonable risk. This list includes those hazardous materials that are (or were) frequently transported and is used to determine whether a substance in question is a regulated material and to give the shipper guidance in labeling containers.

#### Federal and Virginia Regulations

Federal regulations govern materials transported in interstate commerce or in a manner that affects interstate commerce. Unless the Secretary of Transportation determines that a state's requirements afford at least as much protection as the federal regulations, and do not unreasonably burden inter-

state commerce, the federal regulations preempt inconsistent state requirements. To eliminate conflicts, Virginia regulations exempt substances transported in interstate commerce according to federal regulations or exempt from federal regulations.

Both Virginia and federal regulations prohibit the shipping or transporting of hazardous materials not in conformity with applicable regulations. However, the federal regulations also apply to persons that offer or accept nonconforming hazardous materials for transportation and to persons that represent or sell a package as in compliance with the regulations when it does not. Both sets of regulations contain certain exemptions, such as for U.S. military forces. Virginia specifically exempts flammable liquids from any regulation, although SCC does regulate the shipment of petroleum products.

Civil sanctions of up to \$1000/day (state) and \$10 000/day (federal) may be imposed for a violation of these regulations. Criminal sanctions are also available; violations are a misdemeanor in Virginia and a felony under the federal regulations.

#### Cargo Regulations

Virginia and federal regulations prohibit the transportation of hazardous materials in certain situations. For example, Virginia prohibits the transportation of explosives in passenger vehicles and federal regulations prohibit transport of any hazardous materials, with certain exceptions, on for-hire vehicles that carry passengers. Both sets of regulations prohibit the transport of certain combinations of hazardous materials. The federal regulations are far more specific and list 22 categories of prohibited combinations of hazardous materials.

Cargoes must also be loaded and unloaded in conformance with state and federal regulations. In addition, both sets of rules require the identification of cargoes. Federal regulations generally require that all individual containers be marked. In Virginia, if the entire cargo is of the same type of hazardous materials, then only the vehicle must be marked to indicate the contents. Compared with those of Virginia, the federal identification requirements are more detailed, broader in scope, and include additional placarding provisions.

#### Vehicle Regulations

Both Virginia and federal regulations govern the condition and construction of vehicles that transport hazardous materials. Virginia requires that trucks must be strong enough to carry the load and be in first class condition. Federal regulations place responsibility for the vehicle's condition on both the carrier and the driver and prohibit the operation of a truck in a hazardous condition.

Both federal and Virginia regulations require that the vehicle be inspected prior to each trip. As in other areas, the federal regulations are more extensive and detailed in specifying the items to be checked and the manner of inspection and recordkeeping. Both federal and state regulations are concerned with the electrical system, vehicle lighting, condition of the cargo area, use of certain materials in the construction of trucks carrying explosives, and the carrying of fire extinguishers. Again, the federal regulations that govern these areas are more detailed than those of the state.

The federal and state requirements on placarding diverge substantially. Although both require placards that indicate the contents of the vehicle, the federal rules specify 17 placard designations, but Virginia rules specify only 7. The federal rules are more detailed in specifying the design of the sign and its required visibility.

#### Driving Regulations

Regulations on the operation of a vehicle carrying hazardous materials cover the place, time, and manner of operation. For example, both federal and state rules discourage the unnecessary movement of hazardous materials through places where there are likely to be high numbers of people. Federal regulations require vehicles carrying hazardous materials to avoid heavily populated areas, unless there are no practical alternatives. Another example is Virginia's requirement that vehicles that carry explosives or a poisonous gas operate during daylight hours whenever possible.

Regulations that govern a multitude of other aspects of the transport of hazardous materials include those on following distances, parking, emergency stopping and signaling, procedures at railroad crossings, the proper documentation of the nature and quantity of hazardous materials carried, the use of intoxicants or narcotics by drivers, and sleep and rest periods.

Virginia regulations for petroleum trucks differ from other Virginia truck regulations in that they require the drivers of these trucks to be at least 21 years old rather than 18. Virginia also requires that drivers of hazardous materials be experienced, careful, capable, and able to read and write in English, and that they possess a valid chauffeur's license.

In general, the federal regulations on hazardous material cargoes, vehicles, and drivers are more thorough and more concerned with safety than comparable Virginia regulations. In addition, the possibility exists that hazardous materials may be transported on Virginia's highways by carriers or on vehicles not subject to federal regulations. Because of these factors, Virginia regulations on the transportation of hazardous materials, promulgated in the 1950s, are undergoing revision.

#### FINDINGS AND CONCLUSIONS

National accident data reveal an increasing incidence of crashes and fatalities that involve heavy trucks. These statistics are of concern to traffic safety officials because they represent an increasing hazard to truck drivers as well as to the safety of other highway users. Also, indications are that there is a problem in terms of the number of crashes per vehicle and that the problem is worsening at a rapid rate.

The relation between the length of experience of truck drivers and crash involvement is significant. Data indicate that truck drivers that have less than one year of experience with their employers had more crashes than drivers that had more experience. In addition, 18- to 21-year-old truck drivers had a substantially higher rate of crash involvement than did 25- to 40-year-old drivers.

Differences between the FMCSR and state trucking regulations on operator age, operator licensing, accident reporting, hours of off-duty and driving time, use of seat belts, and pretrip inspections are substantial. There also are differences between FMCSR and the Virginia regulations on braking distance standards, requirements for front tire tread, and tire load capacity and pressure for the most common sizes of tires.

In general, the federal regulations on the transportation of hazardous materials are more thorough and safety-oriented than comparable Virginia regulations. Also, the state imposes much lighter penalties for violations of regulations on the transport of hazardous materials than does the federal government.

Most states have truck weighing and inspection programs; however, the effectiveness of these programs varies widely. Based on an analysis of the data presented in this report, Virginia has one of the best programs in the nation.

Safety in truck transportation is of concern to individuals at numerous levels of government and private industry. In Virginia, available data indicate a need for close scrutiny of the involvement of trucks in traffic crashes. In addition, it has been determined that certain revisions to the regulations that govern the trucking industry and the transportation of hazardous materials by truck are warranted.

#### IMPLEMENTATION OF RESEARCH FINDINGS

In the time that has elapsed since the research was initiated and the report published, a number of events have occurred that can be traced directly or indirectly to the research reported here. The most-significant event has been the transfer of responsibility for the regulation of hazardous-material cargoes from SCC to the Department of Health. State regulations on the transport of these materials, which were promulgated during the 1950s, are being revised by officials of that department. Although the final version of the regulations has not been completed, significant changes have been made in the state's operational procedures.

A second major event has been the special attention given to truck safety by the state police. Through a safety grant, approximately 30 troopers have been to the Transportation Safety Institute for courses on truck safety and inspection. These troopers form a core of officers who are carrying out the state's truck inspection programs. In addition, the state police have proposed the establishment of an inspection division that will have two primary responsibilities:

1. The supervision of the current periodic motor vehicle inspection stations and
2. The performance of in-field inspections of trucks for compliance with vehicle safety and hazardous materials regulations.

And finally, the DMV has initiated procedures for the modification of the state accident report form, including the solicitation of input from various state agencies. The format and data items have not been made final, so it is possible that the new form will not require the recording of some essential truck data. If this is the case, then a supplementary form should be developed to aid in gathering these data.

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The opinions, findings, and conclusions expressed in this report are ours and not necessarily those of the sponsoring agencies.

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