Chapter 3
Motor Carrier Issues

As Congress considers the reauthorization of the Federal highway program, two fundamental issues under debate are how to restructure the Federal-aid program and how to pay for the necessary highway improvements. Spearheaded by the American Trucking Associations (ATA), the trucking industry has made clear that if higher truck taxes are considered as part of a funding package, the industry will push for regulatory changes to increase their operating productivity. However, some of the suggested reforms have impacts that greatly concern other members of the transportation community, and debate on this issue has been intense. For example, States have long been in the process of developing agreements to bring their different motor carrier registration, permitting, and fuel tax procedures into greater conformity, so that national and regional trucking companies need not file for operating authority separately in each State. Some progress has been made; for example, the International Registration Plan now includes over 40 States. However, the International Fuel Tax Agreement includes fewer than 20 States, and no universally acceptable compact exists. Trucking companies contend that Federal preemption of State authority (always a difficult issue) in this area is warranted.

Issues of motor carrier safety have also been contentious, with industry sources maintaining that Federal data show that the heavy truck safety record per mile traveled has improved. However, safety reports contend that Federal data substantially underestimate carrier accidents' and that the federally funded Motor Carrier Safety Assistance Program needs to improve its enforcement activities and address uniformity issues associated with penalties and regulations.[2]

This chapter lays out what is known about the most recent very difficult issue--long heavy trucks, known as longer combination vehicles (LCVs)--to assist Congress in its deliberations on the highway reauthorization. It discusses their performance on the highway, the institutional and regulatory framework, technologies and programs that could enhance their safety, their effects on motorists and highway condition, and market impacts. It also provides information on an industry proposal to increase bus productivity by permitting longer intercity buses.

LARGE, HEAVY TRUCKS ON THE ROAD

The most recent Federal Highway Administration (FHWA) statistics show a total of 187 million motor vehicles of all types, of which 76 percent were automobiles, 0.3 percent were buses, and about 23 percent were trucks.[3] Light trucks--pickups, panel trucks, and delivery vans, generally of 10,000 lbs. or less gross vehicle weight (GVW)--make up the bulk (87 percent) of the 42-million-vehicle private and commercial truck fleet, although they play only a minor role in interstate commerce.[4] In 1989, 1.2 million truck-tractor power units and 3.7 million commercial-type trailers and semitrailers (most of the Nation's large, heavy trucks) were counted. Most tractor-trailer configurations travel close to 100,000 miles per year, and they dominate commercial interstate traffic.

One carrier industry proposal, greater standardization of State fuel tax programs and reporting requirements, is supported by the National Governors' Association consensus agenda[5] and may be feasible as a productivity

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[1] See, for example, U.S. Congress, Office of Technology Assessment, ***Gearing Up For Safety: Motor Carrier Safety in a Competitive Environment, OTA- SET-3 82*** (Washington, DC: U.S. Government Printing Office, 1988), ch. 7.

[2] See two reports by the U.S. Congress, Committee on Commerce, Science, and Transportation: ***Motor Carrier Safety Assistance Program (MCSAP): Options Intended to Improve a Generally Successful and Cooperative Federal-State Partnership Promoting Truck and Bus Safety,*** Senate Print 100-109 (Washington, DC: June 1988); and ***Reauthorization of the Motor Carrier Safety Assistance Program (MCSAP): Options Intended to Improve Highway Safety,*** Senate Print 102-10 (Washington, DC: March 1991).

enhancement. However, another industry suggestion--changing the Federal policy to allow States to determine individually whether and where to allow heavy trucks with multiple trailers, has generated substantial public resistance and enormous industry controversy. This issue is particularly salient in view of industry success during recent years in gaining permission to operate 53-foot trailers in a steady succession of eastern States, where they had hitherto not been allowed. This shift occurred after a Federal law was passed that included an industry-backed requirement for States to permit 48- and twin 28-foot trailers on highways built with Federal funds. State officials fear that industry supporters of LCVs will become active in individual State capitols if the Federal posture on this issue is altered.

While OTA's research on the subject of LCVs answered many questions, it raised almost as many more. A mountain of studies has been done by Federal and State Governments, universities, and industry groups, including a number by the Transportation Research Board (TRB), an arm of the National Research Council. However, each TRB study has looked at specific issues, and no conclusions on wider use of current LCV configurations can legitimately be drawn from them, despite some carrier claims. TRB has convened a planning group to consider the need for more studies on the subject.[6]

LCVs DEFINED

A relatively small subset of the Nation's tractor-trailer combination total, LCVs are typically multiunit combination trucks with gross vehicle weights in excess of 80,000 lbs. The most familiar type of multitrailer combination vehicles are western (or short) doubles, allowed on a national basis on the Federal highway network since 1982. These consist of one tractor hauling two 26- to 28-foot trailers, and while they are not considered LCVs, they have some of the same handling properties.

LCVs proper include turnpike doubles, Rocky Mountain doubles, and triple-trailer combinations (see figures 3-1 and 3-2). *Turnpike doubles* consist of one tractor hauling two trailers, each 45- to 48-feet long, can weigh up to 135,000 lbs., and typically have eight or nine axles. *Rocky Mountain doubles* consist of one tractor hauling two trailers, the first of which is 45- to 48-feet long and the second, 26- to 29-feet long. These vehicles can weigh up to 115,000 lbs. and typically have seven axles. *Triple combinations* consist of one tractor hauling three 26-to 29-foot trailers, can weigh up to 110,000 lbs., and have seven axles.[7] LCVs can also include bulk commodity doubles, in turnpike double or Rocky Mountain double configurations, used to transport dry bulk, liquid, or gaseous products in tank-type trailers. At present, Rocky Mountain doubles are the most widely used LCVs.

LCV operations of one type or another are already allowed in some 20 States, primarily in the West, but also in the East on toll roads and turnpikes (see figures 3-3, 3-4, and 3-5). In some areas, and under restricted conditions, LCVs have been operating for as many as 30 years and traveled hundreds of millions of miles. According to State and industry data,[8] the accident record of LCVs equals or compares favorably with that of other trucks. Most States permitting LCVs bar their operations in inclement weather and restrict their use to Interstate highways and roads of high design standard in uncontested areas. At issue is whether existing Federal size and weight limits should be retained, or whether each State should be allowed to determine its own requirements, an eventuality that would almost certainly increase the number of States where LCVs operate.

REGULATORY BACKGROUND

Since States first placed limitations on trucking operations to protect their highways from being damaged by heavy axle weights, trucking companies have sought ways to

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[3] U.S. Department of Transportation, Federal Highway Administration, ***Highway Statistics 1989*** (Washington, DC: 1990).

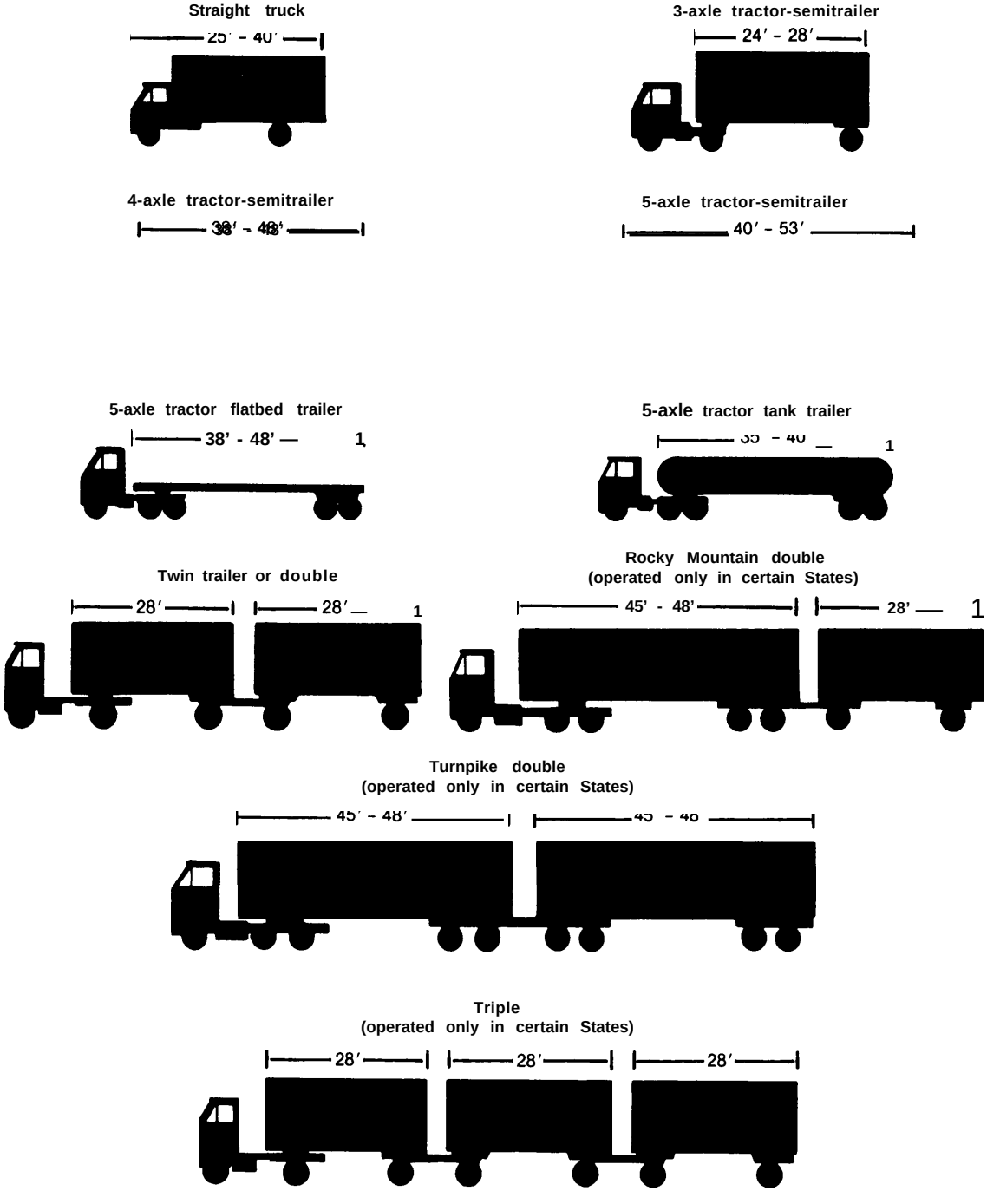
[4] For further information, see Office of Technology Assessment, op. cit., footnote 1, pp. 31-34.

5 Warren Hoemann, Yellow Freight System, Inc., personal communication, May 7, 1991.

[6] Robert Skinner, director, Special Projects, Transportation Research Board, personal communication, May 6, 1991.

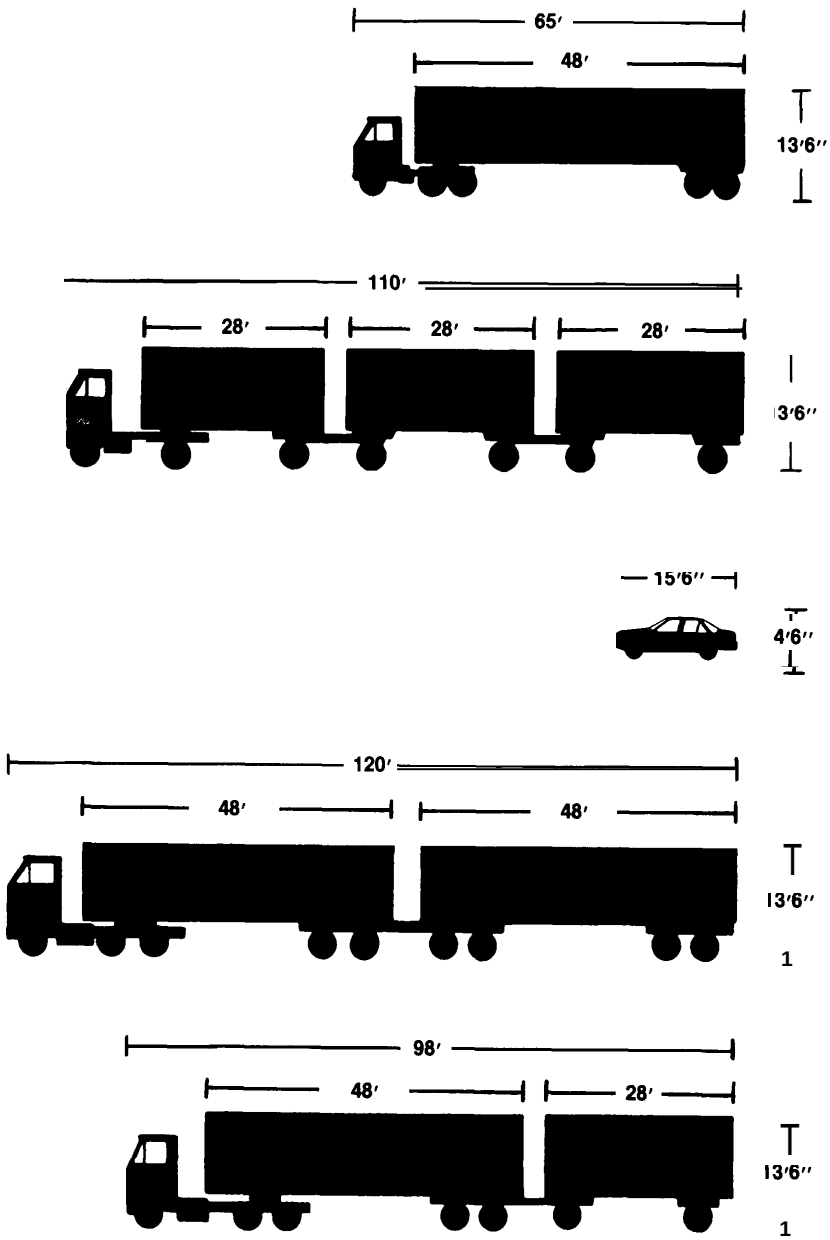
7 A fourth configuration, known as a Turner double, was proposed as part of a Transportation Research Board study and consists of one tractor hauling two 30- to 34-foot trailers and includes nine axles. However, no wide demand for this vehicle is

Figure 3-I—Heavy Truck Configurations



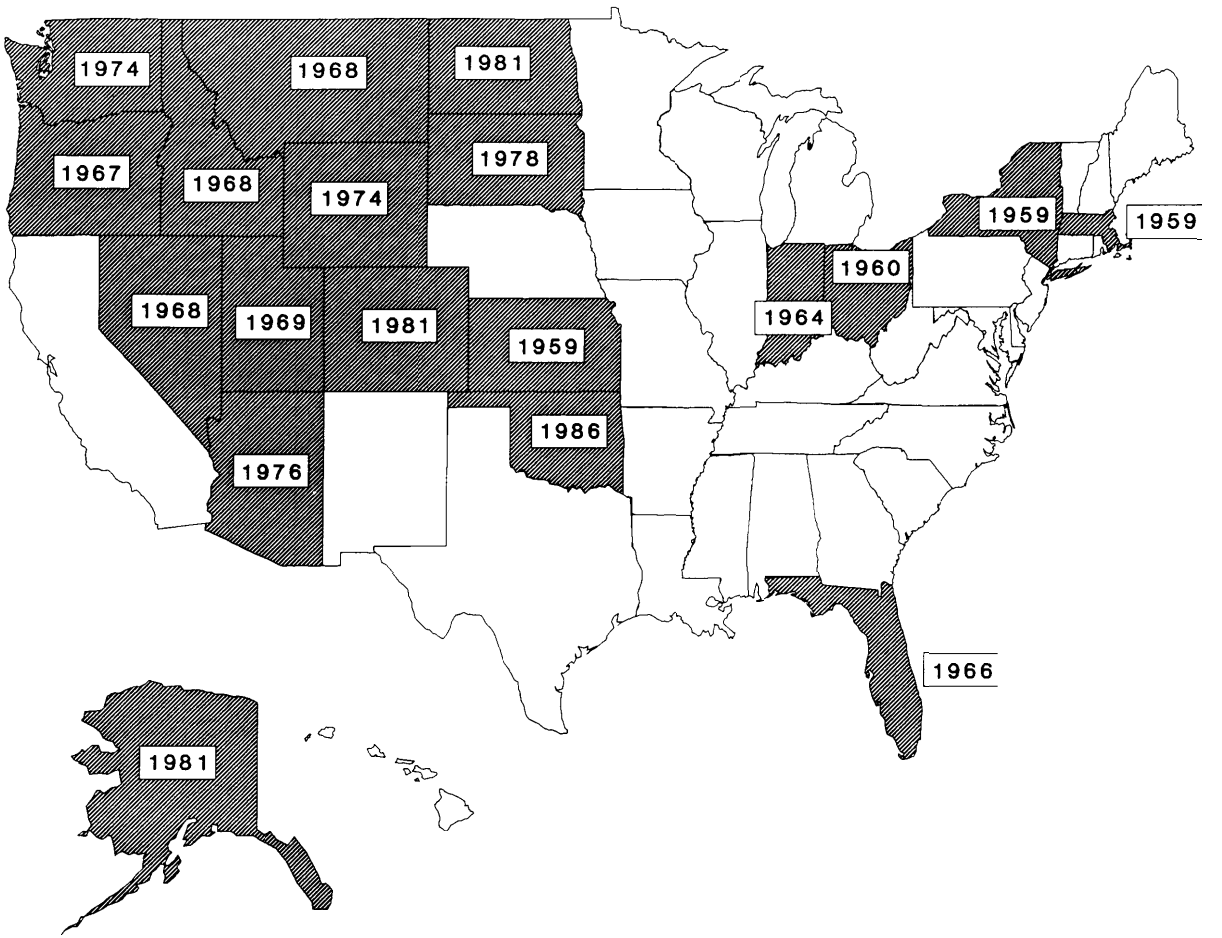
SOURCE: American Trucking Associations, Inc.

Figure 3-2—Vehicle Size Comparison



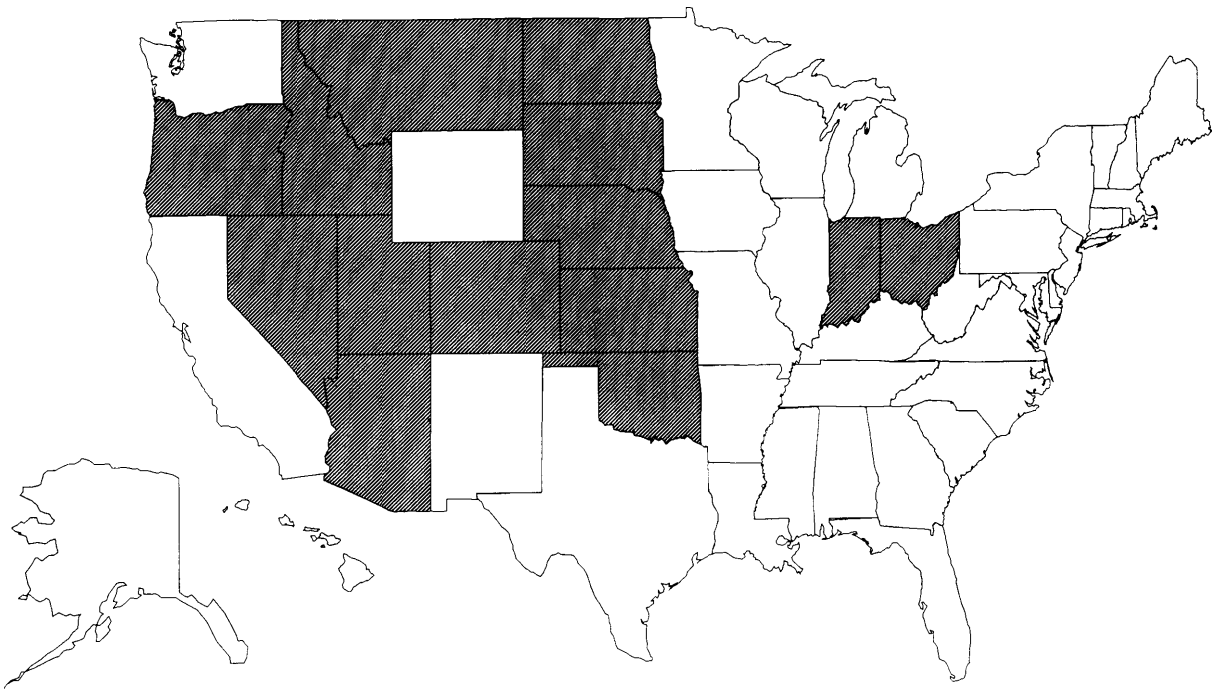
SOURCE: American Trucking Associations, Inc.

Figure 3-3—States Allowing Limited LCV Operations and Year First Allowed



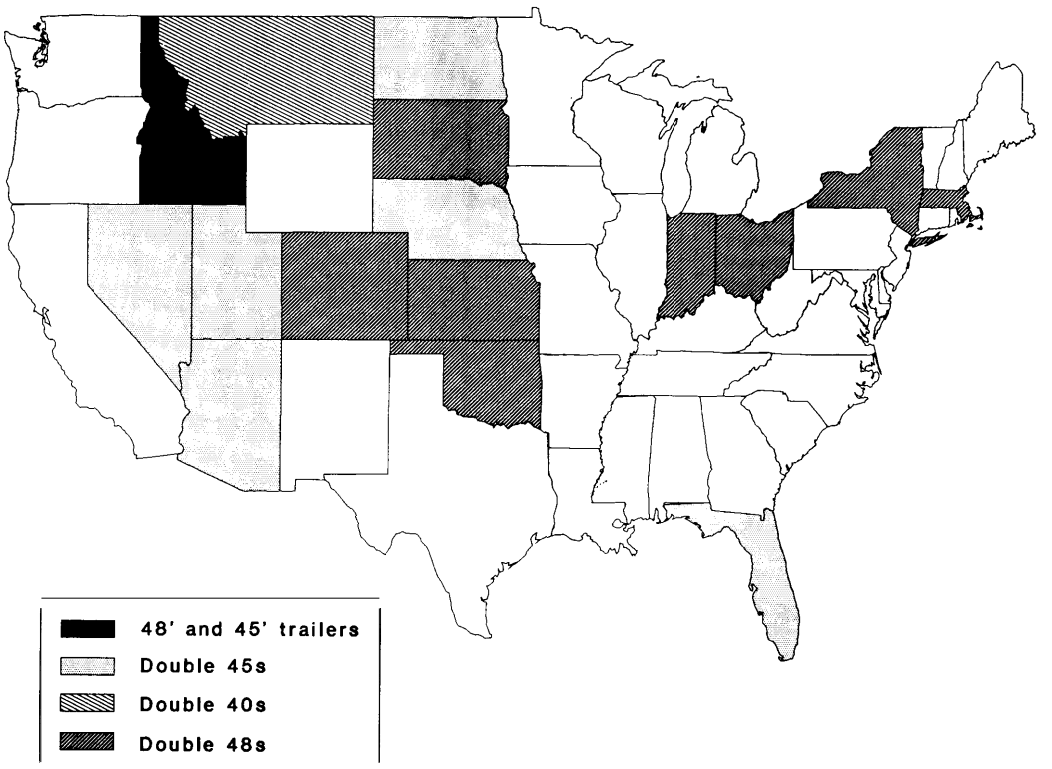
SOURCE: Office of Technology Assessment, 1991.

Figure 3-4—Triple-Trailer Operations



NOTE: Nebraska allows only the movement of empty trailers manufactured in the State.
SOURCE: Office of Technology Assessment, 1991.

Figure 3-5—Turnpike Doubles: States With Designated Routes and Weight Limits



NOTE: Nebraska allows only the movement of empty trailers manufactured in the State.
SOURCE: Office of Technology Assessment, 1991.

increase allowable vehicle sizes and weights. The first State laws regulating truck weight were adopted by Massachusetts and Maine in 1913, limiting gross vehicle weight (GVW) to 28,000 lbs. and 18,000 lbs., respectively. Pennsylvania later expanded on these regulations by placing a single axle limit of 18,000 lbs., a standard used on Interstate highways until 1974, and was the first State to establish a size restriction, requiring that all trucks on its roads be less than 90 inches wide. By 1933, all States had imposed total vehicle weight limits, and almost all States had adopted some sort of axle weight restrictions.[9]

Federal Standards

In response to State and industry concerns about the lack of regulatory uniformity between States, the American Association of State Highway Officials, now the American Association of State Highway and Transportation Officials (AASHTO), published a recommended program of uniform truck size and weight practices in 1946. The weight limits consisted of 18,000 lbs. for single axles, 32,000 lbs. for tandem axles, and 73,320 lbs. for GVW, although States could allow heavier trucks under special permits.

However, no Federal standards were set until 1956, with the passage of Federal legislation establishing the Interstate highway construction program.[10] At that time, the AASHTO axle and gross vehicle weight recommendations and a 96-inch width limit were included in the law, which applied only to Interstate highways. A grandfather clause allowed the continuing operation of wider or heavier trucks in those States where they were legal before the law's passage. The legislation also called on the Commerce Department to issue a report on the maximum desirable size and weight of trucks. The study, completed in 1964, recommended raising the weight restrictions to 20,000 lbs. for single axles, 34,000 lbs. for tandem axles, and 105,5oo lbs. for GVW.

The report also provided three different bridge formula programs, aimed at addressing the effects of heavy trucks on bridges built with Federal aid. One of the three, known as Bridge Formula B, was adopted. It allowed GVW to increase as axle spacing increased and established two main Federal classes of bridges. The HS-20 formula, used for bridges on most Interstate, allows axle weights that exceed design stress levels by 5 percent, while the H-15 model accounts for a possible 30-percent weight increase above optimum stress load.

For the HS-20, the hypothetical truck weighs 72,000 lbs. on three axles, 8,000 lbs. for the front axles and 32,000 lbs. for each of the two remaining axles. An H-15 bridge is designed to support trucks weighing 54,000 lbs. with a front axle weight of 6,000 lbs. and the remaining weight evenly distributed between the axles. The reasoning behind the more conservative formula for excess weight on the HS-20 was the bridge's predominance on the existing Federal-aid system roads and the greater amount of truck travel on these bridges.

Congress incorporated Bridge Formula B as part of amendments to the highway act in 1974.[11] The change in Federal weight regulations was made partly to offset industry concerns about possible reductions in trucking productivity resulting from legislation lowering the Federal speed limit to 55 miles per hour (mph).[12] The amendments also permitted States to raise GVW and single and tandem axle weight limits to the present limits of 80,000 lbs., 20,000 lbs., and 34,000 lbs., respectively.

Safety concerns registered at that time about wider use of larger trucks were countered by U.S. Department of Transportation (DOT) announcements that the trucks would be equipped with antilock brakes as required by new Federal Motor Vehicle Safety Standards and that new truck tire standards would soon go into effect.[3] However, the antilock brake requirements for trucks were later struck down in a court decision (see later discussion of antilock brakes) and no Federal standard for them has yet been promulgated.

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foreseen by the trucking industry, since it does not meet their market needs, and it is not discussed here.

8 However, a number of studies, including OTA's *Gearing Up For Safety (see* the first footnote in this chapter), have raised concerns about the accuracy and completeness of State accident reports and data.

9 National Research Council, Transportation Research Board, ***Truck Weight Limits: Issues and Options*** (Washington DC: 1990), p. 35.

10 70 stat. 374.

11 Public Law 93-643.

Although by the early 1980s, only three States did not allow 80,000 lbs. GVW and required lower axle weight limits on the Interstate system, these States were concentrated in the Mississippi Valley, a fact that had made coast-to-coast transport difficult. Western doubles (28-foot twins) were allowed in 70 percent of the States before enactment of the Surface Transportation Assistance Act (STAA), with nearly all of the States still prohibiting them located on the east coast.

The 1982 STAA[15] relaxed size and weight restrictions further, requiring all States to allow the weights permitted under the 1974 amendments to operate on the Interstate system. These allowances were a tradeoff for increases in Federal heavy vehicle fuel taxes and user fees imposed by the STAA. The width limit was increased as well, this time to 102 inches. The act also gave States control in deciding which trucks fell under the grandfather clause of 1956. In 1984, the Tandem Truck Safety Act[16] again eased restrictions, by requiring States to give broader access for single 28-foot-by-102-inch trailers and freer access for 102-inch trailers in general. Previously, the latter vehicles had been limited to roads with 12-foot-wide lanes.

Grandfather Clauses

The practical effect of the grandfathering of existing weight provisions in 1956 and 1974 has been to create a great deal of variation among the States in allowable truck sizes and weights, even on the Interstate system. Moreover, States can and do allow overweight trucks to operate at higher weights off the Interstate system under laws which vary widely from State to State (see detailed discussion later in this chapter). Two classes of vehicles currently operate on the Interstate system at weights in excess of the Federal axle and gross weight limits under grandfather clauses. One includes vehicles allowed to operate at weights in excess of 20,000 lbs. single axle and 34,000 lbs. tandem axle limits (or in excess of the Bridge Formula) in those States with higher limits before the passage of the 1956 and 1974 acts. This covers single-unit bulk haulers such as concrete mixers, dump trucks, garbage trucks, fire engines, and some local buses. The other class of heavier vehicles allowed on the Interstate system are the various combination vehicles which operate under special permits.

All States allow single or short-term permits for weights in excess of 80,000 lbs. for the movement of nondivisible loads. Furthermore, Federal law has been quite clear about the rights of States to issue single-trip or short-term permits for nondivisible loads.

In addition, 29 States now issue multiple-trip permits for divisible loads on certain highways and under specific operating conditions under the 1956 grandfather provision, an increase from 22 States in 1987. Some groups have argued that multiple-trip special permits for divisible loads should not have been covered by the grandfather provisions of the 1956 act. Extensive controversy has also surrounded the interpretation of State laws and State practices that were in effect in 1956. The amendment to the weight section in the STAA of 1982 was intended to clarify these arguments and provide that States' interpretations of their laws and practices in 1956 should prevail.

In recent years, some States that allow LCVs have substantially increased the numbers of special permits issued. This became necessary when shippers and their customers developed new markets made possible by the higher weights allowed under the permits. However, FHWA has become concerned that the grandfather clauses are being used to nullify Federal weight regulations in some States.

HANDLING AND SAFETY CHARACTERISTICS

Although the handling and stability characteristics of trucks depend greatly on the road geometry, pavement properties, equipment condition, number of axles, number, length, and weight of units, and how they are loaded and operated, any articulated vehicle is more difficult to drive safely than a straight truck or automobile. Some general comparisons can be made, however, between and among LCVs and conventional five-axle tractor-semitrailers. For example, triples have better low-speed maneuverability because of their short trailer

12 Transportation Research Board, op. cit., footnote 9, p. 36.

13 U.S. Congress, Senate Committee on Public Works, *The Federal-Aid Highway Amendment of 1974,* to accompany S. 3934 (Washington, DC:

wheelbases. Generally, low-speed *offtracking,* which occurs when the trailing axles of a vehicle migrate toward the center of a curve, is greatest for turnpike doubles, followed by Rocky Mountain doubles, conventional tractor-semitrailers, and triples. The greater the offtracking, the wider the road needs to be to accommodate turns. [17]

However, when multiple trailers are connected by conventional converter dollies, [18] *trailer sway,* especially in emergency maneuvers, is greatest for triples, followed by western doubles, Rocky Mountain doubles, turnpike doubles, and tractor-semitrailers. Articulated vehicles with more than one trailer experience strong side forces on the rear unit during rapid steering movements, such as those necessary to avoid an accident. The effects of the side forces are magnified between the tractor and rearmost trailer, often creating unstable behavior, such as trailer swing that can lead to rollover. [19] This rearward amplification is of particular concern with triple combinations, but rear trailer rollover occurs even with western (short) doubles.[20] The weight of each trailer and overall weight distribution also affect stability, making careful loading and trailer sequencing especially important. No Federal standards currently exist for trailer order or weight distribution.

Engine power and torque requirements to maintain minimum speed on grades increase with vehicle weight. Thus the most power and torque are needed for turnpike doubles, followed by triples, Rocky Mountain doubles, and tractor-semitrailers. Currently, no Federal requirements exist for engine power to ensure adequate minimum speeds, and such requirements would be difficult to enforce. However, State requirements for adequate performance and ability to maintain a minimum speed on grades could be enforceable and could help ensure adequate power.[21]

Braking power requirements also increase with vehicle weight, but braking distance depends on vehicle weight, tire and pavement characteristics, weight distribution, and the number of brake-equipped axles. In general, when each vehicle is comparably loaded and brakes are adjusted properly, *stopping distance* is essentially the same for all configurations. Under empty or partial loading, particularly when the rear part of any configuration is unloaded, braking distance will increase dramatically. Properly functioning antilock brake systems, discussed later, can greatly relieve this problem.

Safety-Enhancing Technologies

Using experienced, well-trained drivers that employ defensive driving techniques is an important means of avoiding accidents for articulated vehicles. Indeed, accident experience with LCVs thus far indicates that properly trained drivers operating in light-traffic-density, sparsely populated regions of the country can operate LCVs safely. However, even the best trucking companies complain that finding good drivers is difficult at present, and wider use of LCVs could lower the general skill level of LCV drivers and increase LCV exposure to dangerous situations. [22] If LVCs are operated in traffic mixes that increase the need for avoidance maneuvers, increases in crashes and rollovers can be expected.

A number of vehicle technologies are available or are being developed, however, to counter the handling difficulties of articulated trucks and make them safer and/or mitigate damage to the infrastructure. These include

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U.S. Government Printing Office, Aug. 20, 1974).

14 National Research Council, Transportation Research Board, ***Providing Access for Heavy Trucks*** (Washington, DC: 1989), p. 16.

15 Public Law 97-424.

16 Public Law 98-554.

17 U S Department of Transportation, Federal Highway Administration, ***The Feasibility of a Nationwide Network for Longer Combination Vehicles*** (Washington, DC: June 1985), p. III-3.

18 These are known as A-dollies, which have a single drawbar attaching to a pintle hook on the preceding trailer.

19 W.R.J. Mercer et al., ***Test and Demonstration of Double and Triple Trailer Combinations*** (Downsview, Ontario, Canada: Ontario Ministry of Transportation and Communications, August 1982), p. 17.

20 National Transportation Safety Board, recommendation H-90-7, 1990.

21 Larry Strawhorn, American Trucking Associations, personal communication, May 7, 1991.

22 OTA understands that companies with strong driver screening and training requirements, such as

antilock brakes, double-drawbar dollies for multiple-unit trucks, automatic slack adjusters, air suspension systems, and many others.

Brakes

Faulty braking systems are a contributing feature in a significant portion of truck accidents; they can contribute to accidents by not stopping the vehicle in time or causing wheel lockup, jackknifing, or trailer swing. Experts estimate that roughly one-half of all air-braked vehicles have at least one brake out of adjustment. The overall effect of recent fuel efficiency improvements, such as radial tires with lower rolling resistance, aerodynamic shields, and reduced friction engines, is roughly equivalent to increasing the slope of downgrades by 1 percent.[23] This places a much greater premium on properly maintained braking systems.

LCVs have more complex braking systems than conventional tractor-trailers, because the multiple trailers require more brake sets, each of which must be properly adjusted to ensure proper balance, timing, and torque. In addition, tractor and trailer brakes are certified separately, which places an especially large burden on those responsible for LCV maintenance to ensure compatibility between the tractor and various trailer brake sets. Often motor carriers do not control specification and maintenance of all the equipment used in their operations.

Adjustments must be made frequently during the life of a lining with manual adjusting brakes. *Automatic slack adjusters* can keep brakes in better adjustment, provide improved braking, and reduce maintenance costs. Though automatic slack adjusters are fairly standard on tractors, they are not consistently used on trailers, except by the larger fleets.[24] Recent National Transportation Safety Board inspections indicate that even automatic adjusters do not always ensure well-adjusted brakes and require some maintenance.[25]

A number of studies suggest that *antilock brakes* (known as ABS), particularly if introduced on all axles of a configuration, may be effective in reducing the frequency of jackknifing and loss of control due to braking. At present, the National Highway Traffic Safety Administration (NHTSA) is studying ABS on a cooperative basis with industry. Mandatory use of ABS was planned in the United States about 15 years ago, when Federal Motor Vehicle Safety Standard 121 was promulgated. However, ABS systems were unreliable at that time, and suffered from malfunctions caused by electromagnetic interference, among other problems. After a 1978 court decision eliminating the stopping distance requirement that resulted in the mandatory use of ABS, NHTSA proceeded *on* the basis of independent testing before making any decision on mandating ABS again. However, the trucking industry in the United States has remained skeptical about ABS because of their experiences in the late 1970s with systems that were not technically mature.

NHTSA is now conducting a test program with industry where 200 tractors have been placed in service with various ABS systems.[26] Fifty ABS-equipped trailers will be operational by June of 1991. Results of this program have been generally favorable and are expected to guide Federal regulatory efforts.

ABS is viewed by many safety experts as an important accident prevention tool, especially in avoiding trailer swing, jackknifing, or loss of steering control during braking. Although full benefits are achieved only if ABS is employed on all axles, some improvement in braking control can result from any set of ABS-equipped axles. According to a 1988 survey of foreign experience,[27] ABS systems used in Europe have many

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Yellow Freight Systems and United Parcel Service, will continue to use their most experienced and capable drivers for longer combination vehicles (LCVS). However, no such assurances pertain to the thousands of other potential operators of LCVs.

23 Ian S. Jones, Insurance Institute for Highway Safety, "Truck Air Brakes: Current Standards and Performance," proceedings of the 29th Conference of the American Society of Automotive Medicine, 1984, pp. 39-61.

24 Ron Roudebusch, Rockwell International Corp., personal communication, Mar. 8, 1991; and Jerry DeClair, Rockwell International Corp., personal communication, May 7, 1991.

25 James Kolstad, National Transportation Safety Board Chairman, unpublished remarks at the Motor Vehicle Manufacturers Association meeting, Feb. 18, 1991.

26 Transport Canada and Ontario Ministry of Transportation, "B-Train ABS Evaluation," working

checks and redundancies to ensure proper operation, and drivers report feeling safer with ABS and believe their vehicles can stop more quickly. Moreover, European experience with heavy truck and bus fleets indicates no interference problems with radios or other external electronic equipment. The systems require no routine attention aside from checks performed prior to and during required brake inspections, and the life of the ABS equals that of the vehicle. The only frequently mentioned concern is a problem with false alarm warning lights, which does not affect braking ability.

Trailer Connections and Suspensions

The *double-drawbar dolly (C-dolly),* used by some companies in Canada, couples trailers in a manner that eliminates one articulation point, improves roll stability, and reduces rearward amplification (see figure 3-6). It includes a self--steering axle to reduce high stress levels in the equipment due to tire scuffing in low-speed turns. The C-dolly also reduces low-speed offtracking because the axle is self-steerable.

Self-steering axles are vulnerable to unequal longitudinal forces acting through the wheels of the axle, such as when one side is on a paved road and the other is on a dirt shoulder or packed snow and ice. These weaknesses can be offset with the use of an appropriate centering force system. Self-steering axles also require locking mechanisms to immobilize the steering action of the axle when the vehicle moves in reverse. These mechanisms can be controlled from the tractor cab. The locking feature of the C-dolly yields greater vehicle maneuverability in trucking terminals and staging areas.[28] For example, the C-dolly enables multitrailer combinations to back up in a straight line for considerable distances. The C-dolly shows potential to reduce rearward amplification and trailer rollovers and to improve maneuverability for all multitrailer combinations with trailers less than 40 feet in length. This points to a need for large-scale fleet testing. Some Canadian provinces encourage the use of C-dollies over other hitching mechanisms by allowing vehicles equipped with them to carry greater maximum weight.

The *B-train hitch is* an alternative to the standard converter dolly used for multitrailer combinations. When B-trains are used, the towing trailers must have an extended frame with a fifth wheel for attaching the next trailer (see figure 3-6 again). The extended frame can be sliding, which allows the trailer to be backed flush to a loading dock, or fixed. B-trains with fixed frames are difficult to use in some operations because its protruding rear wheels prevent backing up the lead trailer flush to truck loading docks. Tests in Canada, where B-trains see significant use, indicate that they have superior stability, handling, and offtracking characteristics compared to conventional A-trains.*[9] As with the C-dolly, some Canadian provinces encourage the use of B-trains by allowing companies using them to carry greater weights.

Technologies can also be used to mitigate the effects of heavy trucks on pavements and bridges. For instance, *air suspensions* almost always produce lower dynamic loads than steel leaf suspensions. Tests conducted in the United Kingdom show that axle loads on bridges decrease by as much as 27 percent when air suspensions are used. Moreover, dynamic loads increase with speed more with steel leaf suspensions than with air suspensions. These findings point to less wear on roads and bridges when air suspensions are used. Air suspensions also reduce vibrations at the driver's position,[30] leading many drivers to prefer them, and can reduce equipment damage, particularly when a truck is traveling empty.

Despite the potential of these technologies to make driving LCVs safer and easier, manufacturers of such equipment have not found large

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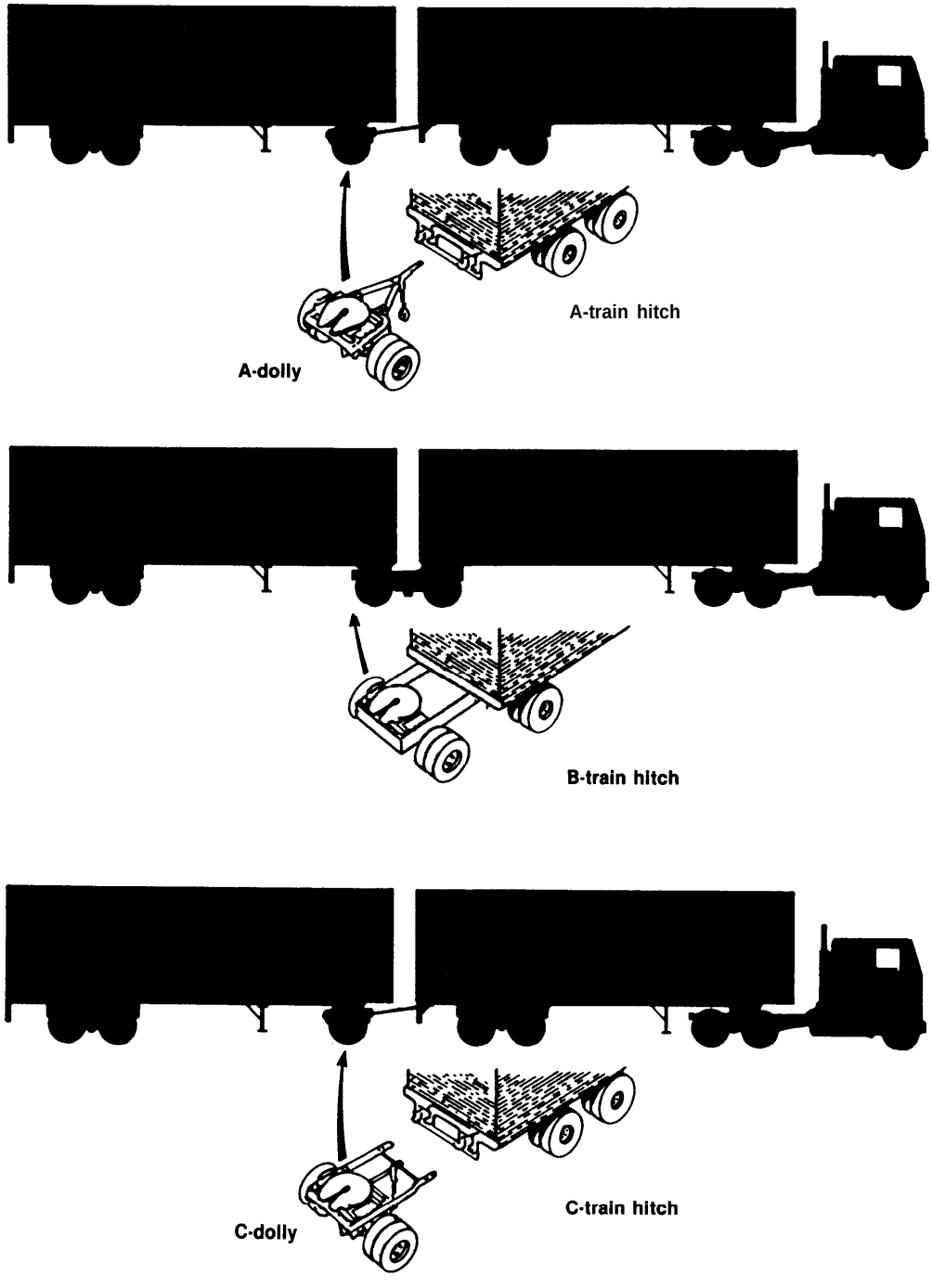
paper, May 1990, pp. 1-2.

27 Paul S. Fancher, Transportation Research Institute, University of Michigan, "European/Australian Experience With Antilock Braking Systems in Fleet Service," DOT Final Report No. DOT HS 807269 (Washington, DC: U.S. Department of Transportation, March 1988).

28 J. Woodroofe et al., Vehicle Dynamics Laboratory, National Research Council of Canada, "Development of Design and Operational Guidelines for the C-Converter Dolly," paper presented at the Second International Symposium on Heavy Vehicle Weights and Dimensions, Kelowna, British Columbia, Canada, June 18-22, 1989.

29 J.R. Billing et al., "Test of a B-Train Converter Dolly" (Downsview, Ontario, Canada: Ontario Ministry of Transportation and Communications,

Figure 3-6-Hitching Mechanisms for Twin-Trailer Trucks



SOURCE: Roads and Transportation of Canada, "Canadian Vehicle Weights and Dimensions Study," Technical Steering Committee Report, 1987.

markets for their products. Technological aids such as ABS and double-drawbar dollies show much potential to improve safety, particularly in emergency situations. Requirements for these, or similar technologies capable of providing controlled braking and reducing trailer sway, are essential to ensure low LCV accident rates. Congress could require DOT to implement standards for these technologies for companies using LCVs.

LCV Accident Records

Despite the handling difficulties of LCVsand the fact that the types of safety-enhancing technologies discussed above are not commonly used, most research and accident records indicate that LCV fatal and nonfatal accident rates per vehicle-mile traveled are equal to or better than those of other articulated trucks. However, most research also shows the accident rate of multitrailer trucks--most of which are western (twin) doubles, since they are allowed nationwide--to be higher than that of conventional tractor-semitrailers.[31] The reasons for the seeming contradictions are two-fold. First, recognizing the special skills required to operate LCVs safely, most carriers assign their most skilled and experienced drivers to LCVs.[32] No such precautions characterize the choice of drivers for western doubles. Second, because of State permitting requirements, LCVS generally travel over the safest roads and under the safest conditions. No such permitting procedures apply to conventional tractor-semitrailer and western doubles operations, accounting for their higher accident rates. Western doubles appear to have the highest accident rates of all articulated trucks.

However, previous LCV use and accident experience are simply inadequate to determine accurately the consequences of LCV use on a wider network. For example, most large national accident databases--those most likely to provide sufficient data to give statistically reliable information--have major limitations, including uneven levels of accident reporting, inaccurate exposure data, and insufficient level of detail. For instance, accident and truck-use databases do not clearly distinguish LCVs from other multitrailer combinations, because they do not include either trailer length or total vehicle length.

State and industry records on LCV operations show that triples have the lowest fatal accident rate, followed by turnpike doubles and Rocky Mountain doubles. Again, this ranking results not from inherent characteristics of each configuration, but from how much and where each vehicle is driven, and from driver selection procedures. For example, Rocky Mountain doubles see much more off-interstate use than other LCVs, and their drivers are less carefully screened than operators of turnpike doubles and triples. Triples operators appear to be the most carefully screened; it is not unusual for a company to require several years of accident-free doubles driving before allowing a driver to operate triples. Comparing inherent safety and vehicle handling characteristics is quite different than comparing how safely the vehicles are operated under present circumstances.

The lack of good data has hampered efforts to evaluate LCV accident experience. Researchers estimate that 1 billion vehicle-miles of travel would be required for reliably detecting a 10- to 20-percent difference in accident rates among different configurations under "clean" conditions (stable fleet composition, reliable data) .33 Such data are simply not available. Moreover, the task of acquiring enough data is daunting, because each LCV configuration has unique properties dependent on such various factors as wind, road geometry, choice of hitching mechanism, tire and suspension properties, trailer wheelbases, and trailer loading.

May 1983), pp. ii-iii.

30 C.G.B. Mitchell and L. Gyenes, Transport and Road Research Laboratory, United Kingdom, "Dynamic Pavement Loads Measured for a Variety of Truck Suspensions, " unpublished report, 1989.

31 For further information, see Office of Technology Assessment, op. cit., footnote 1, pp. 95-97; and a review of past studies in Forrest M. Council and William L. Hall, University of North Carolina Highway Safety Research Center, "Large Truck Safety in North Carolina, " unpublished report, October 1988, pp. 10-17.

32 U.S. Department of Transportation, Federal Highway Administration, ***Longer Combination Vehicle Operations in Western States*** (Washington, DC: October 1986), pp. 11-13-11-18.

33 Gordon A. Sparks, Department Of Civil Engineering, University of Saskatchewan, et al., "Safety Experience of Large Trucks: An Analysis

STATE PROGRAMS

State operating restrictions and permit practices for LCVs and other types of heavy vehicles vary widely because of the many different types of LCVs and the diverse ways and locations in which they are used. Most trucking operations are regional, and State highway officials, even in neighboring States, do not have uniform permitting requirements. For example, in Utah motor carriers must designate their LCV routes and have their safety programs certified, including guarantees that all LCV drivers are tested in accordance with Federal law. The tests at a minimum must include left-hand and right-hand turns, entering and exiting highways, operation in traffic, and operation on grades. Many, but not all, States and toll authorities that allow LCVs perform engineering evaluations to determine the impact on infrastructure, conduct demonstrations with test vehicles, and limit operations to selected carriers before authorizing operations by other qualified companies.[34]

Unstandard Standards

Fourteen States allow the operation of overweight vehicles[35] on Interstate without a special permit. Most of these States allow higher axle weights than permitted by Federal law, although Michigan and New Mexico both allow a GVW greater than the 80,000 lbs. Federal limit. Some States also allow single and tandem axle weights to exceed the Federal limit. In addition, States do not always apply Federal regulations to non-Interstates. The maximum GVW on some non-Interstates ranges from 73,280 lbs. in Illinois, Minnesota, and Missouri to 154,000 lbs. in Michigan.[36] Montana, Nevada, North Dakota, and Wyoming permit LCVs on the entire State highway network, while some other States restrict LCVs to a portion of the Interstate network.[37] Similarly, designated LCV highways may not be continuous from State to State, particularly for turnpike doubles and triples. Table 3-1 summarizes the variety of State regulations governing truck operations. (This table is revised every 6 months, with the next update scheduled for July 1991. Because State laws can change frequently, some information may be slightly outdated.)

The lack of consistent requirements across State boundaries is an obstacle to freer interstate transport that many would like to see addressed, and as a result of State and industry efforts,[38] some uniformity has been achieved in western States in laws governing LCV equipment and operations. However, this is less true for special permits, fees, and driver qualifications,such as minimum age and operating experience. Generally, States issue operating permits to carriers (not individuals) and require them to certify minimum levels of driver experience, insurance coverage, and vehicle safety and inspection standards. Typically, violations of permit conditions result in temporary suspension of the permit and removal of the individual tractor from operation. Carrier use of other LCV units, even by the driver of the suspended vehicle, is not necessarily prohibited. LCV driver experience and training requirements are where States differ the most from Federal regulations and each other. Although numerous safety studies have concluded that drivers less than 25 years of age have the highest accident rate, minimum age requirements for LCV drivers are the same as or below the Federal limit of 21 years of age in all but one State.

HUMAN FACTORS

As stated earlier, LCVs' relatively safe operating history is due in large part to the driver selection and training practices of the companies using them. It is not uncommon for a company to require accident-free driving before allowing a driver to operate an LCV.

Training

Training for companies with the safest LCV operating records includes an extensive on-the-road component. These operators believe that experience is essential in teaching drivers how to operate LCVs safely. Companies operating LCVs

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of Sample Size Requirements, " proceedings of the Second International Symposium on Heavy Vehicle Weights and Dimensions, Kelowna, British Columbia, Canada, June 18-22, 1989.

34 Warren E. Hoemann, Yellow Freight System, personal communication, Apr. 25, 1991.

35 Overweight refers here to weight limits in excess of those set forth in 23 U.S. C. 127.

36 Transportation Research Board, op. cit., footnote 9, pp. 45-47.

37 Federal Highway Administration, op. cit., footnote 32, p. II-1.

DES. = Interstate and federally designated state highways.
OTHER = All other state highways and supplemental routes

	LENGTH (FEET)									
	INTERSTATE AND DESIG. HWYS. (DES.)					STATE AND SUPP. HWYS. (OTHER)				
	STRAIGHT TRUCKS	COMBINATIONS		TRAILING UNITS		STRAIGHT TRUCKS	COMBINATIONS		TRAILING UNITS *	
		TRACTOR-SEMI-TRAILER	TRACTOR-TWIN-TRAILERS	SEMI-TRAILER	TRAILER		TRACTOR-SEMI-TRAILER	TRACTOR-TWIN-TRAILERS	SEMI-TRAILER	TRAILER
ALABAMA	40	0	0	53	28.5	40	0	0	53	28.5
ALASKA	40	0	0	48	48	40	70	75	45	45
ARIZONA	40	0	0	57.5	28.5	40	65	0	51	28.5
ARKANSAS	40	0	65	53.5	28.50	40	0	65	53.5	28.5°
CALIFORNIA	40	B	B	B	B	40	B	B	B	B
COLORADO	40	0	0	57.33[D]	28.5[D]	40	0	0	57.33[D]	28.5[D]
CONNECTICUT	60	0	0	48	28	60	0	0	48	28
DELAWARE	40	0	0	53	29	40	60	60	NS	NS
DISTRICT OF COLUMBIA	40	0	0	48	28	40	55	A	NS	A
FLORIDA	F	0	0	5300	28	F	0	A	5300	A
GEORGIA	60	0	0	53[N N]	28	60[N N]	60[N N]	A[N N]	53[N N]	A[N N]
HAWAII	40	NS	NS	NS	NS	40	60	65	NS	NS
IDAHO	40	0	0	48	61[G G]	40	0	0	48	61[G G]
ILLINOIS	42	G	G	53[G]	28.5	42	G	G	53[G]	28.5
INDIANA	36	0	0	53[H H]	28.5	36	0	0	53[HH]	28.5
IOWA	40	0	0	53	28.5	40	60	60	NS	NS
KANSAS	42.5	0	0	53	28.5	42.5	0	0	53	28.5
KENTUCKY	45	D	0	53	28	45	55	A	NS	A
LOUISIANA	40	0	0	59.5	30	40	65	A	50	A
MAINE	45	0	0	48	28.5	45	65	A	48	A
MARYLAND	40	0	0	48	28	40	0	A	48	A
MASSACHUSETTS	40	0	0	48	28	40	60	A	48[B B]	A
MICHIGAN	40	0	59	5300	28.5	40	0	59	50	NS
MINNESOTA	40	0	0	53[EE]	28.5	40	65	E	48[EE]	28.5[EE]
MISSISSIPPI	40	0	0	53	30	40	0	0	53	30
MISSOURI	40	0	0	53	28	40	60	65	NS	NS
MONTANA	40	0	0	53	28.5	40	0	0	53	28.5
NEBRASKA	40	0	0	53	65[Y]	40	0	0	53	65[Y]
NEVADA	40	0	0	53[T]	28.5[T]	40	0[T]	O[T]	48[T]	28.5[T]
NEW HAMPSHIRE	40	N/S	N/S	48	28	40	0	0	48	28
NEW JERSEY	35	0	0	48	28	35	0	A	48	28
NEW MEXICO	40	0	0	57.5	28.5	40	65	65	NS	NS
NEW YORK	35	0	0	48	28.5	35	60[A A]	60	45[A A]	NS
NORTH CAROLINA	F	0	D	5300	28	F	60	A	NS	A
NORTH DAKOTA	50	0	0	53	53	50	75[U]	75[U]	53	53
OHIO	40	0	D	53	28.5	40	0	0	53	28.5
OKLAHOMA	45	0	0	C	C	45	0	0	59	29

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DES. = Interstate and federally designated state highways.
OTHER = All other state highways and supplemental routes

	HEIGHT (FEET)	WIDTH (INCHES)		WEIGHT (1 ,000 POUNDS)					
				SINGLE AXLE WEIGHT		TANDEM AXLE WEIGHT		GROSS VEHICLE WEIGHT	
		DES.	OTHER	INT.	OTHER	INT.	OTHER	INT.	OTHER
ALABAMA	13.5	102	L	20	20	34	40	80	84
ALASKA	14	102	102	20	20	38	38	K	NS
ARIZONA	13.5	102	96	20	20	34	34	80	80
ARKANSAS	13.5	102	102	20	20	34	34	80	80
CALIFORNIA	14	102	102	20	20	34	34	80	80
COLORADO	14.5	102	102	20	20	36	40	80	85
CONNECTICUT	13.5	102.36	102.36	22.4	22.4	36[w]	36[w]	80	80
DELAWARE	13.5	102	96	20	20	34	40	80	80
DISTRICT OF COLUMBIA	13.5	102	96	22	22	38	38	80	80
FLORIDA	13.5	102	96	22	22	44	44	80	80
GEORGIA	13.5	102	96	P	P	Q	37.34	80	80
HAWAII	13.5	108	108	22.5	22.5	34	34	80.8	88
IDAHO	14	102	102	20	20	34	34	80	105.5
ILLINOIS	13.5	H	H	20[e]	18	34[e]	32	80[e]	73.28
INDIANA	13.5	102	102	20	20	34	34	80	80
IOWA	13.5	102	96	20	20	34	34	80	80
KANSAS	14	102	102	20	20	34	34	80	85.5
KENTUCKY	13.5	102	96	20	20	34	34	80	J
LOUISIANA	13.5	102	96	20	22	34	37	80	80
MAINE	13.5	102	102	R	22.4	34	38	80	80
MARYLAND	13.5	102	96	z	z	z	z	80	80
MASSACHUSETTS	13.5	102	102	22.4	22.4	36	36	80	80
MICHIGAN	13.5	102	96	JJ	JJ	JJ	JJ	JJ	JJ
MINNESOTA	13.5	102	102	20	18	34	34	80	80
MISSISSIPPI	13.5	102	102	20	20	34	34	80[v]	80[v]
MISSOURI	14[kk]	102	96	20	18	34	32	80	73.28
MONTANA	14	102	102	20	20	34	34	80	80
NEBRASKA	14.5	102	102	20	20	34	34	80	95
NEVADA	14	102	102	20	20	34	34	80	M
NEW HAMPSHIRE	13.5	102	102	z	z	22.4	36	80	80
NEW JERSEY	13.5	102	96	22.4	22.4	34	34	80	80
NEW MEXICO	14	102	102	21.6	21.6	34.32	34.32	86.4	86.4
NEW YORK	13.5	102	L	20[11]	22.4	34[11]	36	80	80
NORTH CAROLINA	13.5	102	96	20	20	38	38	80	80
NORTH DAKOTA	13.5	102	102	20	20	34	34	80	105.5
OHIO	13.5	102	102	20	20	x	x	80	80
OKLAHOMA	13.5	102	102	20	20	34	34	80	90

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DES. = Interstates and federally designated state highways.
OTHER = All other state highways and supplemental routes

	LENGTH (FEET)									
	INTERSTATE AND DESIG. HWYS. (DES.)					STATE AND SUPP. HWYS. (OTHER)				
	STRAIGHT TRUCKS	COMBINATIONS †		TRAILING UNITS ‡		STRAIGHT TRUCKS	COMBINATIONS †		TRAILING UNITS ‡	
		TRACTOR-SEMI-TRAILER	TRACTOR-TWIN-TRAILERS	SEMI-TRAILER	TRAILER		TRACTOR-SEMI-TRAILER	TRACTOR-TWIN-TRAILERS	SEMI-TRAILER	TRAILER
OREGON	40	Ø	Ø	53	N	40	N	N	N	N
PENNSYLVANIA	40	Ø	Ø	48[I]	28.5	40	60	A	NS	A
RHODE ISLAND	40	Ø	Ø	48.5	28.5	40	Ø	Ø	48.5	28.5
SOUTH CAROLINA	F	Ø	Ø	53[OO]	28.5	F	60	A	45	A
SOUTH DAKOTA	45	Ø	Ø	53	S	45	Ø	Ø	53	S
TENNESSEE	40	Ø	Ø	50[LL]	28.5	40	Ø	A	50[LL]	A
TEXAS	45	Ø	Ø	59	28.5	45	Ø	Ø	59	28.5
UTAH	45	92	92	48	61[Y]	45	Ø	Ø	48	61[Y]
VERMONT	60	Ø	Ø	48	28	60	65[MM]	A	45[MM]	A
VIRGINIA	40	Ø	Ø	53[L]	28.5	40	60	A	NS	A
WASHINGTON	40	Ø	Ø	48	60[Y]	40	Ø	Ø	48	60[Y]
WEST VIRGINA	40	Ø	Ø	48[L]	28.5	40	60	A	NS	A
WISCONSIN	40	Ø	Ø	53[FF]	28.5	40	60	A	48	A
WYOMING	60	Ø	Ø	60	CC	60	Ø	Ø	60	CC

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NOTE: No state shall prohibit the use of trailers or semitrailers of such dimensions as those that were in actual or lawful use in such state on Dec. 1, 1982. Neither shall any state prohibit the use of existing trailers or semitrailers of up to 28.5 feet in length in a truck tractor-semitrailer-trailer combination if those trailers and semitrailers were actually and lawfully operating on Dec. 1, 1982, within a 65-foot length limit in any state.

TOLERANCES:
ALABAMA - 10% weight tolerance on other roads
CALIFORNIA - 200 lbs. on Platform Scales, or 2% of scale wt. on Portable Scales.
CONNECTICUT - 2% tolerance if below 73,000 lbs.
DISTRICT OF COLUMBIA - 1,000 lbs. tolerance on GVW.
HAWAII - 5% weight tolerance on state and supplemental routes only.
KENTUCKY - 5% tolerance on length.
MARYLAND - 1,000 lbs. tolerance on GVW.
MISSISSIPPI - None on federal highways, 5% on tandem and 2% on gross on selected other highways.
MISSOURI - If on hwys. other than Interstate, can exceed axle and gross wt. limitations up to 2,000 lbs.
MONTANA - Up to 5% (7% for livestock). $10 trip permit fee charged.
NEW HAMPSHIRE - 5% tolerance below 80,000 lbs. on supp. hwys. only.
PENNSYLVANIA - 3% on axle weight except when weighed on stationary scales on Interstate highways.
VERMONT - On other highways only - 10% on axles, 5% on gross.

· Only tractor-semitrailer and tractor-twin-trailer combinations are considered here. For other combinations, contact state agency.

‡ Semitrailer in tractor-semitrailer combination, and trailer in tractor-twin-trailer combination.

ᵥ No overall length restrictions imposed.

NS. Not specified.

L. Not allowed (allowed in some states by permit).

1. **On any hwy.** tractor-semitrailer combo. 65' (distance between kingpin and rearmost semitrailer axle must be 40' or less; single axle semitrailer kingpin dimension is limited to 38 feet).

On federally designated hwys., no overall combination length limitation or kingpin restriction if semitrailer is 48' or less. Or, semitrailer may be 53 feet if kingpin to centerline of rearmost axle of tandems is no longer than 40 feet, single rear axle is limited to 38 feet.

Twin-trailer combinations 65' on all hwys. if either trailer exceeds 28.5'; 75' on non-designated hwys. if neither trailer exceeds 28.5', and unlimited length on federally designated system if neither trailer exceeds 28.5'.

A. No limit on interstate or 4-lane highways, otherwise 59-foot semitrailer and 29-foot twin trailers.

B. Combinations with semitrailers or twin-trailers in excess of limits may not exceed 70'.

C. On class I, II, and III hwys.

E. 2 axles, 35'; 3 axles, 40'.

G. Any semitrailer operated on any hwy. whose length exceeds 48', is limited to maximum distance of 42'6" from kingpin to center of rearmost axle. **On class II, and non-designated hwys.**, maximum tractor-semitrailer wheel base, 55'. **Class II hwys.**, maximum tractor-twin-trailer wheel base, 65'. **On class III and non-designated hwys.**, maximum combination vehicle length, 60'.

H. 102" on class I and II hwys.; 96" on class III and non-designated hwys.

I. 53' long, 8' wide trailer also legal if total length does not exceed 60'.

J. 80,000 lbs. on class AAA hwys.; 62,000 lbs. on class AA hwys.; and 44,000 on class A hwys.

K. GVW is governed by Bridge Formula.

M. 53' trailers permitted if distance between last axle of tractor and first axle of semitrailer does not exceed 37 feet.

M. Uncapped Federal Bridge Formula.

N. **Tractor-semitrailer combo.** 60' for Group 1 hwys.; 50' for groups 2 and 3 hwys. **Semitrailers** not specified for group 1; 40' for group 2; and 35' for group 3. **Tractor-twin-trailers** 75' for group 1; 65' for group 2; and 50' for group 3. **Trailers** 40' for group 1; 35' for groups 2 and 3.
On interstate and designated hwys., no semitrailer or trailer in a twin-trailer combo. may exceed 40'; both trailing units together measured from the front of the 1st to the rear of the 2nd may not exceed 68'.

O. 28'6" if trailer was manufactured prior to December 2, 1982; 28' if trailer manufactured after December 1, 1982.

P. 18,000 lb. + 13%.

Q. 34,000 lb. Exception: If vehicle is less than 55 feet long and gross weight is less than 73,280 lb., will allow 40,680 lb.

R. **Single Axle** 22,000 lbs. if GVW is less than 73,280 lbs.; and 20,000 lbs. if GVW is more than 73,280 lbs. but less than 80,000 lbs.

S. 28½ feet on each trailer unit operating in a road tractor-trailer-trailer combination if the towbars do not exceed 19 feet and the overall length of the trailer-trailer including towbars does not exceed 80 feet. The maximum length of semitrailer or semitrailer-trailer combination, excluding the length of the tractor, is 81½ feet provided the maximum length of either unit does not exceed 45 feet. If the towbar length exceeds 19 feet, the towbar shall be flagged during light hours and lighted at night. The weight of the second unit may not exceed the weight of the first unit by more than 3000 pounds.

T. 70 feet overall limit if semitrailer is over 53 feet on network (48' on other roads) or twin trailers are over 28.5 feet.

U. 2, 3, and 4-unit combos., 110' on 4-lane divided hwys.

V. 80,000 lbs. or 57,650 lbs., depending on highway classification.

W. 4 axles of tandem are less than 6' apart.

X. Two successive axles spaced 4' or less, 24,000 lb.; axles spaced more than 4' to 10', 34,000 lb. & 1,000 lb. for each foot or fraction thereof over 4'.

Table 3-I—Vehicle Sizes and Weights: Maximum Limits, Jan. 1, 1991-Continued

DES. = Interstate and federally designated state highways.
OTHER = All other state highways and supplemental routes

	HEIGHT (FEET)	WIDTH (INCHES)		WEIGHT (1 ,000 POUNDS)					
				SINGLE AXLE WEIGHT		TANDEM AXLE WEIGHT		GROSS VEHICIE WEIGHT	
		DES.	OTHER	INT.	OTHER	INT.	OTHER	INT.	OTHER
OREGON	14	102	102	20	20	34	34	80	80
PENNSYLVANIA	13.5	102	96	22.4[Z]	22.4[Z]	36Z	34Z	80	80
RHODE ISLAND	13.5	102	102	22.4	22.4	44[RR]	44[RR]	80	80
SOUTH CAROLINA	13.5	102	96	20	22	35.2[W]	39.6	80	80.6
SOUTH DAKOTA	14	102	102	20	20	34	34	80	K
TENNESSEE	13.5	102	102	20	20	34	34	80	80
TEXAS	13.5	102	102	20	20	34	34	80	80
UTAH	14	102	102	20	20	34	34	80	80
VERMONT	13.5	102	102	22.5	22.5	36	36	80	80
VIRGINIA	13.5	102	96	20	20	34	34	80	80
WASHINGTON	14	102	102	20	20	34	34	80	80
WEST VIRGINA	13.5	102	96	20	20	34	34	80	65[DD]
WISCONSIN	13.5	102	102	20	20	34	34	80	80
WYOMING	14	102	102	20	20	36	36	80	80

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As measured from front of 1st trailing unit to rear of second

When **GVW** is 73,280 **lbs**. or less, single axle may not exceed 22,400 lbs and tandem, 36,000 lbs, if **GVW** exceeds 73.280 **lbs**., single axle may not exceed 20,000 lbs and tandem 34,000 lbs

Tractor-semitrailer combo. 60' if semitrailer is 45' or less Tractor-semitrailer combo. 55' if semitrailer is greater than 45' and less than 48'

If have 54' between first tractor axle and last trailer axle, plus overall length not over 60'

48' 1st semitrailer, 40' 2nd trailer, but combined length of the two may not exceed 80', including connecting devices Other combinations not shown, 85'

73,500 on some roads

If over 48', kingpin to rear axle cannot exceed 41 Tractor-twin trailer combinations allowed on state designated routes only

Provided distance between kingpin and center of rearmost axle group is 41 feet or less

Combination of trailers can be 61 feet including tongue, or 75 feet overall

Kingpin to rearmost axle cannot exceed 405 feet, if the semitrailer was manufactured before January 1, 1985, the kingpin to rearmost axle distance shall not exceed 42 feet 6 inches A semitrailer, regardless of when it was manufactured, that is longer than 48 feet 6 inches and that has a distance between the kingpin and rearmost axle of 43 feet or less may be operated on the Interstate system and have 10 miles of access

II. If GVW is below 71,000 lb , single axle weight may be 22,400 lb , tandem axle weight may be 36,000 lb

JJ. Variable, contact the Michigan Department of Transportation

KK. 14' on Interstate and designated system only, otherwise 135 feet

LL. Measured from point of attachment (kingpin) to end of trailer or load If the semitrailer (or trader) length limit exceeds 48 feet, the distance between the kingpin and the rearmost axle or a point midway between the two rear axles, if the two rear axles are a tandem axle, shall not exceed 41 feet

MM. A 48' trailer and a 60' overall length is also legal

NN. 53' semitrailer must have maximum of 41 from center of kingpin to center of rear tandem on trailer or center of rearmost axle in the case of a single axle or "stretch tandem" trailer, 67 5' semitrailer combinations and twin trailer combinations, allowed on state designated system

00. 41 maximum from kingpin to center of rear axle assembly If the semitrailer is longer than 48 feet, it must be equipped with a rear underride guard

PP. If gross weight is more than 75,185 lb , legal tandem weight is 34,000 lb

Cm. Semitrailer can only have 2 axles Kingpin to center of tandem axle can't exceed 405 feet + 5 feel

RR. Eff 4-1 91 decreased to 34,000 lbs

SOURCE: *Vehicle Sizes and Weight Manual,* "Vehicle Sizes and Weights Chart," supplement (Neenah, WI: J.J. Keller & Associates, Inc.).

point to a number of other factors contributing to safe driver performance. For example, their drivers often operate close to home and spend a majority of their nights at home. As a consequence, drivers are familiar with the routes they travel, and management supervision is present at both origin and destination.

One trucking company contends that its driver training programs are analogous to those of an airline;[39] each vehicle has unique characteristics, and drivers need specialized training for each configuration just as airline pilots need to log hours in different types of aircraft. However, such a claim overlooks the fact that training requirements and standards for aircraft pilots are set by the Federal Government. No special Federal standards or requirements exist for truck drivers of any type of heavy vehicle, including LCVs. Development of Federal driver standards and rigorous Federal driver training requirements for heavy vehicle drivers is overdue and should be a top priority for DOT[40]*

Should LCVs be more widely allowed, a number of safe operating practices could disappear because the vehicles would operate on a far broader scale. Without adequate equipment, driver training, and other requirements, typical LCV operating practices are likely to resemble western doubles operations, for which many drivers receive little or no special training.[41]

Driver Error

Heavy vehicle drivers must continuously process and react to a variety of information, and even momentary lapses in concentration can cause an accident. Human error is involved in over 60 percent of motor carrier accidents.[42] The same factors affect performance of all truck drivers: attitude, coordination, vision, caution, and fatigue associated with stress, exhaustion, or sleep deprivation.

However, the mental demands of driving can differ among different vehicle types and characteristics. Drivers of doubles and triples report greater tiredness after 8-hour hauling sets than they do with conventional tractor-semitrailers.[43] Though noise and cab vibration may contribute more directly to fatigue and are common to all truck configurations, the additional mental strain from driving multiunit combinations probably stems from concerns about trailer sway and instability caused by a greater number of articulation points on combinations hitched together by A-dollies. Drivers contacted by OTA verify the additional driver concerns from driving multitrailer combinations hooked by conventional A-dollies.[44] Using a double-drawbar dolly increases driver confidence and decreases mental strain and fatigue. Testing and study are needed to determine the possibly differing effects on drivers of various combination lengths, hitching mechanisms, and number of trailing units. Ongoing FHWA/industry fatigue studies could be expanded in scope to provide valuable driver fatigue comparisons between western doubles and conventional tractor-semitrailers.

Sharing the Road With Motorists

Since trucks share the highways with the motoring public, attention to the interaction between automobiles, trucks, and drivers is crucial to any examination of LCV issues. Such concerns as roadway visibility and behavior of nearby passing and oncoming traffic are particularly acute because of the wide disparity in scale between LCVs, automobiles, and motorcycles. (Trucks can be four to six times as long as automobiles and are three times as high--see figure 3-2 again.) For instance, trucks often

38 Groups such as the Western Highway Institute and the Western Association of State Highway and Transportation Officials have promoted uniform size and weight standards with some success.

39 Jerry Hughes, Roadway Express, Inc Q, presentation at Professional Truck Driver Institute of America public forum, Sacramento, CA, Feb. 26, 1991.

40 office of Technology Assessment, op. cit., footnote 1, pp. 12-13.

41 National Transportation Safety Board, op. cit., footnote 20.

42 Office of Technology Assessment, op. cit. ? footnote 1, p. 137.

43 *Overdrive*, July 1987, p. 43.

44 Jim Johnston, Owner-Operators Independent Drivers Association, personal communication, March 1991; and truck driver interviews, unedited footage of Saskatchewan LCV operators produced by University of Michigan Transportation Research

block motorists' view of other traffic and signs, a phenomenon that would likely worsen with greater use of longer vehicles.[45] Even minor trailer sway concerns motorists, who associate it with the possibility of loss of control of the truck. The continuous small steering corrections employed by some drivers to stay in a traffic lane can cause a wave action down through the vehicle, which can be augmented by curves in the road, uneven pavement, and wind. Even though such motions may not result in instability, the impact on motorists' attention to other driving tasks and general behavior has not been rigorously examined.

Surveys of automobile drivers show almost universal opposition to any increased use of longer trucks and indicate that the trucks already on the road overwhelm motorists.[47] Such concerns will become increasingly important in the coming decades, particularly as the population of older drivers grows. A substantial portion of older drivers shows poorer perceptual capabilities--such as reaction time, peripheral vision, sharpness of vision, decisionmaking--than the rest of the driving public. In addition, research and survey and accident data suggest that older drivers have relatively more difficulty interacting with trucks and have the strongest negative reactions to them.[48]

INFRASTRUCTURE IMPACTS

Although LCVs can carry heavier loads than conventional trucks, recent studies by the Transportation Research Board and other organizations find that LCVs cause less pavement damage per unit of freight moved. This is because they have more axles over which the weight is distributed and because fewer trips are necessary to move the same amount of freight. An industry study[49] estimates the annual reduction in pavement costs would be between $16 million to $55 million if LCVs were allowed on a national basis and significant amounts of freight shifted from conventional trucks to LCVs. *Such a shift would occur almost exclusively in States not now allowing* LCVs. Precise impact estimates are difficult because they depend greatly on traffic shifts, vehicle mixes, tires and suspensions used, and other factors.

Although pavement damage might decrease, highway tax payments used to maintain and repair pavements would also decrease if freight shifts from conventional trucks to LCVs. FHWA finds that in general, State permit fees for overweight vehicles do not cover the cost of administration and highway damage.[50] In addition, the reality of lax weight enforcement on the highways and more (often overweight) marine containers traveling on the road network could outweigh any pavement benefits where turnpike doubles are allowed to operate from ports.

The generally poorer offtracking of LCVs (except for triple combinations, as described earlier in this chapter), longer length, and greater gross weight point to a need for redesign and reconstruction of significant portions of the roads where they are used, especially interchanges and bridges. Lane widening, increased turning radii, and provision of climbing/passing lanes will be necessary in some areas to accommodate longer vehicles with poorer off tracking or climbing ability.

Longer Buses

A legislative proposal by the intercity bus industry seeking permission for nationwide operations of 45-foot over-the-road motor coaches is discussed in box 3-A. Coach manufacturers claim that the turning radius of their proposed design is within the design limits of current highways.

Bridges

For States to allow LCV operations and comply with the Bridge Formula as well would mean upgrading many bridges to higher design

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Institute under NHTSA contract, 1991; and Nick Patch, Mayflower Elite Fleet, personal communication, Mar. 12, 1991.

45 Neil D. Lerner et al., Comsis Co w. ! "Older Drivers' Perceptions of Problems in Freeway Use, " unpublished report, March 1990, pp. 32-34.

46 W.R.J. Mercer et al., op. cit., footnote 19, p. 69.

47 American Automobile Association, survey of members, October 1989 and December 1990.

48 Neil D. Lerner et al., Op. cit., footnote 45, pp. 12-13, 32-34.

49 The Urban Institute, 'Pavement and Bridge Impacts of Longer Combination Vehicles, " study prepared for the Trucking Research Institute, The

Box 3-A--Greater Productivity Through Longer Buses

The average length of intercity buses increased from 35 feet to 40 feet in the late **1940s and early 1950s, as vehicle dimension regulations changed. With** the passage of **1956** highway legislation came a set of grandfather provisions unique to intercity buses. States that permitted 45-foot transit buses prior to 1956 were allowed to approve 45-foot intercity buses as well. Currently, 45-foot coaches can be operated legally in 15 States and the District of Columbia (see figure 3-A-l).

The main advantage of longer coaches is increased productivity. A lavatory-equipped 40-foot coach carries 46 or 47 passengers and has 319 cubic feet of baggage space. A similarly equipped 45-foot coach carries 55 passengers, a 20-percent improvement, and has 410 cubic feet for baggage, a 29-percent improvement. One company estimates that this longer vehicle could save 32 million bus-miles each year and 5.5 million gallons of fuel.[1]

No data exist to show whether the 12-percent greater length of 45-foot coaches over 40-foot coaches brings about significant changes in safety and handling, although the manufacturer's computer models indicate it does not. Bus accident data do not include vehicle length, so present 45-foot coach operations cannot be compared with other intercity bus operations. Some, but not all, 45-foot coaches have turning radius, rear swingout, and axle weight distribution characteristics that are equivalent to those of 40-foot coaches and within existing Federal and State limitations. Both transit and intercity buses, when fully loaded, can violate Federal axle and gross weight limits and have significant pavement impacts. Nonetheless, axle and gross weight limits are rarely enforced for these vehicles.[2]

1 Motor Coach Industries, "Background Information on 45-Foot Coaches, " informational document, April 1991.

2 John Pearson, director of research, Western Highway Institute, personal communication, May 8, 19919

loads or replacing load deficient bridges. Even bridges not requiring immediate strengthening could impose an indirect cost because of reduced service life. A trucking industry study,[51] using a similar methodology to that used in the TRB studies, found total bridge costs (not including user costs associated with time delay and additional fuel consumed) associated with national use of LCVs to be on the order of $6 billion.[52]

Other subsequent studies on the rural[53] and urban bridge[54] networks used a similar TRB methodology, enhanced to include estimates of user-borne costs. Moreover these studies used a different bridge rating based on the results of a survey **of** 49 State **highway agencies in calculating bridge replacement costs .55 Estimates for the total bridge costs on the rural and urban Interstate system using this methodology are on the order of** $30 **billion, comprised of $14 billion replacement costs (1989 prices) and $16 billion associated user-borne costs. Bridge impact estimates of the ability to carry LCVs are sensitive to how highway agencies rate their bridges' condition, truck loads and configurations, and construction and material costs. If user borne-costs are considered to reflect total costs more completely, the value of time and additional fuel consumed must be included, and the final total can double original replacement cost estimates.**

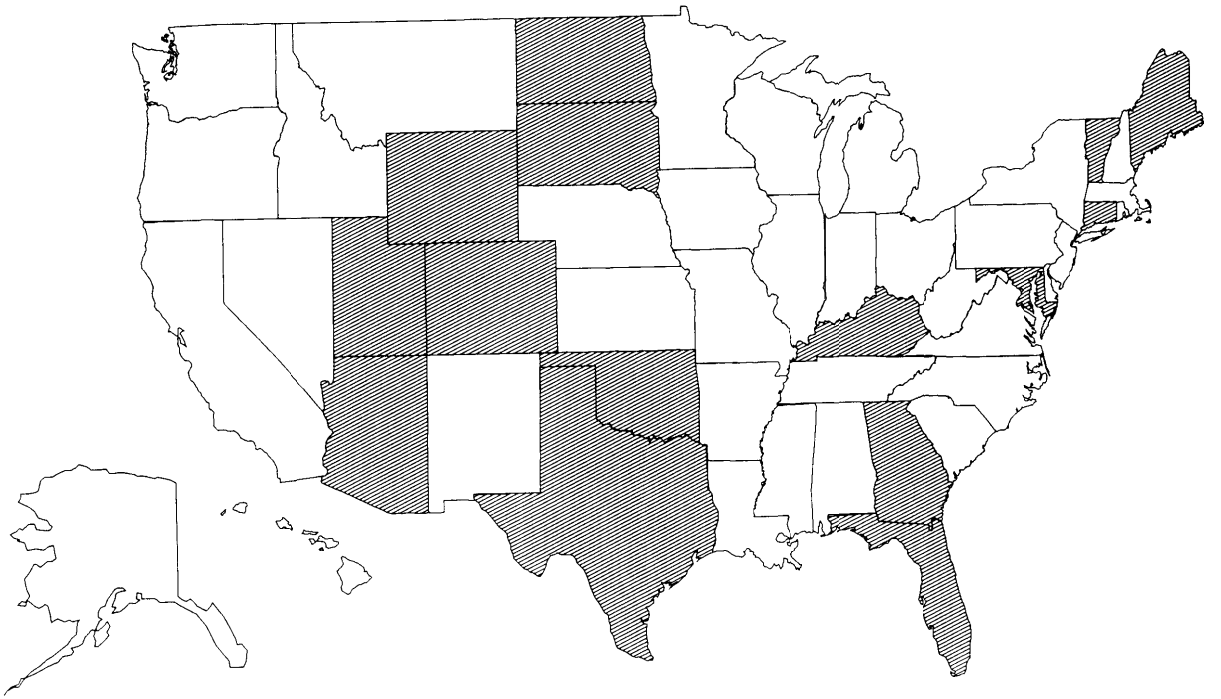
ATA Foundation, June 30, 1990.

50 U S Department of Transportation, Federal Highway Administration, "Overweight Vehicles: Penalties & Permits, " unpublished report, 1987, p. vii.

51 The Urban Institute, op. Cit., footnote 49.

52 As in the Transportation Research Board studies, a discount rate of 7 percent and infinite term for amortizing capital costs were assumed in order to

Figure 3-A-1—States Allowing 45-Foot Coaches



SOURCE: Office of Technology Assessment, 1991.

Costs for bridges are particularly important because these improvements must be made before heavy trucks are allowed to travel on them and require up-front public expenditures. Changes in funding mechanisms are also needed to reflect more accurately the true infrastructure costs incurred by heavy trucks and pay for necessary bridge and road maintenance. Because of these concerns, AASHTO has taken a strong stand against any efforts to allow wider use of LCVs, maintaining that most of the Nation's highways have yet to be reconfigured to standards that accommodate the increases that occurred during the 1980s in truck sizes and weights.

ECONOMIC IMPACTS

The economic impacts of a wider LCV network depend on many factors: which and how many States allow them, future fuel prices and tax rates, the cost and extent of infrastructure upgrades, and responses from various sectors of the trucking, and railroad industries, and many others. Thus, it is impossible to make reliable predictions of the economic impacts of greater LCV use.

However, some studies have suggested[57] that allowing LCVs on a national scale would probably lead to productivity benefits for the trucking industry and the shippers it serves, perhaps on the order of $2 to $4 billion annually, because increased weights and dimensions would enable a given amount of freight to be carried in fewer trips, reducing the per ton-mile cost of each movement. For example, the addition of a single 28-foot trailer to a double 28-foot combination allows 50 percent more product to be hauled at little additional cost and increases flexibility. In addition to the pavement and bridge impacts discussed earlier, other predicted impacts, discussed later, include changes in trucking operations, shifts in freight traffic from rail to trucking, and provision of staging areas. Box 3-B describes the effects that changing truck weight restrictions can have on a State's economic development.

LCVs Advocates

Many shippers support wider use of LCV. Generally, long-haul carriers and some short-haul carriers with high freight volumes between endpoints will benefit the most from turnpike doubles and triples. Short-haul carriers, carriers serving lowdensity freight corridors, and carriers with proportionately greater operations on urban streets will benefit less from LCVs since they are less able to capitalize on the economies these vehicles afford. Each configuration is attractive to various types of carriers.

Truckers most enthusiastic about wider use of triples tend to be large parcel and nationwide Less than Truckload (LTL) carriers. They would like to be able to operate more efficiently over long hauls (or short hauls with high volumes of freight) in more parts of the country. Many of these carriers are already set up to use western doubles for their linehaul movements, and the ability to operate triples in all States would probably lead to substantial savings for these companies. Regional LTL carriers, which use both western doubles and conventional semitrailers for their linehaul operations, could benefit from either triples or turnpike doubles.

Only some truckload (TL) carriers are enthusiastic about LCVs, because many operate on already slender profit margins. Moreover, TL rates are likely to drop more than LTL rates if wider LCV use is allowed, since LTL rates include pickup and delivery charges and tend to be more competitive due to the smaller shipments involved. General commodity TL carriers face additional hurdles in taking advantage of LCVs because few serve a pair of shippers (one at each endpoint) that can consistently offer balanced freight in both directions. Consequently, TL movements tend to be treated on a one-by-one basis with a driver moving a truckload to a receiving dock and then being routed elsewhere for the next load.

Efficient use of turnpike doubles for TL movements would require a reorganization into pickup and delivery operations (using single

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estimate an annual cost. OTA converted annual costs to total costs.

53 Jose Weissmann and Rob Harrison, Texas Research and Development Foundation, "The Impact of Turnpike Doubles and Triple 28s on the Rural Interstate Bridge Network," paper presented at the 70th Annual Meeting of the Transportation Research Board, Washington, DC, January 1991.

54 Rob Harrison and Jose Weissmann, Texas Research and Development Foundation, "Urban

trailers) and linehaul operations between staging areas (using the doubles) that large fleets would be most likely to afford. Small TL carriers would be less likely to take advantage of the longhaul efficiency of turnpike doubles and could suffer in an environment where large firms are able to operate more efficiently over long-haul corridors.

Single commodity TL carriers could benefit from LCVs. Many of these operations are local, and some might need to operate extensively off the Interstate, where the greater maneuverability of triples would be useful. Carriers that make proportionately greater use of Interstate would probably opt for the greater volume of turnpike doubles.

Both weigh-out and cube-out traffic will benefit from more LCVs.[59] Carriers of bulk commodities, such as chemicals, petroleum products, wood pulp, and gravel, are affected mainly by weight restrictions, and weigh out before they cube out. Consequently, turnpike doubles, which can carry the greatest weight, would be likely to see more bulk use. LTL carriers are more likely to need the flexibility of triples. It is unclear how rapidly trucking companies would adapt to any changes in size and weight restrictions. Some, especially large carriers, would simply couple one more trailer to existing combinations, thereby reaping considerable productivity benefits while incurring few capital investment costs. Others would buy new equipment immediately, while some would wait for existing equipment to wear out. No analysis to date has considered the costs to companies that would result from technology requirements or new safety and driver training programs.

LCV Opponents

As noted above, not all trucking companies will benefit from wider use of LCVs. Since some overcapacity still exists in both the TL and LTL sectors, weaker companies now struggling to make a profit would be unlikely to survive if LCVs were widely permitted. Small TL firms, lacking the capital, traffic volumes, and sophisticated management systems needed to exploit LCVs, will lose out to larger, better financed TL competitors, who will be in a position to convert more quickly to LCVs.[60] Other small companies and independents are likely to suffer as well, since they cannot capitalize on economies of scale to purchase equipment.[61] On grounds of both employment and safety, the Teamsters oppose any expansion of LCVs beyond those States where they are presently allowed. Experience of Teamster locals in those States convinces the Union that those LCVs could not be operated as safely in areas with more traffic.[62]

Railroads are concerned about LCVs because of a loss of traffic due to lower trucking costs and rates as well as a potential loss of revenue on traffic for which they would have to lower their rates to meet increased trucking competition. These concerns are particularly acute for railroads in truck competitive markets, such as lumber, chemicals, automobiles, and pulp and food products as well as intermodal container traffic, where significant freight diversion to turnpike doubles can be expected in all regions of the country. Though LTL traffic is not a large portion of overall railroad business, their LTL operations would also be affected, primarily by triples. Rail corridors sensitive to increased use of triples include Chicago, St. Louis, Houston, and Kansas City to the Pacific Northwest and Chicago to Philadelphia. Because they allow combining TL and LTL traffic, Rocky Mountain doubles might reduce rates somewhat, since higher revenue from the 28-foot (LTL) trailer would permit a lower rate for the 48-foot (TL) trailer.[63]

Contrary to assertions that most opposition to LCVs has been orchestrated by their industry

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Interstate Bridges: Turnpike Doubles and Triple 28 Costs," unpublished report, May 1991.

55 Rob Harrison et al., Texas Research and Development Foundation, "Operating Rating or Inventory Rating: A Multi-Billion Dollar Difference," unpublished report, February 1991.

56 Hal Rives, president, American Association of State Highway and Transportation Officials, written communication with six Senators and Congressmen, Feb. 19, 1991.

57 The Trucking Research Institute has sponsored research on potential longer combination vehicle productivity benefits and infrastructure costs, and the Transportation Research Board has conducted studies on heavier (but not longer) trucks and Turner trucks.

58 Paul Roberts, "The Politics of Longer Combination Vehicles," paper submitted to the

Box 3-B--Calculating the Costs of Economic Development in Wyoming

A truck weight study conducted by the Wyoming State Highway Department[1] found that changing truck size and weight regulations could affect economic development. Wyoming is highly dependent on truck transportation, but unlike most western States, did not qualify for the grandfather clause allowing trucks to operate on Intestates beyond the 80,000 lbs, gross weight limit. According to the study, because trucks in other States could haul more cargo, their transportation costs were significantly lower, making Wyoming products more expensive in comparison. Moreover, some vehicles bypassed the State in favor **of** neighboring States that permitted heavier vehicles. (To determine the effect of the ban on trucking productivity, the Wyoming State Highway Departmmt had earlier gained permission from the Federal Government to conduct a 2-year study on heavy truck operations.)

The study showed that almost 26,000 fewer trips werer made when the heavy trucks were utilized than under previous conditions, saving an estimated 700,000 gallons of feul. Reductions in tranportation costs were observed for several commodities, and some Wyoming firms **opened new markets because** they could compete with companies in Montana and Canada.

However, the report did not examine truck accident data or calculate the costs of infrastructure impacts. Thus, no estimates of these public sector costs were used to offset the trucking industry benefits. After the study and at Wyoming's request, a provision allowing the State to permit the operation of trucks weighing greater than 80,000 lbs. on the Interstate system through December 31, 1991, was included in a Federal appropriations bill.[2]

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1 Wyoming State Highway Department, "The Wyoming Weight Study: Increasing the Gross Vehicle Weights on Wyoming Interstate Highways," unpublished report, January 1988.

2 Public Law 101-56.

opponents, public opinion surveys and **OTA staff interviews show an overwhelmingly negative public reaction to increasing truck dimensions.[64] Moreover, in recent trucking industry surveys, 76 percent of the executives from TL carriers polled indicated they would not be willing to trade higher user taxes for a size increase.[65] Professional truck drivers felt triples and turnpike doubles were less safe than conventional tractor-trailer combinations by over 80 percent, and 60 percent said they would feel less safe sharing the road with triples and turnpike doubles if they were operated everywhere. (However, more than 90 percent of the drivers interviewed indicated they had never driven an LCV.)[66]**

CONCLUSIONS

The number and variety of State grandfather clauses and permit programs governinglonger, heavy trucks make clear that the United States does not have uniform truck size and weight requirements, even on Interstate highways. Some State officials contend that the Federal Government has "dropped the ball" on the issue,[67] and that States do not have adequate resources to ensure that their permitting programs are sufficient to guarantee highway safety.

Although not comprehensive, existing accident data do indicate that LCVs are operated safely in those States that allow them under special permit restrictions. These generally include specifications of road type, climate, time-

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Federal Highway Administration, n.d.

59 Freight cubes out when trailer capacity is reached before weight limits are exceeded; it weighs out when the opposite occurs.

60 'Longer Combination Vehicles: A Trucking D i saster, " ***Competitive Policy Reporter,*** AAR/Intermodal Policy Division Report, vol. 2, No. 5, Mar. 15, 1991.

61 Jim Johnston, Owner-Operator Independent Drivers Association, Inc., personal communication,

of-day restrictions, driver qualification, loading, hill-climbing ability, and maximum speed. Such State permit programs, when enforced, have been a key ingredient in promoting the safety of LCV operations to date. The success of these permitting programs raises the possibility of developing Federal safety requirements, especially for driver training, for western double and conventional tractor-trailer operations, since they share many, but not all, of the operating difficulties of LCVs and account for over 99 percent of all tractor-trailer accidents.

Being able to use LCVs on a wider network would bring productivity benefits to a number of motor carriers and could promote economic development in some States. However, many States are not enthusiastic about having more LCVs on their roads and would like the Federal Government to take a more active role in curbing proliferation of LCV operations.[68] Moreover, the trucking industry is not unanimous in its support of LCVs. Each configuration is suited to different industry segments, and some sectors do not favor any changes in the types of vehicles allowed to operate. The benefits of any changes to Federal size and weight laws will accrue to different industry sectors to varying degrees. Some operations, primarily owner-operators and other small outfits, are likely to lose market share if wider use of LCVs is permitted, and they vigorously oppose this idea.[69] Parcel and nationwide LTL carriers would use triples, large TL carriers would use turnpike doubles, and some regional LTL carriers could use either configuration.

While LCVs promote increased productivity and fuel efficiency for trucking companies, wider LCV use is likely to divert some rail traffic to trucks, reducing the overall fuel efficiency of the freight transportation system, under most circumstances. Moreover, permits for overweight vehicles generally do not cover the cost of administration and highway damage, and estimates of the total costs to upgrade bridges to accommodate LCVs range from a low of $6 billion up to at least $14 billion. When broader public interests and costs such as these are taken into account, they may outweigh the productivity benefits (estimated at $2 to $4 billion annually) to the industry.

Mar. 22, 1991.

62 Vernon McDougal, Safety and Health Division, International Brotherhood of Teamsters, personal communication, Apr. 2, 1991.

63 Association of American Railroads officials, personal communications, Feb. 13, 1991.

Accident Data

Accident data are insufficient to evaluate the safety impacts of wider use of LCVs. Congress may wish to consider requiring DOT to develop a database for tractor-trailers and LCVs that includes travel data by type of road, road class, geographical data, type of truck (including length of units, speed restrictions, and loading condition), and fatal and nonfatal truck accidents. A collaborative effort for information gathering between NHTSA, the Office of Motor Carriers in FHWA, and the States would be essential. In the future, information from such a database could help DOT develop guidelines for special LCV permitting and for determining routes based on highway geometry, traffic flow, bridge characteristics, traffic densities, vehicle mixes, and grades.

Federal Safety Requirements

In 1988, OTA suggested that Congress consider Federal training standards and requirements for tractor-trailer drivers. Information gathered since indicates that many companies take no steps to prepare drivers for the transition between conventional tractor-semitrailers and vehicles requiring more skill (such as western doubles and LCVs). The relationship between rearward amplification and trailer sway on multiunit combinations and mental strain and fatigue on drivers is not clear and needs empirical testing. Current FHWA driver fatigue research could be expanded to include analysis of double- v. single-unit combinations and provide valuable, preliminary insight into LCV driver fatigue and how it might differ between combinations.

Given the current high rate of driver turnover in some segments of the trucking industry and the considerable training expenses faced by operators, the public has a right to expect that stringent Federal safety equipment and training requirements and stricter operating regulations will be implemented before any change in Federal policy on LCVs. It is time to address a major loophole in Federal highway safety

programs and for Congress to require DOT to develop training standards and requirements for tractor-trailer and LCV drivers, under the Commercial Drivers' License program. Although some industry segments remain opposed to Federal standards, acceptance of the concept has grown substantially over the past several years.[70]

Performance standards are needed for braking efficiency (particularly for unloaded vehicles), rearward amplification, rollover threshold, minimum grade-climbing ability, low- and high-speed offtracking, steering sensitivity, and vehicle suspension. Congress should require DOT to develop and implement appropriate studies and inservice fleet testing of safety enhancing technologies on LCVs, including antilock brakes, double-drawbar dollies, and sufficiently powerful engines. Vehicles from existing LCV operating fleets could be used for such a test.

On completion of the appropriate studies and operational tests, Congress may wish to require DOT to mandate adequate control measures to mitigate the handling problems and/or infrastructure impacts of LCVs. The use of antilock brakes on all axles, double-drawbar dollies for trailers less than 40 feet in length, air suspensions, and automatic slack adjusters on trailers as well as tractors, or equivalent systems, could be required or encouraged through weight or other incentives. Heavier trailer forward requirements should also be mandated to improve control. Such test programs and development and implementation of Federal standards must precede any changes to Federal laws applicable to heavy vehicle operation to ensure nationwide highway safety.

LCVs and Infrastructure Improvements

Each configuration of LCV needs to be considered against the sort of uniform performance standards discussed above. The infrastructure implications of turnpike doubles are quite different than those of triples. The safety concerns of triples could be addressed by technologies identified in this paper, whereas the infrastructure demands of turnpike doubles involve upgrading substantial portions of the highway network. Taxes and fees for heavy trucks must be set at levels adequate in order to cover their impact on the infrastructure.

Automobile Drivers and LCVs

The overwhelming opposition of motorists to large, heavy trucks is, and should continue to be, a major concern for the trucking industry. It is possible that motorists' discomfort with even conventional truck configurations is so great that the industry will be unable to counter the strong negative public reaction to longer ones. Since the issue of the public's reactions to longer trucks has disturbed the industry in the recent past, trucking companies may want to weigh the costs in goodwill of proposed productivity improvements.

Just as truck drivers need adequate special instruction in operating their equipment safely in mixed truck and car traffic, automobile drivers need special instruction in sharing the road with trucks. Congress could consider requiring DOT to develop guidelines on this for automobile driver training courses and instruction materials, in cooperation with State motor vehicle administrators.

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64 The 1989 Legislative Survey Composite Report prepared by the American Automobile Association's (AAA) Department of Market Analysis and Research found that 89 percent of AAA members are strongly opposed to increasing truck lengths. A 1990 poll conducted by the Frederick/Schneiders Inc. yielded similar results.

65 Memorandum of Interstate Truckload Carriers Conference, Feb. 11, 1991.

66 "A Study of the Operating Practices of Extra-Long Vehicles," *Transportation Research and Marketing,* December 1990, p. 48.

67 Norm Lindgren, director of motor carriers, Utah Department of Highways, personal communication, May 3, 1991.

68 See Rives, op. cit., footnote 56; and ibid.

69 Jim Johnston, executive director, Owner-Operators Independent Drivers Association, Inc., personal communication, May 3, 1991; and Rita Bontz, Independent Truck Drivers Association, personal communication, May 7, 1991.

70 Jim Johnston, Owner-Operators Independent Drivers Association, Inc., and Ed Kynaston, Professional Truck Drivers Institute of America, personal communications, May 1991.