Findings of the Longer Combination Vehicle Study

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ABSTRACT

In this paper are presented findings contained in the U.S. Department of Transportation's report to Congress entitled "The Feasibility of a Nationwide Network for Longer Combination Vehicles" that was mandated by Sections 138 and 415 of the Surface Transportation Assistance Act of 1982. The purpose of this study was to examine the feasibility of establishing a network of highways for the operation of Rocky-Mountain doubles, turnpike doubles, and triple-trailer combinations. Among the factors that were considered in assessing the feasibility of a network were (a) safety, (b) vehicle performance and handling, (c) highway improvements needed to allow the safe operation of longer combinations, (d) regulations imposed by states that currently allow longer combinations, and (e) increases in productivity that might be achieved by longer combinations. Among the findings of the study were that (a) longer combinations are almost always operated under special permits issued by states or turnpike authorities; (b) longer combinations usually must meet certain performance standards, and many states require special driver certification; (c) most Interstate interchanges would have to be modified to safely accommodate turnpike doubles; (d) it is unclear where and under what conditions various longer combinations could be operated safely; and (e) pavement condition, interchange spacing and geometrics, the availability of services, bridge characteristics, lane widths, curves and grades, and traffic levels would all have to be considered when assessing the suitability of a particular highway route for longer combinations.

Sections 138 and 415 of the Surface Transportation Assistance Act (STAA) of 1982 required that the Secretary of Transportation conduct a study of the feasibility of a nationwide network for the operation of long combination vehicles (LCVs) up to 110 ft in length. For purposes of the study, it was to be assumed that the 80,000-lb weight cap would be lifted and that gross weights would be limited only by the bridge formula.

Conceivably many different vehicle configurations could have been analyzed in this study. Three general vehicle configurations that currently are used on a limited basis were chosen for analysis--the turnpike double, which consists of a tractor and two trailing units each up to 48 ft long; the Rocky-Mountain double, which consists of a tractor and two trailing units, one of which may be up to 48 ft long and the other of which is limited to about 28 ft in length; and the triple, which consists of a tractor and three trailing units each up to 28 ft in length.

Among the factors considered in assessing the overall feasibility of a network for these long combinations were

1. Safety and the importance of operating restrictions on the accident experience of existing LCV operations,
2. The geometric adequacy of various highways in rural and urban areas,
3. The costs of highway improvements necessary to accommodate LCVs,
4. The need to construct special staging areas where LCVs could assemble and disassemble adjacent to segments of a network,
5. The potential increases in productivity achievable if longer combinations were allowed to operate,
6. Damage to pavements and bridges if longer combinations were allowed to operate, and
7. The administrative constraints to establishing a national network for longer combinations.

The primary sources of information for this study were (a) reports from previous state studies of longer combinations; (b) a survey, sponsored by the Western Highway Institute, the American Trucking Associations, and the Private Truck Council, of shippers and carriers that potentially might use longer combinations; (c) a survey by the International Bridge, Tunnel and Turnpike Association of LCV operations on turnpikes; (d) a survey of the states, sponsored by AASHTO, to identify problems that states foresaw if various longer combinations were allowed on their highway systems; (e) comments to the docket established for the study; and (f) the Truck Inventory and Use Survey and the Commodity Transportation Survey conducted by the Census Bureau.

Table 1 gives the states that currently allow longer combinations to operate on part or all of the state highway system. Maximum lengths and weights and the number of miles of state highways open to each combination are also given. Rocky-Mountain doubles are currently permitted in 11 states, triples in 6 states, and turnpike doubles in 7 states. Allowable weights for these operations range from 80,000 lb in Colorado to 129,000 lb in Utah and South Dakota (turnpike doubles only). In most states the longer combinations are allowed to operate on only certain state highways, and not all configurations may be allowed to use the same highways. With the exception of California, which does not allow longer combinations, and Arizona, which allows them on only 29 mi, there is a solid block of western states that allow various longer combinations to operate on an extensive network of highways. Rocky-Mountain doubles can travel on a total of more than 60,000 mi in those states.

In addition to the states that allow longer com-

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TABLE 1 Current Length, Weight, and Route Miles for Longer Combination Vehicles Operating on State Highways

State	Rocky-Mountain Doubles [length (ft) weight (lb) miles]	Triples [length (ft) weight (lb) miles]	Turnpike Doubles [length (ft) weight (lb) miles]
Alaska			105 109,000 475
Arizona	90 111,000 29	105 111,000 29	105 111,000 29
Colorado	95 80,000 9,218	105 80,000 9,218	105 80,000 9,218
Idaho	105 105,500 2,150	105 105,500 2,150	
Montana	95 105,000 11,405		
Nevada	105 129,000 4,872	105 129,000 4,872	105 129,000 4,872
North Dakota	110 105,500 2,170	110 105,500 2,170	110 105,500 2,170
Oregon	75 105,500 4,065	105 105,500 3,525	
South Dakota	90 105,000 7,875		110 129,000 679
Utah	90 129,000 5,000	105 129,000 690	105 129,000 690
Washington	75 105,500 6,917		
Wyoming	85 117,000 6,378		

TABLE 2 Current Length, Weight, and Route Miles for Longer Combination Vehicles Operating on Turnpikes

State	Rocky-Mountain Doubles [length (ft) weight (lb) miles]	Triples [length (ft) weight (lb) miles]	Turnpike Doubles [length (ft) weight (lb) miles]
Florida			110 138,000 272
Indiana	NA 127,400 157	NA 127,400 157	NA 127,400 157
Kansas	119 120,000 231	119 120,000 231	119 120,000 231
Massachusetts	108 127,000 132		108 127,000 132
New York	114 143,000 531		114 143,000 531
Ohio	108 127,000 241		108 127,000 241

binations to travel on state highways, there are several states in which longer combinations are allowed to travel on turnpikes. Table 2 gives the lengths and weights of longer combinations that are allowed on turnpikes as well as the number of miles on which they can travel in each state.

Whether they operate on state highways or on turnpikes, longer combinations are subject to restrictions that are not generally applied to conventional vehicles. There are three main areas of regulation--vehicle equipment, operations, and driver qualifications. The items of equipment most often subject to regulations are brakes, pintle hooks, and draw bars. Operating restrictions imposed by various states may require that LCVs (a) maintain a minimum speed, (b) maintain minimum following distances, (c) travel only in good weather, (d) travel only during off-peak periods, and (e) travel only on certain specified highways. More than half of the states have special driver requirements that may cover age, experience, training, or safety record.

In reports on the safety of longer combination vehicles, there appears to be a consensus among both researchers and highway agency officials that the various restrictions imposed on LCV operations have contributed significantly to the relatively good safety record of LCVs. Perhaps even more important than operating restrictions are the permits that carriers must have to operate longer combinations. The knowledge that permits will be revoked if carriers do not comply with operating restrictions or if they have poor safety records is a strong incentive for them to follow the strictest of safety standards. Although the relative contribution of specific restrictions cannot be determined, permits and restrictions almost certainly have improved the safety records of longer combinations currently in use.

AASHTO SURVEY

An important aspect of the longer combination vehicle study was assessing the operational characteristics of LCVs and analyzing how those characteristics would affect the safe and efficient operation of an LCV network. Officials of AASHTO were particularly concerned about the potential costs of highway improvements that might be necessary to allow LCVs to operate. In July 1984 AASHTO sent a questionnaire to members of its Subcommittee on Design requesting information on the nature and extent of potential highway problems in each state and the cost of improvements needed to safely accommodate LCVs.

Forty-six states responded to the AASHTO survey, and responses to the survey were made available to the FHWA so that relevant findings could be summarized in the report to Congress on the longer combination vehicle study. In this paper, survey responses are discussed in greater detail than was possible in the report to Congress.

SUMMARY OF SURVEY RESPONSES

One question concerned Interstate highway system interchanges that could not accommodate various types of longer combinations. Part A of that question requested information on the percentage of interchanges in rural and urban areas that could accommodate the various longer combinations. Part B requested an estimate of the percentage of deficient interchanges that could not be reconstructed for various reasons, and Parts C and D concerned the average cost of improving interchanges to safely accommodate LCVs.

The average percentages of rural and urban Interstate system interchanges that states estimated could accommodate the several longer combination vehicles are as follows:

	Rural	Urban
Turnpike double	27.5	27.2
Triple	42.1	43.7
Rocky-Mountain double	33.6	34.1

More than 40 percent of the interchanges nationwide were judged by the states to be adequate for triples, but only about one-quarter of Interstate interchanges were deemed adequate for turnpike doubles. Among the states there were substantial differences reported in the adequacy of Interstate interchanges. Many states responded that fewer than 10 percent of their interchanges were adequate for LCVs, but many others indicated that 75 percent or more of their interchanges could accommodate longer combinations without improvements. Most of these latter states are in the West where longer combinations already operate on a limited basis.

There were large variations in state estimates of required interchange improvement costs. Many states estimated costs of less than $100,000 to improve typical interchanges to accommodate LCVs, but in several states improvements were estimated to cost more than $2 million per interchange. Costs were typically at least 50 percent greater in urban areas than in rural areas. Cost variations reflect differences in the amount of additional right-of-way required, whether complete or only partial reconstruction would be necessary, whether structures would have to be reconstructed, and many other factors.

The average interchange improvement costs to accommodate each of the LCV types in rural and urban areas were

	Rural ($)	Urban ($)
Turnpike doubles	500,452	877,031
Triples	320,375	505,748
Rocky-Mountain doubles	386,759	625,797

Costs generally varied directly with the relative turning radius of each vehicle.

On the basis of estimates of the number and average cost of interchanges needing improvements, the cost of improving all inadequate interchanges was calculated. Total estimated needs in many states would be less than $5 million, but, in several others, total improvement needs would be more than $250 million. The average costs in each state to make all necessary interchange improvements to accommodate various longer combinations in rural and urban areas were estimated to be

	Rural ($ millions)	Urban ($ millions)
Turnpike doubles	50	89
Triples	32	48
Rocky-Mountain doubles	37	57

In practice, not all Interstate interchanges would have to be improved before a network for LCVs could be established; needs in each state would depend on many local factors.

Costs for states to improve every inadequate interchange that could feasibly be improved are given in Table 3. Estimated costs vary widely; costs in many states would be less than $10 million, but in several states costs would be more than $300 million. The average cost for each state to make all necessary and feasible improvements to accommodate turnpike doubles would be almost $50 million.

Although potential problems at interchange areas were of particular concern to AASHTO in its survey, information on several other topics related to the operation of LCVs was also requested in the survey. Those topics were (a) the spacing between interchanges with nearby truckstops, (b) problems on through portions of the Interstate system, and (c) the cost of improving typical at-grade intersections to accommodate LCVs.

Figure 1 shows the distance between Interstate interchanges that have truckstops and other service facilities within a mile of the interchange in various states. The average distance between interchanges with nearby service facilities is 24 mi. Only six states indicated that service facilities were spaced farther than 50 mi apart. Although the survey question stipulated that the facilities had to be capable of accommodating LCVs, interchanges and access roads might have to be improved in many instances to allow longer combinations to safely get to the service facilities.

TABLE 3 Number of States with Various Costs for All Feasible Interchange Improvements To Accommodate LCVs

Cost ($ millions)	Turnpike Doubles	Triples	Rocky-Mountain Doubles
0-9	14	20	18
10-19	7	8	8
20-49	5	6	4
50-99	4	5	7
100-199	7	1	4
200-299	5	3	2
> 300	3	2	4

Most states indicated that through portions of the Interstate system were generally safe for LCVs. Several specific problems associated with LCV operations were mentioned, however, including (a) poor performance on steep grades, (b) safety and operational difficulties on congested urban segments, (c) rest areas and weigh stations that could not accommodate LCVs, and (d) safety and operational difficulties during adverse weather. The number of states that mentioned each of these problems is

Problem	States
Steep grades	18
Weigh stations and rest areas	14
Urban congestion	14
Poor weather	4

The questionnaire did not suggest these or other potential problems to the states; the states identified the problems on their own. Other states might also have identified these problems if they had been suggested to them.

In mentioning problems that LCVs would have on steep grades, states implicitly assumed that LCVs would not be pulled by more powerful tractors than are used with conventional combinations. Without more powerful tractors, LCVs could not accelerate or climb hills as well as conventional combinations. To reduce operational problems caused by speed and performance differentials, states indicated they might have to construct additional climbing lanes and extend acceleration lanes leading on to some Interstate highways. Most states that currently allow LCVs require that they be able to maintain a minimum speed of about 20 mph. Such regulations reduce performance differentials between heavy LCVs and conventional combinations and eliminate the need for many costly improvements.

The problem of turnpike doubles and perhaps Rocky-Mountain doubles not being able to get into weigh stations and rest areas because of their large turning radii was mentioned by 14 states but would probably apply to many others as well. Reconstructing every rest area and weigh station on the Interstate system to accommodate turnpike doubles would require a significant investment and would be difficult to justify in many states if an LCV network were established. On the other hand, weighing heavy vehicles and providing drivers ample opportunities to stop for rest contribute to safe and efficient highway

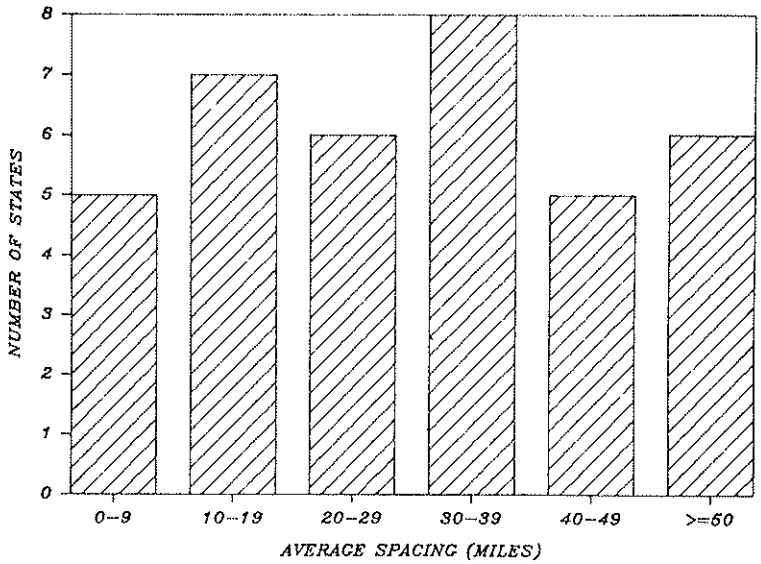

FIGURE 1 Truckstop spacing in various states.

operations. Each state would have to develop a plan for dealing with problems of access to weigh stations and rest areas.

Safety and operational problems that LCVs would have in congested urban areas were mentioned by only 14 states but could be expected in most metropolitan areas. Potential remedies would be to either prohibit some or all LCVs entirely from certain segments or to restrict their operations to hours when congestion is not severe. If LCVs were banned during peak periods, productivity would be reduced far less than if they were completely banned from a segment, and the most severe safety and operational problems would be eliminated.

Weather-related problems were mentioned by only four states but could be anticipated wherever LCVs operate. Many states that currently allow LCVs restrict their operations during adverse weather. Although there is no solid research evidence that LCVs are significantly less safe than other large combinations in adverse weather, their length, weight, and number of articulation points suggest that LCVs could have greater safety and operational problems than conventional tractor-semitrailer combinations when visibility is reduced or when pavements are slick.

Another question on the AASHTO survey concerned the costs of staging areas adjacent to the Interstate system where longer combinations could assemble and disassemble. Such staging areas are used by many turnpikes that permit LCVs because the longer vehicles are generally not allowed on state highways connecting with the turnpikes.

Forty-two states estimated costs to construct staging areas on the fringe of urban areas. The survey asked for the cost of a 2-acre staging area plus all ramps that would be necessary to operate the break-up area. The average cost estimated by the states was $717,000 and ranged from $52,000 to $3 million. As shown in Figure 2, almost half the states estimated that each staging area would cost between $500,000 and $1 million. Of the states with estimates falling outside this range, many more estimated costs of less than $500,000 than estimated costs greater

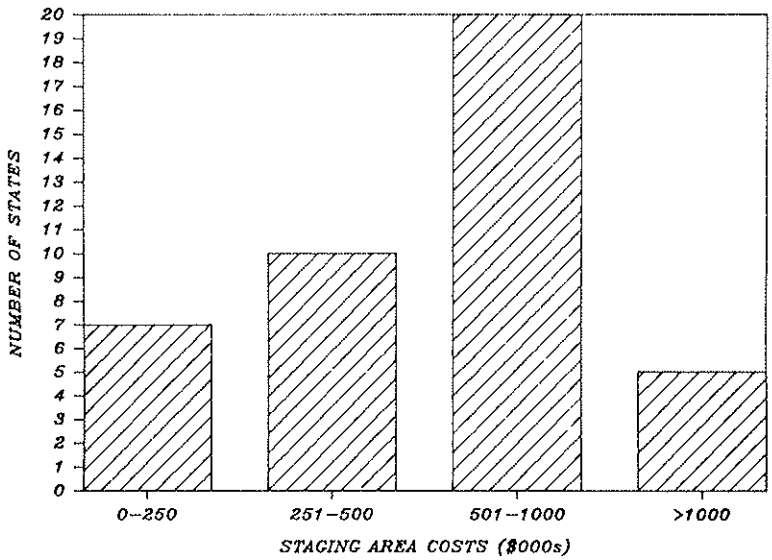

FIGURE 2 Estimated staging area costs.

than $1 million. Several states suggested that 2 acres would not be enough space for staging areas adjacent to large urban areas.

Several other questions that were included on the AASHTO survey will not be discussed in this paper. Those questions for the most part required narrative answers or detail that cannot be condensed in an overview of the survey.

In examining the results of this survey it is important to remember that the purpose was not to get precise estimates of improvement needs but rather to estimate the order of magnitude of the needs and to determine the factors that would influence costs for states in various regions of the country. Basic assumptions used in developing cost estimates varied considerably among the states, and these variations led to large differences in estimated improvement needs. The many views expressed by the states on access, staging areas, and other policy issues were perhaps just as important as their estimates of highway improvement costs.

SUMMARY OF FINDINGS

The DOT's longer combination vehicle study had several specific findings related to the operation of LCVs and the geometric design problems associated with longer combinations. Among those findings were

- Few nonfreeway street intersections could realistically be modified to accommodate turnpike doubles and, although modification could be considered for the Interstate system, most interchanges would have to be upgraded to accommodate them.
- LCVs operating at heavy weights need high-power engines to maintain speed on grades and thus avoid creating traffic operation problems or safety hazards.
- Performance and handling limitations of LCVs, as well as their higher gross weights, could create significant safety problems if LCVs are used more generally under a greater variety of road, environmental, and traffic conditions.
- Each potential LCV route should be analyzed segment by segment to determine whether LCVs could be safely operated.
- Mountainous terrain and urban areas are primary locations of geometric or capacity deficiencies on the Interstate system.
- Pavement condition, interchange spacing and geometrics, availability of services, bridge characteristics, lane widths, curves and grades, and traffic levels all must be considered when assessing the suitability of a particular highway route for inclusion in an LCV network.
- Costs of providing staging areas or, alternatively, of rebuilding interchanges to allow partial access to points off the network could be substantial. These costs are highly dependent on the access policies that are adopted.

Many issues concerning the administration and operation of a network for longer combinations could not be resolved during the course of the longer combination vehicle study. Among those unresolved issues were

- How could the federal government administer a network and ensure the enforcement of weight and operating restrictions?
- Which vehicles should be allowed on the network? The three vehicle types in use today have different operating characteristics that affect not only productivity and safety but also the improvements that would be required to accommodate those vehicles on a national network.
- What operating restrictions and permit practices, at a minimum, should be required for longer combinations nationwide?
- How extensive a network for longer combinations should be designated? Potential productivity gains would suggest a large network, but the investment required to afford longer combinations access to and from the network might prohibit a large network, especially because the necessary investment would be a front-end cost that would be incurred before any productivity gains were realized.
- How can a reasonable level of local access be assured, and will the local access policies result in large inequities among potential users of longer combinations and those who must pay the cost of special facilities for those vehicles?

Many factors other than geometric design were considered in the DOT longer combination vehicle study, but geometric design problems are clearly among the most important considerations in decisions regarding the operation of LCVs on the nation's highways.