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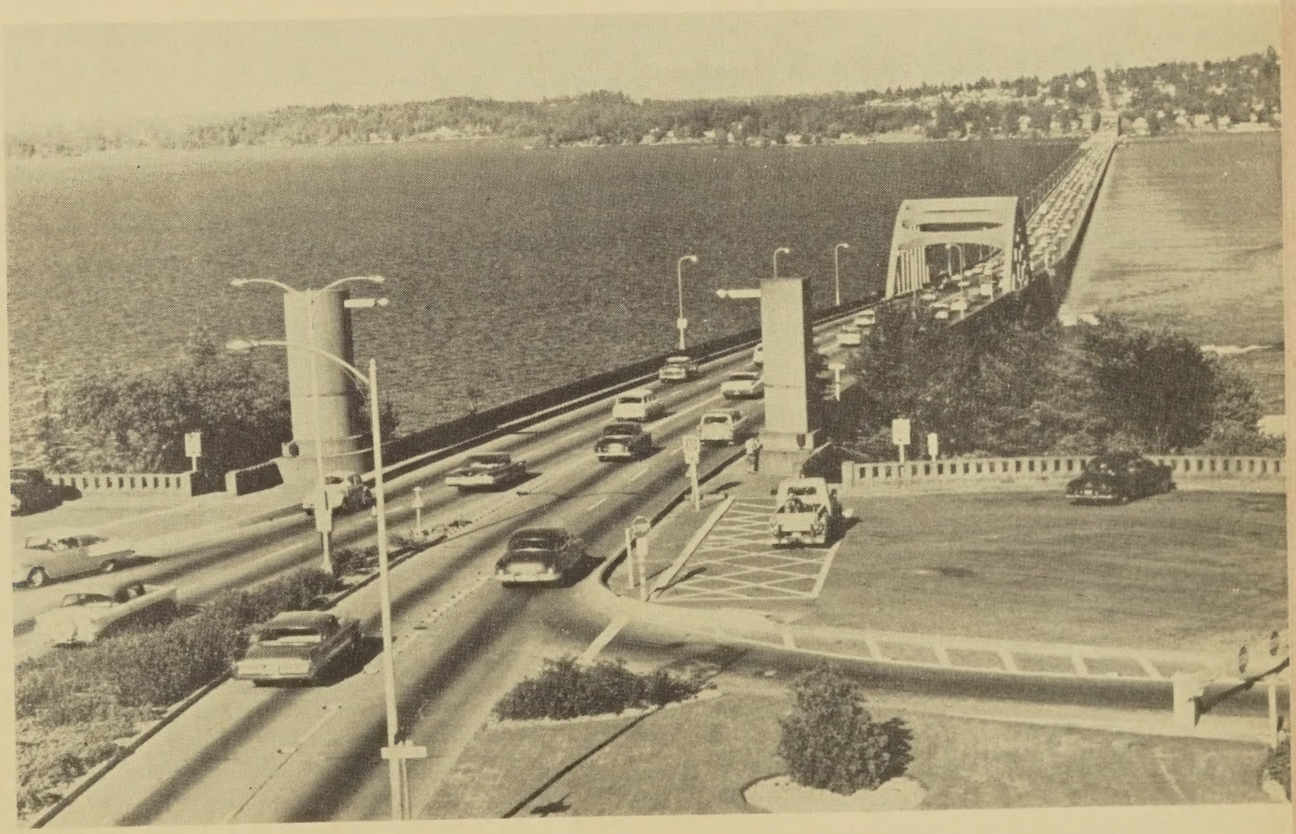

Lake Washington Floating Bridge on Interstate Route 90–1, major entry into Seattle, Washington from the east.

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IN THIS ISSUE

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Dimensions and Weights of Highway Trailer Combinations and Trucks, 1959

BY THE TRAFFIC SYSTEMS RESEARCH DIVISION BUREAU OF PUBLIC ROADS

Reported by[1] MALCOLM F. KENT, Transportation Economist, and HOY STEVENS, Highway Transport Research Engineer

Small 2-axle, single-unit trucks are the predominant freight vehicle in use on all but Interstate and main rural primary roads; however, on Interstate and main rural primary roads the intercity, line-haul freight is generally hauled in trailer combinations. It is for this use that large trailer combinations are an important part of the Nation's transportation system. Many communities are served only by trailer combinations for their incoming and outgoing freight deliveries. Because of the importance and amount of line-haul freight transport by highway commercial vehicles, it is of value to highway planners as well as to highway engineers to have data on the types, sizes, gross weights, degree of loading, and numbers of trailer combinations and trucks actually in use.

This article provides information showing the range and distribution of freight vehicles in use in 1959 in terms of length, width, height, and weight. Since 1959, large increases have occurred in use of trailer combinations, such as the use on Michigan's rural primary roads of 10- and 11-axle trailer combinations for which the loaded gross weights were more than 140,000 pounds, within the overall length limitation of 55 feet. Also, 9-axle trailer combinations having overall lengths of approximately 100 feet and carrying gross weights of 128,000 to 130,000 pounds are now being permitted on some toll roads. By 1963 the predominant length of new semitrailers and full trailers in use had increased to 40 feet, 5 feet more than the 35-foot predominant length in 1959.

Periodic sampling of dimensions and gross weights of trailer combinations currently in use on urban and rural highways is needed to keep the highway planning and design engineers informed as to the sizes and weights of highway freight vehicles being permitted and used on the highways. This type of information on trailer combinations and trucks is also useful in economic and public finance studies and for making estimates on the cargo-carrying potential of highway freight transport vehicles available for emergency situations and National Defense.

Introduction

A SAMPLING of the weights of highway freight trailer combinations and single-unit trucks is obtained by the highway departments in most of the States each year. But, no precise census of the number and type of trailers in highway freight service is available in the United States because of the multiple registration of trailers in more than one State, the short trailers used principally in city service, and the trailers used only for utility and construction purposes.

Because new cargo bodies of 40 feet and longer are entering the traffic stream, a need exists for repeating the size and dimension study periodically so that data on cargo-carrying capabilities of highway vehicles may be kept current. Therefore, in 1959, the Bureau of Public Roads collected data regarding the dimensions and weights of 155,300 vehicles—both empty and loaded—of which 90,200 were trailer combinations and 65,100 were single-unit trucks. A study and analysis of these data are presented in this article.[2] It is possible that some vehicles and combinations may have been weighed and measured more than once because of the location of the weighing stations, the period of time for which the stations were used at a specific location, and the random selection of vehicles and combinations in transit past the station. However, the sample is believed to represent a cross section of the automotive freight vehicles in use in the continental United States in 1959. Insofar as trailer combinations are concerned, the data portray the trucking industry's use of sizes and weights under the legal limitations in effect for several years prior to 1959.

Information was published in 1958 from a study on the demand for highway transportation (*1*)[3] in terms of shipping densities of commodities and tons involved in the five principal media of transportation. In 1957, according to an estimate printed in 1961 (*2*), there were 712,129 semitrailers and full trailers in highway freight service in the United States being used in 602,457 trailer combinations for rural and intercity highway freight transportation. This article includes data that show a distribution of highway freight vehicles by weights and dimensions in 1959.

By the nature of the trucking industry, vehicle sizes and cubic capacities are not immediately changed to take advantage of permitted increases in sizes, although any additional weight allowances are used in the hauling of the heavier commodities in the currently owned vehicles. Older and smaller vehicles usually are operated until no longer serviceable, although a pressure develops for their earlier retirement and replacement when legal limitations are raised to higher levels. Changes in legal limitations are dependent upon technological developments of vehicles, upon changes in the characteristics and amount of highway freight transport, and upon improvement in the design and construction of a State's highway system. The amount of highway freight has been increasing during the past several years, and this increase has caused the motor carriers to press for larger, more efficient vehicles.

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[1] Presented at the 42d annual meeting of the Highway Research Board, Washington, D.C., January 1963.

[2] Instructions and procedures for obtaining the data as part of the 1959 truck weights study were developed by Alexander French, Chief of the Planning Services Branch, Office of Planning. Miss Mildred M. Milazzo, Mrs. Madalene H. Kendall, and Mrs. Kathleen V. Toole of the Vehicle Research Branch helped to arrange the field data, prepare the data for machine analysis, and develop the summary tables and charts. John H. Jones of the Data Processing Division, Office of Administration, made the machine tabulations and suggested forms for the tables, which were produced by the electric accounting machine.

[3] Figures in parentheses indicate references listed on page 285.

During recent years, legal limitations have been raised to afford additional transport efficiency to motor carriers. The extent of these changes over the 5-year period, May 1957 to July 1962, are evident from the data on increases in lengths allowed for semitrailers and are shown in the appendix. The length limitations in effect in 1957 and previous years probably had a controlling influence on the lengths of semitrailers recorded in the 1959 weight studies. In 1957, 31 States permitted semitrailers 40 feet or longer, although 18 States prohibited the use of 40-foot semitrailers in long haul interstate service. By 1962, this prohibition had been eased and only West Virginia (35 feet) and Georgia (39.5 feet) restricted trailer length to less than 40 feet. For States having no statutory limit on semitrailer length, the maximum possible semitrailer length was assumed to be 7 feet less than the permitted length of the tractor semitrailer combination. This 7-foot dimension consists of a bumper-to-rear-of-cab dimension of 4 feet, obtainable for cab-over-engine tractors, plus 3 feet of clearance between rear of cab and nose of semitrailer.

Definitions

Trailer combinations

Trailer combinations are classified according to the axle classification code developed by the Bureau of Public Roads. In this code, each digit represents the number of axles of one vehicle in the combination. The symbol for a trailer combination consists of two or three digits separated by hyphens. The first digit represents the power vehicle, either a truck tractor or a tractive truck (a truck equipped to carry a cargo body and haul a full trailer). An "S" before the second digit indicates a semitrailer, the power vehicle being a tractor. A digit appearing without an "S" in either the second or third position in a combination symbol indicates a full trailer. Some examples are given in the following sentences.

The code for a 3-axle tractor and a 2-axle semitrailer combination is 3–S2. Codes for double cargo body combinations include: 3–2 for a 3-axle tractive truck and a 2-axle full trailer; 2–S1–2 for a 2-axle tractor plus a 1-axle semitrailer and a 2-axle full trailer. Such combinations are also known as double trailer combinations.

Cargo body types

Approximately 40 types of cargo bodies are defined in the Society of Automotive Engineers publication, *Commercial Motor Vehicle Nomenclature* (*3*). However, such a detailed classification was not suitable for use in this study and descriptive terms were used to group cargo bodies according to their similarity in cargo containing characteristics. The following list shows the types of vehicles included in each classification used in this study.

Flatbed: Platform (flat or stake), low-bed, riggers or oil field, lumber, and express or pickup bodies.

Van: Livestock rack, canopy, open-top box, fully enclosed van, insulated van, furniture or moving van, bottler, multistop or standup delivery, and panel truck bodies.

Log: Log, pulpwood, or pipe bodies.

Dump: Grain, dump low side open box, and hopper bodies.

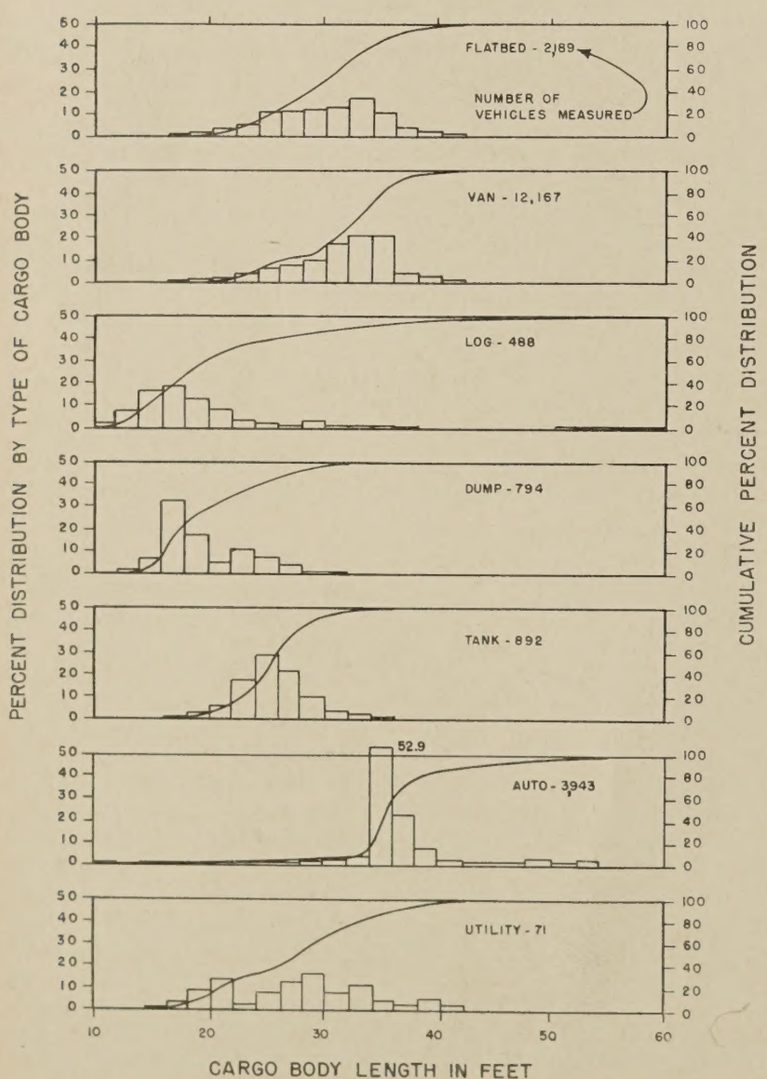

Figure 1.—Distribution of cargo body lengths, 3-axle trailer combinations.

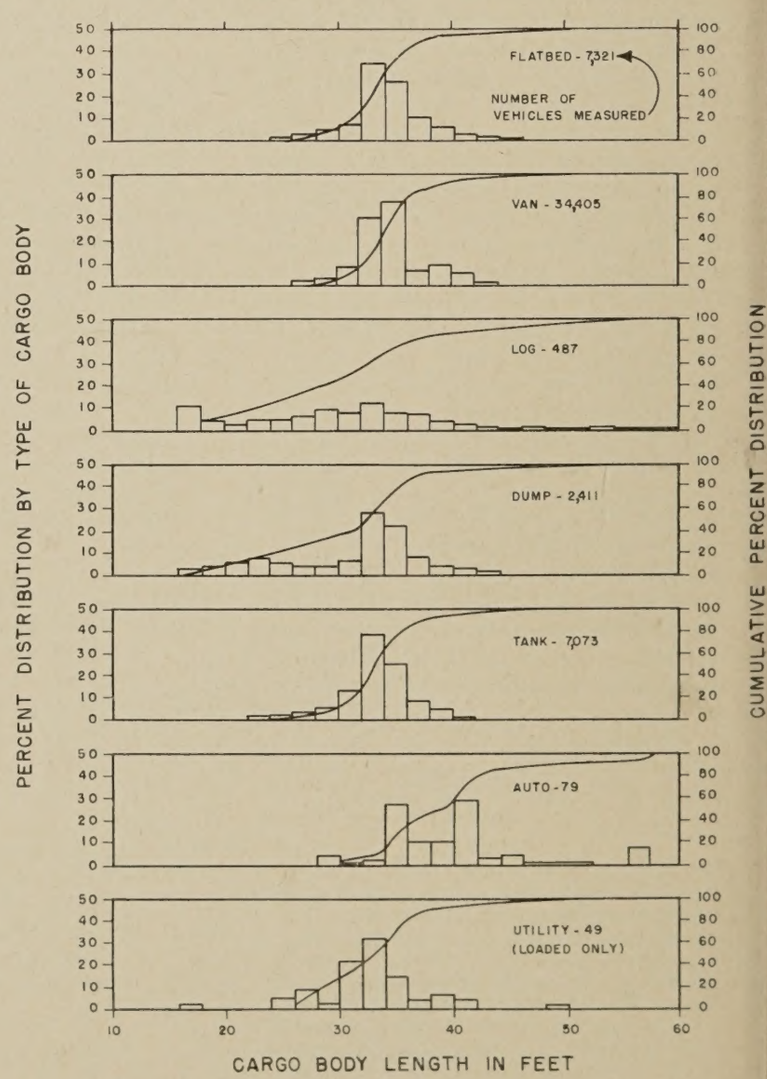

Figure 2.—Distribution of cargo body lengths, 4-axle trailer combinations.

Tank: Petroleum, insulated and uninsulated; bituminous distributor; and other liquid product bodies (milk, acids, sugar, etc.).

Auto: Bodies designed primarily for transportation of other vehicles.

Concrete: Bodies designed and equipped to mix and agitate concrete.

Utility: Wrecker; utility (transportation of tools; equipment; and supplies for construction, maintenance and repair purposes); garbage, refuse, lift and equipment (tank-mounted cranes, well drills, compressors, etc.) bodies.

Empty vehicle weight

The empty weight of a vehicle or trailer combination is its weight with fuel and without cargo or payload; it may include fixtures permanently carried to support the payload.

Loaded gross weight

The loaded gross weight of a trailer combination is its empty weight plus the weight of the cargo or payload carried.

Summary

Some of the more important findings from the 1959 study are stated in the following paragraphs.

Most of the van and flatbed cargo bodies of semitrailer combinations were 35 feet long in 1959. Because 40-foot cargo bodies have been constructed since 1959 in significant numbers, periodic studies of cargo body lengths will be necessary to provide current information on highway freight movement usage and capabilities.

Van cargo bodies on 2-axle, 6-tired trucks averaged about 12 to 14 feet in length and van cargo bodies on 3-axle trucks averaged about 18 to 20 feet.

Empty weights of 3–S2, 2–S1–2, and 3–2 trailer combinations averaged about 30,000 pounds; and empty weights of 2–S1 and 2–S2 combinations averaged about 20,000 and 25,000 pounds, respectively. Average empty vehicle weights of five different vehicle classes, all having van bodies, increased in step intervals of approximately 5,000 pounds, as follows: 2-axle, 6-tired trucks, 9,300 pounds; 3-axle trucks, 15,200 pounds; 2–S1 combinations, 20,100 pounds; 2–S2 combinations, 24,800 pounds; and 3–S2 combinations, 30,700 pounds.

Average empty weights of van body, single-unit trucks were: panels, 6,100 pounds; other 2-axle, 4-tired trucks, 6,400 pounds; 2-axle, 6-tired trucks, 9,300 pounds; and 3-axle trucks, 15,200 pounds. The 2–S2 combinations on the average had loaded gross weights of about 15,000 pounds more than those of the 2–S1 combinations of the same body types. The loaded gross weights of 3–S2 combinations having flatbed, van, and tank cargo bodies were about 11,000 pounds more on the average than those for the 2–S2 combinations having these same body types. The loaded gross weights of 2–S1–2 combinations were between 28,000 and 38,000 pounds more than those for the 2–S1 combinations in the States where the double cargo combinations are permitted.

The average payload of 10,800 pounds carried by 2–S1 van combinations was 12,000 pounds less than the payload carried by 2–S2 van combinations and 16,000 pounds less than that carried by 3–S2 van combinations.

The number of trailer combinations having loaded gross weights of more than 60,000 pounds was, as follows: 35 percent of the total number of the loaded combinations weighed in the States having a maximum gross weight limit of 60,000 pounds; 41 percent in the States having a maximum gross weight limit of 65,000 pounds; 50 percent in the States having a maximum gross weight limit of 76,000 pounds; and nearly 64 percent in those States having maximum gross weight limits of 78,000 pounds or more.

Approximately 10 percent of the total of the 2-axle, 6-tired trucks, the 3-axle trucks, and the trailer combinations exceeded the 8-foot width limitation, and only about 1 percent of the total exceeded the width limitation of 8.3 feet. Approximately 0.3 percent of all vehicles were more than 13 feet 6 inches high. A greater percentage of the 3–S2 combinations exceeded this height than any of the other classes of vehicles.

Procedures

Loaded and empty weights and the dimensions of highway cargo vehicles were obtained at truck weighing stations in 46 States during 1959. These vehicles were classified as to axle arrangement and type of cargo body. The lengths of cargo bodies were arrayed in 2-foot intervals, which provided a means of investigating the cubic capacities of cargo bodies in use during 1959. The greatest number of cargo bodies had lengths of 32 to 36 feet.

Loaded and empty weights of vehicles were averaged and the resultant averages were used to compute average payloads by type and length of cargo body for each vehicle classification. Average empty weights of five different vehicle classes of vehicles having van bodies increased in step intervals of approximately 5,000 pounds. These five average empty weights were: 2-axle, dual-rear-tire truck, 9,300 pounds; 3-axle truck, 15,200 pounds; 2–S1 trailer combination, 20,100 pounds; 2–S2 trailer combination, 24,800 pounds; and the 3–S2 trailer combination, 30,700 pounds. The 4-axle (2–S2), tractor van-semitrailer combination carried on the average about 6 tons more payload than the 3-axle (2–S1), tractor van-semitrailer combination, and 2 tons less than the 5-axle (3–S2), tractor van-semitrailer combination.

In the States that limited gross weights of motor vehicles to 56,000 to 60,000 pounds, the greatest percentage of loaded gross weights was in the 50,000- to 60,000-pound weight bracket. But weights recorded for States that have higher gross weight limits had the greatest percentage of loaded gross weights in the 60,000- to 70,000-pound weight bracket. About 1 percent of all trailer combinations and 1 percent of all 2- and 3-axle, dual-tired trucks exceeded 8.3 feet in width across the wheels and approximately 0.3 percent of the vehicles exceeded 13.5 feet in height.

Length of Cargo Bodies in the Traffic Stream

In 1959, the length, height, and width of 155,300 commercial cargo vehicles were recorded as the vehicles were weighed at truck weighing stations in 46 States (the District of Columbia was included and treated as a State). Although at least one estimation (*4*) had been made by the motor-vehicle industry of the lengths of van trailers by year of construction, no industry tabulation had been made available that would give a cross section of cargo motor vehicles operating on the highways at any given time. Dimensional information concerning new vehicles going into the traffic stream each year would be useful, but a cross section of the vehicles, old and new, on the highways would give a better understanding of highway freight movement capabilities.

Trailer combinations

In figure 1 the percentage distributions of cargo body lengths and the cumulative percentage curves of 2–S1 trailer combinations are shown. The 20,544 sample of 2–S1 combinations included flatbed, van, auto, log, dump, tank, and utility bodies. Fifty percent of the flatbed bodies were more than 30 feet long, and 50 percent of the van bodies were more than 32 feet long. Most of the dump bodies were 16 to 18 feet long, and most of the tanks were 24 to 26 feet long. Automobile carrier bodies were predominantly 34 to 36 feet long and log bodies were mostly 16 to 18 feet long. Utility body lengths were spread rather evenly over the wide range of 14 to 42 feet.

A rather marked difference in the configurations of the distributions of cargo body lengths in 2–S2 combinations can be seen in figure 2 as compared to the distributions of cargo bodies in 2–S1 combinations. The distributions of cargo body lengths in 2–S2 combinations show a predominance of 32- to 34-foot lengths for all but vans and auto carriers, which were mostly 34 to 36 feet long. The data shown here are for 1959, before the advent of 40-foot cargo bodies in appreciable numbers.

Because 40-foot trailers have been built in considerable numbers since 1959 it would seem advisable to repeat this vehicle dimension study every 3 to 5 years to study the extent of the addition of longer cargo bodies to the traffic stream. Periodic studies would also reflect what lengths of cargo bodies were being retired from service. In this connection, note that of the 34,405 van cargo bodies measured on 2–S2 combinations approximately 36 percent were 34 to 36 feet long and 30 percent were 32 to 34 feet long. Thus in 1959 two-thirds of the 2–S2 van cargo bodies were 32 to 36 feet long and 42 and 47 percent respectively of the 2–S1 and 3–S2 van cargo bodies were 32 to 36 feet long.

The 3–S2 tractor semitrailer combinations had a marked predominance of 35-foot cargo bodies, except for the log and utility body types, as shown in figure 3. Fifty-eight percent of the 3–S2 tanks were at least 36 feet long and some were longer, but only about 14 per-

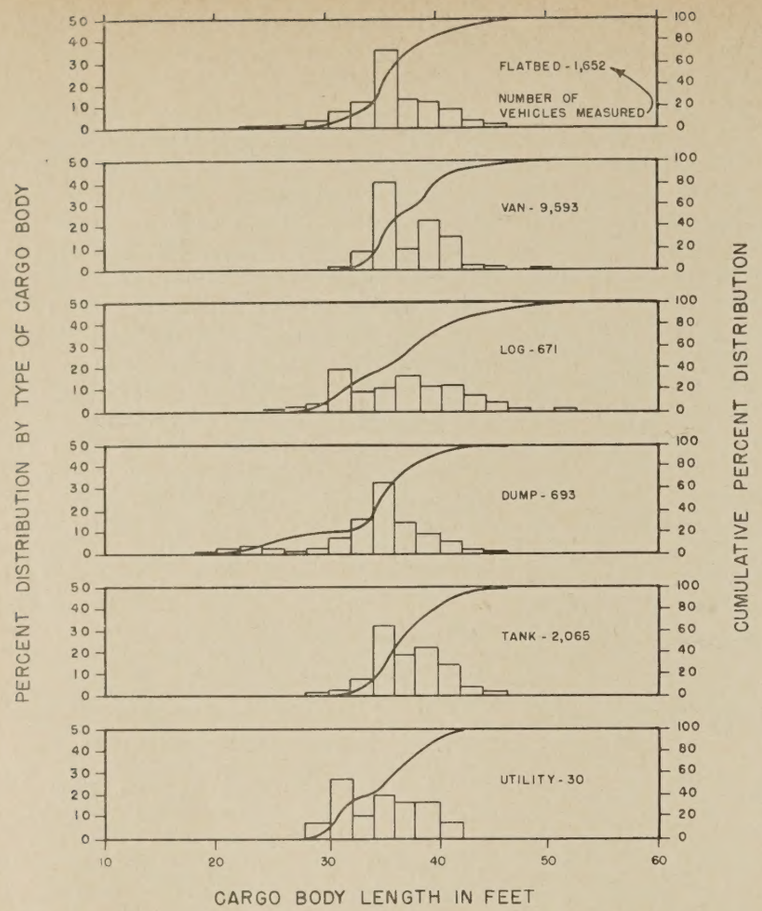

Figure 3.—Distribution of cargo body lengths, 5-axle tractor trailer combinations.

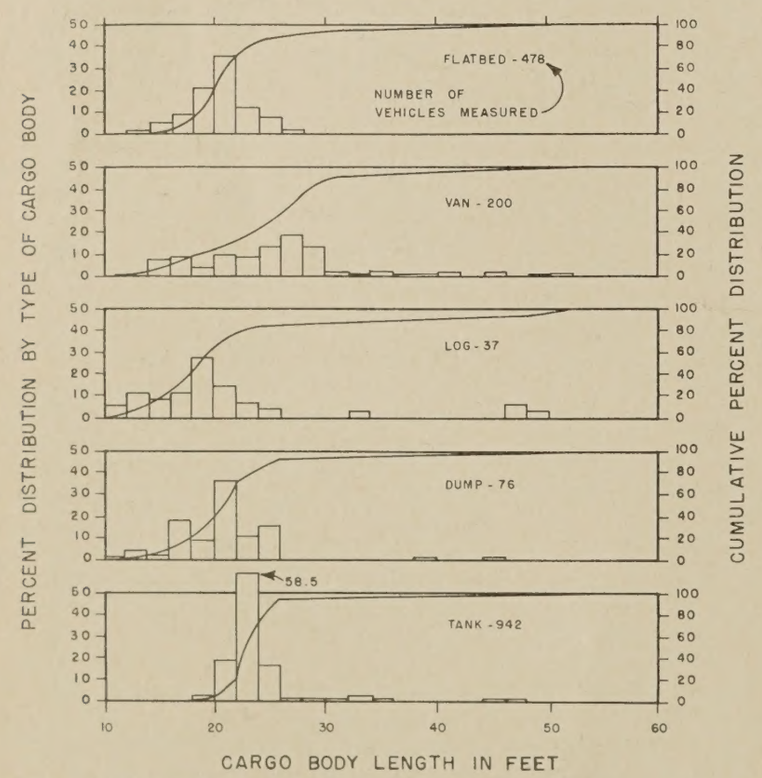

Figure 4.—Distribution of cargo body lengths, tractive-truck full-trailer combinations.

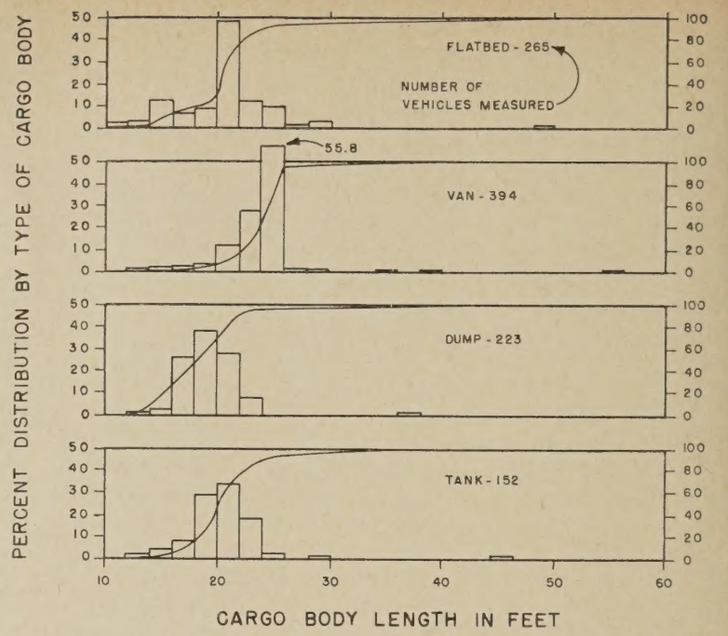

Figure 5.—Distribution of cargo body lengths, tractor semitrailer full-trailer combinations.

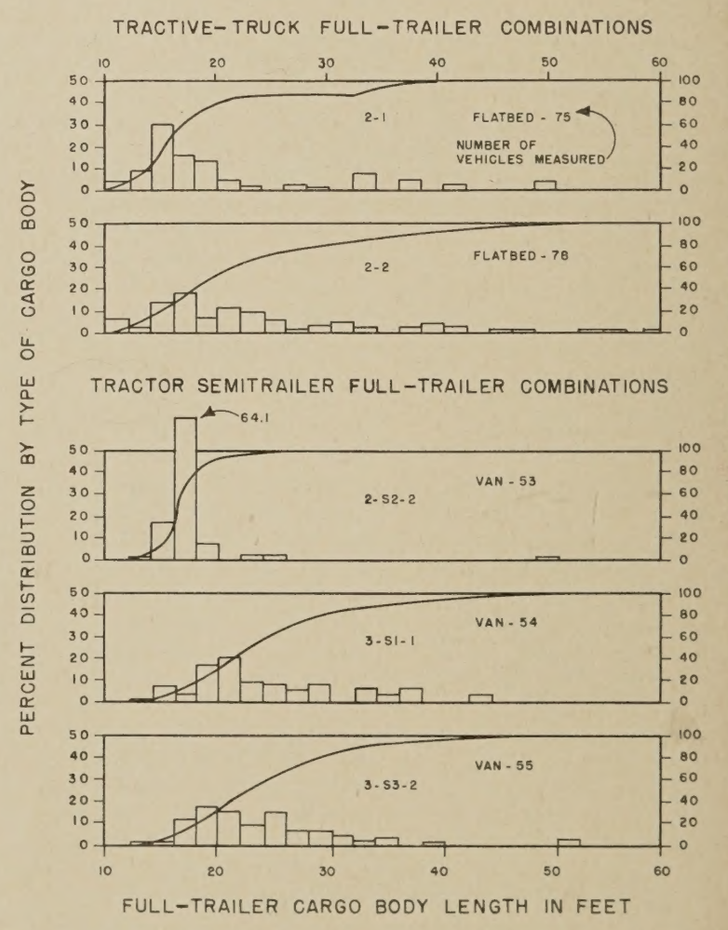

Figure 6.—Distribution of cargo body lengths, miscellaneous vehicles.

cent of the 2–S2 tanks and 1 percent of the 2–S1 tanks were 36 feet long. Length of cargo bodies for log trailers ranged evenly from 30 to 46 feet. Only 30, 5-axle tractor-utility-trailers were counted in this study and their cargo bodies were from 28 to 42 feet long.

Although high percentages of the total double cargo body combinations counted were weighed and measured, the samples were small in number as compared to the samples obtained for single cargo body combinations. The data for the 3–2, tractive-truck, full-trailer combinations are reported in figure 4, and th data for the 2–S1–2 tractor, semitrailer, ful trailer combinations are shown in figure 5 The lengths of the semitrailers in the 2–S1– combinations were the same as the lengths o the full-trailers in such combinations.

Most of the flatbed, full-trailers used in the 2–2 and 2–S1–2 trailer combinations were 20 feet long. Ninety percent of the van, full-trailers in the 3–2 combinations were less than 30 feet long, and 97 percent of the van, full-trailers used in the 2–S1–2 combinations were less than 26 feet long. Dump, full-trailers were mostly 16 to 22 feet long. Tank, full-trailers in 3–2 combinations were mostly 22 to 24 feet long, and lengths of the tank trailers in the 2–S1–2 combinations were rather evenly distributed from 18 to 24 feet. The basic data used for figs. 1–5 are given in tables 1 and 2.

In figure 6, trailer length distributions of five different, double cargo body trailer combinations are shown for between 50 and 100 observations made for each combination. The 2–1 class of trailer combinations has a limited local use, usually as a seasonal, auxiliary freight vehicle in agricultural areas. The trailers observed in such combinations were flatbed, balanced full-trailers and were from 14 to 20 feet long. In the 2–2 class of trailer combinations, only flatbed full-trailers were observed and they had a predominant range in length from 14 to 26 feet. This class of 2–2 trailer combinations apparently was not adequately sampled in this study because other types of bodies are used in this class of trailer combinations.

Data collected for tractor, semitrailer, and full-trailer combinations (2–S2–2, 3–S1–1, and 3–S3–2), three classes of trailer combinations less frequently used than others, also are shown in figure 6. All of these had van full-trailers. The 2–S2–2 van trailers were mostly 16 to 18 feet long; the lengths of van trailers in both 3-axle tractor combinations were spread over a wide range from 14 to 40 feet, most of them were from 18 to 26 feet long.

Cumulative percentage curves for all the 2–S1, 2–S2, 3–S2, 3–2 and 2–S1–2 combinations, by cargo body type, are shown in figure 7 for easy comparison. Of course, some long cargo bodies reported may have been special permit vehicles. These charts indicate that in 1959 no predominant length of trailer was used for all purposes, the predominant lengths ranged from 20 to 40 feet.

Trucks

Of the 268 pickup trucks, 85 percent had cargo bodies 6 to 10 feet long and the 614 panel trucks were evenly distributed as to length over the 2-foot intervals from 6 to 18 feet, figure 8 and table 3. Few panel and pickup trucks were recorded on rural roads; their primary use is in urban areas.

Two-axle motortrucks having 4 tires, other than panels and pickups, had cargo body measurements similar to the panels and pickups; most of the flatbed bodies were 6 to 10 feet long and the length of van bodies ranged from 6 to 20 feet. Two-axle motortrucks having 6 tires had cargo body lengths mostly in the range of 12 to 16 feet, except for dump trucks and utility vehicles. Dump bodies had average lengths of about 10 feet and utility body lengths were rather evenly distributed over the range of 8 to 16 feet, figure 9 and tables 3 and 4.

Table 1.—Distribution of trailer body lengths in combinations, 46 States

Trailer body length	2-S1		2-S2		3-S2		3-2		2-S1-2	
	Number	*Percent*	*Number*	*Percent*	*Number*	*Percent*	*Number*	*Percent*	*Number*	*Percent*
FLATBED										
Feet										
10–11.9	4	0.2								
12–13.9	11	0.5							4	1.5
14–15.9	7	0.3							29	10.9
16–17.9	32	1.5	12	0.2	3	0.2	80	16.7	17	6.4
18–19.9	40	1.8	4	0.1	1	0.1	104	21.8	22	8.2
20–21.9	105	4.8	16	0.2	3	0.2	168	35.2	130	48.7
22–23.9	118	5.4	33	0.5	9	0.5	55	11.5	31	11.6
24–25.9	251	11.5	80	1.1	10	0.6	35	7.3	23	9.0
26–27.9	269	12.3	168	2.3	21	1.3	20	4.2	3	1.1
28–29.9	278	12.7	433	5.9	57	3.5	7	1.5	4	1.5
30–31.9	294	13.4	875	12.0	113	6.8	2	0.4		
32–33.9	367	16.7	2,534	34.5	202	12.2	1	0.2		
34–35.9	223	10.2	1,843	25.1	578	35.0				
36–37.9	101	4.6	655	8.9	219	13.3				
38–39.9	55	2.5	373	5.1	205	12.4				
40–41.9	16	0.7	181	2.5	137	8.3				
42–43.9	9	0.4	45	0.6	38	2.3				
44–45.9	1	0.1	34	0.5	31	1.9	1	0.2		
46–47.9			11	0.2	5	0.3				
48–49.9	5	0.2	10	0.1	7	0.4	2	0.4		0.4
50–52 and over	3	0.2	14	0.2	13	0.7	3	0.6	2	0.7
Total	2,189	100.0	7,321	100.0	1,652	100.0	478	100.0	265	100.0
VAN										
10–11.9	8	0.1								
12–13.9	9	0.1							1	0.2
14–15.9	15	0.1							3	0.8
16–17.9	69	0.6	21	0.1	12	0.1	38	19.0	6	1.5
18–19.9	83	0.7	14	0.1	10	0.1	9	4.5	8	2.0
20–21.9	314	2.6	38	0.1	12	0.1	19	9.5	44	11.2
22–23.9	490	4.0	91	0.3	10	0.1	19	9.5	100	25.3
24–25.9	774	6.4	117	0.3	21	0.2	29	14.5	220	55.8
26–27.9	947	7.8	199	0.6	13	0.1	38	19.0	5	1.3
28–29.9	1,200	9.9	799	2.3	36	0.4	27	13.5	3	0.8
30–31.9	2,011	16.5	3,212	9.3	134	1.4	2	1.0		
32–33.9	2,561	20.9	10,329	30.0	744	7.8	1	0.5		
34–35.9	2,543	20.9	12,386	35.9	3,786	39.5	3	1.5	2	0.5
36–37.9	518	4.3	2,233	6.5	793	8.3	1	0.5		
38–39.9	416	3.4	2,941	8.5	2,129	22.2	1	0.5	1	0.3
40–41.9	158	1.3	1,648	4.8	1,386	14.4	4	2.0		
42–43.9	28	0.2	259	0.8	230	2.4				
44–45.9	13	0.1	68	0.2	126	1.3	2	1.0		
46–47.9	7	0.1	19	0.1	42	0.4				
48–49.9			23	0.1	46	0.5	1	0.5		
50–52 and over	3	0.0	8	0.0	63	0.7	6	3.0	1	0.3
Total	12,167	100.0	34,405	100.0	9,593	100.0	200	100.0	394	100.0
LOG										
10–11.9	13	2.7								
12–13.9	42	8.6							NA	NA
14–15.9	84	17.2							NA	NA
16–17.9	96	19.7	55	11.3	2	0.3	13	35.2	NA	NA
18–19.9	67	13.7	21	41.3	1	0.1	10	27.0	NA	NA
20–21.9	45	9.2	19	3.9	2	0.3	5	13.5	NA	NA
22–23.9	21	4.3	27	5.6	1	0.1	2	5.4	NA	NA
24–25.9	20	4.1	28	5.8			1	2.7	NA	NA
26–27.9	13	2.7	34	7.0	13	2.0			NA	NA
28–29.9	9	1.8	44	9.0	32	4.8			NA	NA
30–31.9	17	3.5	40	8.2	128	19.0			NA	NA
32–33.9	10	2.1	70	14.4	59	8.8	1	2.7	NA	NA
34–35.9	10	2.1	44	9.0	80	12.0			NA	NA
36–37.9	11	2.3	34	7.0	103	15.3			NA	NA
38–39.9	9	1.8	21	4.3	72	10.7			NA	NA
40–41.9	6	1.2	15	3.1	76	11.3			NA	NA
42–43.9	3	0.6	8	1.6	48	7.1			NA	NA
44–45.9	2	0.4	4	0.8	30	4.8			NA	NA
46–47.9	2	0.4	6	1.2	9	1.3	2	5.4	NA	NA
48–49.9	2	0.4	4	0.8	3	0.4	1	2.7	NA	NA
50–52 and over	6	1.2	13	2.7	12	1.7	2	5.4	NA	NA
Total	488	100.0	487	100.0	671	100.0	37	100.0	NA	NA
DUMP										
10–11.9	1	0.1								
12–13.9	8	1.0							1	0.4
14–15.9	58	7.3							3	1.4
16–17.9	267	33.6	76	3.2			20	26.3	57	25.6
18–19.9	133	16.8	88	3.6	8	1.2	7	9.2	85	38.1
20–21.9	69	8.7	141	5.8	20	2.9	27	35.6	59	26.5
22–23.9	39	4.9	155	6.4	26	3.8	8	10.5	17	7.6
24–25.9	90	11.3	120	5.0	20	2.9	12	15.8		
26–27.9	57	7.2	100	4.1	14	2.0				
28–29.9	31	3.9	101	4.2	19	2.7				
30–31.9	16	2.0	147	6.1	43	6.2				
32–33.9	12	1.5	659	27.3	104	15.0				
34–35.9	3	0.4	496	20.6	221	31.9				
36–37.9	7	0.9	173	7.2	95	13.7			1	0.4
38–39.9	2	0.3	82	3.4	63	9.0	1	1.3		
40–41.9	1	0.1	40	1.7	36	5.2				
42–43.9			21	0.9	13	1.9				
44–52 and over			12	0.5	11	1.6	1	1.3		
Total	794	100.0	2,411	100.0	693	100.0	76	100.0	223	100.0

Table 2.—Distribution of cargo body lengths in trailer combinations, 46 States

Cargo body length	2-S1		2-S2		3-S2		3-2		2-S1-2		2-S1		2-S2		2-S1		2-S2		3-S2	
	TANK										AUTO				UTILITY					
Feet	*Number*	*Percent*	*Number*	*Percent*	*Number*	*Percent*	*Number*	*Percent*	*Number*	*Percent*	*Number*	*Percent*	*Number*	*Percent*	*Number*	*Percent*	*Number*	*Percent*	*Number*	*Percent*
10–11.9											4	0.1								
12–13.9	1	0.1							3	2.0	1	0.0								
14–15.9	2	0.2							7	4.5	2	0.1			1	1.4				
16–17.9	11	1.2	9	0.1	2	0.1	14	1.5	13	8.5	3	0.1			2	2.8	1	2.0		
18–19.9	32	3.6	3	0.1			26	2.7	45	29.4	2	0.1			6	8.4				
20–21.9	54	6.1	13	0.2			177	18.7	52	33.9	5	0.1			10	14.1				
22–23.9	152	17.0	41	0.6			554	58.5	28	18.3	2	0.1			2	2.8				
24–25.9	265	29.7	73	1.0	3	0.1	146	15.4	2	1.3	8	0.2			6	8.5	2	4.1		
26–27.9	203	22.8	164	2.3	6	0.3	2	0.2			11	0.3			9	12.7	4	8.2		
28–29.9	108	12.1	393	5.6	22	1.1	2	0.2	1	0.7	19	0.5	3	3.8	11	15.5	1	2.0	2	6.4
30–31.9	30	3.4	931	13.2	36	1.7	5	0.5			22	0.6	1	1.3	5	7.1	11	22.5	8	25.7
32–33.9	17	2.0	2,682	38.0	157	7.6	8	0.9			138	3.5	2	2.5	8	11.3	15	30.6	3	9.7
34–35.9	9	1.0	1,734	24.5	636	30.8	2	0.2			2,090	52.9	21	26.6	3	4.2	7	14.3	6	19.4
36–37.9	4	0.4	564	8.0	357	17.3					855	21.6	8	10.1	2	2.8	2	4.1	5	16.2
38–39.9	4	0.4	353	5.0	441	21.4					282	7.2	8	10.1	3	4.2	3	6.1	4	16.2
40–41.9			60	0.8	283	13.7					81	2.0	22	27.8	2	2.8	2	4.1		
42–43.9			30	0.4	74	3.6				0.7	32	0.8	2	2.5					2	6.4
44–45.9			17	0.2	42	2.0	1	0.2			34	0.9	3	3.8						
46–47.9			2	0.0	3	0.1	1	0.1			85	2.2	1	1.3	1	1.4				
48–49.9			2	0.0	1	0.1					127	3.2	1	1.3			1	2.0		
50–51.9			1	0.0					1	0.7	44	1.1	1	1.3						
52 and over			1	0.0	2	0.1	4	0.9			96	2.4	6	7.6						
TOTAL	892	100.0	7,073	100.0	2,065	100.0	942	100.0	152	100.0	3,943	100.0	79	100.0	71	100.00	49	100.0	30	100.0

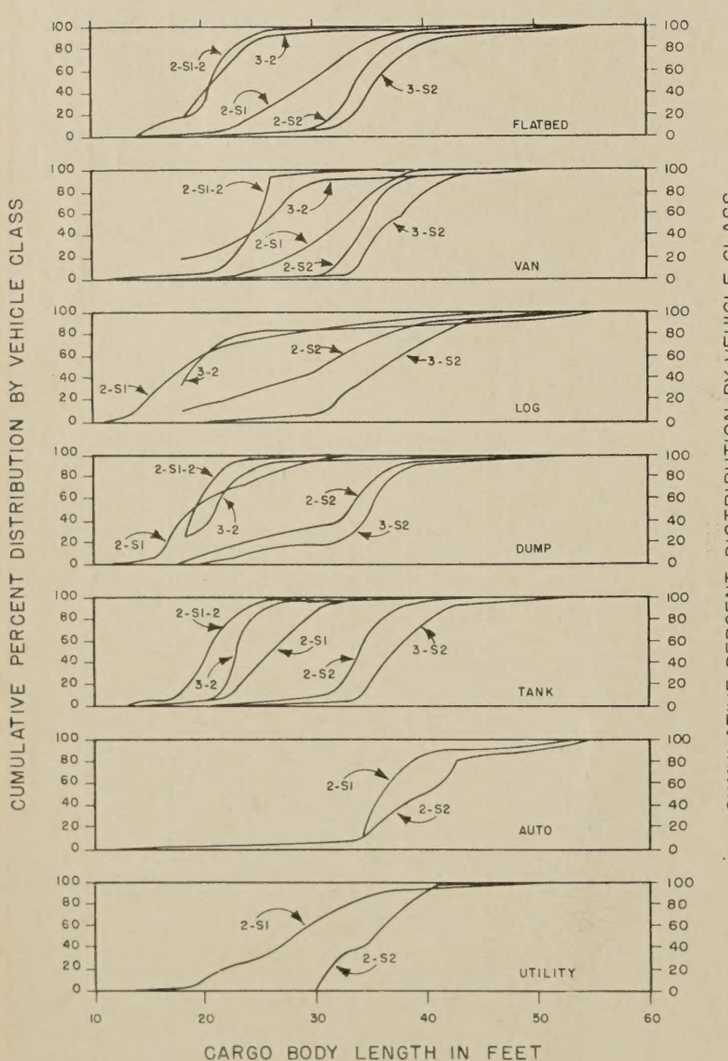

Figure 7.—Cumulative percentage distribution by vehicle type and cargo body length.

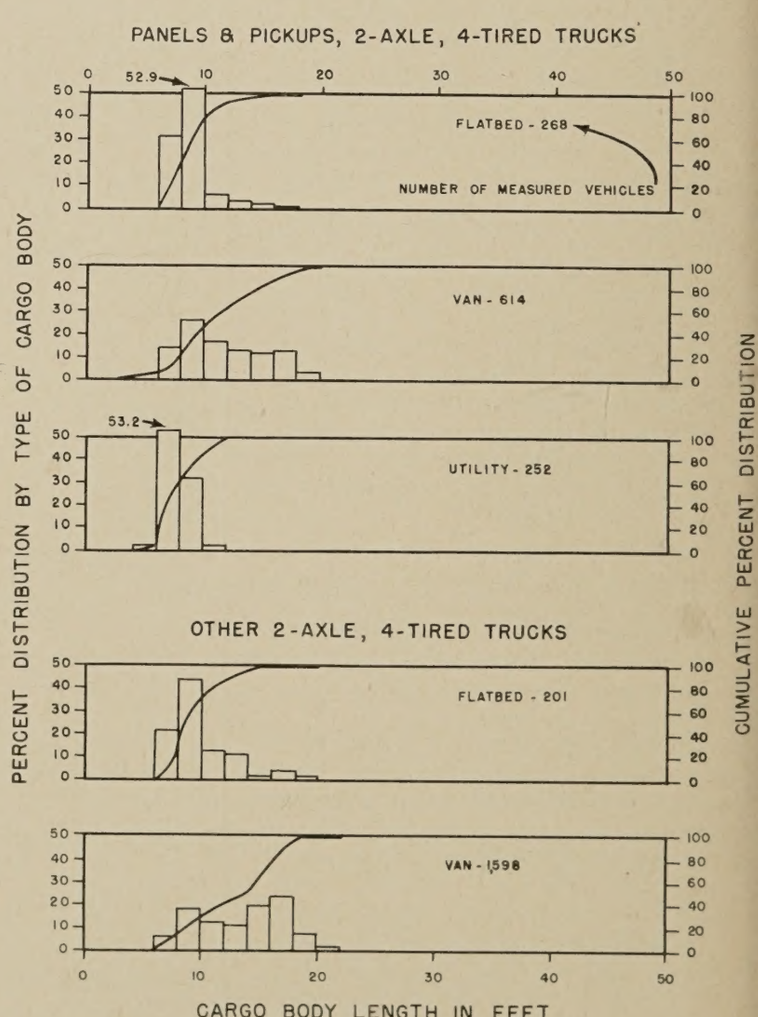

Figure 8.—Distribution of cargo body lengths, 2-axle, 4-tired motortrucks.

Considerable differences were noted in the length distributions of the different types of cargo bodies of 3-axle trucks, figure 10. Lengths of flatbed and van bodies were predominantly in the range of 16 to 22 feet, and lengths of log and tank bodies were mostly in the 14- to 20-foot range. Nearly two-thirds of the dump trucks and 85 percent of the ready-mix concrete trucks were equipped with cargo bodies 12 to 16 feet long, tables 3 and 4.

Empty Vehicle Weights

Trailer combinations

Empty weights were obtained for 27,144 trailer combinations for the five classifications for which the greatest number of trailer combinations occurred—2–S1, 2–S2, 3–S2, 3–2, and 2–S1–2—and are shown in table 5. The weighted average empty weights by class of combination and type of cargo body provide a means of computing average payload weights when average loaded gross weights are known. The empty 2–S2 combinations on the average weighed about 5,000 pounds more than the 2–S1 empty van combinations. Other variations in empty weights between these three classes of combinations and the six types of cargo bodies are shown in table 5. Sometimes the sample of vehicles weighed was small, and averages computed from these data are not as reliable as data might have been if a larger sample could have been obtained. The sizes of the samples are shown in table 5 for use in evaluating the reliability of the data for average empty weights.

In figure 11, average empty weights of trailer combinations have been arranged by cargo body types to show the variations in weight of the same body type for the five main combination classes. Similarly, in figure 12, average empty weights have been arranged by the five main combination classes to show the variations in weight for the different cargo body types.

Single-unit trucks

The four classes of single-unit trucks weighed and measured were panels and pickups having 4 tires, other 2-axle trucks having 4 tires, 2-axle trucks having 6 tires, and 3-axle trucks. Data collected are recorded in table 6. The total number of these types of trucks observed was 23,844. Empty weights averaged 4,800 pounds for pickup trucks and 6,100 pounds for panel trucks. Other 2-axle, 4-tired trucks, having van cargo bodies, on the average had empty weights of only about 300 pounds more than the panel trucks. Two-axle trucks equipped with 6 tires had empty weights that were approximately 3,000 pounds heavier than trucks having 4 tires. Empty weights of 3-axle flatbed, van, and dump trucks ranged between 15,000 and 16,000 pounds; and empty weights of tank trucks averaged about 19,000 pounds. Ready-mixed concrete trucks and utility trucks weighed empty 22,500 and 25,000 pounds, respectively, equipment was a regular part of their empty weight.

In figure 13, average empty weights have been arranged by cargo body types to show the differences in weight of the same body type for the four different vehicle classes. Similarly, in figure 14, average empty weights have been arranged by the four vehicle classes to show the differences in weights for the eight cargo body types.

Table 3.—Cargo body lengths of single-unit trucks, 46 States

Cargo body length	Panels, pickups, 4-tired trucks		2-axle, 4-tired trucks		2-axle, 6-tired trucks		3-axle trucks	
FLATBED								
Feet	*Number*	*Percent*	*Number*	*Percent*	*Number*	*Percent*	*Number*	*Percent*
Under 6.0			2	1.0	22	0.2		
6–7.9	87	32.5	43	21.4	68	0.6		
8–9.9	142	52.9	90	44.8	921	8.1	1	0.1
10–11.9	17	6.3	26	12.9	1,023	9.0	11	0.9
12–13.9	9	3.4	24	11.9	3,983	35.1	70	5.8
14–15.9	8	3.0	4	2.0	2,714	24.0	118	9.7
16–17.9	2	0.7	8	4.0	1,511	13.3	342	28.1
18–19.9	1	0.4	4	2.0	589	5.2	309	25.4
20–21.9					254	2.2	233	19.2
22–23.9					122	1.1	60	4.9
24–25.9					62	0.5	29	2.4
26–27.9	1	0.4			39	0.3	12	1.0
28–29.9					15	0.1	12	1.0
30–31.9					8	0.1	4	0.3
32–33.9					6	0.1	8	0.7
34–35.9					13	0.1	4	0.3
36–41.9	1	0.4			4	0.0	2	0.2
Total	268	100.0	201	100.0	11,354	100.0	1,215	100.0
VAN								
Under 4.0	3	0.5	1	0.1				
4–5.9	1	0.2	3	0.2	39	0.1		
6–7.9	90	14.7	91	5.7	136	0.4		
8–9.9	160	26.0	289	18.0	1,857	6.0	6	0.4
10–11.9	105	17.0	206	12.9	2,288	7.3	10	0.7
12–13.9	77	12.5	197	12.3	9,888	31.7	43	2.8
14–15.9	71	11.6	308	19.3	7,960	25.6	103	6.8
16–17.9	79	12.9	379	23.6	5,251	17.0	319	20.8
18–19.9	27	4.4	105	6.6	1,988	6.4	446	29.2
20–21.9			9	0.6	712	2.3	345	22.6
22–23.9			6	0.4	391	1.3	130	8.5
24–25.9	1	0.2	3	0.2	258	0.8	74	4.9
26–27.9					161	0.5	15	1.0
28–29.9					86	0.3	13	0.9
30–31.9					33	0.1	6	0.4
32–33.9					40	0.1	4	0.3
34–35.9					34	0.1	6	0.4
36–37.9			1	0.1	14	0.0	1	0.1
38–51.9					10	0.0	2	0.2
Total	614	100.0	1,598	100.0	31,146	100.0	1,523	100.0
LOG								
Under 6.0	NA	NA	NA	NA	3	0.5		
6–7.9	NA	NA	NA	NA	1	0.2		
8–9.9	NA	NA	NA	NA	12	2.1	2	0.5
10–11.9	NA	NA	NA	NA	35	6.1	15	3.6
12–13.9	NA	NA	NA	NA	276	48.2	38	9.1
14–15.9	NA	NA	NA	NA	158	27.6	76	18.2
16–17.9	NA	NA	NA	NA	55	9.6	127	30.3
18–19.9	NA	NA	NA	NA	15	2.6	98	23.4
20–21.9	NA	NA	NA	NA	7	1.2	37	8.9
22–23.9	NA	NA	NA	NA	6	1.0	8	1.9
24–35.9	NA	NA	NA	NA	5	0.9	17	4.1
Total	NA	NA	NA	NA	573	100.0	418	100.0
DUMP								
Under 6.0	NA	NA	NA	NA	20	0.3		
6–7.9	NA	NA	NA	NA	228	3.2		
8–9.9	NA	NA	NA	NA	2,952	41.7	75	2.8
10–11.9	NA	NA	NA	NA	1,587	22.4	444	16.5
12–13.9	NA	NA	NA	NA	1,338	19.0	1,028	38.3
14–15.9	NA	NA	NA	NA	598	8.4	642	24.0
16–17.9	NA	NA	NA	NA	245	3.5	225	8.4
18–19.9	NA	NA	NA	NA	76	1.1	167	6.2
20–21.9	NA	NA	NA	NA	16	0.2	60	2.2
22–23.9	NA	NA	NA	NA	6	0.1	26	1.0
24–35.9	NA	NA	NA	NA	15	0.1	18	0.6
Total	NA	NA	NA	NA	7,081	100.0	2,685	100.0

Average Payload Weights of Trailer Combinations

The average payload weights shown in table 9 were derived by subtracting the average

Table 4.—Number and percent of length of cargo bodies of single-unit trucks, 46 States

Cargo body length	2-axles, 6-tired		3-axle trucks		2-axles, 6-tired		3-axle trucks		Panels and pickups, 4-tired		2-axles, 6-tired		3-axle trucks	
	TANK				CONCRETE				UTILITY					
Feet	*Number*	*Percent*	*Number*	*Percent*	*Number*	*Percent*	*Number*	*Percent*	*Number*	*Percent*	*Number*	*Percent*	*Number*	*Percent*
Under 6.0	4	0.1							4	1.6	22	1.4		
6–7.9	3	0.1			1	1.1			134	53.2	56	3.7		
8–9.9	45	1.4			6	7.0	3	0.3	81	32.1	335	21.9	13	5.6
10–11.9	166	5.3	3	1.1	25	28.7	54	5.9	28	11.1	269	17.6	23	9.9
12–13.9	1,115	35.4	14	5.4	44	50.6	384	41.6	4	1.6	340	22.2	34	14.7
14–15.9	1,315	41.8	66	25.3	5	5.8	396	42.9			214	14.0	28	12.1
16–17.9	396	12.6	71	27.2	3	3.5	63	6.8	1	0.4	124	8.1	30	12.9
18–19.9	78	2.5	63	24.2	1	1.1	10	1.1			83	5.4	39	16.8
20–21.9	11	0.3	35	13.4	1	1.1	3	0.3			24	1.6	24	10.3
22–23.9	6	0.2	4	1.5			6	0.7			13	0.8	9	3.9
24–25.9	6	0.2	3	1.1	1	1.1	2	0.2			18	1.2	10	4.3
26–27.9	1	0.0					1	0.1			14	0.9	5	2.2
28–29.9											5	0.3	5	2.2
30–31.9			1	0.4							6	0.4	1	0.4
32–33.9	1	0.0									2	0.1	1	0.4
34–35.9	2	0.1					1	0.1			3	0.2	1	0.4
36–37.9	1	0.0									2	0.1		
38–39.9											1	0.1		
40–41.9	1	0.0												
42–43.9 [1]			1	0.4										
44–45.9													1	0.4
46–47.9													2	0.9
48–49.9													1	0.4
50 and over													5	2.2
TOTAL	3,151	100.0	261	100.0	87	100.0	923	100.0	252	100.0	1,531	100.0	232	100.0

[1] For the tank cargo bodies, length is 42 feet and over.

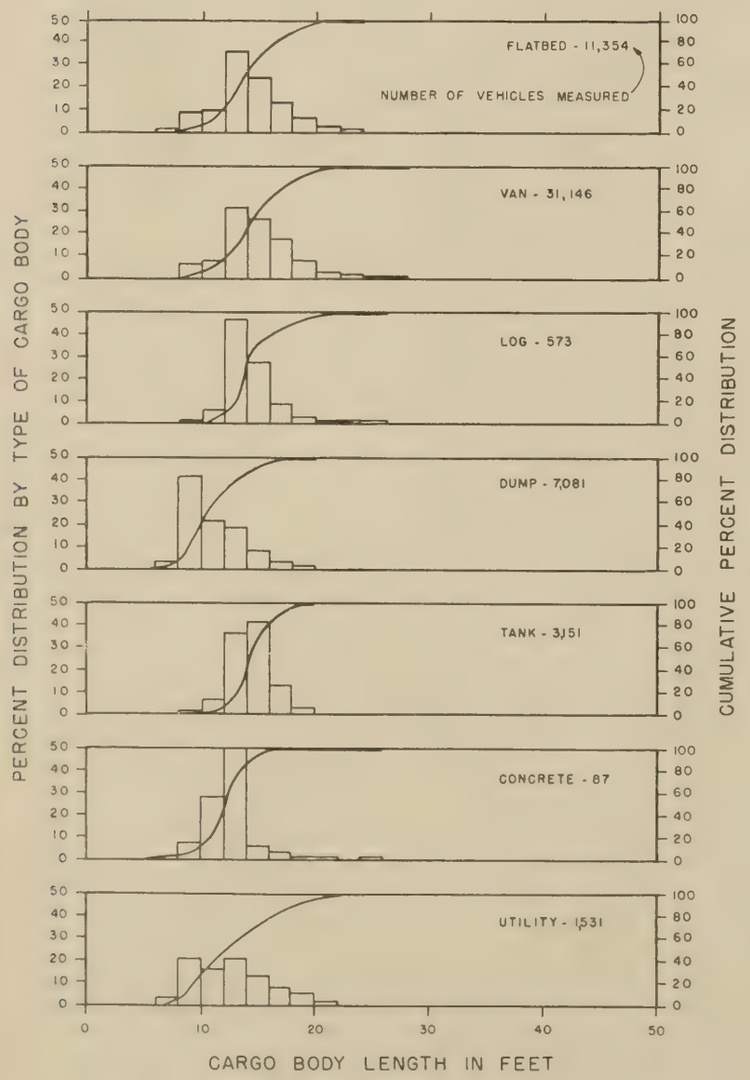

Figure 9.—Distribution of cargo body lengths, 6-tired motortrucks.

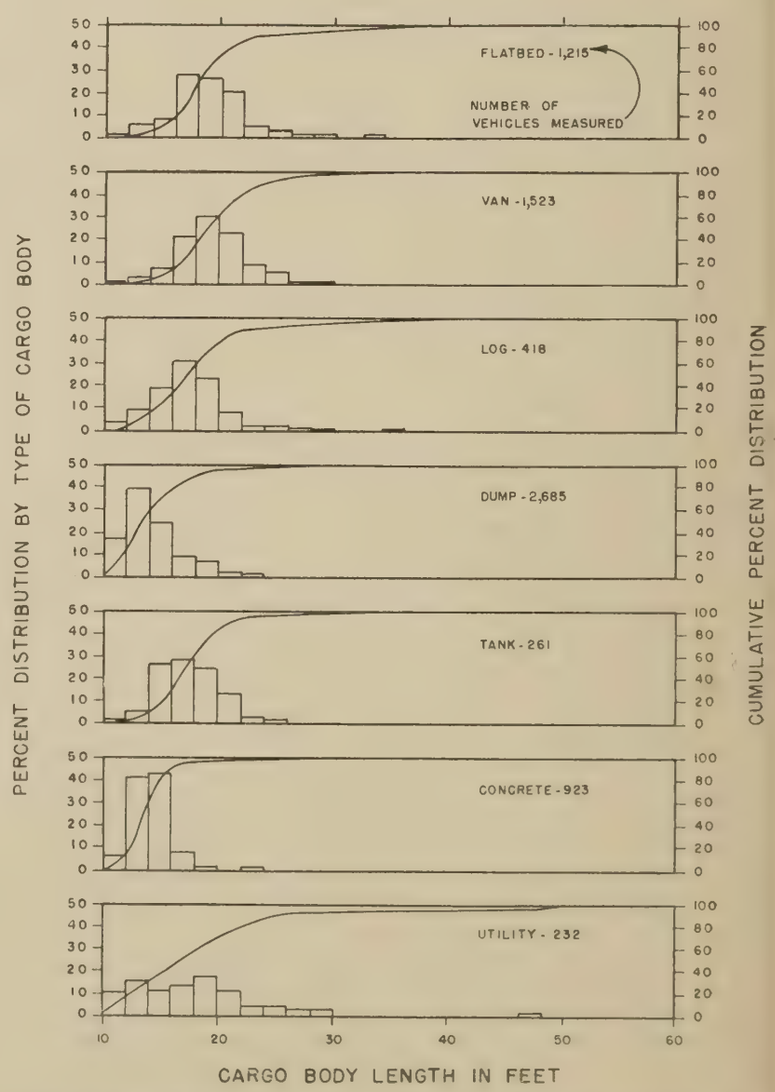

Figure 10.—Distribution of cargo body lengths, 3-axle motortrucks.

Table 5.—Average empty weights of trailer combinations by length and type of cargo body, 46 States, 1959

Trailer body length	Flatbed	Van	Log	Dump	Tank	Auto	Utility
2–S1							
Feet	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
10–11.9		23,600	11,500				
12–13.9		17,500	9,400	18,300			
14–15.9	16,000	17,900	9,600	15,500		20,000	
16–17.9	14,200	18,000	10,500	16,800	18,100	12,600	21,400
18–19.9	17,300	18,300	10,700	15,700	19,500		12,200
20–21.9	15,200	17,800	10,800	15,400	19,900		21,200
22–23.9	16,500	18,600	12,300	16,400	20,200		
24–25.9	17,000	18,900	13,400	15,600	19,400	17,700	19,600
26–27.9	16,700	19,100	11,300	15,300	22,100	20,600	17,000
28–29.9	17,500	19,300		16,500	22,200	18,100	22,700
30–31.9	18,300	20,400	12,400	16,700	22,700	20,100	22,100
32–33.9	18,800	20,400	15,000	20,000	21,100	19,900	20,000
34–35.9	18,200	21,200	11,700		17,000	19,000	
36–37.9	17,300	20,900	12,300	16,800		18,600	
38–39.9	17,300	21,300	11,000		19,800	19,300	21,800
40–41.9	16,400	21,500	13,500			20,100	17,800
42–43.9	20,400	23,400				19,300	
44–45.9	16,000	17,900				19,000	
46–47.9		22,300	10,100			20,400	
48–49.9			10,400			21,300	
50–51.9						20,700	
52 and over		17,700				22,100	
Weighted Average	17,500	20,100	10,600	16,200	20,600	19,200	19,900
Vehicles Weighed	866	3,447	216	337	395	1,672	16
2–S2							
Under 16	25,700	25,700		19,900			NA
16–17.9	18,900	25,100	14,600	21,200			NA
18–19.9		19,000	16,200	23,300	24,200		NA
20–21.9	15,000	27,000	13,000	24,500	24,400		NA
22–23.9	25,400	24,300	16,900	25,700	31,400		NA
24–25.9	24,400	25,500	17,500	26,200	25,200		NA
26–27.9	22,300	23,100	19,700	24,800	25,000		NA
28–29.9	23,900	24,400	19,300	23,800	25,700		NA
30–31.9	22,100	24,100	20,200	24,000	25,400		NA
32–33.9	22,300	24,200	18,700	24,700	24,400		NA
34–35.9	22,500	25,100	20,400	22,500	24,700	21,600	NA
36–37.9	22,300	25,400	20,300	23,400	25,200	20,100	NA
38–39.9	22,900	25,400	18,000	22,400	25,000	22,600	NA
40–41.9	22,300	25,900	19,100	21,400	25,600	24,400	NA
42–43.9	21,700	26,300		21,600	23,600		NA
44–45.9	23,200	25,800		19,800	24,100		NA
46–47.9	25,300	24,000		21,200			NA
Weighted Average	22,500	24,800	17,800	23,900	24,800	21,800	NA
Vehicles Weighed	2,925	8,653	166	885	3,180	25	NA
3–S2							
Under 18	37,800					NA	
18–19.9	32,800	17,100		26,300		NA	
20–21.9	38,000	23,400	22,100	28,300		NA	
22–23.9	28,400	27,300		27,900		NA	
24–25.9	35,600	30,800		30,500		NA	
26–27.9	31,600	22,300	24,600	29,300	32,200	NA	
28–29.9	32,300	25,400		34,900	29,200	NA	32,900
30–31.9	29,100	30,000	19,800	27,300	33,000	NA	25,500
32–33.9	30,800	28,000		27,400	30,900	NA	25,000
34–35.9	31,000	31,100	24,500	29,300	27,600	NA	25,800
36–37.9	32,500	30,500	22,500	27,500	28,800	NA	
38–39.9	30,300	31,400	24,000	28,200	27,700	NA	
40–41.9	28,500	31,500		27,200	25,000	NA	
42–43.9	31,900	33,300		26,600	26,700	NA	
44–45.9	31,100	30,600		25,600	25,800	NA	
46–47.9	30,500	30,600		31,000		NA	
48–49.9		34,400		23,000		NA	
50–51.9		39,600				NA	
52 and over		33,300		27,000		NA	
Weighted Average	31,000	30,700	23,500	28,500	27,800	NA	26,400
Vehicles Weighed	611	1,522	14	212	973	NA	8
3–2							
Weighted Average	29,400	28,600	26,300	31,200	28,400	NA	NA
Vehicles Weighed	156	89	6	27	415	NA	NA
2–S1–2							
Weighted Average	28,000	33,000	NA	28,800	32,700	NA	NA
Vehicles Weighed	80	77	NA	98	73	NA	NA

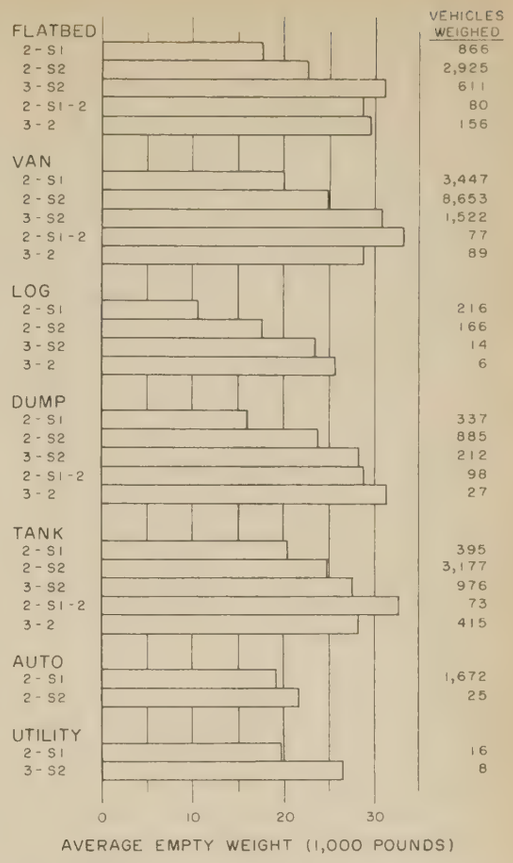

Figure 11.—Average empty weights of trailer combinations by vehicle and cargo body types.

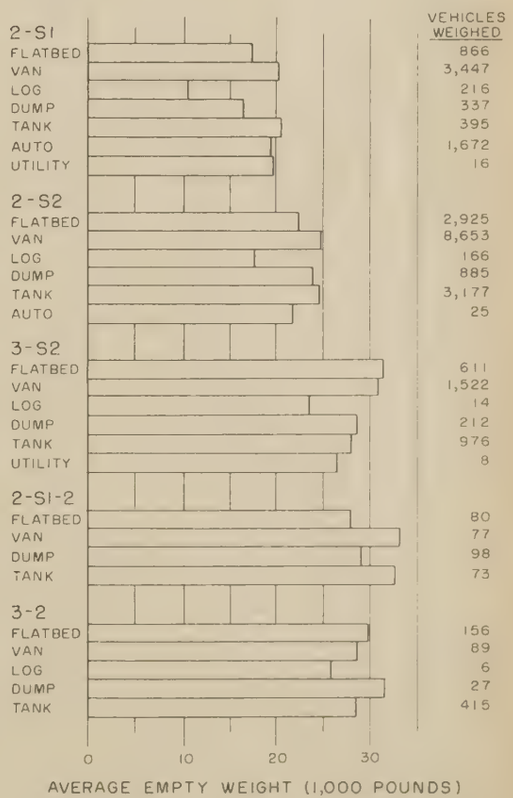

Figure 12.—Average empty weights of trailer combinations by cargo body and vehicle types.

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Table 6.—Average empty weights of single-unit trucks by length and type of cargo body, 46 States, 1959

Cargo body length	Flatbed	Van	Log	Dump	Tank	Auto	Concrete	Utility
PANELS AND PICKUPS, 4-TIRED								
Feet	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
6.0–7.9	4,200	4,600	NA	4,600	NA	NA	NA	4,100
8.0–9.9	4,800	5,400	NA	5,800	NA	NA	NA	5,100
10.0–11.9	5,400	5,700	NA	5,600	NA	NA	NA	5,100
12.0–13.9	7,000	6,600	NA	8,400	NA	NA	NA	----
14.0–15.9	7,200	7,900	NA	----	NA	NA	NA	----
16.0–17.9	10,000	10,400	NA	----	NA	NA	NA	----
18.0–19.9	----	6,400	NA	----	NA	NA	NA	----
Weighted average	4,800	6,100	NA	5,700	NA	NA	NA	4,900
Vehicles weighed	144	218	NA	20	NA	NA	NA	26
OTHER 2-AXLE, 4-TIRED								
Under 6.0	----	6,500	NA	NA	NA	NA	NA	----
6.0–7.9	4,500	4,600	NA	NA	NA	NA	NA	4,600
8.0–9.9	5,000	5,000	NA	NA	NA	NA	NA	6,500
10.0–11.9	5,500	5,800	NA	NA	NA	NA	NA	10,000
12.0–13.9	8,400	7,300	NA	NA	NA	NA	NA	5,200
14.0–15.9	6,200	6,300	NA	NA	NA	NA	NA	----
16.0–17.9	7,700	6,600	NA	NA	NA	NA	NA	----
18.0–19.9	7,200	6,800	NA	NA	NA	NA	NA	----
20.0–21.9	----	7,600	NA	NA	NA	NA	NA	----
22.0–23.9	----	8,600	NA	NA	NA	NA	NA	----
Weighted average	5,400	6,400	NA	NA	NA	NA	NA	7,500
Vehicles weighed	110	423	NA	NA	NA	NA	NA	11
2-AXLE, 6-TIRED								
Under 6.0	7,400	7,900	9,800	9,200	8,800	5,900	----	6,000
6.0–7.9	6,500	6,900	7,200	9,900	10,400	----	----	7,500
8.0–9.9	6,200	6,600	7,200	9,900	8,100	----	11,800	8,600
10.0–11.9	7,100	7,600	7,200	9,900	9,700	----	14,000	9,600
12.0–13.9	7,700	8,800	7,200	9,100	10,600	8,800	14,200	10,500
14.0–15.9	8,400	9,800	7,500	9,700	11,400	9,600	15,400	12,600
16.0–17.9	9,200	10,300	8,700	9,500	13,400	12,500	13,300	12,200
18.0–19.9	9,900	11,000	10,400	11,500	14,400	----	----	13,400
20.0–21.9	10,400	11,800	9,100	9,400	16,100	----	----	12,100
22.0–23.9	9,600	11,900	8,000	----	15,600	----	----	5,900
24.0–25.9	11,000	12,700	7,600	----	19,200	----	22,000	10,800
26.0–27.9	9,400	12,700	----	12,600	----	----	----	10,900
28.0–29.9	10,200	13,700	----	----	----	----	----	8,400
30.0–31.9	10,800	14,200	----	----	----	----	----	10,800
32.0–33.9	11,000	13,200	----	6,500	----	----	----	----
34.0–35.9	9,800	16,500	----	8,700	11,000	----	----	17,500
36.0–37.9	8,100	9,300	----	8,400	----	----	----	----
38.0–39.9	----	----	----	----	----	----	----	----
40.0–41.9	----	----	----	----	----	----	----	----
42.0–43.9	----	7,000	----	----	----	----	----	----
44.0–45.9	----	21,700	----	----	----	----	----	----
Weighted average	8,000	9,300	7,600	9,700	11,300	9,100	14,300	10,200
Vehicles weighed	4,901	9,479	337	3,799	967	7	33	429
3-AXLE TRUCKS								
Under 6.0	----	----	25,100	16,400	----	NA	----	24,700
6.0–7.9	----	12,600	24,200	17,200	----	NA	----	----
8.0–9.9	----	16,700	----	12,400	----	NA	26,200	25,500
10.0–11.9	14,300	12,800	22,500	13,800	----	NA	20,900	22,300
12.0–13.9	14,300	15,700	22,500	16,900	13,500	NA	20,900	20,400
14.0–15.9	13,500	15,000	24,000	17,600	16,400	NA	23,400	23,000
16.0–17.9	13,900	13,600	13,700	18,200	18,500	NA	26,600	23,100
18.0–19.9	14,400	15,300	16,900	16,800	19,000	NA	20,500	26,100
20.0–21.9	15,400	15,300	22,200	16,400	27,100	NA	----	18,100
22.0–23.9	21,400	17,000	20,800	17,300	23,400	NA	20,300	36,400
24.0–25.9	20,400	15,200	12,900	14,200	25,600	NA	----	40,200
26.0–27.9	30,400	15,700	15,100	17,700	----	NA	26,700	29,800
28.0–29.9	35,400	15,200	18,800	----	----	NA	----	21,400
30.0–31.9	----	19,400	----	13,800	----	NA	----	----
32.0–33.9	18,000	14,700	----	15,400	----	NA	----	----
34.0–35.9	12,200	17,000	----	----	----	NA	25,800	----
36.0–37.9	----	----	----	----	----	NA	----	----
38.0–39.9	----	28,000	----	----	----	NA	----	----
40.0–41.9	----	----	----	----	----	NA	----	----
42.0–43.9	----	----	----	----	----	NA	----	----
44.0–45.9	----	----	----	----	----	NA	----	----
46.0–47.9	----	----	----	----	----	NA	----	52,700
48 and over	----	----	----	----	----	NA	----	63,000
Weighted average	15,100	15,200	19,600	16,600	18,900	NA	22,500	25,000
Vehicles weighed	485	564	137	1,232	96	NA	361	65
TOTAL VEHICLES WEIGHED	5,640	10,684	474	5,051	1,063	NA	394	531

empty weights given in table 5 from average loaded gross weights given in tables 7 and 8. Although there is little correlation between cargo body length and average payload weights, a considerable difference is shown in average payload weights as between different combination classes and different cargo body types. For example, the 2–S1 flatbed combinations had an average payload of 15,000 pounds but 2–S1 van combinations carried average payloads of about 11,000 pounds. Corresponding average payload figures for the 2–S2 combinations were 24,000 and 22,000 pounds, and for the 3–S2 combinations 28,000 and 26,000 pounds.

The 2–S2 combinations for all body types, except auto and utility bodies, operated on the average with gross vehicle weights of about 15,000 pounds more than 2–S1 combinations with the same body types. The 3–S2 combination having flatbed, van, and tank body types operated with gross vehicle weights between 10,000 and 12,000 pounds more, on the average, than the 2–S2 combinations having the same body types. The 3–S2 dump combination gross vehicle weights, on the average, were 14,000 pounds heavier than the 2–S2 dump combination.

In those States where the double cargo body combination is permitted, the addition of a 2-axle full-trailer to the 2–S1 combination caused an average increase in gross vehicle weight of 28,000 pounds for the flatbed and van combinations and of 36,000 to 38,000 pounds more for the dump and tank combinations.

Trailer Lengths Related to Loaded Gross Weights

An analysis was made to determine whether any significant difference existed in lengths of trailer cargo bodies for different gross vehicle weights. For this purpose, the gross weights of the different combination classes, broken down by cargo body types, were arrayed in 10,000-pound intervals of gross vehicle weight. Each 10,000-pound interval was further arrayed as to length of cargo body. The results are shown, in figures 15–17, for the three main combination classes—the 2–S1, 2–S2, and 3–S2 tractor semitrailer combinations having van cargo bodies. The configurations in these figures are similar in weight intervals from 20,000- to 70,000-pound gross vehicle weights. No significant increase in lengths of cargo bodies can be detected as gross weights increased. The median of cargo body lengths of 2–S1 combinations for 10,000-pound weight intervals between 20,000 and 60,000 pounds was 32 feet, and the median cargo body length for the 2–S2 combination was 35 feet. Commodity data, not collected in this study, would be needed to further analyze choice of trailer body lengths made by industry.

Effect of Gross Weight Limits on Loaded Gross Weights

Maximum gross weight limits prescribed for permitted classes of trailer combinations by the 45 States and the District of Columbia in 1959 are as enumerated: limits in 7 States were 56,000 to 60,000 pounds, in 16 States were 60,000 to 68,000 pounds, in 18 States were 71,000 to 76,000 pounds, and in 5 States were 78,000 pounds and more. The loaded trailer combinations weighed in these 46 States were grouped by their loaded gross weights into four weight categories. The combinations in each weight category were arranged in 10,000-pound class intervals of gross vehicle weight, and the number of loaded combinations observed in each weight category were converted to a percentage of total loaded combinations observed.

Weights of 3–S2 combinations

Depending upon the axle limits allowed, the 3–S2 combination can legally operate at a gross vehicle weight of 72,000 pounds where 32,000-pound tandem axles are specified, and at about 80,000 pounds where 36,000-pound tandem axles are specified. In figure 18, percentages are shown of loaded trailer combinations of the 3–S2 combination that had van cargo bodies. As gross weight limits increased, a higher percentage of the loads were more than 60,000 pounds. For example, the percentages of combinations above this figure and the maximum gross weights permitted by the States were: 35 percent and 60,000-pound maximum gross weight, nearly 41 percent and 68,000-pound maximum gross weight, 50 percent and 76,000-pound maximum gross weight, and nearly 64 percent and 78,000-pound and more maximum gross weight.

These figures would seem to indicate that from the freight standpoint there was a demand for heavier permitted gross weight in the States limiting it to 60,000 pounds and that this demand was held in check by the low weight limits. The greatest percentage of loaded gross weights in the States having maximum limits of 56,000 to 60,000 pounds occurred in the 50,000–60,000-pound weight bracket, and in the other three groups of States a preference was shown for 60,000- to 70,000-pound gross loads. In similar analysis of the data for 3–S2 flat-bed loaded vehicles, shown in figure 19, the findings paralleled those given for the vehicles with van cargo bodies.

Gross Weights of 2–S1–2 and 3–2 Combinations

The 2–S1–2 trailer combination, if operating at single-axle limitations of 18,000 pounds, would have a gross weight of about 80,000

Table 7.—Average loaded weights of trailer combinations by length and type of cargo body, 46 States, 1959

Trailer body length	Flatbed	Van	Log	Dump	Tank	Auto	Utility
			2–s1				
Feet	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Under 10.0		36,300		40,400		42,200	
10.0–11.9	43,400	49,200	31,100			24,800	
12.0–13.9	30,000	24,700	34,600	37,100	15,900	32,700	
14.0–15.9	36,700	31,400	33,000	42,500	38,500		18,200
16.0–17.9	31,600	33,100	34,000	44,100	27,800	26,600	20,000
18.0–19.9	30,400	30,200	33,700	40,400	34,700	32,200	30,100
20.0–21.9	31,800	29,000	39,300	38,700	35,700	26,100	34,300
22.0–23.9	31,100	28,900	38,400	38,600	36,100	34,800	15,600
24.0–25.9	32,500	29,400	30,200	38,800	38,900	29,900	28,800
26.0–27.9	33,900	30,100	29,300	36,500	42,300	28,400	24,100
28.0–29.9	32,100	30,700	36,400	37,500	44,700	32,600	35,500
30.0–31.9	33,300	30,500	21,400	31,800	40,900	35,500	26,500
32.0–33.9	34,200	30,600	32,700	32,400	42,300	32,400	30,600
34.0–35.9	31,000	32,000	36,200	34,500	38,900	33,300	23,500
36.0–37.9	30,300	32,600	37,700	35,800	29,300	33,700	23,800
38.0–39.9	30,800	32,900	34,700	29,900	34,300	33,800	26,800
40.0–41.9	30,600	32,300	26,200	21,200		33,200	37,600
42.0–43.9	30,000	35,100	33,500			32,900	
44.0–45.9		38,500	42,000			35,600	
46.0–47.9		36,400	17,800			36,500	42,000
48.0–49.9	27,400		16,400			34,500	
50.0–51.9	29,500					38,600	
52 and over	46,600	26,400	31,900			39,600	
Weighted average	32,500	30,900	33,700	40,300	39,400	33,800	29,200
Vehicles weighed	1,323	8,720	272	457	497	2,271	55
			2–s2				
Under 10.0		19,200			35,700		
10.0–11.9	46,500	37,300					
12.0–13.9	25,900	38,700	32,300	52,200	50,900		
14.0–15.9	18,600	35,400	47,800	48,800	54,500		
16.0–17.9	16,000		49,600	54,500			7,800
18.0–19.9	36,200	51,900	43,800	58,800	56,600		
20.0–21.9	45,000	46,100	41,400	55,500	46,600		
22.0–23.9	48,300	48,700	46,000	60,600	52,200		
24.0–25.9	44,900	46,500	46,800	57,400	51,600		33,800
26.0–27.9	45,500	46,800	50,500	56,700	53,400		27,400
28.0–29.9	47,000	45,700	47,300	55,700	53,200	45,900	
30.0–31.9	47,800	47,100	51,400	52,600	54,400		38,800
32.0–33.9	47,700	47,300	49,000	53,000	55,100	50,700	39,000
34.0–35.9	47,700	44,400	48,600	53,000	55,700	30,200	48,800
36.0–37.9	46,000	47,300	51,200	56,400	56,600	25,500	38,600
38.0–39.9	46,200	47,200	49,700	56,000	59,000	36,300	40,800
40.0–41.9	46,000	48,300	48,800	52,400	55,800	46,800	41,200
42.0–43.9	46,300	48,500	55,100	55,400	56,300	32,600	
44.0–45.9	46,400	49,100	43,200	59,000	58,400	13,600	
46.0–47.9	43,500	47,000	54,700	51,800	58,700		
48.0–49.9	36,500	46,600	46,700	62,400	65,800		34,200
50.0–51.9	37,900	48,700	46,400		67,800	47,400	
52 and over	36,400	57,200	44,800			27,400	
Weighted average	47,200	47,300	48,500	54,600	55,300	36,900	38,700
Vehicles weighed	4,396	25,752	321	1,526	3,896	54	49
			3–s2				
Under 10.0	63,400	62,200			70,900	NA	
10.0–11.9	62,600		36,700			NA	
12.0–13.9		36,900				NA	
14.0–15.9		20,500	60,700			NA	
16.0–17.9		20,500				NA	
18.0–19.9		20,500	83,600	67,600		NA	
20.0–21.9	66,800	51,900	62,100	71,000		NA	
22.0–23.9	64,300	60,600	64,900	69,500		NA	
24.0–25.9	68,000	59,800		65,200	67,100	NA	
26.0–27.9	65,500	62,100	67,100	79,300	66,400	NA	
28.0–29.9	55,200	60,300	70,400	68,900	59,200	NA	41,700
30.0–31.9	52,600	55,900	71,500	71,500	60,600	NA	43,100
32.0–33.9	55,700	53,300	70,100	65,700	64,800	NA	58,300
34.0–35.9	58,100	57,800	68,900	64,900	66,900	NA	57,800
36.0–37.9	59,200	58,100	70,600	66,800	66,900	NA	65,300
38.0–39.9	60,000	57,000	69,600	65,800	66,500	NA	81,200
40.0–41.9	62,700	57,100	70,200	65,800	65,700	NA	
42.0–43.9	61,900	59,000	70,700	66,800	66,500	NA	84,100
44.0–45.9	63,100	57,100	70,300	61,700	66,000	NA	
46.0–47.9	74,600	50,700	67,900	70,600	58,300	NA	
48.0–49.9	62,200	56,800	64,300	64,800	61,900	NA	
50.0–51.9	68,600	56,000	62,000			NA	
52 and over	62,600	59,200	60,200			NA	
Weighted average	58,800	57,100	70,000	68,500	66,300	NA	61,400
Vehicles weighed	1,041	8,071	657	481	1,089	NA	22

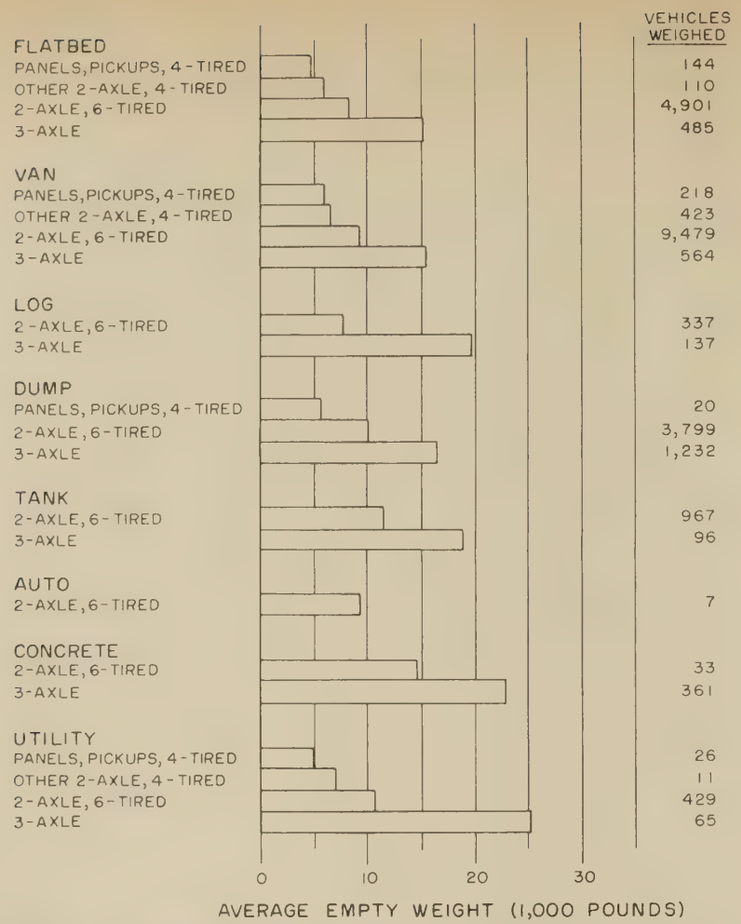

Figure 13.—Average empty weights of single-unit trucks by vehicle and cargo body types.

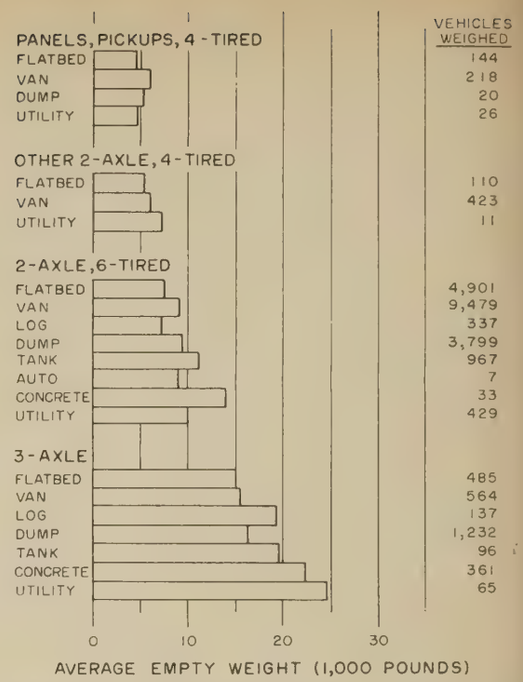

Figure 14.—Average empty weights of single-unit trucks by cargo body and vehicle types.

pounds; and if operating at single-axle limitations of 22,400 pounds, would have a gross weight of about 98,000 pounds. The 3–2 trailer combinations, if operating with 18,000-pound single axles and 32,000-pound tandem axles, would have a maximum gross weight of about 77,000 pounds. The 3–2 combination, if operating with 22,400-pound single axles and 36,000-pound tandem axles, would have a maximum gross weight of about 91,000 pounds. The 2–S1–2 tractor, semitrailer, full-trailer combinations and the 3–2 tractive truck full-trailers combinations were observed mostly in two groups of States—18 States that have maximum weight limits of 71,000 to 76,000 pounds and 5 States that have maximum weight limits of 78,000 pounds and more.

As shown in figure 20, the percentage of 2–S1–2 trailer combinations having gross weights of 80,000 pounds or more was higher in the 5 States having weight limits of 78,000 pounds and more in the 18 States having maximum weight limits of 71,000 to 76,000 pounds. The same trend existed in percentage relationship for the three major body types—flatbed, van, and tank. Similar trends in the relationship of gross weights and the permitted weights were noted for the 3–2 tractive-truck full-trailer combination, figure 21. The percentages for gross weights of combinations of more than 80,000 pounds are shown in table 10.

The data included in figures 20 and 21 and in table 10 indicated that tank cargo body combinations are the ones that can most consistently use the maximum permitted, or higher, gross weights. The two other cargo body types of combinations regularly carried loads that weighed much below the maximum permitted weights. Hence, it may be concluded that not all freight carriers could use to advantage any increase in permitted gross weights. This situation presents a difficult problem in allocating any increased highway construction and maintenance costs for higher load-capacity roadways only to those vehicles that could and would use such increased load-carrying capacities built into a road system. Therefore, the increased roadway costs, occasioned by permitting heavier axle and larger gross weight limits, might not be justified because of possible insufficient use by vehicles carrying heavier loads.

Widths and Heights

During the 1959 truck weight study, the widths of cargo vehicles less than 7 feet wide and heights of cargo vehicles less than 10 feet high were not recorded in most States. Measurement figures were recorded for cargo vehicles of these dimensions and larger. In 1959, Connecticut and Rhode Island permitted widths of 8.5 feet but all other continental States limited widths to 8 feet, exclusive of safety equipment. Out of all the continental States studied, 2 had no height limitations, 2 specified 14.0 feet, 26 specified 13.5 feet, 2 specified 13.0 feet, and 17 specified 12.5 feet. Thus, 30 States in 1959 permitted heights of 13.5 feet or more. As of December 31, 1961, 44 of the continental States had height limitations of 13.5 feet or more and 5 retained the limitation of 12.5 feet.

Because of the trend toward the 8-foot width and 13.5-foot height, measurements taken at truck weight stations have been tabulated to show measurements in excess of these two modal figures. Some of the figures showing measurements greater than the permitted widths and heights probably may be ascribed to special permit loads and to the mounting of tires larger than the 10.00×20 size. When 11.00×20 and larger size tires are placed on highway freight vehicles having body widths of exactly 8 feet, frequently as much as 2 inches of tire may project beyond the body frame on each side. With this in mind, width measurements were separated into intervals of 8.0 to 8.3 feet (8 feet 3.6 inches), 8.4 to 8.5 feet, 8.6 to 9.0 feet, and 9.1 feet and over. Although approximately 10 percent of the total of the trucks having six or more tires and the trailer combinations exceeded the 8-foot width limitation, only about 1 percent of the total of these vehicles exceeded the width of 8 feet 3.6 inches (8.3 feet), as shown in table 11. Approximately 0.3 percent of all trailer combinations and trucks having six or more tires were more than 13.5 feet high. More of the 3–S2 combinations exceeded this height than any other type of vehicle, as shown in table 12.

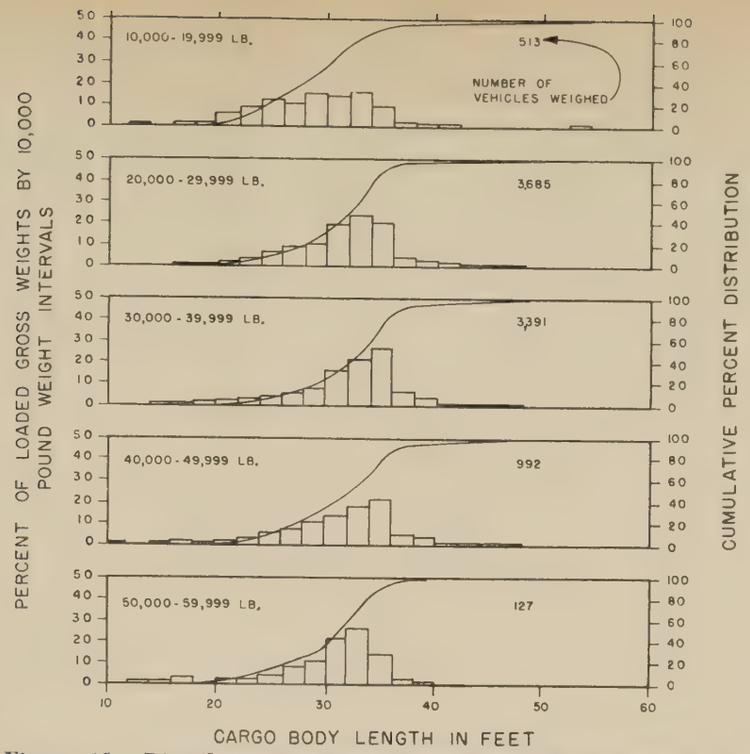

Figure 15.—Distribution of loaded gross weights by lengths of van cargo bodies for 3-axle, tractor semitrailers in the 10,000-pound weight group.

Table 8.—Average loaded weights of trailer combinations by length and type of cargo body, 46 States, 1959

Trailer body length	Flatbed	Van	Log	Dump	Tank
			3-2		
Feet	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Under 10.0		20,500		74,700	75,700
10.0–11.9			69,400		69,900
12.0–13.9	50,800		78,400	57,600	62,300
14.0–15.9	63,700	30,500	66,900		70,600
16.0–17.9	64,600	48,400	74,400	68,300	67,200
18.0–19.9	68,700	62,000	71,900	75,200	66,000
20.0–21.9	68,900	57,000	73,400	77,200	72,200
22.0–23.9	62,100	51,600	65,200	74,800	71,200
24.0–25.9	57,600	61,300	74,600	88,700	72,800
26.0–27.9	63,000	67,500			72,600
28.0–29.9	71,800	68,700			72,300
30.0–31.9	46,100	16,400			76,000
32.0–33.9		50,100	73,800		78,500
34.0–35.9		47,000			76,000
36.0–37.9		74,500			
38.0–39.9		59,500		60,400	
40.0–41.9		20,500			
42.0–43.9					
44.0–45.9				68,800	73,400
46.0–47.9			67,800		55,700
48.0–49.9	63,800		64,500		
50.0–51.9		45,500			
52 and over	61,800	23,800	70,000		66,600
Weighted average	66,100	56,700	71,800	75,200	71,500
Vehicles weighed	322	111	31	49	527
			2-S1-2		
10.0–11.9	78,000		NA		
12.0–13.9	66,800	72,200	NA	74 000	58,600
14.0–15.9	66,300	61,700	NA	77,000	51,100
16.0–17.9	72,600	48,500	NA	78,000	70,200
18.0–19.9	65,200	62,200	NA	78,600	83,000
20.0–21.9	56,200	59,000	NA	75,700	70,800
22.0–23.9	67,600	57,100	NA	88,700	80,200
24.0–25.9	64,500	59,400	NA		80,600
26.0–27.9	62,600	69,400	NA		
28.0–29.9		47,700	NA		40,400
30.0–31.9			NA		
32.0–33.9			NA		
34.0–35.9		46,500	NA		
36.0–37.9			NA	71,400	
38.0–39.9		59,100	NA		
50.0–51.9			NA		55,600
52 and over	84,300	69,300	NA		
Weighted average	61,600	58,600	NA	78,300	74,600
Vehicles weighed	185	317	NA	125	79

Table 9.—Average payload weights of trailer combinations by length and type of cargo body, 46 States, 1959

Trailer body length	Flatbed	Van	Log	Dump	Tank	Auto	Utility
			2-S1				
Feet	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
10.0–11.9			19,600				
12.0–13.9			25,200	18,800			
14.0–15.9	20,700	13,500	23,400	27,000			
16.0–17.9	17,400	15,100	23,500	27,300	9,700	14,000	
18.0–19.9	13,100	11,900	23,000	24,700	15,200		17,900
20.0–21.9	16,600	14,000	28,500	23,300	15,800		13,100
22.0–23.9	14,500	12,500	26,100	22,200	15,900		
24.0–25.9	15,500	10,500	16,800	23,200	19,500	12,200	9,200
26.0–27.9	17,200	11,000	18,000	21,200	20,200	7,800	7,100
28.0–29.9	14,600	11,400		21,000	22,500	14,500	12,800
30.0–31.9	15,000	10,100	9,000	15,100	18,200	15,400	4,400
32.0–33.9	15,400	10,200	17,700	12,400	21,200	12,500	10,600
34.0–35.9	12,800	10,800	24,500		21,900	14,300	
36.0–37.9	13,000	11,700	25,400	19,000		15,100	
38.0–39.9	13,500	11,600	23,700		14,500	14,500	5,000
40.0–41.9	14,200	10,800	12,700			13,100	19,800
42.0–43.9	9,600	11,700				13,600	
44.0–45.9		20,600				16,600	
46.0–47.9		14,100	7,700			16,100	
48.0–49.9			6,600			13,200	
50.0–51.9						17,900	
52 and over						17,500	
Weighted average	15,000	10,800	23,100	24,100	18,800	14,600	9,300
Vehicles weighed	1,306	8,705	252	450	490	2,257	40
			2-S2				
16.0–17.9			35,000	33,300			NA
18.0–19.9		32,900	27,600	35,500			NA
20.0–21.9	30,000	19,100	28,400	32,200			NA
22.0–23.9	22,900	24,400	29,100	34,900			NA
24.0–25.9	20,500	21,000	29,300	31,200			NA
26.0–27.9	23,200	23,700	30,800	31,900			NA
28.0–29.9	23,100	21,300	28,000	31,900	27,500		NA
30.0–31.9	25,700	23,000	31,200	28,600			NA
32.0–33.9	25,400	23,100	30,300	28,300	36,700		NA
34.0–35.9	25,200	22,300	28,200	30,500	31,000	8,600	NA
36.0–37.9	23,700	21,900	30,900	33,000		5,400	NA
38.0–39.9	23,300	21,800	31,700	33,600	34,000	13,900	NA
40.0–41.9	23,700	22,400	29,700	31,000	30,200	22,400	NA
42.0–43.9	24,600	27,200		33,800	32,700		NA
44.0–45.9	23,200	23,300		39,200			NA
46.0–47.9	18,200	23,000		30,600			NA
Weighted average	24,700	22,500	30,700	30,700	30,800	15,100	NA
Vehicles weighed	4,363	25,712	271	1,519	2,918	39	NA
			3-S2				
18.0–19.9				41,300		NA	
20.0–21.9	28,800	28,500	40,000	42,700		NA	
22.0–23.9	35,900	33,300		41,600		NA	
24.0–25.9	32,400	29,000		34,700		NA	
26.0–27.9	33,900	39,800	42,500	40,000	34,200	NA	
28.0–29.9	22,900	34,900		34,000	30,000	NA	8,800
30.0–31.9	23,500	25,900	51,700	44,200	27,600	NA	17,600
32.0–33.9	24,900	25,300		38,300	33,900	NA	25,300
34.0–35.9	27,100	26,800	44,400	35,600	39,300	NA	32,000
36.0–37.9	26,700	27,600	48,100	39,300	31,800	NA	
38.0–39.9	29,700	25,600	45,600	37,600	38,800	NA	
40.0–41.9	34,200	25,600		38,600	40,700	NA	
42.0–43.9	30,000	25,700		40,200	39,800	NA	
44.0–45.9	32,000	26,500		36,100	40,200	NA	
46.0–47.9	44,100	20,200		39,600		NA	
48.0–49.9		22,400		41,800		NA	
50.0–51.9		16,400				NA	
52 and over		25,900				NA	
Weighted average	27,800	26,400	46,500	40,000	38,500	NA	22,700
Vehicles weighed	1,022	8,059	384	481	1,084	NA	11
			3-2				
Weighed average	36,700	28,100	45,500	44,000	43,100	NA	NA
Vehicles weighed	315	91	14	43	515	NA	NA
			2-S1-2				
Weighted average	33,600	25,600		49,500	41,800	NA	NA
Vehicles weighed	163	300		122	74	NA	NA

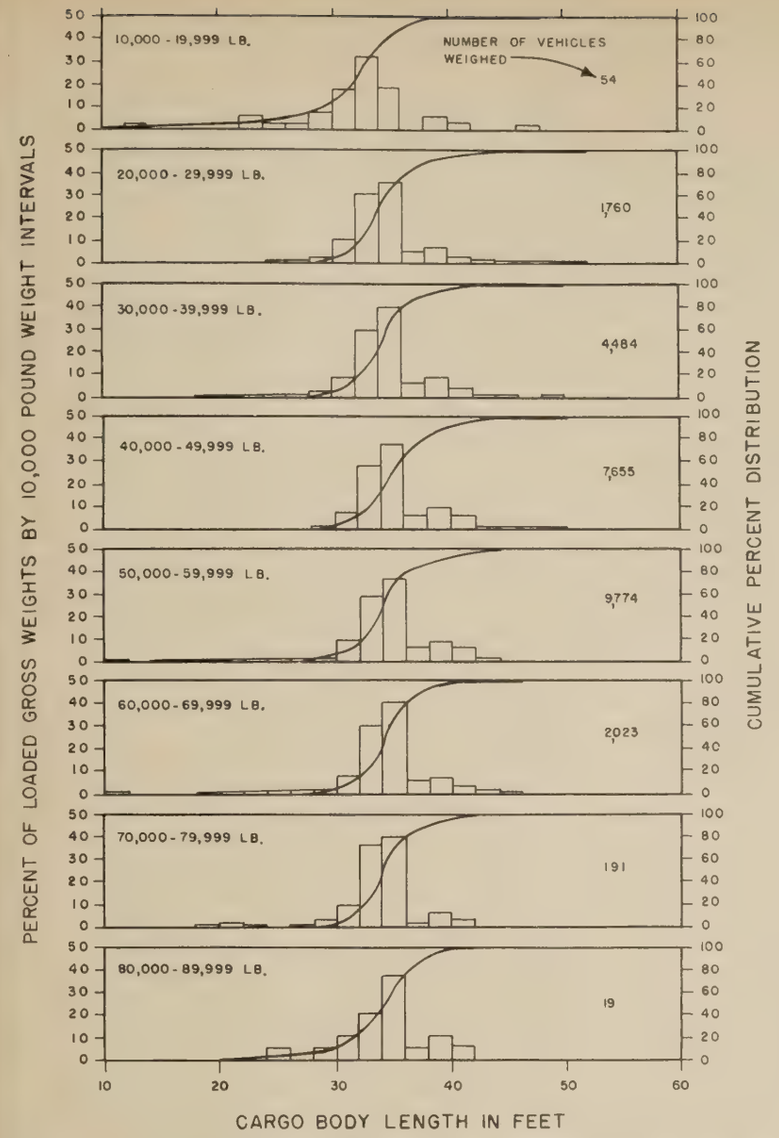

Figure 16.—Distribution of loaded gross weights by lengths of van cargo bodies for 4-axle, tractor semitrailers in the 10,000-pound weight group.

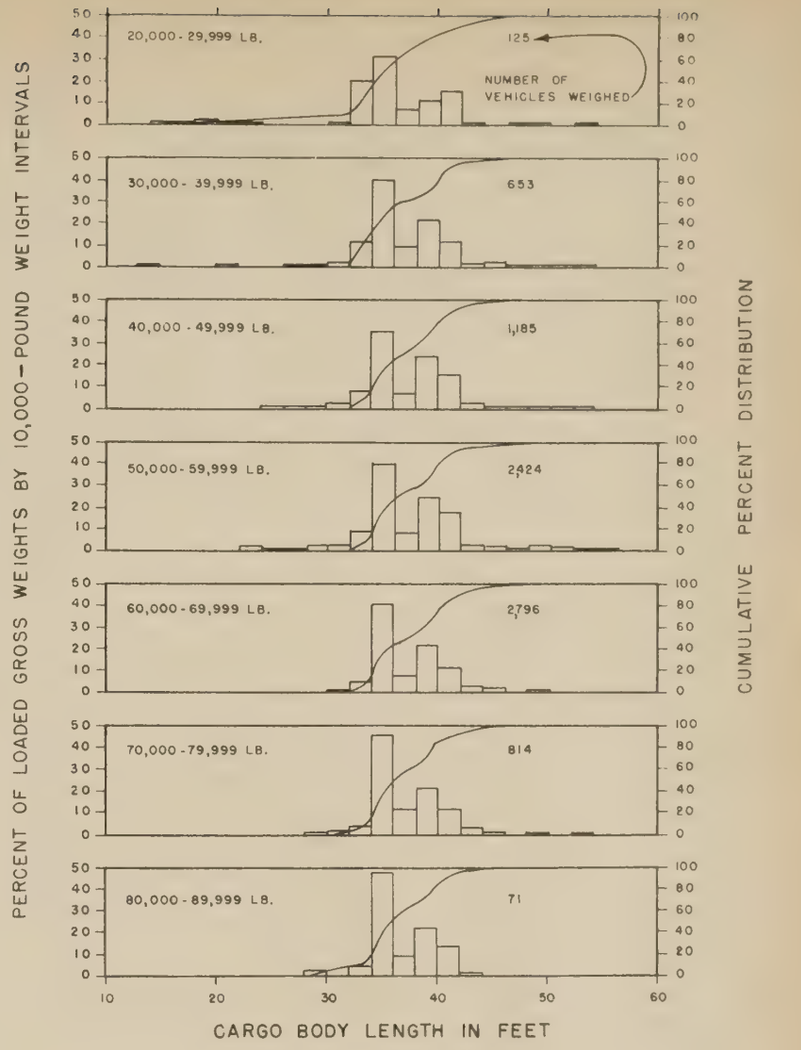

Figure 17.—Distribution of loaded gross weights by lengths of van cargo bodies for 5-axle, tractor semitrailers in the 10,000-pound weight group.

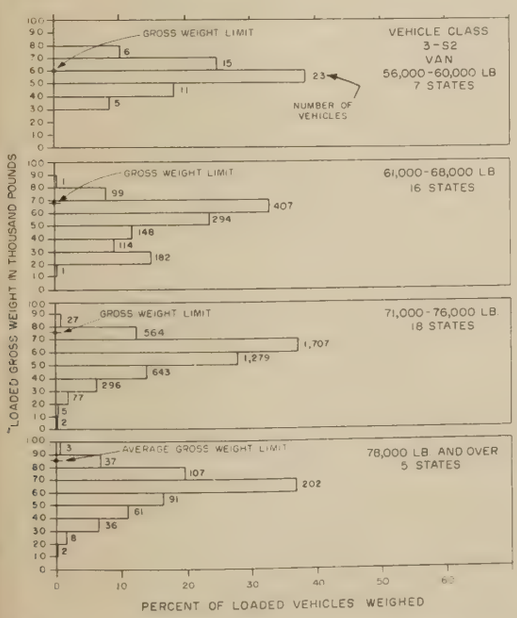

Figure 18.—Distribution of gross weights by body type and axle classification in relation to permitted weight limits.

Table 10.—Percentages of 2-S1-2 and 3-2 trailer combinations having gross weights of more than 80,000 pounds

Cargo bodies	18 States [1]	5 States [2]
2-S1-2 trailer combinations:	*Percent*	*Percent*
Flatbed	6	25
Van	1	16
Tank	7	45
3-2 trailer combinations:		
Flatbed	0	23
Van	0	5
Tank	1	12

[1] Percentages given are for States where maximum legal weight was 71,000 to 76,000 pounds.
[2] Percentages given are for States where maximum legal weight was 78,000 pounds and more.

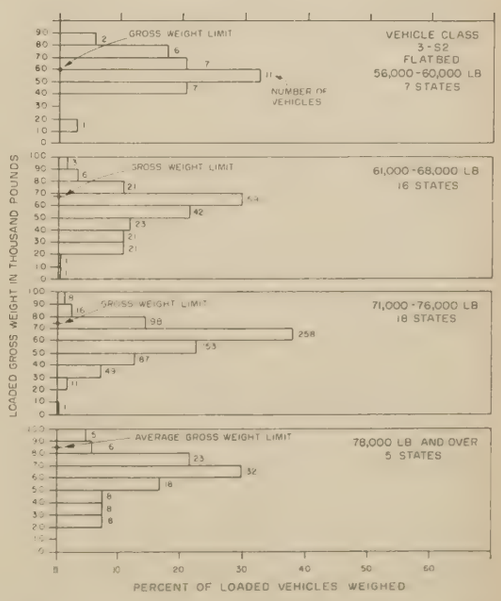

Figure 19.—Distribution of gross weights by body type and axle classification in relation to permitted weight limits.

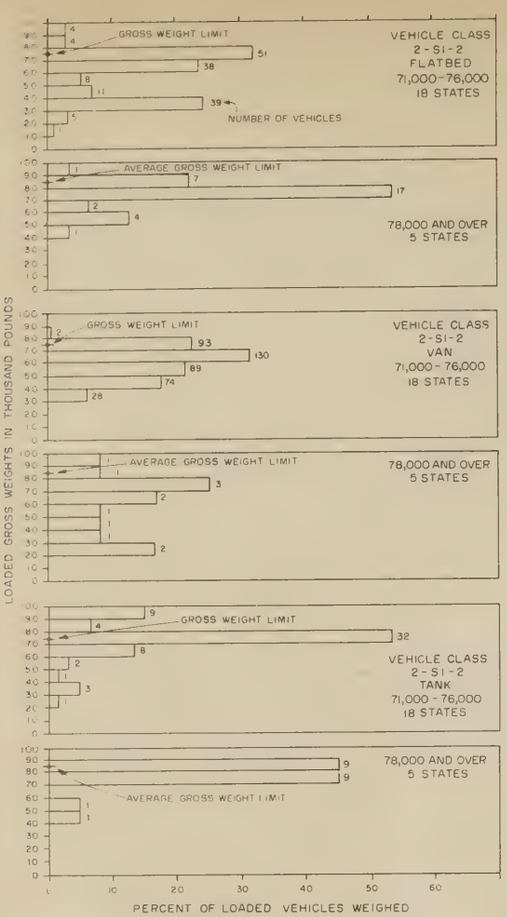

Figure 20.—Distribution of gross weights by body type and axle classification in relation to permitted weight limits.

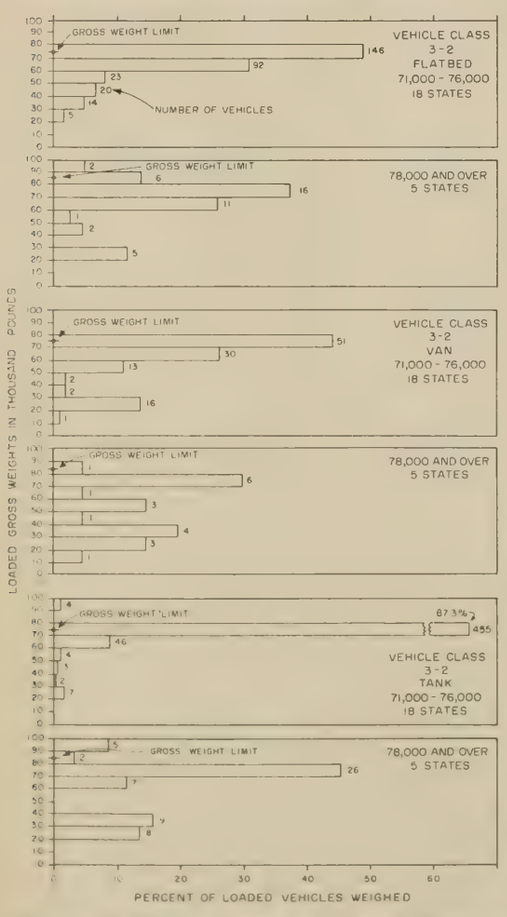

Figure 21.—Distribution of gross weights by body type and axle classification in relation to permitted weight limits.

Table 11.—Number and percent of single-unit trucks and trailer combinations that exceeded 8 feet in width, 46 States, 1959

Cargo or trailer body widths, feet	Flat-bed	Van	Log	Dump	Tank	Auto	Con-crete	Utility	Total
2-axle, 6-tired trucks:									
8.1–8.3	712	1,905	10	255	87	NA	8	66	3,043
8.4–8.5	61	84	3	9	10	NA	3	7	177
8.6–9.0	57	41	1	13	6	NA		4	122
9.1 and over	32	8		5	3	NA		1	49
Over 8.0	862	2,038	14	282	106	NA	11	78	3,391
Over 8.3	150	133	4	27	19	NA	3	12	348
Total measured	11,354	31,146	573	7,081	3,151	NA	87	1,531	54,923
Percent over 8.0	7.6	6.5	2.4	4.0	3.3	NA	12.6	5.0	6.1
Percent over 8.3	1.3	0.4	0.7	0.4	0.6	NA	3.4	0.8	0.6
3-axle, single-unit trucks:									
8.1–8.3	146	125	55	339	11	NA	143	24	843
8.4–8.5	14	5	7	17	3	NA	24	15	85
8.6–9.0	17	1	1	19	15	NA	18	8	79
9.1 and over	7	1		1		NA	1	2	12
Over 8.0	184	132	63	376	29	NA	186	49	1,019
Over 8.3	38	7	8	37	18	NA	43	25	176
Total measured	1,215	1,523	418	2,685	261	NA	923	232	7,257
Percent over 8.0	19.2	8.7	15.1	14.0	11.2	NA	20.2	21.1	14.6
Percent over 8.3	4.0	0.5	1.9	1.4	6.9	NA	4.7	10.8	2.5
2-S1:									
8.1–8.3	229	1,148	42	65	104	360	NA	6	1,954
8.4–8.5	18	43	6		9	11	NA	1	88
8.6–9.0	23	20	2	2	1	7	NA		55
9.1 and over	17	5	3				NA		25
Over 8.0	287	1,216	53	67	114	378	NA	7	2,122
Over 8.3	58	68	11	2	10	18	NA	1	168
Total measured	2,189	12,167	488	794	892	3,943	NA	71	20,544
Percent over 8.0	13.1	10.1	10.9	8.4	12.8	9.6	NA	9.9	10.3
Percent over 8.3	2.6	0.6	2.3	0.3	1.1	0.5	NA	1.4	0.8
2-S2:									
8.1–8.3	807	3,161	74	225	895	7	NA	5	5,174
8.4–8.5	67	85	16	6	64	2	NA	1	241
8.6–9.0	37	51	5	4	28		NA	1	126
9.1 and over	27	8	3	1	2	1	NA	4	46
Over 8.0	938	3,305	98	236	989	10	NA	11	5,587
Over 8.3	131	144	24	11	94	3	NA	6	413
Total measured	7,321	34,405	487	2,411	7,073	79	NA	49	51,825
Percent over 8.0	12.8	9.6	20.2	9.8	14.0	12.7	NA	22.4	10.8
Percent over 8.3	1.8	0.4	5.0	0.5	1.3	3.8	NA	12.2	0.8
3-S2:									
8.1–8.3	278	890	90	68	97	NA	NA	3	1,426
8.4–8.5	15	10	15	7	6	NA	NA		53
8.6–9.0	22	8	21		2	NA	NA	1	54
9.1 and over	27	3	6	2	1	NA	NA	5	44
Over 8.0	342	911	132	77	106	NA	NA	9	1,577
Over 8.3	64	21	42	9	9	NA	NA	6	151
Total measured	1,652	9,593	671	693	2,065	NA	NA	30	14,704
Percent over 8.0	20.7	9.5	20.1	11.1	5.1	NA	NA	40.9	10.7
Percent over 8.3	3.9	0.2	6.4	1.3	0.4	NA	NA	27.3	1.0
2-S1-2:									
8.1–8.3	36	70	NA	32	46	NA	NA	NA	184
8.4–8.5	5	1	NA	1		NA	NA	NA	7
8.6–9.0	4		NA		3	NA	NA	NA	7
9.1 and over			NA			NA	NA	NA	
Over 8.0	45	71	NA	33	49	NA	NA	NA	198
Over 8.3	9	1	NA	1	3	NA	NA	NA	14
Total measured	265	394	NA	223	152	NA	NA	NA	1,034
Percent over 8.0	17.0	18.0	NA	14.8	32.2	NA	NA	NA	19.1
Percent over 8.3	3.4	0.3	NA	0.4	2.0	NA	NA	NA	1.4
3-2:									
8.1–8.3	105	30	2	33	164	NA	NA	NA	334
8.4–8.5	1		1		4	NA	NA	NA	6
8.6–9.0	1		2			NA	NA	NA	3
9.1 and over	1			1		NA	NA	NA	2
Over 8.0	108	30	5	34	168	NA	NA	NA	345
Over 8.3	3		3	1	4	NA	NA	NA	11
Total measured	478	200	37	76	942	NA	NA	NA	1,733
Percent over 8.0	22.6	15.0	13.5	44.7	17.8	NA	NA	NA	19.3
Percent over 8.3	0.6		8.1	1.3	0.4	NA	NA	NA	0.6
Other trucks:									
Panels and pickups, 4-tired	268	614	NA	NA	NA	NA	NA	252	1,134
2-axle, 4-tired	201	1,598	NA	NA	NA	NA	NA		1,799
Other combinations:									
2-1	75	NA	NA	NA	NA	NA	NA	NA	75
2-2	78	NA	NA	NA	NA	NA	NA	NA	78
2-S2-2	NA	53	NA	NA	NA	NA	NA	NA	53
3-S1-1	NA	54	NA	NA	NA	NA	NA	NA	54
3-S3-2	NA	55	NA	NA	NA	NA	NA	NA	55
TOTAL MEASURED	25,096	91,802	2,674	13,963	14,536	4,022	1,010	2,165	155,268
7 vehicle classes	24,474	89,428	2,674	13,963	14,536	4,022	1,010	1,913	152,020
Over 8.0	2,766	7,703	365	1,105	1,561	388	197	154	14,239
Over 8.3	453	374	92	88	157	21	46	50	1,281
Percent over 8.0	11.3	8.6	13.6	7.9	10.7	9.6	19.5	8.1	9.4
Percent over 8.3	1.9	0.4	3.4	0.6	1.1	0.5	4.6	2.6	0.8

Table 12.—Number and percent of single-unit trucks and trailer combinations that exceeded 13.5 feet in height, 46 States, 1959

Cargo or trailer body heights, feet	Flat-bed	Van	Log	Dump	Tank	Auto	Con-crete	Utility	Total
2-axle, 6-tired trucks:									
13.6 to 14.0	17			2		NA			19
14.1 to 14.5	7	1				NA			8
14.6 and over	5	1				NA			6
13.6 and over	29	2		2		NA			33
Total measured	11,354	31,146	573	7,081	3,151	NA	87	1,531	54,923
Percent 13.6 and over	0.3					NA			0.1
3-axle trucks:									
13.6 to 14.0	1	2	2			NA		3	8
14.1 to 14.5						NA			
14.6 and over				1		NA			1
13.6 and over	1	2	2	1		NA		3	9
Total measured	1,215	1,523	418	2,685	261	NA	923	232	7,257
Percent 13.6 and over	0.1	0.1	0.5			NA		1.3	0.1
2-S1:									
13.6 to 14.0	14	6				34	NA	1	55
14.1 to 14.5	1					10	NA		11
14.6 and over	3	2				1	NA		6
13.6 and over	18	8				45	NA	1	72
Total measured	2,189	12,167	488	794	892	3,943	NA	71	20,544
Percent 13.6 and over	0.8	0.1				1.1	NA	1.4	0.4
2-S2:									
13.6 to 14.0	38	11	3	1		5	NA		58
14.1 to 14.5	12					2	NA		14
14.6 and over	8	14					NA		22
13.6 and over	58	25	3	1		7	NA		94
Total measured	7,321	34,405	487	2,411	7,073	79	NA	49	51,825
Percent 13.6 and over	0.8	0.1	0.6			8.9	NA		0.2
3-S2:									
13.6 to 14.0	34	105	11	3	1	NA	NA	1	155
14.1 to 14.5	8	3	3			NA	NA		14
14.6 and over	21	5	3	1		NA	NA	1	31
13.6 and over	63	113	17	4	1	NA	NA	2	200
Total measured	1,652	9,593	671	693	2,065	NA	NA	30	14,704
Percent 13.6 and over	3.8	1.2	2.6	0.6		NA	NA	9.1	1.4
2-S1-2:									
13.6 to 14.0	3	26	NA			NA	NA	NA	29
14.1 to 14.5	1	2	NA			NA	NA	NA	3
14.6 and over			NA			NA	NA	NA	
13.6 and over	4	28	NA			NA	NA	NA	32
Total measured	265	394	NA	223	152	NA	NA	NA	1,034
Percent 13.6 and over	1.5	7.1	NA			NA	NA	NA	3.1
3-2:									
13.6 to 14.0		1				NA	NA	NA	1
14.1 to 14.5		2				NA	NA	NA	2
14.6 and over						NA	NA	NA	
13.6 and over		3				NA	NA	NA	3
Total measured	478	200	37	76	942	NA	NA	NA	1,733
Percent 13.6 and over		1.5				NA	NA	NA	0.2
Other trucks:									
Panels and pickups, 4-tired	268	614				NA		252	1,134
2-axle, 4-tired	201	1,598				NA			1,799
Other combinations:									
2-1	75	NA	NA	NA	NA	NA	NA	NA	75
2-2	78	NA	NA	NA	NA	NA	NA	NA	78
2-S2-2	NA	53	NA	NA	NA	NA	NA	NA	53
3-S1-1	NA	54	NA	NA	NA	NA	NA	NA	54
3-S3-2	NA	55	NA	NA	NA	NA	NA	NA	55
TOTAL MEASURED	25,096	91,802	2,674	13,963	14,536	4,022	1,010	2,165	155,268
7 vehicle classes	24,474	89,428	2,674	13,963	14,536	4,022	1,010	1,913	152,020
13.6 and over	173	181	22	8	1	52		6	443
Percent 13.6 and over	0.7	0.2	0.8	0.1		1.3		0.3	0.3

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(1) *The Freight's the Weight*, by M. F. Kent, Highway Research Board Proceedings, 37th annual meeting, 1958, vol. 37, pp. 21–44.

(2) *Line Haul Trucking Costs in Relation to Vehicle Gross Weights*, report of Committee on Economics of Motor Vehicle Size and Weight, Highway Research Board Bulletin 301, 1961.

(3) *Commercial Motor Vehicle Nomenclature*, Society of Automotive Engineers, Inc., 1961 SAE Handbook, pp. 776–777.

(4) *Trailer Manufacturing Leader Notes Trend Toward Larger Truck Trailers*, by Fred Neumann, Traffic World, vol. 112, No. 7, Nov. 17, 1962, pp. 31–32.

APPENDIX I

Legal Maximum Semitrailer Lengths and Possible Permitted Lengths

The following data show the legal maximum length of semitrailers and the possible permitted lengths[1] calculated from the legal lengths for tractor semitrailers in the Continental United States.[2]

Number of States and maximum legal length limits for semitrailers as of May 1, 1957 and July 1, 1962 were,[3,4] as follows:

Number of States			*Semitrailer length, feet*
1957	*1962*		
15	1	(W. Va.)	35
1	1	(Ga.)	39½
6	12	. . . . .	40
1	1	. . . . .	42
3	1	. . . . .	45
0	1	. . . . .	50
1	1	. . . . .	55

The following list shows the number of States that prescribed length limits on the tractor semitrailer, and the calculated maximum possible for semitrailers.

Number of States		*Tractor semitrailer length, feet*[5]	*Calculated semitrailer length, feet*
1957	*1962*		
2	0	. . . . . 45	38
1	0	. . . . . 48	41
13	17	. . . . . 50	43
0	5	. . . . . 55	48
4	6	. . . . . 60	53
1	2	. . . . . 65	58

As shown, in 1957 semitrailers 40 feet long were permitted in six States, and by 1962 twelve States permitted semitrailers of this length. Semitrailers more than 40 feet long were permissible in 25 States in 1957 and in 35 States by 1962.

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[1] In States where there are no restrictions on length of semitrailers the maximum possible length (van bodies) was assumed to be 7 feet less than the permitted tractor semitrailer combination length. Automobile transport bodies may exceed these lengths when an automobile is carried above the tractor cab, a practice that is permitted in most States.

[2] Includes District of Columbia, making 49.

[3] From *Summary of Size and Weight Limits and Reciprocity Authority (By Regions), in Effect as of May 1, 1957*, American Trucking Assoc., Inc.

[4] From *Summary of Size and Weight Limits and Reciprocity Authority (By Regions) in Effect as of July 1, 1962*, American Trucking Assoc., Inc.

[5] Nevada had no restrictions on length of tractor semitrailer.

Summary Analysis of Reports on State Highway Department Management

BY THE ECONOMIC RESEARCH DIVISION
BUREAU OF PUBLIC ROADS

by PRISCILLA FAMOUS, Management Analyst,
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No single type of organization structure is best for all State highway departments, according to the conclusion reached from an analysis of 76 management reports summarized in this article. However, the information developed from these reports, including notation of the types of structural organizations most often inefficient, should be of interest to those concerned with directing and managing the organization of State highway departments. Interest in these organizational structures has developed as a result of the attention being focused on the necessity for a transportation system adequate to promote and meet the needs of economic growth, and for the wisest possible use of the large sums of money being appropriated for highway construction.

This summary analysis of the findings and recommendations of consultants, committees, and others engaged to survey the management of State highway departments should be useful as a guide for highway administrators in evaluating their organizations and highway researchers in outlining further studies in this area.

Introduction

THE EXPANSION of highway operations in recent years, and the accompanying increases in personnel and amounts of money spent for highway activities, have focused the attention of highway administrators on the necessity of applying to highway administration the best management practices and procedures available. Many of the State highway departments have made studies concerning their organizational and management needs. This article, an analysis of the resultant reports, serves to determine the problem areas within the highway organizations and to indicate those areas most often inefficient. This analysis of the findings and recommendations made to improve the areas examined will be useful as a guide to highway administrators in appraising their own organizations and to highway researchers in outlining a program of research studies.

The material presented here is primarily concerned with the structural organization for highway administration. The functional areas of highway operations are not discussed except when necessary to emphasize the structural concept. Recommendations as to the duties and responsibilities of either the organizational units or the assigned personnel are not discussed except in general terms.

In addition to reports exclusively on management, analysis also was made of studies or surveys concerned with: (1) highway needs, engineering, and financing; (2) State government reorganization; and (3) reorganization of the executive offices of State government. Studies made by private and civic organizations interested in highway affairs were also included in the analysis. Any relevant discussions of State highway operations in the reports examined have been included. The findings presented here represent information and recommendations from 76 selected reports [1] involving 41 States and the District of Columbia.[2] Not all of the problem areas discussed are covered in each of the reports.

All but two—one in 1935 and one in 1941—of the 76 studies analyzed were made during the period 1947–62: 11 in 1952; 10 each in 1948 and 1950; 7 in 1954; 6 in 1953: 5 each in 1949, 1955, and 1956; and 1 to 4 in each of the other years.

Fifty-five of the studies were authorized by legislative enactment, resolution, or request; eight were made at the request of the respective highway authorities; and five were requested by the governor of the State surveyed. The authority for making the remaining studies is not clear. The surveys were made or directed by legislative investigative committees and commissions, State universities, management consultants, and some by the highway authority. Most of the reports analyzed are in the library of the Bureau of Public Roads; those not in the Bureau's library are in the libraries of the Highway Research Board, National Highway Users Conference, or the Library of Congress.

Reasons

The reasons, as stated in the reports, for making or having the surveys made are nearly as varied as the number of studies represented. Some of the broader reasons given were: to establish highway needs; to investigate relationships between the State and subdivisions; to remove the division of highways from the State department of public works; to strengthen basic organization of highway department; to establish a true highway department in law; and to meet present highway problems.

More specific reasons for recommending changes in the organization include: to separate policy making and administrative functions, to assure continuity in policy, administration, and employment, and thus stabilize the organization; to eliminate duplication of operations and overlapping jurisdictions; to require the commission and its engineering organization to function on a State-wide basis; to improve performance in the area of construction and maintenance; to establish definite lines of authority; to permit firm direction; to give the highway administrative organization constitutional status in order to bar the legislature from making radical changes; to prevent the governor from changing entire complexion of commission; to eliminate injection of politics into highway programs; to meet standards for good administration; and others of a similar expression.

No investigation was made in the analysis presented here to determine whether any of the recommendations presented by the reports have been adopted either by law or administrative action. Highway organization and management investigations, in some States, are a continuous operation. In addition,

[1] For listing of reports examined see pp. 290-292.

[2] For the purposes of this analysis the District of Columbia has been treated as a State.

at the present time (November 1963), eight State highway departments have underway research programs approved by the Bureau of Public Roads, Office of Research and Development, concerning either the organization of the highway department or one of the management operations such as concurrent audit, personnel, performance budgeting, training, and the critical path method of scheduling operations.

Summary

The criticisms and recommendations made in the management reports analyzed tend to support the opinion of many that no one type of organizational structure is best suited for State highway administration. On the basis of the studies analyzed, a conclusion has been reached that the dominant trend recommended for highway organization is for the administrative commission form of management to be modified or replaced entirely by a policy-making commission or an advisory commission, each with a chief administrative officer who is not a member of the commission. The analysis also indicates that management consultants are favoring the organization of highway departments under two major staff units or functional areas—administrative (nontechnical) and engineering (technical). Other recommendations point up the need for tightening the organization by eliminating units not directly related to highways, integrating or combining separate but related functions, and placing authority for the operations of the highway department in the hands of responsible personnel.

Top Administrative Organization

Some discussion of the top or upper echelon of the organizational structure of 31 State highway agencies was included in 51 of the 76 management studies investigated. The changes recommended are treated in the following paragraphs.

Name of highway agency

It was recommended by 16 studies or reports that the name or title of the State agency administering highway affairs be changed. Some of the title changes reflect recommendations for change in the type of administrative organization, such as removal of the highway function from a department of public works and creation of a department of highways. Other changes appear to have been recommended only to indicate a modification of the existing organization or to establish in law a department of highways as distinguished from the State highway commission and thus separate the policy-making group from the operating organization. Recommended title changes are listed in table 1.

Form of organization

Of the 51 reports concerned with top management, 37 suggested a change in the form or type of highway department organization. Eighteen reports proposed the establishment of a policy-making body with an administrator or director to carry out the policy. One of the reports, as an alternative to the appointment of a policy-making body, suggested that a single executive make the policy and that it be administered by the chief engineer. Six of the reports suggested that the activities of the established body be limited by law to policy making or that the policy-making and administrative responsibilities of the administrator be fixed by law.

Eleven reports proposed the establishment of an advisory board or commission to advise the administrator or director of highway activities. Two of these reports suggested that the division of duties and responsibilities between the board or commission and the administrative officer be set forth in law, and one recommended that the board be advisory in "the strict sense of the law." Five of the reports suggested that the advisory board be in addition to the single-executive type of organization already established. Another report recommended two advisory units—one for traffic and one for parking. Three reports suggested that the highway organization be of the commission-director type, but did not specify whether the body was to be policy-making or advisory. Two reports recommended that the administrative type of commission be abolished and a single executive be appointed to administer highway affairs.

One report proposed that the department be placed within the Department of Public Works; and another that the Division of Highways be removed from the Department of Public Works and be given departmental status in the State, and that the advisory board, already provided for by law but to which appointments have not been made in recent years, be reactivated.

Of the remaining 51 reports, 10 recommended that no change be made in the type of existing organization, and four made no recommendation on the type of administrative organization. Although no changes were recommended, three of these reports suggested that the highway commission should be charged by law with policy-making functions and not have administrative or operating functions; and one report suggested that the requirement for highway commission members to serve full time, which in reality they did not do, be removed from the law.

Responsibility for highway operations in the States at the time of this study was vested in different types of organizations. The head of the highway department in 19 States is a single executive, usually titled State highway commissioner or director, who is both the chief executive and administrative officer. In three of these States the law provides for a commission to advise the single executive on the business of the department.

The other 31 States each have a highway board or commission. In 10 of these States the chairman of the board or commission is the administrative officer; 14 States employ a director, who is neither a member of the board or commission nor chief engineer, to be the administrative head; and in 7 States the chief engineer is the chief administrative officer. The division of authority and responsibility between the board or commission and the administrative officer is usually provided for in the law.

Members on board or commission

Recommendations as to the number of members that should serve on highway boards or commissions were made in 19 of the 51 reports, as follows:

No. of reports	*Members*
2	12
1	10
1	9
1	8
3	7
1	6
4	5
3	3
1	Not to exceed 7
2	"Small number"

Two of the 51 reports suggested that the commission be abolished and a single executive be appointed to administer highway affairs; 16 recommended that no change should be made in the number of members on the highway board or commission; and 14 studies expressed no opinion on the subject.

Selecting officials

Some reference to the method of selecting board and commission members or single executive officers was made in 26 reports. All reports proposed that such appointments be made by the governor. However, ten recommended that the appointments be given some form of senate approval, and one recommended confirmation by the governor's advisory council.

Four reports recommended that commission members be appointed on the basis of district

Table 1.—Recommended title changes

Number of reports	Title of highway agency at time study was made	Recommended title
2	State Highway Department.	Department of Public Works.
1	Department of Highways.	Department of Highways and Traffic.
1	State Highway Advisory Board.	State Highway Commission.
1	State Highway Commission.	Board of Highways.
3	State Highway Commission.	Department of Highways.
1	State Highway Commission.	State Highway Department.
1	State Roads Commission.	Department of State Roads.
1	State Engineering Commission.[1]	Public Works Commission, Division of Highways.
1	State Engineering Commission.[1]	State Highway Department.
1	State Highway and Public Works Commission.	State Highway Commission.
3	Department of Public Works.	Department of Highways.

[1] The members of the State Engineering Commission also composed the membership of the State Highway Commission. Reports proposed the establishment of a new department of State government.

or specified geographical areas; and eight advised appointment at-large, one of these further recommended that no two persons from the same county be members at any one time. Two reports recommended that the appointments be made on a nonpartisan basis; one on a bipartisan basis; one that no more than two members of the three-member advisory body be of the same political party; and in the report that recommended a twelve-member commission appointed at large, it was stated that not more than seven members should be of the same political affiliation. Although two reports did not make specific recommendations, they pointed out that an official's interest should be as broad as his field of responsibility and that, therefore, representation on highway commissions should be on a Statewide, nonpartisan basis.

Tenure of highway officials

The tenure of members of advisory and policy making boards and of single-executive officers was discussed in 25 of the 51 reports in which recommendations were made concerning the top administration of State highway departments. Terms suggested vary from 3 to 10 years, as shown by the following list of number of reports and recommended terms: One, 3 years; two, 4 years; three, 5 years; six, 6 years; one, 8 years; two, 10 years; one, not less than 4 years; one, not less than 6 years; one, at the pleasure of the governor but long enough to give opportunity to become acquainted with work; two, no change in term (term was 2 years in one case, the other 6 years, both staggered); four, not specified in years.

In 19 of the reports that discussed tenure, recommendation was made that the terms of commission members be staggered in order to provide continuity of policy, eliminate political domination, and ensure stability of purpose. In connection with tenure, six reports made recommendations regarding the removal of highway officials, as follows: Three, by governor for cause; one, for cause after hearing; one, for cause after determination by district court; and one, subject to removal for cause.

Chief Administrative Officer

Of the 76 reports reviewed 28 made recommendations concerning the chief administrative officer of the respective State highway agencies. Different titles are assigned to the officer charged with the administration of highway affairs, and no particular title can be associated with a specific type of organization. The following list shows the distribution of titles recommended in these 28 reports; a recommended title did not necessarily mean a change in title: 15, Director of Highways, Director of Highway Department, Highway Director, or Director; 4, Commissioner of Highways; 1, Superintendent of Public Roads; 1, Director of Road Policy Board; 2, State Highway Engineer; 2, Chief Engineer; and 3, title not specified.

Where the title for the administrator was not specified, one report suggested that the official be someone other than the chairman of the road board; one suggested that the administrative authority not rest in the chief engineer, whose principal responsibility was to direct operations, but that the secretary of the commission be named administrative officer or that the office of administrator be created; and one specified that the appointee be a "top flight administrator." When the State highway engineer was recommended as the chief administrative officer, one report also recommended that his authority be redefined so that his office would be the clearing house for all matters below the policy-making board.

Further recommendations concerning the chief administrative officer were made in three reports: one, that the director be a member of the road policy board and the only member to work full time; another, that the director of the highway department also be the chairman of the State highway commission; and the third, that something be done to remove the director from the area of policy making where by law he has the right to vote in a tie upon matters coming before the commission.

Method of selection

Selection and appointment of the chief administrative officer usually is within the authority of the commission or the governor. Although specific appointing authority was not suggested in all of the 28 reports, except for two some indication was made as to where the authority should be. The following list shows the appointing authority suggested or the location of the authority indicated and the number of reports showing each: Commission, 13; governor, 8; commissioner or governor, 1; should be responsible to the commission, 3; should serve directly under the board, 1; and not specified, 2.

Three reports suggested qualifying the authority of the governor to select the administrator: One by requiring that the appointment be made with the consent of the senate; another, by requiring that the appointment be confirmed by the council; and the third by requiring confirmation of the appointment by the senate. Two reports suggested that appointing authority of the commission be qualified by requiring the appointment to be made with the approval of the governor.

Tenure

The tenure of the chief administrative officer was not a subject of major concern to the investigators making the surveys. Of the 28 reports only two recommended a term in years; the others made no reference to term or left the question of tenure with the appointing authority. Tenure was suggested, as follows: 4 years, 2 reports; at the pleasure of the commission, 7 reports; at the pleasure of the governor, 4 reports; and none specified, 15 reports. One of the reports, which recommended a 4-year term, specified that the appointee be a "career" official.

Highway Organization at the Staff Level

The data with respect to the staff level of highway organizations is varied.[3] Some reports recommended a general reorganization of the department, others the addition of a major unit, and still others the removal or consolidation of units. All significant recommendations made in the 43 reports that are concerned with organization or reorganization at the staff level are included under the subsequent headings. There are 33 States represented by the 43 reports.

Reasons for changes

The reasons for changes in staff level organization are many, and have, from the benefit hoped to be achieved, been grouped under five headings. Sometimes a report gave more than one reason. Of the 43 reports, 35 gave reasons as follow for making recommended changes in organization: Establish specific responsibility, 15 reports; consolidate like activities, 11 reports; make orderly improvement in the administration of State and/or highway affairs, 12 reports; remove from the highway department activities unrelated to highways, 2 reports; and minimize political influence, 1 report.

Under the broad heading, "establish specific responsibility," are such terms as: "fix lines of authority," "permit firm direction," "separate policy making from administration," and "relieve chief engineer of administrative duties;" under the heading, "consolidate like activities," are "reduce reporting heads," "eliminate waste," "strengthen control," and "achieve efficient highway administration." Under "make orderly improvement in administration, etc.," are such reasons as "modernize administration organization," "take care of expanding responsibilities," "better management for future programs," and "provide continuity of policy."

Organizational structure

Of the 43 reports 27 made recommendations concerning the number of staff units or divisions into which the highway department should be organized for the purpose of administering highway activities. The number of divisions recommended are as follows: Two, 16 reports; three, 2 reports; four, 2 reports; five, 4 reports; six, 1 report; seven, 1 report; and nine, 1 report. As indicated, 16 reports suggested that all highway activities be divided into two principal staff divisions—administrative (nonengineering) and engineering (technical). Thirteen of these reports provided that each of the two units be headed by a person responsible to the chief administrator. The other three provided that the engineering or technical unit be headed by an engineer responsible to the chief

[3] The term staff level as applied here means that level of organization directly below the chief administrator. The different staff units are termed divisions, although many reports following the practice of the State concerned in giving a name to the units used other titles, such as department, bureau, and section.

administrator, and that the administrative or nontechnical functions be handled directly by the chief administrator. Several of the recommendations made to set up two main staff divisions, of necessity, included the creation of the nontechnical office and the appointment of a manager or director.

Two reports in which three divisions were suggested called for an administrative or management services division, and engineering division, and a third division, entitled in one "Traffic Services," and in the other "Planning and Programming." An official responsible to the chief administrator was recommended to head each of these divisions.

Two reports recommended an organization made up of four divisions, one to be an engineering or technical division. One report suggested the three remaining divisions should be for accounting, motor vehicles, and public safety; and the other report suggested divisions of administrative services, planning, and maintenance.

Four reports recommended that the headquarters office of the highway department consist of five divisions; as shown for each report: (1) administrative, design, construction and maintenance, planning and research, and field operations; (2) administrative, planning, technical, maintenance, and tourist bureau; (3) program, operations, accounting, personnel, and purchasing; (4) administration, planning and research, operations, engineering and bridge design, and construction. Some of these titles refer to the same function and could be used interchangeably. For the purpose of this analysis, however, the same titles given in the report analyzed have been used.

One report recommended six organizational or staff divisions, as follows: Engineering, personnel, motor vehicles, comptroller, public safety, and publication (for publishing the department's magazine). The two reports suggesting seven and nine divisions, respectively, were for States where the highway function is incorporated within a State bureau or department of public works. One report recommended that there be established, within the public works bureau, a division of highways that would include all engineering activity divided into seven major sections of—design, construction, maintenance, local roads, traffic operations, planning, and right-of-way—the administrative or nontechnical activities would remain a part of the overall administrative authority of the public works agency. The other report recommended that the existing division of highways in the public works department be divided into eight bureaus, plus a unit headed by a State-aid engineer. The eight bureaus suggested are: Location and design, bridges, construction, maintenance, traffic, materials, right-of-way, and planning. No recommendation was made concerning administrative matters.

New divisions

The establishment or creation of new divisions was recommended by 27 of the 43 reports in which recommendations were made with respect to highway organization at the division or staff level. When the report suggested that a present division be expanded, either by the addition of personnel or functions, or that the principal functions be reorganized under a new title, these divisions were not included in this summary analysis—only those divisions suggested for establishment or creation as new organizational structures have been included. New divisions to be established or created and the number of reports suggesting them are, as follows.

Urban, 4; State-local, division of local government, or similar title, 7; traffic engineering, 3; personnel, 5; advance planning and programming, 2; construction, 2; comptroller or fiscal, 2; land, 1; planning and research, 2; planning and administrative research, 1; public information, 6; public and intergovernmental relations, 1; and special projects (tolls), 1. Number of reports listed is greater than 27 because some reports made more than one recommendation. In addition, four reports recommended that a legal division be established in the highway department in cooperation with the State's attorney general; four others recommended that a full-time legal staff be provided; and another recommended that an office of legal services be established.

Other organization recommendations

In addition to the new divisions suggested the reports recommended other organizational changes. Six reports proposed that units existing in the highway organization at the section or lower level be raised in status to division level. Recommendations that the function be given division status were made for: Traffic engineering, 2 reports; planning, 2 reports; traffic and safety, 1 report; and State-aid construction, 1 report. One of these reports also recommended that the office of the State highway patrol and the bureau of motor vehicles, provided that the functions remained under the direction of the highway administrator, be given the same status level as the heads of the recommended division of engineering and business management.

One report recommended combining the divisions of materials and tests, and planning and design, thus making two divisions from four. Another report recommended the reduction of the number of divisions in the department to the smallest possible number required to keep the span of control at an efficient minimum.

Eight reports suggested that divisions not directly related to the operations of the department be removed from the highway organization, and that these divisions be abolished, be made a separate agency of the State government, or be included in another established agency. Typical recommendations were: Transfer safety division to State department of traffic and transportation; integrate purchasing with purchasing division of State department of administration; remove motor vehicle division except for collection of fees; and abolish traffic safety division.

Eight reports made 10 recommendations for the creation of a unit below the division level. Units suggested for creation and the number of recommendations for each are as follows: Personnel, 1; public information, 2; local road section, 1; program planning section in planning and research division, 1; section to prepare and maintain a long-range program of improvements, 1; advance programming and planning section in the planning division, 1; research section apart from materials, 1; section to aid counties and municipalities in connection with Federal-aid, 1; and section or unit directly under the State highway engineer to study operations, methods, procedures, and work functions, and recommend changes, 1.

Organization in the Field

In this analysis the field refers to offices other than those of the central or headquarters offices of the highway departments. Such organizational units will be called districts, although in the management reports analyzed the terms district, division, and section were used. Most of the recommendations as to organization at the district level have been given little emphasis in the overall management discussions.

Out of 76 reports reviewed, 20 reports suggested changes or modifications in field organizations, 9 of these reports made recommendations as to the number of districts necessary for the proper handling of highway affairs. Number of districts recommended are, as follows: Five, 1 report; six, 3 reports; not more than nine, 1 report; six to eight, 1 report; reduce to unspecified number, 2 reports; and increase to unspecified number, 1 report.

One State, for which three reports were examined, had offices termed zones in its organization concerned with field work in location and design, and right-of-way acquisition. Little relationship existed between these zones and the district offices. One of the reports suggested that there be no change in these areas, but that they be called regions rather than zones. Another suggested that the zone offices be discontinued and the duties and responsibilities be taken over by the district engineers. The third report, which made no reference to the zones, suggested that the number of district offices be reexamined but made no recommendation as to the number needed to do the work.

Two reports recommended that in the field organization the duties of district engineer should be confined to maintenance, and that he be made responsible to the chief maintenance engineer. Each of the following recommendations was made in a single report.

- The structure of field operations should more properly be left to administrative determination.
- Revise district organization to include all construction and maintenance activities under the head of district engineer.
- Organize district with district engineer and two assistant engineers, one for construction the other for maintenance.
- District engineers should be under the technical direction of the chief engineer.
- Establish each district as a complete administrative unit headed by a district engineer,

have an assistant district engineer to head each major function, and establish direct line of authority from chief of operations to each district engineer.

- Formulate policies and programs in the central office; the job of the districts is to carry them out.
- Give more authority to district engineer thereby reducing the amount of detail reaching central office division heads.
- Channel maintenance policies, controls, and operation directly through the district engineers; and require that district maintenance engineers report to the district engineer.
- Locate district offices on a permanent basis.

All major functions of the department should be directly administered in each district under firm policies established by top administrative staff members.

Table 2.—Recommendations on personnel practices

Number of reports	Recommendations
	CIVIL SERVICE OR MERIT SYSTEM
8	Establish a merit system.
3	Establish a civil service system.
3	Establish a personnel system and/or program.
4	That, until a State-wide merit system is established a merit system be set up within the highway department by administrative action.
1	Amend civil service law to include all positions in highway department.
	RECRUITMENT AND TRAINING
13	Institute an organized system of recruitment.
11	Make available or increase in-service training.
5	Establish training project with engineering schools for in-service training and as a means of interesting undergraduates in highway work.
	SALARY AND WAGES
2	Remove constitutional or statutory ceilings on salary of public officers.
2	Raise salary of chief administrative officer.
10	Compensate at salary level effective in private enterprise and other competitive areas (other State highway departments).
5	Provide salary increases for all engineers, and technical and professional personnel.
2	Adopt policy under which salary and wage rates will be adjusted to a cost of living index or other base.

Personnel Practices

Recommendations on personnel policies and practices were made in 37 reports of the 76 reports analyzed. These recommendations do not include those to establish personnel divisions, which were reported in the discussion of highway department organizational structure. Seven reports recommended that laws be enacted to establish a State retirement system. The other suggested changes and practices are shown in table 2.

The suggestion was made in one report that the number of positions secondary to principal division or department heads be increased so that experienced, capable persons would be available for the higher positions as normal retirements occur.

Two reports discussed the appointment and tenure of division heads. One recommended that the law giving the administrative body authority to appoint assistant highway engineers be repealed and that the authority be given to the State highway engineer. The other recommended that division heas dserve according to civil service regulations rather than at the pleasure of the director of highways.

Three reports suggested that personnel practices be removed from the influence of politics. One of these recommended that the selection, promotion, and treatment of all employees be on a nonpolitical basis; another report suggested that restrictions be placed on political activity of officers and employees; and the third report stated that the only permanent solution to personnel problems is to take the highway department out of politics.

REPORTS ANALYZED

The reports reviewed and included in the summary analysis of this article are listed in the following paragraphs.

Alabama:

The Reorganization of Alabama's State Government, Legislative Reference Service, 1950.

Arizona:

Report of the Arizona Special Legislative Highway Study Committee to the Governor and Legislative Council, December 1953.

A Report to the State of Arizona on Operations of the Highway Department: State Highway Engineer, Motor Vehicle Division, Highway Patrol Division, Traffic Safety Division, and Courts of Limited Jurisdiction, based on studies conducted cooperatively by the American Bar Association; American Association of Motor Vehicle Administrators; Traffic Division, International Association of Chiefs of Police; and Traffic Institute, Northwestern University, 1953.

Arkansas:

An Organizational and Personnel Analysis of the Arkansas State Highway Department, prepared by the University of Arkansas, and published by the Arkansas State Highway Commission, 1952.

California:

California's Highway Problem, A Report by Joint Fact-finding Committee on Highways, Streets and Bridges. Report made to the Fifty-seventh (First Extraordinary) Session of the California Legislature, January 13, 1947.

General Survey California Division of Highways, Report to the Joint Legislative Budget Committee, by Booz, Allen and Hamilton, February 1955.

Colorado:

The Committee Reports to John Q. Public on the Long Range Highway Plan, by the Colorado Highway Planning Committee, 1951.

Connecticut:

State and Local Governmental Relationships in Connecticut, A Report of the Commission to Investigate the Relationship between the State and its Subdivisions, [1955].

Delaware:

Reorganization of the Executive Branch of the State Government of Delaware. A report to the Commission on Reorganization of the State Government by its Executive Committee, by Griffenhagen & Associates, December 1950.

Florida:

Report on a Study of Florida Highways for the State Road Department of Florida, by Parsons, Brinckerhoff, Hall & MacDonald, July 1952.

Report to Legislative Council Covering Florida Primary Roads, by Select Committee on Roads, compiled and published by the Florida Legislative Reference Bureau, September 1954.

Idaho:

Idaho Highways, a report of a study made for the Idaho Highway Study Committee, by Public Administration Service, Chicago, San Francisco, and Washington, December 1949.

Illinois:

A Highway Improvement Program for Illinois, a report for Illinois Division of Highways by Griffenhagen & Associates, November 1948.

Report of the Illinois Highway and Traffic Problems Commission on A Highway Improvement Program for Illinois, February 1949.

Organization and Functioning of the State Government, a report of the Commission to Study State Government made to the Illinois General Assembly, December 1950.

A Program to Meet Present Illinois Highway Problems, recommended to the 68th General Assembly by the Illinois State Chamber of Commerce, 1953.

Indiana:

Report on State Highway Commission, by the State of Indiana Commission on Organization of the Executive and Administrative Branches of the State Government, October 1952.

Iowa:

Report of Highway Investigation Committee, published by the State of Iowa, November 1948.

Report of the Governmental Reorganization Commission to Governor William S. Beardsley for Submission to the Fifty-fourth General Assembly, 1950.

Iowa Highway Needs 1960–1980, A Plan to Pace Highway Development with Economic Growth, a report to the Iowa Highway Study

Committee by the Automotive Safety Foundation, Washington, D.C., Nov. 1, 1960.

Kansas:

Highway Needs of Kansas: An Engineering Analysis, a report of the Kansas Highways Fact-Finding and Research Committee to Governor Frank C. Carlson, The State Highway Commission, The Legislative Council, and Members-elect of the 1949 Legislature, by the Automotive Safety Foundation, Washington, D.C., Dec. 15, 1948.

General Report of the Legislative Committee on Economy and Efficiency, 1959.

Kentucky:

A Report on Kentucky Highways, Their Administration and Financing, by the Public Administration Service, Chicago, San Francisco, and Washington, October 1947.

Kentucky Highway Systems and the State Department of Highways, prepared by the Public Administration Service for the Kentucky Department of Highways. Published by the Kentucky Legislative Research Commission, Research Publication No. 29, 1951.

A Highway Program for Kentucky, Engineering Recommendations for Adequate Road and Street Systems, by the Automotive Safety Foundation, Washington, D.C., November 1955.

Louisiana:

Louisiana's Highway Problem, An Engineering Analysis for the Louisiana Legislative Council, by the Automotive Safety Foundation, Washington, D.C., September 1954.

Maine:

Maine Highway Needs, An Engineering and Economic Study, prepared for the 94th Legislature by the Maine State Highway Commission in cooperation with the United States Public Roads Administration, March 1949.

A Plan for Highway Classification in Maine, An Engineering Report to the State Highway Commission, by the Automotive Safety Foundation, Washington, D.C., 1952.

Organization and Administration of the Government of the State of Maine, A Survey Report, by the Public Administration Service, Chicago, San Francisco, and Washington, June 1956.

Maryland:

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